City of Franklin

109 3rd Ave S
Franklin, TN 37064
(615) 791-3217

Meeting Agenda

Work Session

Tuesday, April 13, 2021 | **5:00 PM** | **Board Room**

The Board of Mayor and Aldermen Work Session will limit physical access in the meeting room due to current limitations on public gatherings. Accommodations have been made to ensure that the public is able to participate in the meeting. The public may participate in the following ways: • Watch the meeting on FranklinTV or the City of Franklin website. • Watch the live stream through the City of Franklin Facebook and YouTube accounts. • Call in to the conference meeting 1-312-626-6799, Meeting ID: 949 8138 5348 Passcode: 478152. Callers will be unmuted and given an opportunity to comment during the meeting at specific times. • Limited viewing will be available in the lobby of City Hall to watch the live video and make public comment. • The public may email comments and questions prior to 3:30 p.m. on the day of the meeting to recorder@franklintn.gov to be read aloud. • Live comments and those submitted by email will be limited to 2 minutes. • City YouTube: https://www.youtube.com/user/CityOfFranklin • City Facebook Live: https://www.facebook.com/CityOfFranklin • City website: https://www.franklintn.gov/franklin-tv

CALL TO ORDER

MEETING PROCEDURE CHANGES

1. Consideration Of Resolution 2021-63, A Resolution Declaring That The Board Of Mayor And Aldermen Members Shall Meet On April 13, 2021 For Work Session And Conduct Its Essential Business By Electronic Means Rather Than Being Required To Gather A Quorum Of The Members Physically Present In The Same Location Because It Is Necessary To Protect The Health, Safety, And Welfare Of Tennesseans In Light Of The COVID-19 Outbreak.

   Sponsors: Shauna Billingsley

CITIZEN COMMENTS

WORK SESSION DISCUSSION ITEMS

2. Presentation By The City Of Franklin Housing Commission (John Besser, Chair) .

   Sponsors: Tom Marsh, Kathleen Sauseda

3. *Consideration Of Ordinance 2021-04, An Ordinance To Rezone 13.81 Acres From Estate Residential (ER) District To Planned (PD 3.12) District For The Property Located West Of Hillhaven Lane And North Of Arsenal Drive, Located At 171 Hillhaven Lane (Hillhaven PUD Subdivision). Establishing A Public Hearing On May 11, 2021.
   FMPC 3/25/21, 7-0

   Sponsors: Kelly Dannenfelser, Amy Diaz-Barriga, Joseph Bryan

4. Consideration Of Resolution 2021-51, A Resolution Approving A Development Plan For Hillhaven PUD Subdivision, For The Property Located West Of Hillhaven Lane And North Of Arsenal Drive, Located At 171 Hillhaven Lane. Establishing A Public Hearing On May 11, 2021.
FMPC 3/25/21, 7-0

   Sponsors: Kelly Dannenfelser, Amy Diaz-Barriga, Joseph Bryan

5. Consideration Of COF Contract No. 2021-0002, Parkland Impact Fee Payment Only Agreement Between The City Of Franklin And Community Housing Partnership For CHP - Hillhaven Development.

   Sponsors: Lisa Clayton

6. *Consideration Of Ordinance 2020-36, An Ordinance To Rezone 35.36 Acres From Planned (PD) District To Planned (PD 0.17/14,300) District For The Property Located South Of Spencer Creek Road And North Of Mack Hatcher Parkway, Located At 285 Spencer Creek Road (Cheekwood North PUD). Establishing A Public Hearing On May 11, 2021.
FMPC 3/25/21, 8-0

   Sponsors: Kelly Dannenfelser, Amy Diaz-Barriga, Joseph Bryan

7. Consideration of Resolution 2020-298, A Resolution Approving A Development Plan For Cheekwood North PUD Subdivision, For The Property Located South Of Spencer Creek Road And North Of Mack Hatcher Parkway, Located At 285 Spencer Creek Road. Establishing A Public Hearing For May 11, 2021.
FMPC 3/25/21, 7-1

   Sponsors: Kelly Dannenfelser, Amy Diaz-Barriga, Joseph Bryan

8. Consideration Of COF Contract No. 2021-0059, Parkland Impact Fee (Payment Of Fees Only) Agreement For Cheekwood North PUD Between The City Of Franklin And Cheekwood Golf Club LP.

   Sponsors: Lisa Clayton

9. *Consideration of Ordinance 2020-37, An Ordinance To Rezone 53.52 Acres From Civic Institutional (CI) District To Planned (PD 58,909) District For The Property Located West Of Aldersgate Way And South Of Mack Hatcher Parkway (Cheekwood South PUD). Establishing A Public Hearing On May 11, 2021.
FMPC 3/25/21, 8-0

   Sponsors: Kelly Dannenfelser, Amy Diaz-Barriga, Joseph Bryan

10. Consideration Of Resolution 2020-299, A Resolution Approving A Development Plan For Cheekwood South PUD Subdivision, For The Property Located West Of Aldersgate Way And South Of Mack Hatcher Parkway. Establishing A Public Hearing On May 11, 2021.
FMPC 3/25/21, 8-0

    Sponsors: Kelly Dannenfelser, Amy Diaz-Barriga, Joseph Bryan

11. *Consideration Of COF Contract No. 2021-0064, An Agreement Between The Department Of The Army And City Of Franklin, Tennessee, To Provide Real Estate Assistance For The Harpeth River Flood Risk Management Project (U.S. Army Corps Of Engineers Home Raising Program).

    Sponsors: Paul Holzen, William Banks

12. *Consideration Of Resolution 2021-78, A Resolution Authorizing The City Administrator To Execute Department Of The Army Flood Proofing Participation Agreements And City Of Franklin Homeowner Funding Agreements For The Harpeth River Flood Risk Management Project (U.S. Army Corps Of Engineers Home Raising Program).

Sponsors: Paul Holzen, William Banks

13. Consideration Of COF Contract No. 2021-0053, A Contract with the Franklin Housing Authority (FHA) For The Receipt Of Up To $28,836 of Community Development Block Grant Funds From The City Of Franklin As Reimbursement For Costs Associated With Construction of Public Facilities That Benefit Low To Moderate Income Residents.

    Sponsors: Tom Marsh, Kathleen Sauseda

14. Consideration Of Resolution 2021-56, A Resolution To Adopt The 2021 Best Management Practice Stormwater Manual.

    Sponsors: Paul Holzen, Jimmy Wiseman

15. Presentation And Acknowledge Receipt Of The Final Report For The Cool Springs Transportation Study.

    Sponsors: Paul Holzen, Jonathan Marston, Jimmy Wiseman, Adam Moser

16. Consideration Of Ordinance 2021-06, An Ordinance To Update The City Of Franklin Transportation & Street Technical Standards.

    Sponsors: Paul Holzen, Jimmy Wiseman

17. Discussion Regarding Street Naming After Tom Miller, Former Mayor Of Franklin.

    Sponsors: Eric Stuckey, Lisa Clayton

18. Presentation On The Street Department's Main Street Sidewalk Repair Project.
    CIC 03/25/21, forwarded to BOMA 4-0 for further discussion without recommendation

    Sponsors: Steve Grubb, William Banks

OTHER BUSINESS

ADJOURN

Anyone needing accommodations due to disabilities please contact the ADA Coordinator at 615-791-3277 at least 24 hours prior to the meeting.

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01876

DATE: March 25, 2021

TO: Board of Mayor and Aldermen

FROM: Eric Stuckey, City Administrator
Shauna Billingsley, City Attorney

SUBJECT:

Consideration Of Resolution 2021-63, A Resolution Declaring That The Board Of Mayor And Aldermen Members Shall Meet On April 13, 2021 For Work Session And Conduct Its Essential Business By Electronic Means Rather Than Being Required To Gather A Quorum Of The Members Physically Present In The Same Location Because It Is Necessary To Protect The Health, Safety, And Welfare Of Tennesseans In Light Of The COVID-19 Outbreak.

PURPOSE:

The purpose of this memorandum is to provide information to the Franklin Board of Mayor and Aldermen (BOMA) concerning conducting the Board of Mayor and Aldermen by electronic means to limit physical contact for the health and safety of all citizens.

BACKGROUND/STAFF COMMENTS:

Due to the COVID-19 Outbreak citizens need to limit potential exposure to the virus by limiting contact with others. To support this effort the City of Franklin boards and commissions will meet electronically rather than gathering a quorum physically in the same location to conduct their essential business.

FINANCIAL IMPACT:

N/A

RECOMMENDATION:

Staff recommends that the Board of Mayor and Aldermen approve Resolution 2021-63.

RESOLUTION 2021-63

A RESOLUTION DECLARING THAT THE BOARD OF MAYOR AND ALDERMEN SHALL MEET ON APRIL 13, 2021, FOR WORK SESSION AND CONDUCT ITS ESSENTIAL BUSINESS BY ELECTRONIC MEANS RATHER THAN BEING REQUIRED TO GATHER A QUORUM OF THE MEMBERS PHYSICALLY PRESENT IN THE SAME LOCATION BECAUSE IT IS NECESSARY TO PROTECT THE HEALTH, SAFETY, AND WELFARE OF TENNESSEANS IN LIGHT OF THE COVID-19 OUTBREAK

WHEREAS, Coronavirus Disease 2019 (COVID-19) is a severe acute respiratory disease that appears to occur through respiratory transmission, presents with similar symptoms to those of influenza, and can lead to serious illness or death, particularly in the case of older adults and persons with serious chronic medical conditions; and

WHEREAS, the Centers for Disease Control and Prevention has recommended that all states and territories implement aggressive measures to slow and contain transmission of COVID-19 in the United States; and

WHEREAS, on March 12, 2020, pursuant to the authority granted by Tenn. Code Ann. § 58-2-107, the Governor of Tennessee, Bill Lee, issued Executive Order No. 14, declaring a state of emergency to facilitate the response to COVID-19; and

WHEREAS, on March 13, 2020, the President of the United States, Donald J. Trump, declared a national state of emergency with respect to COVID-19; and

WHEREAS, on March 20, 2020, Mayor Ken Moore issued Executive Order No. 2020-01 Declaring a State of Emergency and Civil Emergency; and

WHEREAS, on March 20, 2020, Governor Lee issued Executive Order No. 16, and later issued Executive Order No. 34, Executive Order No. 51, Executive Order No. 60, Executive Order No. 65, Executive Order No. 71, and Executive Order No. 78 allowing electronic meetings while continuing to function openly and transparently; and

WHEREAS, Mayor Moore issued Executive Orders No. 2020-03, No. 2020-05, No. 2020-07, No. 2020-09, No. 2020-11, No. 2020-12, No. 2020-13, No. 2020-14, No. 2020-15, No. 2020-16, and No. 2020-17 continuing the Declaration of a State of Emergency and Civil Emergency; and

WHEREAS, the Board of Mayor and Aldermen believes it is in the best interest of the City of Franklin to conduct the April 13, 2021, work session by electronic means.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF MAYOR AND ALDERMEN OF THE CITY OF FRANKLIN, TENNESSEE, AS FOLLOWS:

The work session scheduled for April 13, 2021, at 5 p.m. shall be conducted by electronic means rather than requiring a quorum of the members of the Board of Mayor and Aldermen to attend in person to protect the health, safety, and welfare of Tennesseans in light of the COVID-19 outbreak. Physical access in the meeting room will be limited. The public can view and participate in the meetings by watching the meeting live or later as a recording on FranklinTV, the City of Franklin website, the City of Franklin's Facebook page, and the City of Franklin's YouTube account. Specific dial-in and website links can be found on the City's website at:

https://www.franklintn.gov/Home/Components/Calendar/Event/10761/1092

Law Dept. approved 03.26.21

IT IS SO RESOLVED AND DONE on this 13th day of April, 2021.

ATTEST:

By:_____
Eric S. Stuckey
City Administrator

CITY OF FRANKLIN, TENNESSEE:

By:_____
Dr. Ken Moore
Mayor

Approved as to Form By:
Shauna R. Billingsley, City Attorney

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01827

DATE: March 24, 2021

TO: Board of Mayor and Aldermen

FROM: Kelly Dannenfelser, Asst. Director of Planning
Amy Diaz-Barriga, Planning Supervisor
Joseph Bryan, Principal Planner

SUBJECT:

*Consideration Of Ordinance 2021-04, An Ordinance To Rezone 13.81 Acres From Estate Residential (ER) District To Planned (PD 3.12) District For The Property Located West Of Hillhaven Lane And North Of Arsenal Drive, Located At 171 Hillhaven Lane (Hillhaven PUD Subdivision). Establishing A Public Hearing On May 11, 2021.
FMPC 3/25/21, 7-0

PURPOSE:

PROJECT INFORMATION
COF Project Number: 7371
Applicant: Greg Gamble, GDC
Owner: Cumberland & Western Resources

BACKGROUND/STAFF COMMENTS:
The applicant is requesting to rezone the subject property at 171 Hillhaven Lane from Estate Residential (ER) District to Planned (PD 3.12) District to accommodate the Hillhaven PUD Subdivision. The property consists of 13.81 acres and is currently vacant. Envision Franklin places this parcel in the Conservation Subdivision Design Concept, which recommends that 50% of the property be preserved and remain as open space. The proposed rezoning to Planned District with the corresponding development plan is consistent with the recommendations of Envision Franklin and can be supported. The Hillhaven PUD Subdivision Development Plan is also up for review on this agenda.

FINANCIAL IMPACT:

Unknown.

RECOMMENDATION:

Staff recommends that the Board of Mayor and Aldermen approve Ordinance 2021-04.

ORDINANCE 2021-04

AN ORDINANCE TO REZONE 13.81 ACRES FROM ESTATE RESIDENTIAL (ER) DISTRICT TO PLANNED (PD 3.12) DISTRICT FOR THE PROPERTY LOCATED WEST OF HILLHAVEN LANE AND NORTH OF ARSENAL DRIVE, LOCATED AT 171 HILLHAVEN LANE (HILLHAVEN PUD SUBDIVISION).

WHEREAS, the City of Franklin, Tennessee, encourages responsible growth and the sensible transition of land uses and densities; and

WHEREAS, the Planned (3.12) district provides zoning for land uses compatible with both the Franklin Land Use Plan and surrounding development; and

WHEREAS, the Board of Mayor and Aldermen (BOMA) of the City of Franklin, Tennessee, adopted Resolution 2021-51, approving a Planned Unit Development (PUD) Development Plan as required by the Franklin Zoning Ordinance; and

WHEREAS, the zoning has been reviewed and approved by BOMA after a public hearing and a recommendation by the Franklin Municipal Planning Commission.

NOW THEREFORE, BE IT ORDAINED BY THE BOARD OF MAYOR AND ALDERMEN OF THE CITY OF FRANKLIN, TENNESSEE, AS FOLLOWS:

SECTION I. That the following described property shall be, and is hereby, rezoned from its present zoning classification of **Estate Residential (ER)** District to **Planed (PD3.12)** District:

PREMISES CONSIDERED

Map-Parcel	Acres
062-01.00	13.81
Total	13.81

SECTION II. That the attached Location Map and Survey shall serve the purpose of further delimiting the geographical boundaries as described by this Ordinance.

SECTION III. BE IT FINALLY ORDAINED by the Board of Mayor and Aldermen of the City of Franklin, Tennessee, that this Ordinance shall take effect from and after its passage on third and final reading, the health, safety, and welfare of the citizens requiring it.

ATTEST:

By: _____
Eric S. Stuckey
City Administrator/Recorder

CITY OF FRANKLIN, TENNESSEE:

By: _____
Dr. Ken Moore
Mayor

Approved as to form by:

_____
Shauna R. Billingsley
City Attorney

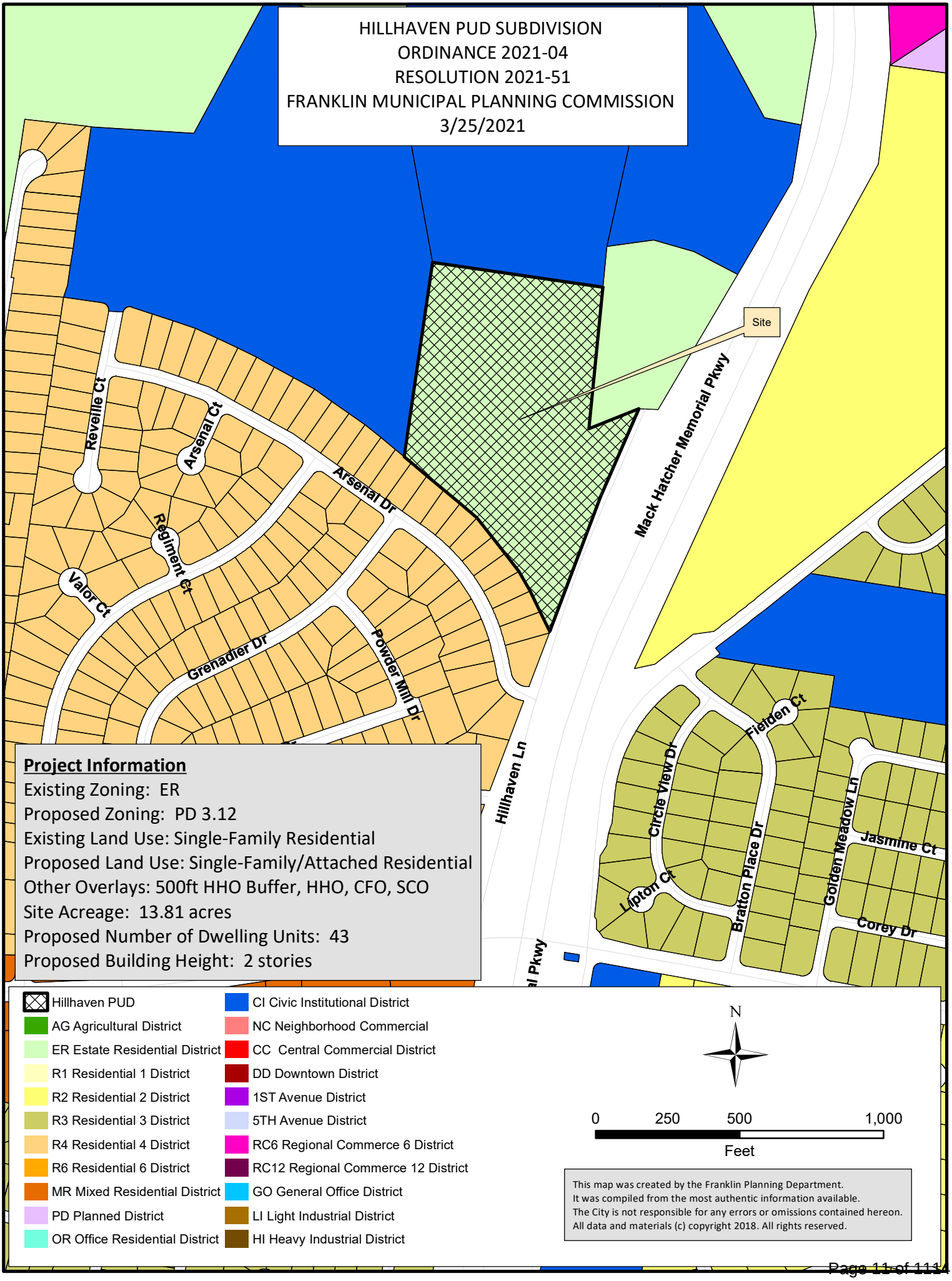
PLANNING COMMISSION RECOMMENDED: _____

PASSED FIRST READING: _____

PUBLIC HEARING HELD: _____

PASSED SECOND READING: _____

PASSED THIRD READING: _____


HILLHAVEN PUD SUBDIVISION
ORDINANCE 2021-04
RESOLUTION 2021-51
FRANKLIN MUNICIPAL PLANNING COMMISSION
3/25/2021
Site
Mack Hatcher Memorial Pkwy
Revelle Ct
Arsenal Ct
Arsenal Dr
Regiment Ct
Valor Ct
Grenadier Dr
Powder Mill Dr
Hillhaven Ln
Fielden Ct
Circle View Dr
Bratton Place Dr
Golden Meadow Ln
Jasmine Ct
Lipton Ct
Corey Dr
Project Information
Existing Zoning: ER
Proposed Zoning: PD 3.12
Existing Land Use: Single-Family Residential
Proposed Land Use: Single-Family/Attached Residential
Other Overlays: 500ft HHO Buffer, HHO, CFO, SCO
Site Acreage: 13.81 acres
Proposed Number of Dwelling Units: 43
Proposed Building Height: 2 stories
Hillhaven PUD
AG Agricultural District
ER Estate Residential District
R1 Residential 1 District
R2 Residential 2 District
R3 Residential 3 District
R4 Residential 4 District
R6 Residential 6 District
MR Mixed Residential District
PD Planned District
OR Office Residential District
CI Civic Institutional District
NC Neighborhood Commercial
CC Central Commercial District
DD Downtown District
1ST Avenue District
5TH Avenue District
RC6 Regional Commerce 6 District
RC12 Regional Commerce 12 District
GO General Office District
LI Light Industrial District
HI Heavy Industrial District
N
0 250 500 1,000
Feet
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It was compiled from the most authentic information available.
The City is not responsible for any errors or omissions contained hereon.
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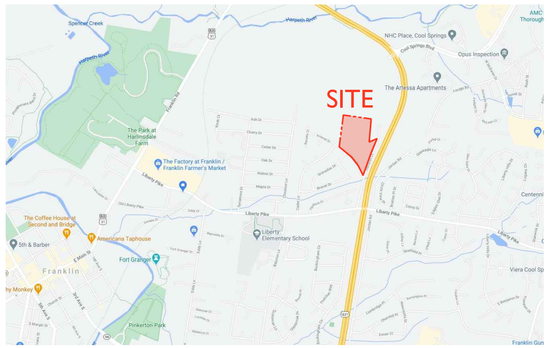
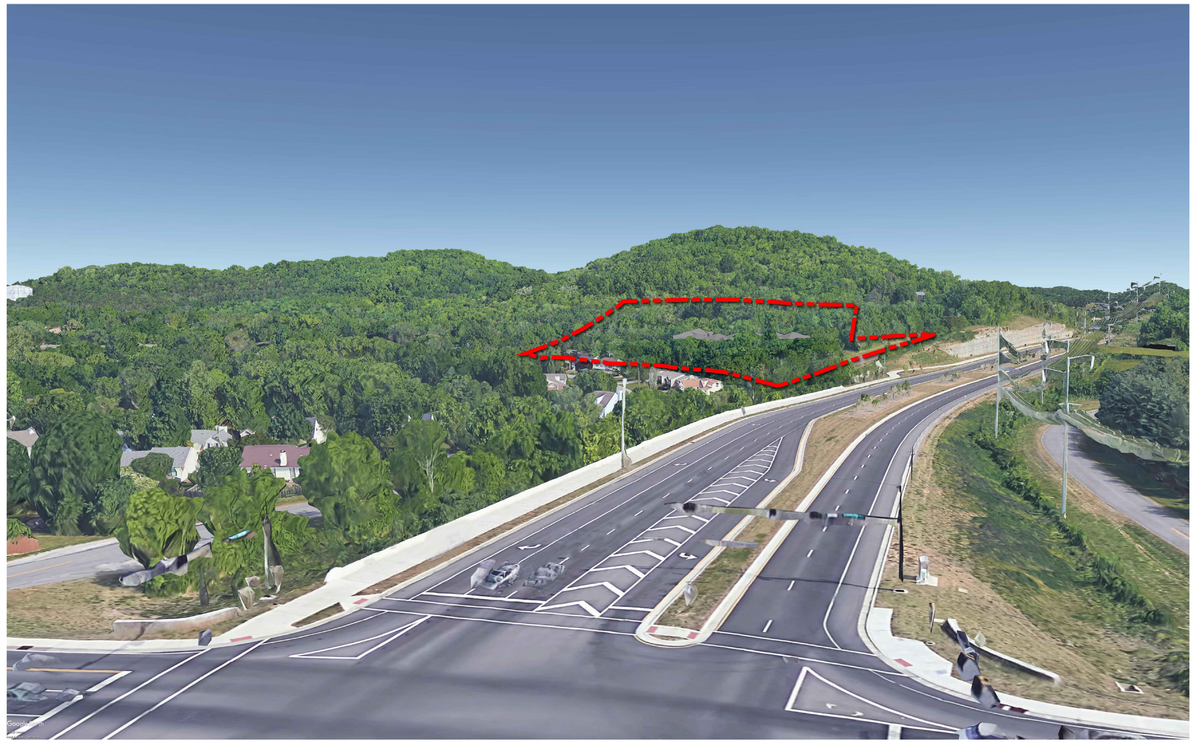


CHP - HILLHAVEN

REZONING

PLANNED DISTRICT (3.12 DUA)
FRANKLIN, WILLIAMSON, TENNESSEE



SITE DATA

SUBDVISION/DEVELOPMENT:	HILLHAVEN PD
COF PROJECT NUMBER:	7371
TAX MAP & PARCELS:	062, 00100
ADDRESS:	171 HILLHAVEN LANE
CITY:	FRANKLIN
COUNTY:	WILLIAMSON
STATE:	TN
CIVIL DISTRICT:	9TH CIVIL DISTRICT
SITE ACREAGE:	13.81 AC
CHARACTER OVERLAY:	HHO, HHO 500' BUFFER
EXISTING ZONING:	ER
PROPOSED ZONING:	PD (3.12 DUA)

SHEET INDEX

C0.0	COVER SHEET
C1.0	EXISTING CONDITIONS

APPLICANT & LANDSCAPE ARCHITECT:
GAMBLE DESIGN COLLABORATIVE
GREG GAMBLE
324 LIBERTY PIKE
SUITE 145
FRANKLIN, TN 37064
615-975-5765
greg.gamble@gdc-tn.com

ENGINEER:
CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
BERT MORTON
117 SEABOARD LANE
SUITE E-100
FRANKLIN, TN 37067
615-333-7797
bmorton@cecinc.com

OWNER:
CUMBERLAND & WESTERN RESOURCES LLC.
735 E, VENICE AVENUE
VENICE, FL 34285

STATEMENT OF IMPACTS

WATER FACILITIES
WATER SERVICE TO BE PROVIDED BY MALLORY VALLEY UTILITY DISTRICT.
32 TWO-BEDROOM APARTMENTS x 300 GPD = 9,600 GPD
11 SINGLE FAMILY x 350 GPD = 3,850 GPD
TOTAL GPD = 13,450 GPD

SEWER FACILITIES
SEWER SERVICE WILL BE PROVIDED BY THE CITY OF FRANKLIN.

REPURIFIED (REUSE) WATER FACILITIES
NOT AVAILABLE TO THIS SITE.

POLICE, FIRE, AND RECREATIONAL FACILITIES
NEAREST POLICE STATION: 2.6 MI (FRANKLIN POLICE DEPARTMENT)
NEAREST FIRE STATION: 1.5 MI (FRANKLIN FIRE STATION 2)
NEAREST RECREATIONAL FACILITY: 2.4 MI (K-9 KORRAL DOG PARK)

PROJECTED STUDENT POPULATION
43 x 0.25 = 11 STUDENTS

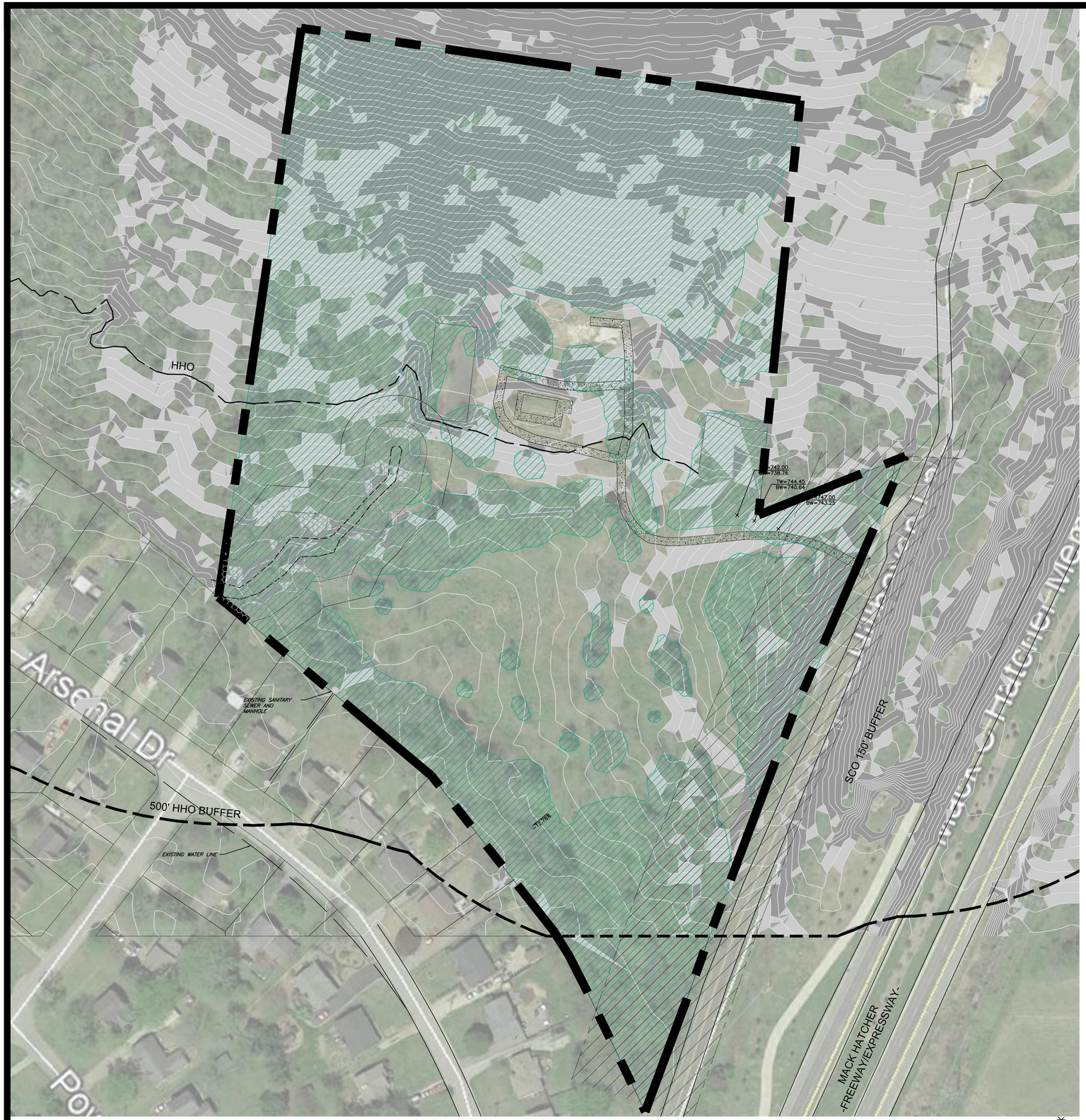
REFUSE STORAGE AND SANITATION COLLECTION FACILITIES
REFUSE COLLECTION FOR THE DEVELOPMENT SHALL BE PROVIDED BY THE CITY OF FRANKLIN

TRIP GENERATION
315 VEHICLES PER DAY. PEAK HOUR TRIP GENERATION, 31 VEHICLES PER HOUR.

DRAKE A. REEDER
REGISTERED
ENGINEER
TENNESSEE No. 125...
LANDSCAPE ARCHITECT
03.01.2021

INITIAL SUBMITTAL: JANUARY 11, 2021
RESUBMITTAL: MARCH 4, 2021

GDC
GAMBLE
DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE
greg.gamble@gdc-tn.com



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SITE ACREAGE:	13.81 AC
CHARACTER OVERLAY:	HHO, HHO 500' BUFFER
EXISTING ZONING:	ER
PROPOSED ZONING:	PD (3.12 DUA)

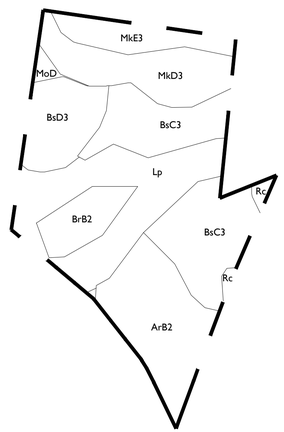
KEY

STREAM BUFFER
- 30' RIPARIAN ZONE '1'
- 30' RIPARIAN ZONE '2'

SLOPE ANALYSIS
- 14% - 19% SLOPES
- 20% AND GREATER SLOPES

TREE CANOPY
- EXISTING TREE CANOPY

NOTES:
1. EXISTING CONDITIONS GATHERED FROM GIS DATA.



SOIL DATA

ArB2 - Armour silt loam, 2% to 5% slopes, eroded
BrB2 - Braxton cherty silt loam, 2% to 5% slopes, eroded
BsC3 - Braxton cherty silt loam, 5% to 12% slopes, severely eroded
BsD3 - Braxton cherty silt loam, 12% to 20% slopes, severely eroded
Lp - Lindell silt loam, 0% to 2% slopes, occasionally flooded
MoD - Ashwood-Mimosa-Rock outcrop complex, 5% to 15% slopes
MkD3 - Mimosa gravelly silty clay, 12% to 20% slopes, severely eroded
MkE3 - Mimosa gravelly silty clay, 20% to 30% slopes, severely eroded
Rc - Rockland, 3% to 30% slopes

GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHP - HILLHAVEN REZONING

Franklin, Williamson County, Tennessee

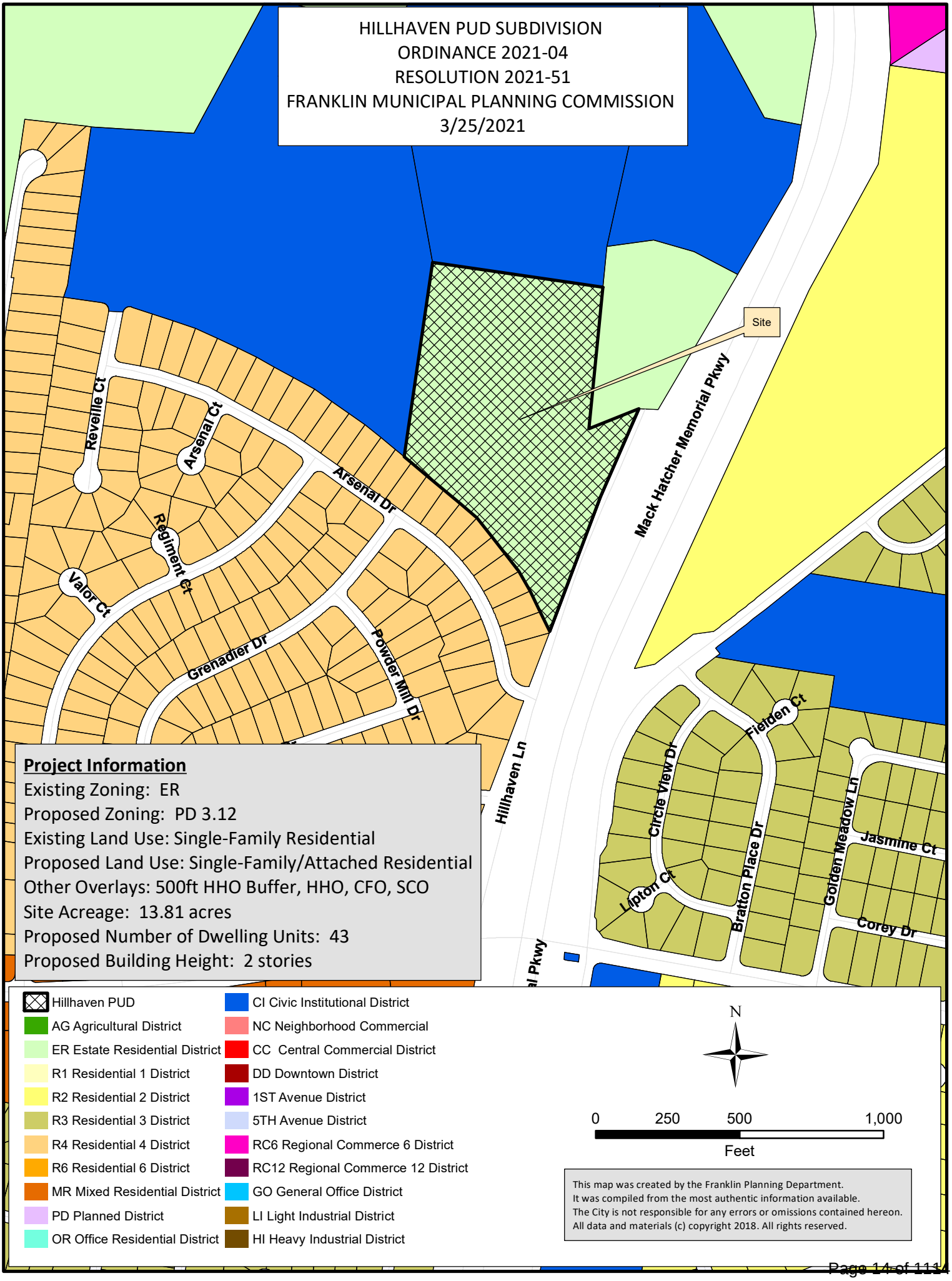
DRAKE A. REEDER REGISTERED COMMERCE TENNESSEE No. 1214 LANDSCAPE ARCHITECT
03.04.2021

Revision Date

EXISTING CONDITIONS

SHEET
C1.0

COF # 7371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OR Office Residential District
CI Civic Institutional District
NC Neighborhood Commercial
CC Central Commercial District
DD Downtown District
1ST Avenue District
5TH Avenue District
RC6 Regional Commerce 6 District
RC12 Regional Commerce 12 District
GO General Office District
LI Light Industrial District
HI Heavy Industrial District
N
0 250 500 1,000
Feet
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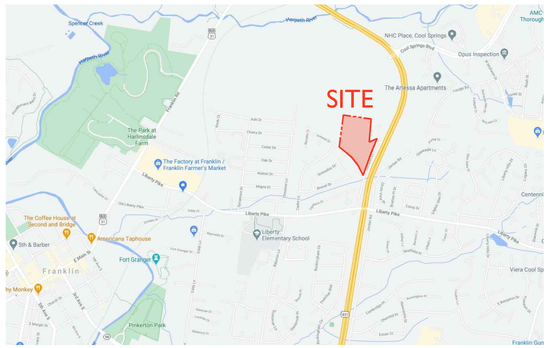
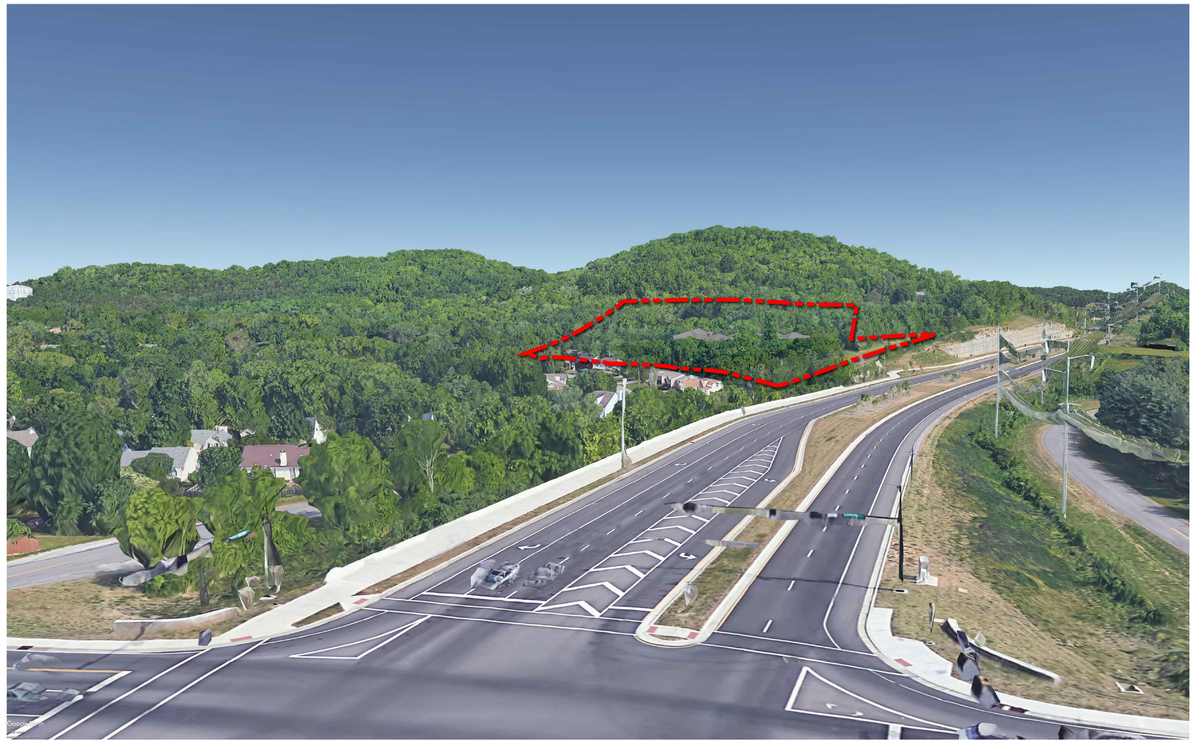


CHP - HILLHAVEN

REZONING

PLANNED DISTRICT (3.12 DUA)
FRANKLIN, WILLIAMSON, TENNESSEE



APPLICANT & LANDSCAPE ARCHITECT:
GAMBLE DESIGN COLLABORATIVE
GREG GAMBLE
324 LIBERTY PIKE
SUITE 145
FRANKLIN, TN 37064
615-975-5765
greg.gamble@gdc-tn.com

ENGINEER:
CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
BERT MORTON
117 SEABOARD LANE
SUITE E-100
FRANKLIN, TN 37067
615-333-7797
bmorton@cecinc.com

OWNER:
CUMBERLAND & WESTERN RESOURCES LLC.
735 E, VENICE AVENUE
VENICE, FL 34285

STATEMENT OF IMPACTS

WATER FACILITIES
WATER SERVICE TO BE PROVIDED BY MALLORY VALLEY UTILITY DISTRICT.
32 TWO-BEDROOM APARTMENTS x 300 GPD = 9,600 GPD
11 SINGLE FAMILY x 350 GPD = 3,850 GPD
TOTAL GPD = 13,450 GPD

SEWER FACILITIES
SEWER SERVICE WILL BE PROVIDED BY THE CITY OF FRANKLIN.

REPURIFIED (REUSE) WATER FACILITIES
NOT AVAILABLE TO THIS SITE.

POLICE, FIRE, AND RECREATIONAL FACILITIES
NEAREST POLICE STATION: 2.6 MI (FRANKLIN POLICE DEPARTMENT)
NEAREST FIRE STATION: 1.5 MI (FRANKLIN FIRE STATION 2)
NEAREST RECREATIONAL FACILITY: 2.4 MI (K-9 KORRAL DOG PARK)

PROJECTED STUDENT POPULATION
43 x 0.25 = 11 STUDENTS

REFUSE STORAGE AND SANITATION COLLECTION FACILITIES
REFUSE COLLECTION FOR THE DEVELOPMENT SHALL BE PROVIDED BY THE CITY OF FRANKLIN

TRIP GENERATION
315 VEHICLES PER DAY. PEAK HOUR TRIP GENERATION, 31 VEHICLES PER HOUR.

SITE DATA

SUBDVISION/DEVELOPMENT:	HILLHAVEN PD
COF PROJECT NUMBER:	7371
TAX MAP & PARCELS:	062, 00100
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COUNTY:	WILLIAMSON
STATE:	TN
CIVIL DISTRICT:	9TH CIVIL DISTRICT
SITE ACREAGE:	13.81 AC
CHARACTER OVERLAY:	HHO, HHO 500' BUFFER
EXISTING ZONING:	ER
PROPOSED ZONING:	PD (3.12 DUA)

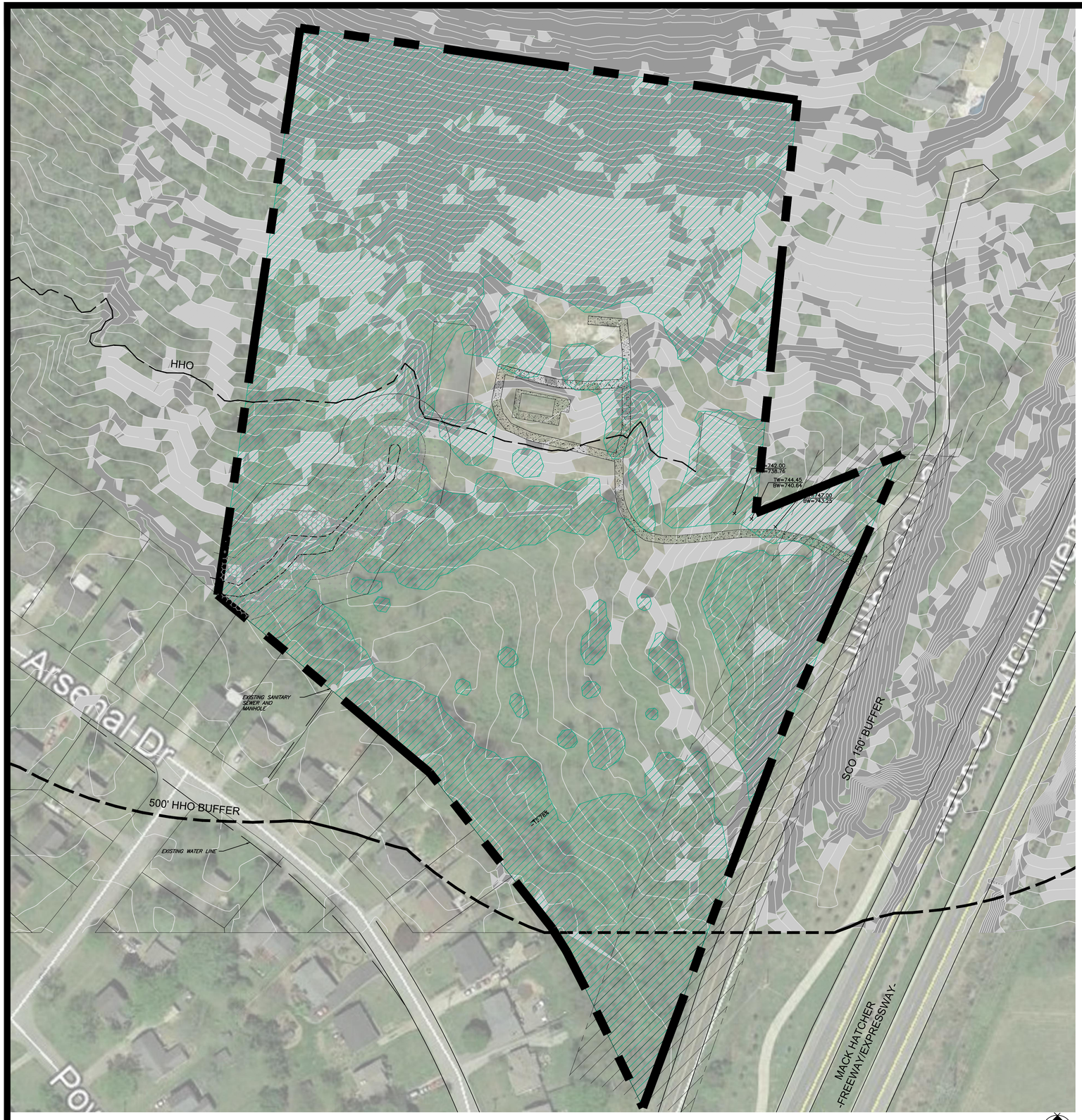
SHEET INDEX

C0.0 COVER SHEET
C1.0 EXISTING CONDITIONS

DRAKE A. REEDER REGISTERED ENGINEER TENNESSEE No. 125... 03.01.2021 LANDSCAPE ARCHITECT

INITIAL SUBMITTAL: JANUARY 11, 2021
RESUBMITTAL: MARCH 4, 2021

GDC GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE
greg.gamble@gdc-tn.com



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STREAM BUFFER
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- 30' RIPARIAN ZONE '2'

SLOPE ANALYSIS
- 14% - 19% SLOPES
- 20% AND GREATER SLOPES

TREE CANOPY
- EXISTING TREE CANOPY

NOTES:
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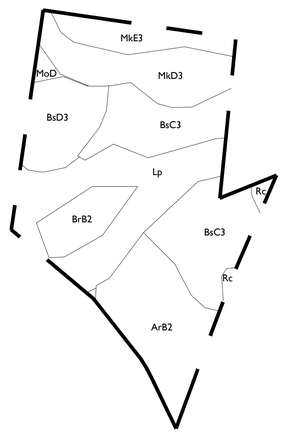

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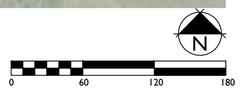
Rc - Rockland, 3% to 30% slopes



GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHP - HILLHAVEN REZONING

Franklin, Williamson County, Tennessee

Revision Date
- △ _____
- △ _____
- △ _____
- △ _____

EXISTING CONDITIONS

SHEET
C1.0
COF # 7371

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01828

DATE: March 24, 2021

TO: Board of Mayor and Aldermen

FROM: Kelly Dannenfelser, Asst. Director of Planning
Amy Diaz-Barriga, Planning Supervisor
Joseph Bryan, Principal Planner

SUBJECT:

Consideration Of Resolution 2021-51, A Resolution Approving A Development Plan For Hillhaven PUD Subdivision, For The Property Located West Of Hillhaven Lane And North Of Arsenal Drive, Located At 171 Hillhaven Lane. Establishing A Public Hearing On May 11, 2021.
FMPC 3/25/21, 7-0

PURPOSE:

PROJECT INFORMATION
COF Project Number: 7372
Applicant: Greg Gamble, GDC
Owner: Cumberland & Western Resources

BACKGROUND/STAFF COMMENTS:
The Hillhaven PUD Subdivision consists of a total of 43 dwelling units, 11 single-family lots and 8 multiplex buildings with 4 attached dwelling units in each building. Envision Franklin places the subject property in the Conservation Subdivision Design Concept, which states, "New development should preserve a minimum of 50 percent open space, strategically targeted toward scenic vistas, greenways, pastures, trails, woodlands, or other uses that maintain scenic character, protect habitat value, and contribute to the quality of life for residents." The parcel lies adjacent to Roper's Knob at the end of Hillhaven Lane. The applicant has responded to the recommendations of Envision Franklin by offering a mixture of housing options while preserving the hillside views the community is accustomed to from this side of the natural feature.

Additionally, Envision Franklin states that, "Architectural sensitivity for new developments should be observed. The style and architecture should draw from the character of the surrounding area and historically significant buildings." The architectural conceptions provide a variety of styling that are compatible with the surrounding established neighborhoods.

Lot 11 is proposed to be in a location with more than 14% of natural slope. This area is located with the 500ft HHO Buffer and the Zoning Ordinance requires that when lots include this percentage slopes, new lots be minimally two acres in size. Further, the area remaining that is outside of the protected slopes does not have enough buildable area to warrant a single-family residential lot in this

location. As a **condition of approval**, Lot 11 must be removed from the Hillhaven PUD Subdivision.

Project Consideration:
This proposal includes three lots that are well below the minimum lot size within any of the City's Base Zoning Districts. These three lots are an average size of 2,500 square feet. The size of the lots and the proposed setbacks can accommodate a house, but not necessarily on-site parking or a private yard. Open spaces are provided nearby in the neighborhood, and off-street parking is provided adjacent to the lots. Normally, staff would not support a lot this small. However, due to the mission of the organization developing the site, the limited number of sub-size lots being proposed, and the accommodation of parking and open space near the lots, staff can support these lots in this very specific case.

FINANCIAL IMPACT:

Unknown.

RECOMMENDATION:

Staff recommends that the Board of Mayor and Aldermen approve Resolution 2021-51 with conditions.

RESOLUTION 2021-51

A RESOLUTION APPROVING A DEVELOPMENT PLAN FOR HILLHAVEN PUD SUBDIVISION, FOR THE PROPERTY LOCATED WEST OF HILLHAVEN LANE AND NORTH OF ARSENAL DRIVE, LOCATED AT 171 HILLHAVEN LANE.

WHEREAS, the Board of Mayor and Aldermen (BOMA) of the City of Franklin, Tennessee, has, or will, approve the zoning for the property as part of Ordinance 2021-04; and

WHEREAS, the Planned Unit Development (PUD) process is a review procedure that is intended to encourage innovative land planning and design and avoid the monotony sometimes associated with large developments by:

(a) Reducing or eliminating the inflexibility that sometimes results from strict application of zoning standards that were designed primarily for individual lots;

(b) Allowing greater freedom in selecting the means to provide access, light, open space, and design amenities;

(c) Encouraging a sensitive design that respects the surrounding established land use character and natural or man-made features of the site including, but not limited to, trees, historic features, streams, hillsides, and floodplains;

(d) Promoting quality design and environmentally sensitive development by allowing development to take advantage of special site characteristics, locations, and land uses; and

(e) Allowing deviations from certain zoning standards that would otherwise apply if not contrary to the general spirit and intent of this ordinance; and

WHEREAS, the PUD process requires the approval of a Development Plan that is reviewed and approved by BOMA, after a public hearing and a recommendation by the Franklin Municipal Planning Commission; and

WHEREAS, in accordance with the provisions of the City of Franklin, Tennessee, Zoning Ordinance, and as required by *Tennessee Code Annotated* § 13-4-310, as amended, the approval of the Development Plan by the BOMA will initiate a vesting period during which the development standards adopted by the City and in effect on the date of approval shall remain the standards applicable to the approved Development Plan.

NOW THEREFORE, BE IT RESOLVED BY THE BOARD OF MAYOR AND ALDERMEN OF THE CITY OF FRANKLIN, TENNESSEE, AS FOLLOWS:

SECTION I. That the legal description of the property included in the Development Plan is as follows:

PREMISES CONSIDERED

Map-Parcel	Acres
062-01.00	13.81
Total	13.81

SECTION II. That the attached Location Map and Survey shall serve the purpose of further delineating the geographical boundaries as described by this Resolution.

SECTION III. That the overall entitlements for the Hillhaven PUD are as follows:

Entitlements	Hillhaven PUD
Base Zone District	PD
Other Zoning Overlays	HHO, 500ft HHO Buffer, SCO, CFO
Number of Dwelling Units	43
Number of Nonresidential Square Footage	0
Number of Hotel Rooms	0
Open Space Requirements	5% 0.7 AC 10% 1.37 AC
Number of Phases in Development	1

SECTION IV. That the Development Plan, the exhibits accompanying the Development Plan, and all conditions and restrictions placed upon the Development Plan by the Franklin Municipal Planning Commission and this Board shall be made a part of this Resolution as though copied verbatim herein, and that a permanent record of the Development Plan, the exhibits accompanying the Development Plan, and all such conditions and restrictions shall be kept in the Franklin Planning and Sustainability Department.

SECTION V. That this Resolution shall take effect from and after the passage of Ordinance ORD 2021-04, on third and final reading, the health, safety, and welfare of the citizens requiring it.

_____ _____

Eric S. Stuckey
City Administrator

Dr. Ken Moore
Mayor

Approved as to form by:

_____

Shauna R. Billingsley
City Attorney

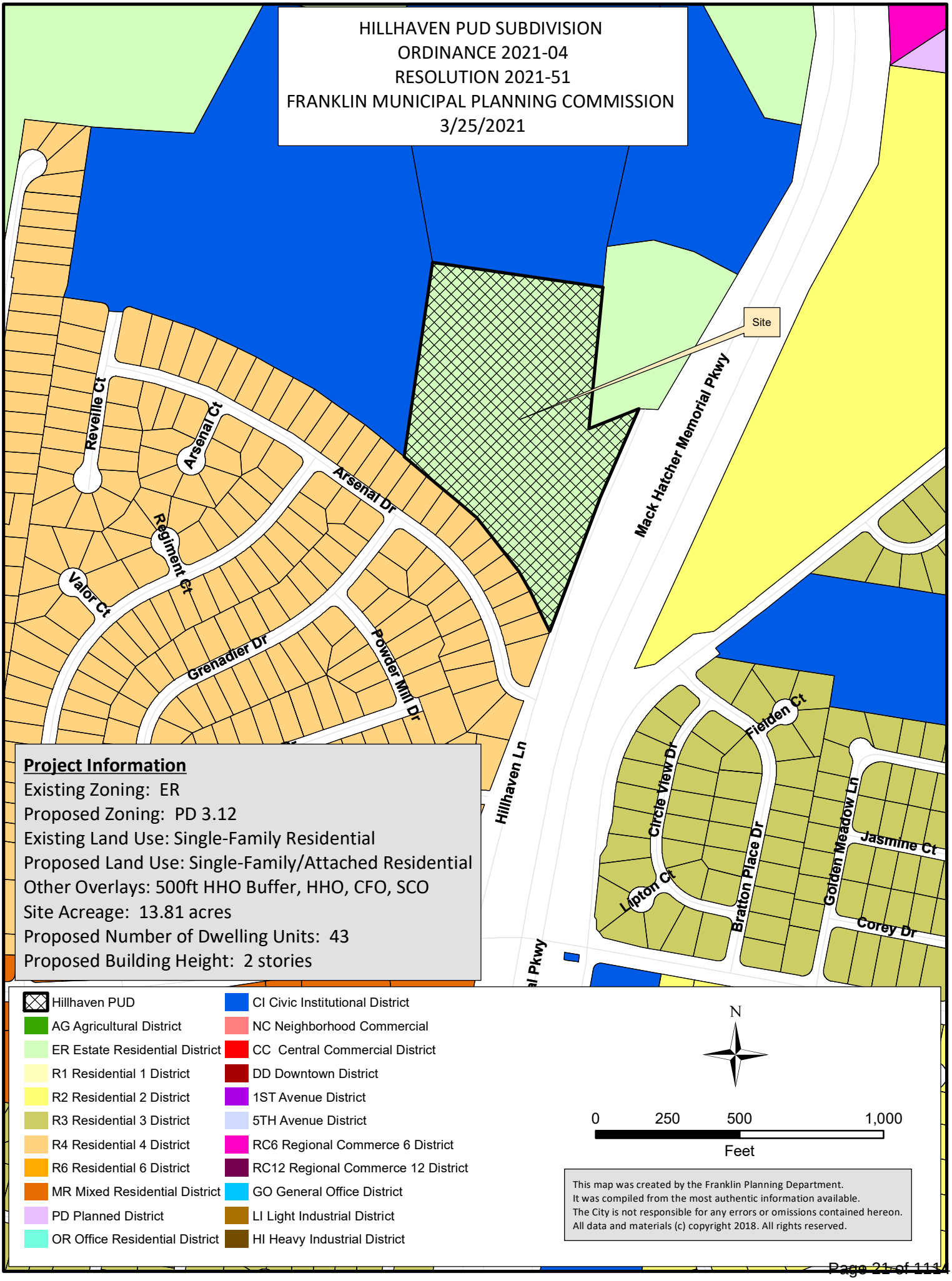
PREAPPLICATION CONFERENCE: _____

BOMA/FMPC JOINT CONCEPTUAL WORKSHOP: _____

NEIGHBORHOOD MEETING: _____

PLANNING COMMISSION RECOMMENDED APPROVAL: _____

PUBLIC HEARING AND BOMA APPROVAL: _____


HILLHAVEN PUD SUBDIVISION
ORDINANCE 2021-04
RESOLUTION 2021-51
FRANKLIN MUNICIPAL PLANNING COMMISSION
3/25/2021
Site
Mack Hatcher Memorial Pkwy
Hillhaven Ln
Reveille Ct
Arsenal Ct
Arsenal Dr
Regiment Ct
Valor Ct
Grenadier Dr
Powder Mill Dr
Fielden Ct
Circle View Dr
Bratton Place Dr
Golden Meadow Ln
Jasmine Ct
Lipton Ct
Corey Dr
Project Information
Existing Zoning: ER
Proposed Zoning: PD 3.12
Existing Land Use: Single-Family Residential
Proposed Land Use: Single-Family/Attached Residential
Other Overlays: 500ft HHO Buffer, HHO, CFO, SCO
Site Acreage: 13.81 acres
Proposed Number of Dwelling Units: 43
Proposed Building Height: 2 stories
Hillhaven PUD
AG Agricultural District
ER Estate Residential District
R1 Residential 1 District
R2 Residential 2 District
R3 Residential 3 District
R4 Residential 4 District
R6 Residential 6 District
MR Mixed Residential District
PD Planned District
OR Office Residential District
CI Civic Institutional District
NC Neighborhood Commercial
CC Central Commercial District
DD Downtown District
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GO General Office District
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0 250 500 1,000
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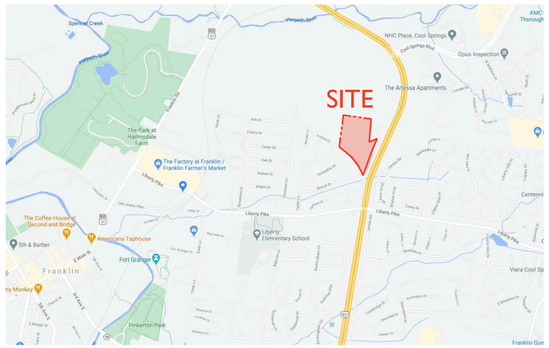
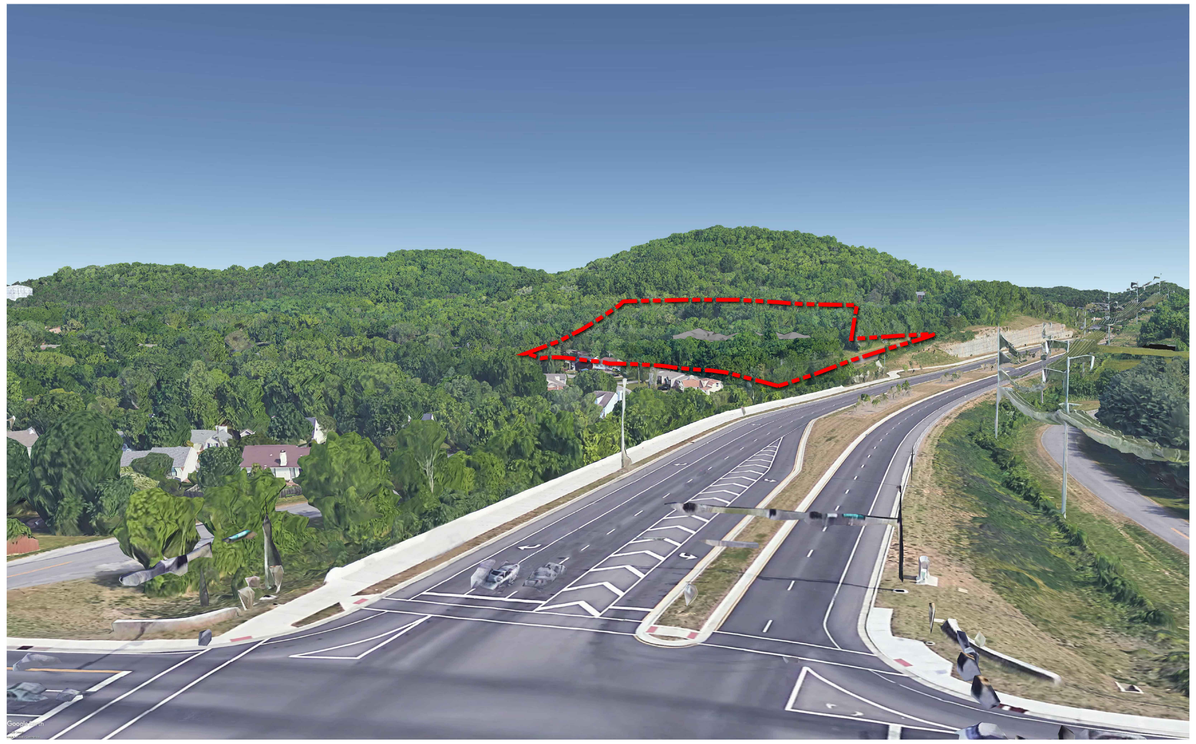


CHP - HILLHAVEN

REZONING

PLANNED DISTRICT (3.12 DUA)
FRANKLIN, WILLIAMSON, TENNESSEE



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C0.0	COVER SHEET
C1.0	EXISTING CONDITIONS

APPLICANT & LANDSCAPE ARCHITECT:
GAMBLE DESIGN COLLABORATIVE
GREG GAMBLE
324 LIBERTY PIKE
SUITE 145
FRANKLIN, TN 37064
615-975-5765
greg.gamble@gdc-tn.com

ENGINEER:
CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
BERT MORTON
117 SEABOARD LANE
SUITE E-100
FRANKLIN, TN 37067
615-333-7797
bmorton@cecinc.com

OWNER:
CUMBERLAND & WESTERN RESOURCES LLC.
735 E, VENICE AVENUE
VENICE, FL 34285

STATEMENT OF IMPACTS

WATER FACILITIES
WATER SERVICE TO BE PROVIDED BY MALLORY VALLEY UTILITY DISTRICT.
32 TWO-BEDROOM APARTMENTS x 300 GPD = 9,600 GPD
11 SINGLE FAMILY x 350 GPD = 3,850 GPD
TOTAL GPD = 13,450 GPD

SEWER FACILITIES
SEWER SERVICE WILL BE PROVIDED BY THE CITY OF FRANKLIN.

REPURIFIED (REUSE) WATER FACILITIES
NOT AVAILABLE TO THIS SITE.

POLICE, FIRE, AND RECREATIONAL FACILITIES
NEAREST POLICE STATION: 2.6 MI (FRANKLIN POLICE DEPARTMENT)
NEAREST FIRE STATION: 1.5 MI (FRANKLIN FIRE STATION 2)
NEAREST RECREATIONAL FACILITY: 2.4 MI (K-9 KORRAL DOG PARK)

PROJECTED STUDENT POPULATION
43 x 0.25 = 11 STUDENTS

REFUSE STORAGE AND SANITATION COLLECTION FACILITIES
REFUSE COLLECTION FOR THE DEVELOPMENT SHALL BE PROVIDED BY THE CITY OF FRANKLIN

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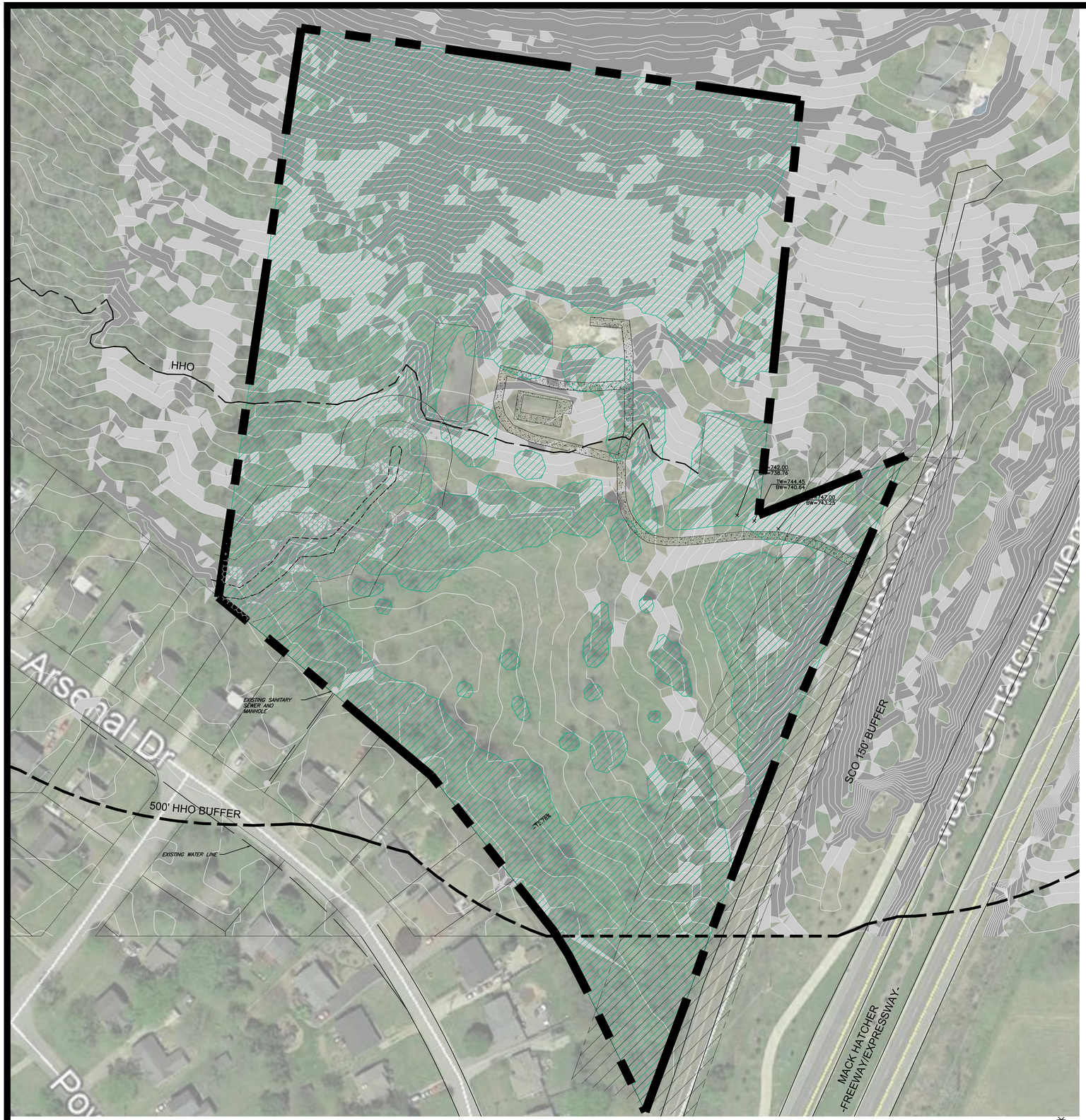

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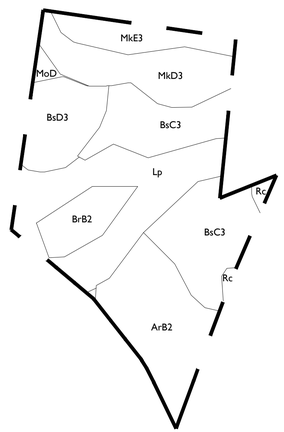

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GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHP - HILLHAVEN REZONING

Franklin, Williamson County, Tennessee

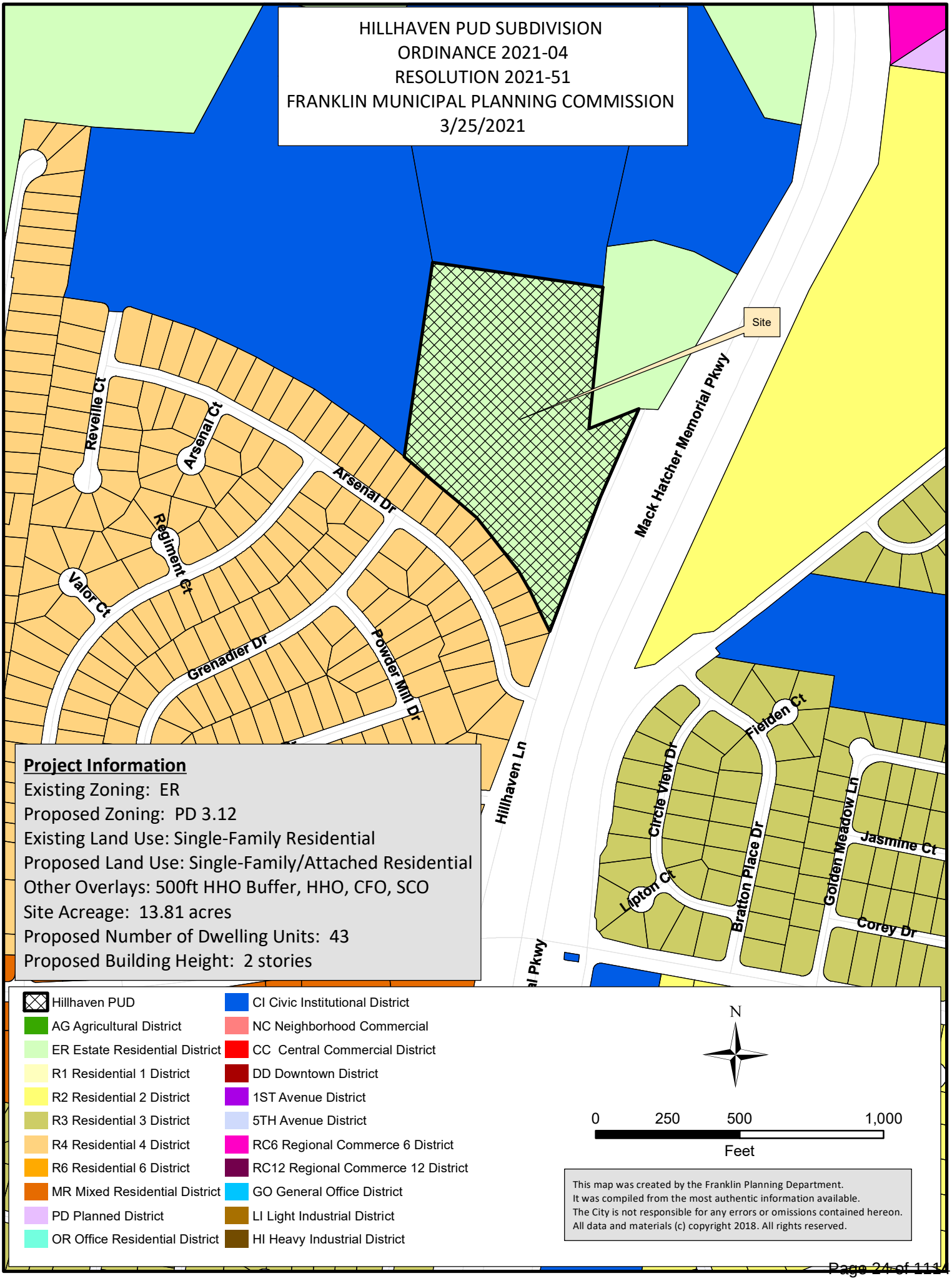
DRAKE A. REEDER REGISTERED LANDSCAPE ARCHITECT TENNESSEE No. 1214 COMMERCE
03.04.2021

Revision Date

EXISTING CONDITIONS

SHEET
C1.0

COF # 7371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3/25/2021
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COF no: 7372

CONDITIONS OF APPROVAL:

Open Issues: 12 These issues are currently being filtered

Engineering - Development Plan Checklist

General Issues

34. Street Sections

joe.marlo@franklintn.gov	*Comment to remain open as a Condition of Approval,* ***but does not hinder approval of the Development Plan.*** At Site Plan, grading adjacent to ROW at new streets shall provide a 2-foot width beyond the sidewalk with a maximum slope of 2%, per COF Street Section TS-6.

35. Connection to Liberty

jimmy.wiseman@franklintn.gov	Thank you. This item shall remain open as a reminder to Staff. The first site plan shall include detailed construction drawings for Hillhaven Lane.

41. Sidewalk

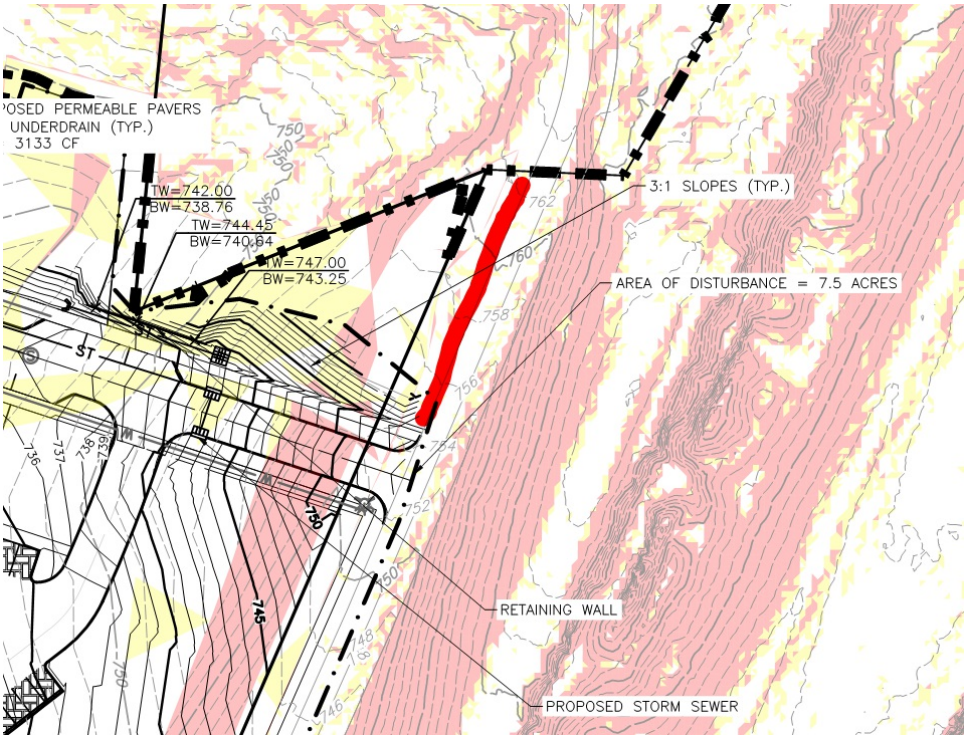
jimmy.wiseman@franklintn.gov *Comment partially addressed.*

A sidewalk is now shown between the two entrances, and from the south entrance to the southern property line however, no sidewalk has been shown from the north entrance to the northern property line. No conceptual curb/gutter/grading/storm infrastructure needed for sidewalks along Hillhaven Lane has been shown.

A sidewalk and curb/gutter are required along the frontage with Hillhaven Lane. *[COF Zoning Ordinance 9.6.1]*

The applicant shall indicate conceptual sidewalk and corresponding street frontage improvements along Hillhaven Lane from the northern entrance to the southern property line. Improvements shall meet the City of Franklin Street Technical Standards for a local street, including:

1. 5-foot sidewalk
2. 6-foot grass strip
3. 24-inch curb and gutter
4. Associated grading and storm infrastructure as necessary to meet drainage requirements



[Edited By Jimmy Wiseman]

76. Street Grade

jimmy.wiseman@franklintn.gov The current Street Standards https://www.franklintn.gov/home/showpublisheddocument?id=31138 only allow up to 10%. Any increase can only be increased or amended by the City Engineer for safe and efficient street operations. The need to increase the slope is self-created and therefore does not qualify for an increase in the slope above 10%.

FIRE--Planning

General Issues

14. Auto-turn

curt.edelmann@franklintn.gov Auto-turn still shows the truck driving over curbs.

And through parking spaces.

[Edited By Curt Edelmann]

16. Fire Protection

curt.edelmann@franklintn.gov Maximum hydrant spacing is 500-feet. This distance is measured along a driving path between hydrants. Please space the hydrants accordingly.

I'm reluctant to approve a flow test taken + / - 1200-feet from the proposed site and possibly at a lower elevation.

Please provide documentation from the engineer or MVUD specifying the 1,500-gpm at 20-psi fire flow requirement will be available at the site.
[Edited By Curt Edelmann]

Parks

General Issues

1. Parkland information

kevinl@franklintn.gov The Parkland Agreement will have to be revised to 43 units instead of the 44. I have started that conversation with Law.
[Edited By Kevin Lindsey]

Planning

General Issues

91. Lot 11

joseph.bryan@franklintn.gov

As a condition of approval, the applicant must remove Lot 11 from the plans. This area is within the 500ft HHO buffer and has natural occurring slopes greater than 14% and not enough buildable area to warrant a 2 acre-minimum lot, per the requirements in Section 17.1.4 of the Zoning Ordinance.

Planning (Landscape)

General Issues

52. Open Space

jason.arnold@franklintn.gov per conversations with the designers, the open space lot 100 will be reconfigured so that the space does not surround the homes and will in cooperate a trail head across the drive aisle.

Stormwater

General Issues

92. Riparian Buffer

jeff.willoughby@franklintn.gov Tree protection fencing shall be located outside the riparian buffer limits

Water/Sewer

General Issues

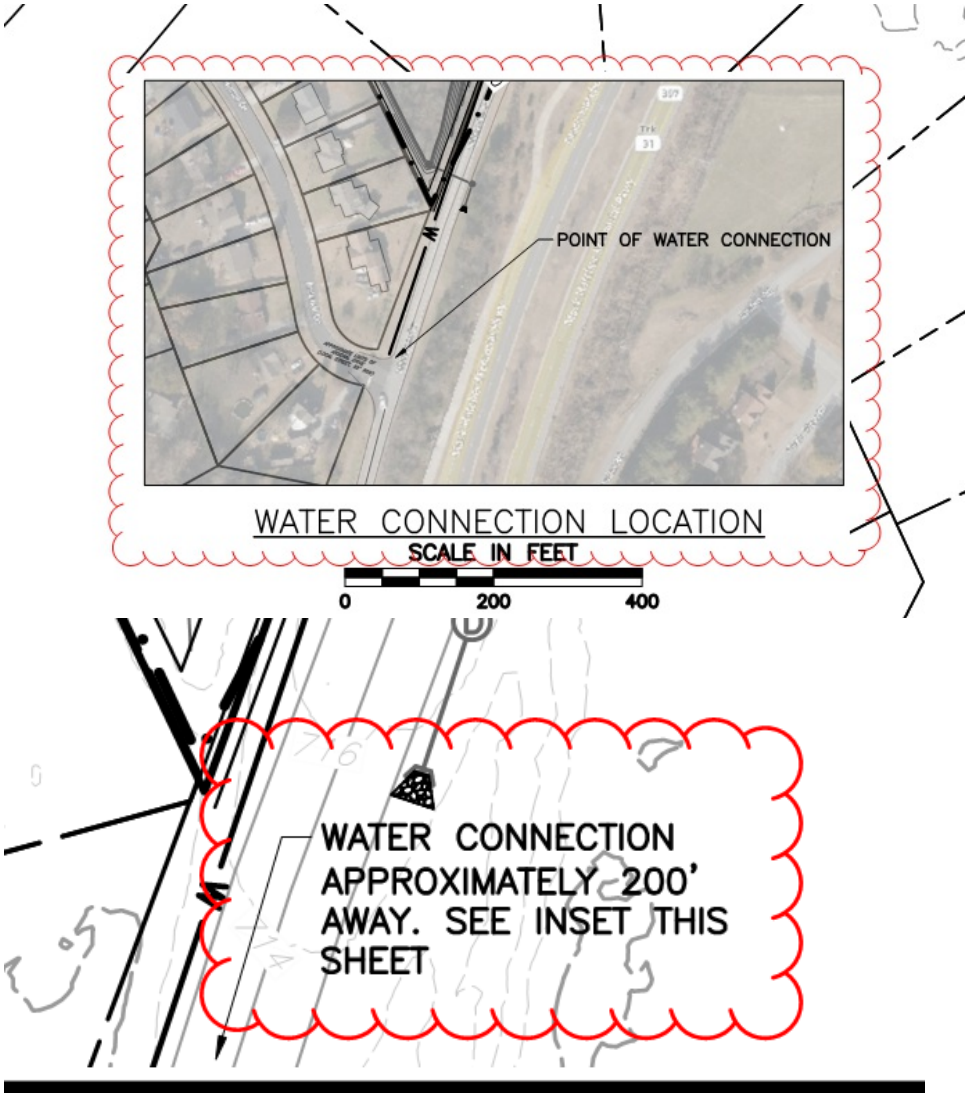
5. Sanitary sewer

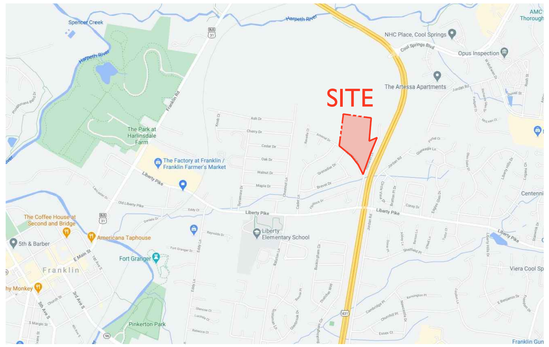
ben.mcneil@franklintn.gov The meeting to discuss upgrades to downstream sanitary sewer has been held. The requirement is for the development to line approximately 700'+/- of downstream sanitary sewer main is due to infiltration and capacity issues in relation to the infiltration. Lining the downstream line will offset the impact of the development and allow the additional capacity to be connected to the existing line.

The applicant shall note the approximate lining responsibility on the development plan and the actual locations will be shown at site plan.
[Edited By Ben McNeil]

7. Water

ben.mcneil@franklintn.gov	The applicant shall remove the water connection point showing connection to Franklin water. Until Mallory releases the service to Franklin, the service shall be directed to Mallory Valley.



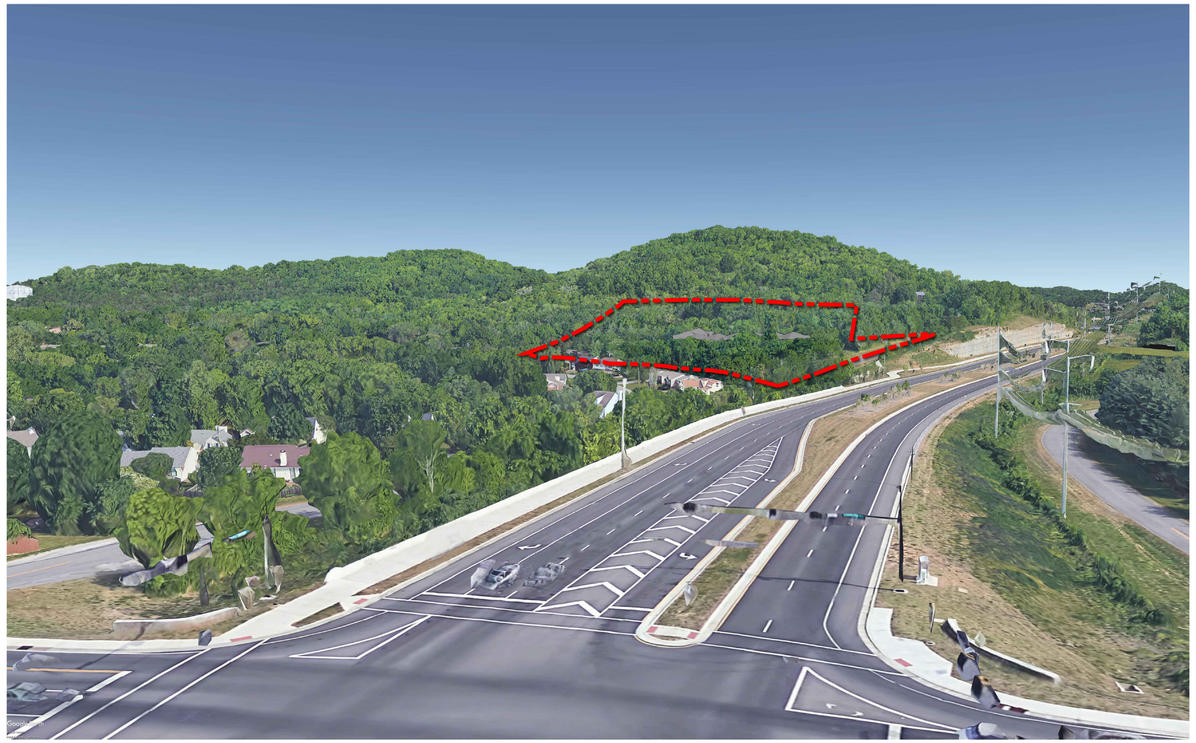


VICINITY MAP

CHP - HILLHAVEN

DEVELOPMENT PLAN

PLANNED DISTRICT (3.12 DUA)
FRANKLIN, WILLIAMSON, TENNESSEE



SITE DATA:

PROJECT NAME:	CHP - HILLHAVEN DEVELOPMENT PLAN
PROJECT NUMBER:	7372
PARCEL ID:	062 00100 00009062
ADDRESS:	171 HILLHAVEN LANE
CITY:	FRANKLIN
COUNTY:	WILLIAMSON
STATE:	TENNESSEE
CIVIL DISTRICT:	9TH CIVIL DISTRICT
SITE ACREAGE:	13.81 AC
EXISTING ZONING:	ER
PROPOSED ZONING:	PD (3.12 DUA)
APPLICABLE OVERLAYS:	HHO, HHO 500' BUFFER
MINIMUM REQUIRED SETBACK LINES:	
65' LOTS	
FRONT YARD SETBACK:	10'
SIDE YARD SETBACK:	7.5'
REAR YARD SETBACK:	20'
40' LOTS	
FRONT YARD SETBACK:	10'
SIDE YARD SETBACK:	5'
REAR YARD SETBACK:	5'
OWNER:	CUMBERLAND & WESTERN RESOURCES LLC
ADDRESS:	2200 LAPSLEY LANE BOWLING GREEN, KY 42103
APPLICANT:	GAMBLE DESIGN COLLABORATIVE
ADDRESS:	354 LIBERTY PIKE SUITE 145 FRANKLIN, TN 37064
CONTACT:	GREG GAMBLE 615.975.5765
EMAIL ADDRESS:	greggamble209@gmail.com
BUILDING SQUARE FOOTAGE:	N/A
NUMBER OF RESIDENTIAL UNITS:	11 SINGLE FAMILY 32 TWO-BEDROOM CONDOS (8 MULTIPLEX BUILDINGS WITH 4 CONDOS EACH)
NUMBER OF TOTAL DWELLINGS:	43 UNITS
BUILDING HEIGHT:	2 STORIES
MINIMUM REQUIRED LSR:	.20 / 2.76 AC
MINIMUM PARKING REQUIREMENT:	102 SPACES
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32 2 BEDROOM CONDOS (2.5/UNIT)	80 SPACES
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SINGLE FAMILY LOTS 8-10 AND MULTIPLEXES: ON-STREET PARKING:	35 SPACES
PARKING LOT SPACES:	51 SPACES
RESIDENTIAL DENSITY:	3.12 DUA
EXISTING TREE CANOPY:	10.13 AC (73.35% OF TOTAL SITE)
OPEN SPACE:	
OPEN SPACE ACREAGE REQUIRED:	5% (0.70 AC)
NATURAL AREA ACREAGE REQUIRED:	10% (1.37 AC)
PARKLAND AGREEMENT	43 UNITS X $4,304=$185,072 REQUEST FEES IN LIEU PAYMENT SHALL BE PAID AT THE FIRST PLAT

SHEET INDEX

C0.0	COVER SHEET
C1.0	EXISTING CONDITIONS
C2.0	DEVELOPMENT PLAN
C2.1	RIPARIAN BUFFER PLAN
C3.0	GRADING AND DRAINAGE PLAN
C4.0A	ROW AND ACCESS PLAN
C4.0B	FEL ROW AND ACCESS PLAN
C4.0C	LIBERTY PIKE CONNECTION PLAN
C5.0	UTILITY PLAN
L1.0	TREE PROTECTION PLAN
A0.0	ARCHITECTURAL MODELING
A1.0	FLOOR PLAN BIG HOUSE 4-UNIT CONDO
A2.0	EXTERIOR ELEVATION BIG HOUSE 4-UNIT CONDO
A3.0	ARCHITECTURAL ELEVATIONS SINGLE FAMILY HOMES
EX1.0	STREAM BUFFER MITIGATION PLAN

APPLICANT & LANDSCAPE ARCHITECT:
GAMBLE DESIGN COLLABORATIVE
GREG GAMBLE
324 LIBERTY PIKE
SUITE 145
FRANKLIN, TN 37064
615-975-5765
greg.gamble@gdc-tn.com

ENGINEER:
CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
BERT MORTON
117 SEABOARD LANE
SUITE E-100
FRANKLIN, TN 37067
615-333-7797
bmorton@cecinc.com

OWNER:
CUMBERLAND & WESTERN RESOURCES LLC.
735 E, VENICE AVENUE
SUITE 200
VENICE, FL 34285

STATEMENT OF IMPACTS

WATER FACILITIES
WATER SERVICE TO BE PROVIDED BY MALLORY VALLEY UTILITY DISTRICT.
32 TWO-BEDROOM APARTMENTS x 300 GPD = 9,600 GPD
11 SINGLE FAMILY x 350 GPD = 3,850 GPD
TOTAL GPD = 13,450 GPD

SEWER FACILITIES
SEWER SERVICE WILL BE PROVIDED BY THE CITY OF FRANKLIN.

REPURIFIED (REUSE) WATER FACILITIES
NOT AVAILABLE TO THIS SITE.

POLICE, FIRE, AND RECREATIONAL FACILITIES
NEAREST POLICE STATION: 2.6 MI (FRANKLIN POLICE DEPARTMENT)
NEAREST FIRE STATION: 1.5 MI (FRANKLIN FIRE STATION 2)
NEAREST RECREATIONAL FACILITY: 2.4 MI (K-9 KORRAL DOG PARK)

PROJECTED STUDENT POPULATION
43 x 0.25 = 11 STUDENTS

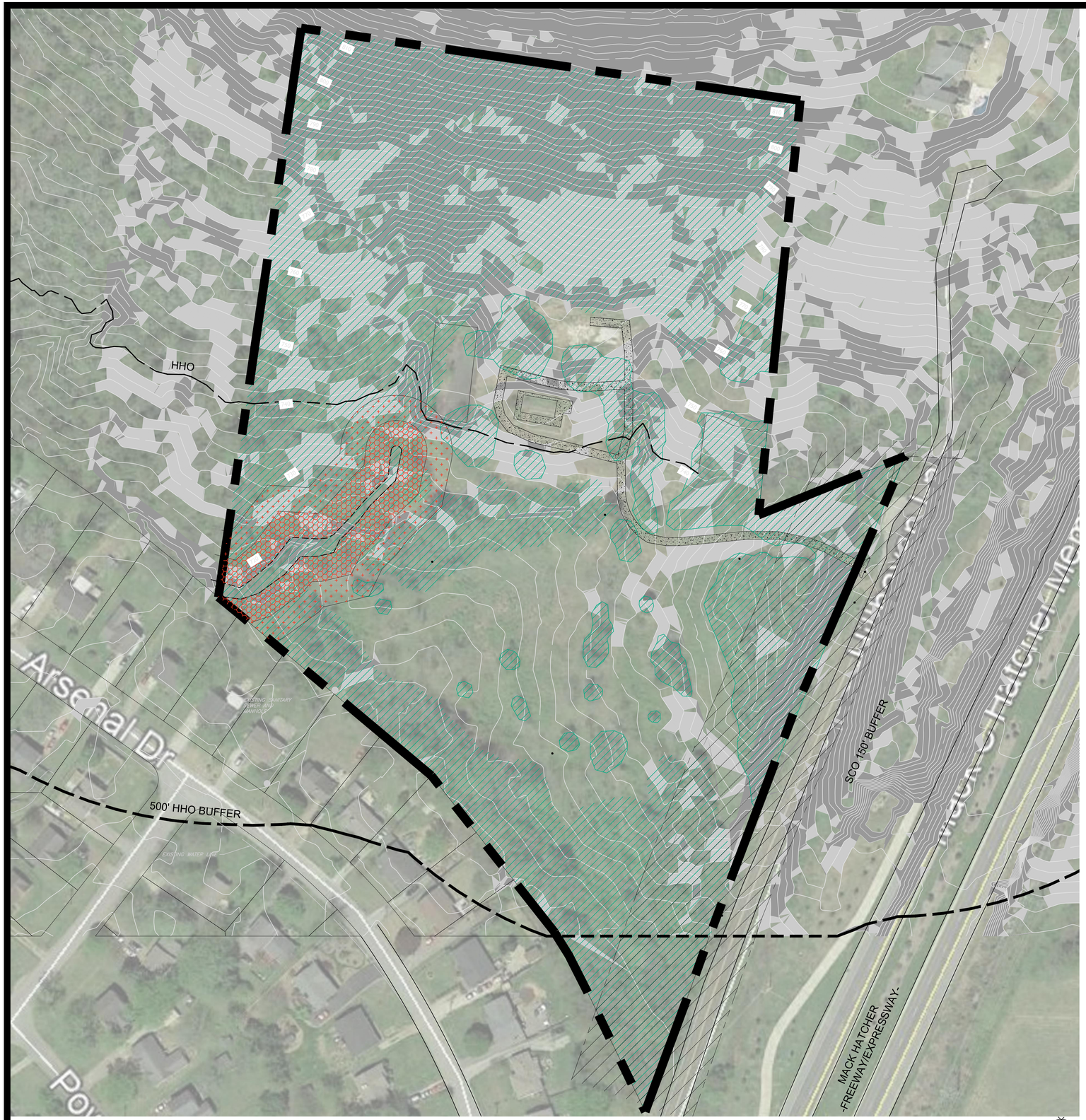
REFUSE STORAGE AND SANITATION COLLECTION FACILITIES
REFUSE COLLECTION FOR THE DEVELOPMENT SHALL BE PROVIDED BY THE CITY OF FRANKLIN

COMPREHENSIVE REVIEW OF ROADWAY, STORMWATER, AND UTILITY ELEMENTS BY CITY OF FRANKLIN STAFF WILL OCCUR AT THE SITE PLAN STAGE. PROJECT ENTITLEMENTS APPROVED WITH THIS DEVELOPMENT PLAN DO NOT CONSTITUTE APPROVAL OF THE ROADWAY, STORMWATER, AND UTILITY ELEMENTS SHOWN ON THE DEVELOPMENT PLAN. IF, UPON APPLICATION OF CITY OF FRANKLIN STREET, STORMWATER, AND UTILITY STANDARDS AT THE SITE PLAN STAGE, THE APPLICANT CANNOT ACHIEVE THE MAXIMUM APPROVED ENTITLEMENTS, THE APPLICANT SHALL BE CONFINED TO THE ENTITLEMENTS ACHIEVABLE FROM THE APPLICATION OF SAID STANDARDS.

INITIAL SUBMITTAL: JANUARY 11, 2021

RESUBMITTAL: MARCH 4, 2021

GDC
GAMBLE
DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE
greg.gamble@gdc-tn.com



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PARKLAND AGREEMENT	43 UNITS X $4,304=$185,072 REQUEST FEES IN LIEU PAYMENT SHALL BE PAID AT THE FIRST PLAT

KEY

STREAM BUFFER

- 30' RIPARIAN ZONE '1'
- 30' RIPARIAN ZONE '2'

SLOPE ANALYSIS

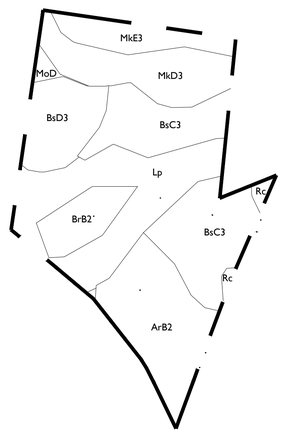
- 14% - 19% SLOPES
- 20% AND GREATER SLOPES

TREE CANOPY

- EXISTING TREE CANOPY

NOTES:

1. EXISTING CONDITIONS GATHERED FROM GIS DATA.



SOIL DATA

ArB2 - Armour silt loam, 2% to 5% slopes, eroded
BrB2 - Braxton cherty silt loam, 2% to 5% slopes, eroded
BsC3 - Braxton cherty silt loam, 5% to 12% slopes, severely eroded
BsD3 - Braxton cherty silt loam, 12% to 20% slopes, severely eroded
Lp - Lindell silt loam, 0% to 2% slopes, occasionally flooded
MoD - Ashwood-Mimosa-Rock outcrop complex, 5% to 15% slopes
MkD3 - Mimosa gravelly silty clay, 12% to 20% slopes, severely eroded
MkE3 - Mimosa gravelly silty clay, 20% to 30% slopes, severely eroded
Rc - Rockland, 3% to 30% slopes

GDC
GAMBLE
DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHP - HILLHAVEN DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

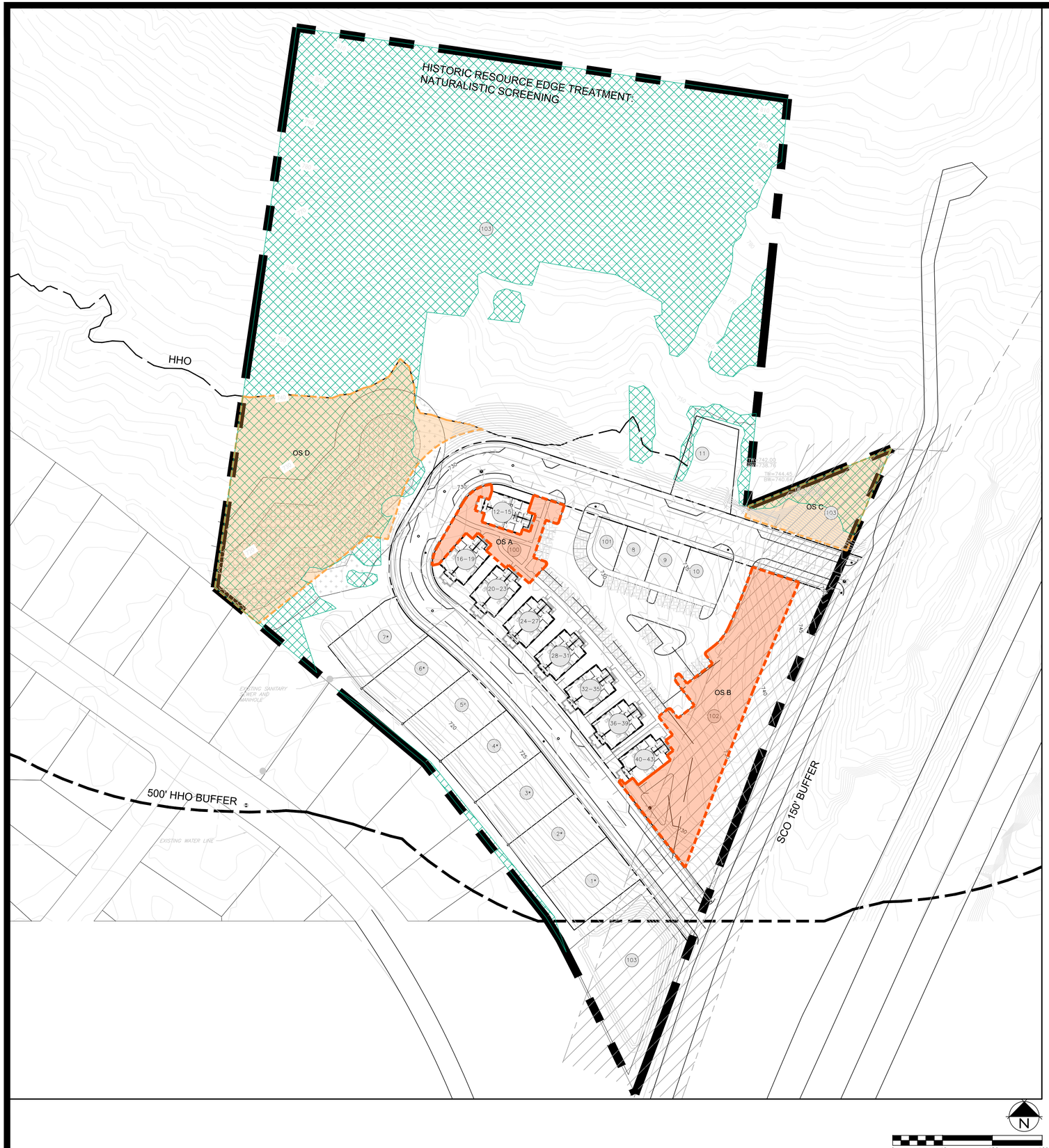
DRAKE A. REEDER
REGISTERED
COMMERCE
TENNESSEE No. 12...
LANDSCAPE ARCHITECT
03.04.2021

Revision Date

EXISTING CONDITIONS

SHEET
C1.0

COF # 7372



OPEN SPACE REQUIREMENT ENVISION FRANKLIN

MINIMUM OPEN SPACE REQUIREMENT
REQUIRED: 50% - 301,000 SF (6.91 AC)
PROVIDED: 68.7% - 413,220 SF (9.49 AC)*

OPEN SPACE REQUIREMENT ZONING ORDINANCE

MINIMUM OPEN SPACE REQUIREMENT
REQUIRED: 5% OPEN SPACE: 30,492 SF
10% 'NATURAL AREA': 59,677.2 SF
PROVIDED: OPEN SPACE: 30,605 SF
NATURAL AREA: 60,186 SF

LOT	TYPE	AREA (SF)
OS A	COURTYARD	6,587
OS B	POCKET PARK	24,350
OS C	NATURAL AREA	9,607
OS D	NATURAL AREA	50,579

NOTE*: OPEN SPACE LOTS ARE INTENDED TO SERVE AS PUBLIC UTILITY, DRAINAGE, AND ACCESS EASEMENTS.

KEY

STREAM BUFFER
- 30' RIPARIAN ZONE '1'
- 30' RIPARIAN ZONE '2'

TREE CANOPY
- PRESERVED TREE CANOPY
- TREE PROTECTION FENCE

OPEN SPACE
- OPEN SPACE
- NATURAL AREA

* CRITICAL LOTS

TREE CANOPY RETENTION

OVERALL SITE AREA = 601,563.6 SF (13.81 AC)

EXISTING TREE CANOPY	PRESERVED TREE CANOPY
441,082.5 (10.13 AC)	260,779 SF (5.99 AC)

TREE CANOPY DATA:

TOTAL EXISTING TREE CANOPY:	441,082.5 SF; 10.13 AC (73.35% OF SITE)
REQUIRED CANOPY PRESERVATION:	36% (158,854.6 SF; 3.65 AC)
PROVIDED CANOPY PRESERVATION:	260,779 SF; 5.99 AC (59.18% OF EXISTING TREE CANOPY)

STATEMENT OF IMPACTS

WATER FACILITIES
WATER SERVICE TO BE DETERMINED FOLLOWING FURTHER COORDINATION WITH THE CITY OF FRANKLIN AND MALLORY VALLEY UTILITY DISTRICT.
32 TWO-BEDROOM APARTMENTS x 300 GPD = 9,600 GPD
11 SINGLE FAMILY x 350 GPD = 3,850 GPD
TOTAL GPD = 13,450 GPD

SEWER FACILITIES
SEWER SERVICE WILL BE PROVIDED BY THE CITY OF FRANKLIN.

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NOT AVAILABLE TO THIS SITE.

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GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHP - HILLHAVEN DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

DRAKE A. REEDER REGISTERED LANDSCAPE ARCHITECT TENNESSEE No. 329 — 25.04.2022

Revision Date
- △
- △
- △
- △

DEVELOPMENT PLAN

SHEET
C2.0

COF # 7372

STREAM BUFFER REDUCTION REQUEST

The Hillhaven property is a Community Housing Partnership development of affordable homes in Franklin consisting of single-family homes and multiplexes. Density is particularly important in this type of development, as it is the main factor in determining the affordability for the end user. The location of these homes, and the associated road location, are strategically designed in order to maximize the number of affordable homes. Due to the Hillside/Hillcrest Overlay and steep slope constraints, a portion of the road grading encroaches in the Zone 2 Riparian Buffer.

The applicant requests the reduction of a portion of Zone 2 in the amount of 2,728 square feet.

The goal of this buffer reduction request is to create new riparian buffer areas to offset the grading impact. These new areas would be located along the same stream side as the encroached areas and at the northern tip of the stream to provide additional means of capturing and filtering downhill water.

If request is granted, then the applicant will purchase the required stream buffer signs and install them along the edge of the existing and newly created stream buffer limits. The applicant also proposes to add a total of 5,617 SF of new Zone 2 buffer. A full plan for this request shall be submitted with the site plan for this project and will include the removal of invasive species to the re-establishment of native species, where appropriate.

STREAM BUFFER VEGETATION

In the urban riparian zone buffers, all water resources shall be enhanced. Enhancement shall include removal of invasive species and the re-establishment of native species which includes a mix a canopy trees, understory trees, shrubs, and a native seed mix of forbes/grasses/sedges/rushes suitable for a moist shaded understory environment.

There shall be no mowing, clearing grading, construction, storage, or disturbanceof vegetation in riparian buffers except as permitted by the City Engineer, or his/her designee.

KEY

- ZONE 1 STREAM BUFFER
  30' FROM TOP OF BANK, UNLESS ADJUSTED FOR SLOPE
- ZONE 2 STREAM BUFFER
  30' OFFSET OF ZONE 1 BUFFER
- AREAS OF STREAM BUFFER ENCROACHMENT
  2,728 SF
- AREAS OF NEW STREAM BUFFER ZONE 2
  5,617 SF
- SLOPES 14%-20%
- SLOPES 20%+
- PRESERVED TREE CANOPY

THIS EXHIBIT HAS BEEN SUBMITTED TO THE COF STORMWATER COORDINATOR FOR APPROVAL OF A VARIANCE REQUEST TO FMC 23-107. THIS EXHIBIT WILL TRACK WITH THE DEVELOPMENT PLAN AND FUTURE SITE PLAN.

0 20 40 60

GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHP - HILLHAVEN DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

DRAKE A. REEDER
REGISTERED
COMMERCE
TENNESSEE No. 12
LANDSCAPE ARCHITECT
03.01.2022

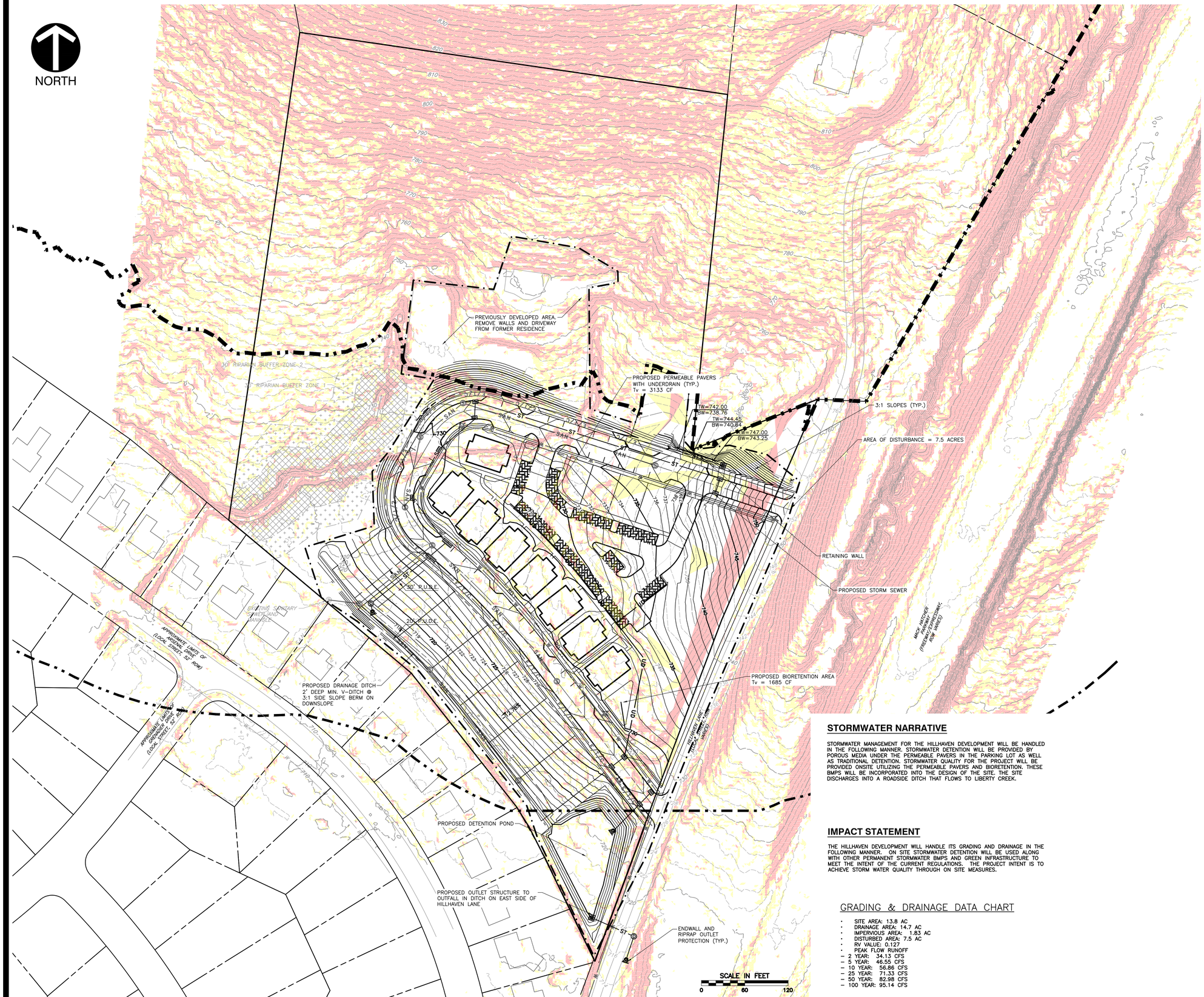
Revision Date

RIPARIAN BUFFER PLAN

SHEET
C2.1

COF # 7372

NORTH



LEGEND

- EXISTING PROPERTY LINE
- EXISTING RIGHT-OF-WAY
- 385 EXISTING INDEX (MAJOR) CONTOUR
- EXISTING INTERMEDIATE (MINOR) CONTOUR
- EXISTING STREAM
- EXISTING BUFFER ZONE 1
- EXISTING BUFFER ZONE 2
- EXISTING HILLSIDE/HILLCREST OVERLAY
- EXISTING HILLSIDE/HILLCREST OVERLAY BUFFER
- EXISTING EDGE OF PAVEMENT
- EXISTING STRUCTURES
- EXISTING 14%-20% SLOPES
- EXISTING SLOPES > 20%
- PROPOSED ROADWAY CENTERLINE
- PROPOSED CURB & GUTTER
- PROPOSED EDGE OF PAVED DRIVE
- PROPOSED STRIPING
- PROPOSED SIDEWALK
- PROPOSED EASEMENT
- PROPOSED SUBJECT PROPERTY BOUNDARY
- PROPOSED RIGHT-OF-WAY
- PROPOSED BUILDING
- PROPOSED LIMITS OF DISTURBANCE
- 1050 PROPOSED INDEX (MAJOR) CONTOUR
- 1048 PROPOSED INTERMEDIATE (MINOR) CONTOUR
- 5.00% PROPOSED SLOPE LABEL
- ST PROPOSED STORM PIPE
- PROPOSED CURB INLET
- PROPOSED STORM MANHOLE
- PROPOSED LIMITS OF DETENTION POND
- RD PROPOSED ROOF DRAIN
- UD PROPOSED UNDERDRAIN

CITY OF FRANKLIN GRADING & DRAINAGE GENERAL NOTES

1. GRADING PERMIT IS REQUIRED FOR ANY PROJECT DISTURBING MORE THAN 10,000 SF, ADDING MORE THAN 5,000 SF OF IMPERVIOUS SURFACE OR FOR ANY SITE GRADING REQUIRING STOCKPILING OF MATERIAL.
2. THE DEVELOPER SHALL PROVIDE THE NECESSARY LABOR AND SUPERVISION REQUIRED TO SUPPORT FIELD TESTING BY THE INDEPENDENT TESTING FIRM AND INSPECTIONS BY CITY OFFICIALS AT NO COST TO THE CITY. TEST REPORTS OF FIELD TESTING IF APPLICABLE SHALL BE SUBMITTED DIRECTLY TO THE STREET DEPARTMENT. DEFECTS DISCLOSED BY TESTS SHALL BE RECTIFIED.
3. AN AUTHORIZED REPRESENTATIVE OF THE CITY SHALL MAKE A FINAL INSPECTION OF THE PROJECT AFTER COMPLETION TO DETERMINE ACCEPTABILITY OF THE WORK AND FOR RELEASE OF PERFORMANCE BONDS IF REQUIRED. BEFORE THIS FINAL INSPECTION CAN BE MADE, THE ENGINEER RESPONSIBLE FOR THE PROJECT SHALL CERTIFY IN WRITING TO THE CITY ENGINEER THAT THE WORK HAS BEEN COMPLETED IN ACCORDANCE WITH APPROVED PLANS AND SPECIFICATIONS.
4. DRAINAGE FACILITIES INCLUDING, BUT NOT LIMITED TO, CULVERTS, DETENTION BASINS AND DITCHES, AS WELL AS THE ROADWAY SUB-GRADE, BASE STONE AND BINDER & SURFACE COARSE SHALL BE INSPECTED, TESTED AND GIVEN APPROVAL AT EACH STAGE OF INSTALLATION PRIOR TO PROCEEDING TO THE NEXT STAGE OF CONSTRUCTION. FINAL CONSTRUCTION INSPECTION FOR APPROVAL AND ACCEPTANCE OF STREETS AND DRAINAGE SYSTEMS WILL NOT BE GRANTED UNTIL ALL WORK HAS BEEN COMPLETED IN ACCORDANCE WITH THE APPROVED PLANS.
5. LOCATING AND COORDINATION FOR THE RELOCATION OF EXISTING UTILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR. TENNESSEE'S ONE-CALL AND THE CITY OF FRANKLIN UTILITY LOCATION SERVICE SHALL BE UTILIZED IN ADDITION TO COORDINATION WITH LOCAL UTILITY OWNERS. THE CONTRACTOR SHALL AT ALL TIMES PROTECT EXISTING UTILITIES AND WILL BE RESPONSIBLE FOR COSTS DUE TO DAMAGE CAUSED TO ANY UTILITY LINES.
6. THERE SHALL BE NO MOWING, CLEARING, GRADING, CONSTRUCTION, STORAGE, OR DISTURBANCE OF VEGETATION IN RIPARIAN BUFFERS EXCEPT AS PERMITTED BY CITY ENGINEER, OR HIS DESIGNEE.

STORMWATER NARRATIVE

STORMWATER MANAGEMENT FOR THE HILLHAVEN DEVELOPMENT WILL BE HANDLED IN THE FOLLOWING MANNER. STORMWATER DETENTION WILL BE PROVIDED BY POROUS MEDIA UNDER THE PERMEABLE PAVERS IN THE PARKING LOT AS WELL AS TRADITIONAL DETENTION. STORMWATER QUALITY FOR THE PROJECT WILL BE PROVIDED ONSITE UTILIZING THE PERMEABLE PAVERS AND BIORETENTION. THESE BMPS WILL BE INCORPORATED INTO THE DESIGN OF THE SITE. THE SITE DISCHARGES INTO A ROADSIDE DITCH THAT FLOWS TO LIBERTY CREEK.

IMPACT STATEMENT

THE HILLHAVEN DEVELOPMENT WILL HANDLE ITS GRADING AND DRAINAGE IN THE FOLLOWING MANNER. ON SITE STORMWATER DETENTION WILL BE USED ALONG WITH OTHER PERMANENT STORMWATER BMPS AND GREEN INFRASTRUCTURE TO MEET THE INTENT OF THE CURRENT REGULATIONS. THE PROJECT INTENT IS TO ACHIEVE STORM WATER QUALITY THROUGH ON SITE MEASURES.

GRADING & DRAINAGE DATA CHART

- SITE AREA: 13.8 AC
- DRAINAGE AREA: 14.7 AC
- IMPERVIOUS AREA: 1.83 AC
- DISTURBED AREA: 7.5 AC
- RV VALUE: 0.127
- PEAK FLOW RUNOFF
  - 2 YEAR: 34.13 CFS
  - 5 YEAR: 46.55 CFS
  - 10 YEAR: 56.86 CFS
  - 25 YEAR: 71.33 CFS
  - 50 YEAR: 82.98 CFS
  - 100 YEAR: 95.14 CFS

GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHP -HILL HAVEN PROPERTY MASTER PLAN

Franklin, Williamson County, Tennessee

Civil & Environmental Consultants, Inc.
117 Seaboard Lane - Suite E-100 - Franklin, TN 37067
615-333-7797 - 800-763-2326
www.cecinc.com

Revision Date
△
△
△
△

ROBERT G. MORTON
REGISTERED ENGINEER
AGRICULTURE
No. 109393
STATE OF TENNESSEE
3/4/2022

GRADING & DRAINAGE PLAN
SHEET
C3.0
COF # 7372

NORTH

30' RIPARIAN BUFFER ZONE 2

30' RIPARIAN BUFFER ZONE 1

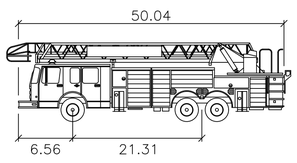
EXISTING SANITARY SEWER AND MANHOLE

APPROXIMATE LIMITS OF (LOCAL STREET, 52' R.O.W.)

HILLHAVEN LANE (LOCAL STREET, 52' R.O.W.)

STREET LIGHTING TO BE DESIGNED BY OTHERS. STREET LIGHTS SHALL HAVE AN LED LIGHT SOURCE.

SCALE IN FEET
0 60 120



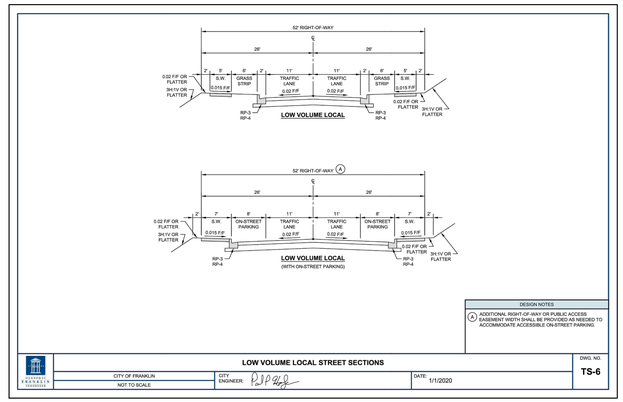
City of Franklin Firetruck 2

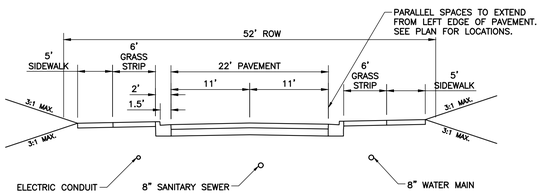
DATA TABLE

NUMBER OF FRONT AXLES	= 1
FRONT TRACK WIDTH	= 8"
WHEELS ON EACH FRONT AXLE	= 2
NUMBER OF REAR AXLES	= 2
REAR TRACK WIDTH	= 8'
WHEEL BASE	= 21.616'
REAR AXLE SPACING	= 4.417'
BODY LENGTH	= 50.0417'
WIDTH	= 8.333'
REAR OVERHANG	= 22.1424'
BODY STYLE	FIRE TRUCK
TURNING RADIUS WALL TO WALL	= 42'
DESIGN SPEED	= 5 MPH
LOCK TO LOCK TIME	= 6.0
STEERING ANGLE	= 38.0

LEGEND

- EXISTING PROPERTY LINE
- EXISTING RIGHT-OF-WAY
- 385 EXISTING INDEX (MAJOR) CONTOUR
- EXISTING INTERMEDIATE (MINOR) CONTOUR
- EXISTING STREAM
- EXISTING BUFFER ZONE 1
- EXISTING BUFFER ZONE 2
- EXISTING HILLSIDE/HILLCREST OVERLAY
- EXISTING HILLSIDE/HILLCREST OVERLAY BUFFER
- EXISTING EDGE OF PAVEMENT
- EXISTING STRUCTURES
- EXISTING MACK HATCHER SCENIC CORRIDOR
- PROPOSED ROADWAY CENTERLINE
- PROPOSED CURB & GUTTER
- PROPOSED EDGE OF PAVED DRIVE
- PROPOSED STRIPING
- PROPOSED SIDEWALK
- PROPOSED EASEMENT
- PROPOSED SUBJECT PROPERTY BOUNDARY
- PROPOSED RIGHT-OF-WAY
- PROPOSED BUILDING
- PROPOSED LIMITS OF DISTURBANCE
- 1050 PROPOSED INDEX (MAJOR) CONTOUR
- 1048 PROPOSED INTERMEDIATE (MINOR) CONTOUR
- 5.00% PROPOSED SLOPE LABEL
- ST PROPOSED STORM PIPE
- PROPOSED CURB INLET
- PROPOSED STORM MANHOLE
- PROPOSED LIMITS OF DETENTION POND
- RD PROPOSED ROOF DRAIN
- UD PROPOSED UNDERDRAIN





PROPOSED HILLHAVEN LANE CROSS SECTION

SCALE IN FEET
0 10 20

CITY OF FRANKLIN R.O.W. & ACCESS GENERAL NOTES:

1. PRIOR TO BEGINNING ANY CONSTRUCTION, THE DEVELOPER AND/OR CONTRACTOR, SHALL OBTAIN ALL NECESSARY PERMITS AS REQUIRED BY LAW. SUCH PERMITS MAY INCLUDE, BUT ARE NOT LIMITED TO, THOSE REQUIRED BY STATE OF TENNESSEE, WILLIAMSON COUNTY AND OTHER CITY OF FRANKLIN AGENCIES.
2. ALL OFF-SITE WORK WITHIN THE PUBLIC RIGHT-OF-WAY SHALL REQUIRE AN APPROVED TRAFFIC CONTROL PLAN WHICH COMPLIES WITH THE MUTCD. NO OFF-SITE EXCAVATION MAY BE UNDERTAKEN IN ANY STREET, ROAD, ALLEY OR RIGHT-OF-WAY OF ANY UTILITY OR TEMPORARY CONSTRUCTION EASEMENT OF THE CITY OF FRANKLIN BY ANY ENTITY UNLESS 72-HOUR NOTICE HAS BEEN GIVEN TO THE CITY OF FRANKLIN TRAFFIC OPERATIONS CENTER. THE CONTRACTOR SHALL HAVE AN APPROVED TRAFFIC CONTROL PLAN ONSITE DURING CONSTRUCTION.
3. CONSTRUCTION MATERIALS SHALL BE FULLY TESTED IN ACCORDANCE WITH THE DESIGNATIONS AND REQUIREMENTS WITHIN THE REFERENCED "TDOT STANDARD SPECIFICATIONS" SECTIONS, UNLESS OTHERWISE NOTED WITHIN THE "STANDARD SPECIFICATIONS" SECTION OF THE CITY OF FRANKLIN TRANSPORTATION & STREET TECHNICAL STANDARDS.
4. AN AUTHORIZED REPRESENTATIVE OF THE CITY SHALL MAKE A FINAL INSPECTION OF THE PROJECT AFTER COMPLETION TO DETERMINE ACCEPTABILITY OF THE WORK AND FOR RELEASE OF PERFORMANCE BONDS IF REQUIRED. BEFORE THIS FINAL INSPECTION CAN BE MADE, THE ENGINEER RESPONSIBLE FOR THE PROJECT SHALL CERTIFY IN WRITING TO THE CITY ENGINEER THAT THE WORK HAS BEEN COMPLETED IN ACCORDANCE WITH APPROVED PLANS AND SPECIFICATIONS.
5. LOCATING AND COORDINATION FOR THE RELOCATION OF EXISTING UTILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR. TENNESSEE'S ONE-CALL AND THE CITY OF FRANKLIN UTILITY LOCATION SERVICE SHALL BE UTILIZED IN ADDITION TO COORDINATION WITH LOCAL UTILITY OWNERS. THE CONTRACTOR SHALL AT ALL TIMES PROTECT EXISTING UTILITIES AND WILL BE RESPONSIBLE FOR COSTS DUE TO DAMAGE CAUSED TO ANY UTILITY LINES.
6. ALL TEMPORARY STRIPING SHALL CONFORM TO " STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" PUBLISHED BY TDOT,, THE LATEST REVISION EXCEPT AS HEREIN AMENDED. WHEN APPROVED, TEMPORARY STRIPING SHALL BE REQUIRED PRIOR TO THE OPENING OF A STREET FOR TRAVEL WHERE PAVEMENT AND/OR PERMANENT STRIPING CANNOT BE COMPLETED DUE TO WEATHER AND/OR TIME CONSTRAINTS.
7. THERMOPLASTIC PAVEMENT MARKINGS SHOULD BE USED ON ALL PUBLIC AND PRIVATE CITY STREET PROJECTS. THERMOPLASTIC TRAFFIC STRIPING AND PAVEMENT MARKINGS SHALL CONFORM TO SECTION 716.03 "THERMOPLASTIC PAVEMENT MARKINGS" OF THE TENNESSEE DEPARTMENT OF TRANSPORTATION SPECIFICATIONS (TDOT), AND TO THE CITY OF FRANKLIN TRANSPORTATION & STREET TECHNICAL STANDARDS.

R.O.W. & ACCESS DATA CHART:

DAILY TRIP GENERATION:	315 VEH. PER DAY
PEAK HOUR TRIP GENERATION:	31 VEH. PER HOUR
TRAFFIC IMPACT STUDY REQUIRED:	NO
CIRCULATION PLAN REQUIRED:	NO

ROADWAY NETWORK NARRATIVE

TRAFFIC ENTERING AND EXITING THE DEVELOPMENT WILL USE THE EXISTING HILLHAVEN LANE AND ITS EXISTING INTERSECTION OF LIBERTY PIKE.

ROADWAY NETWORK IMPACT STATEMENT

THE NUMBER OF TRIPS GENERATED BY THE DEVELOPMENT DOES NOT MEET THE CRITERIA TO REQUIRE A TRAFFIC IMPACT STUDY, THEREFORE, THE DEVELOPMENT IS NOT EXPECTED TO CAUSE ANY SIGNIFICANT IMPACTS TO TRAFFIC.

GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHP -HILL HAVEN PROPERTY MASTER PLAN

Franklin, Williamson County, Tennessee

Civil & Environmental Consultants, Inc.
117 Seaboard Lane · Suite E-100 · Franklin, TN 37067
615-333-7797 · 800-763-2326
www.cecinc.com

Revision Date

ROBERT G. MORTON
REGISTERED ENGINEER
AGRICULTURE
No. 109382
STATE OF TENNESSEE
3/4/2021

ROW & ACCESS PLAN

SHEET
C4.0A
COF # 7372

NORTH

DATA TABLE:

NUMBER OF FRONT AXLES	= 1
FRONT TRACK WIDTH	= 6.5'
WHEELS ON EACH FRONT AXLE	= 2
NUMBER OF REAR AXLES	= 1
REAR TRACK WIDTH	= 6.5'
WHEEL BASE	= 19.5'
REAR AXLE SPACING	= 6.5'
BODY LENGTH	= 35.0'
WIDTH	= 8.083'
REAR OVERHANG	= 11.25'
BODY STYLE	FEL REFUSE TRUCK
TURNING RADIUS WALL TO WALL	= 46'
DESIGN SPEED	= 5 MPH
LOCK-TO-LOCK TIME	= 6.00s

LEGEND

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ROBERT G. MORTON
REGISTERED ENGINEER
AGRICULTURE
No. 106385
STATE OF TENNESSEE
3/4/202

GAMBLE DESIGN COLLABORATIVE
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Franklin, Williamson County, Tennessee

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www.cecinc.com

Revision Date

FEL ROW & ACCESS PLAN

SHEET

C4.0B

COF # 7372

LEGEND

- EXISTING PROPERTY LINE
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ROBERT G. MORTON
REGISTERED ENGINEER
AGRICULTURE
No. 109386
STATE OF TENNESSEE
3/4/2022

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Revision Date
△ _____
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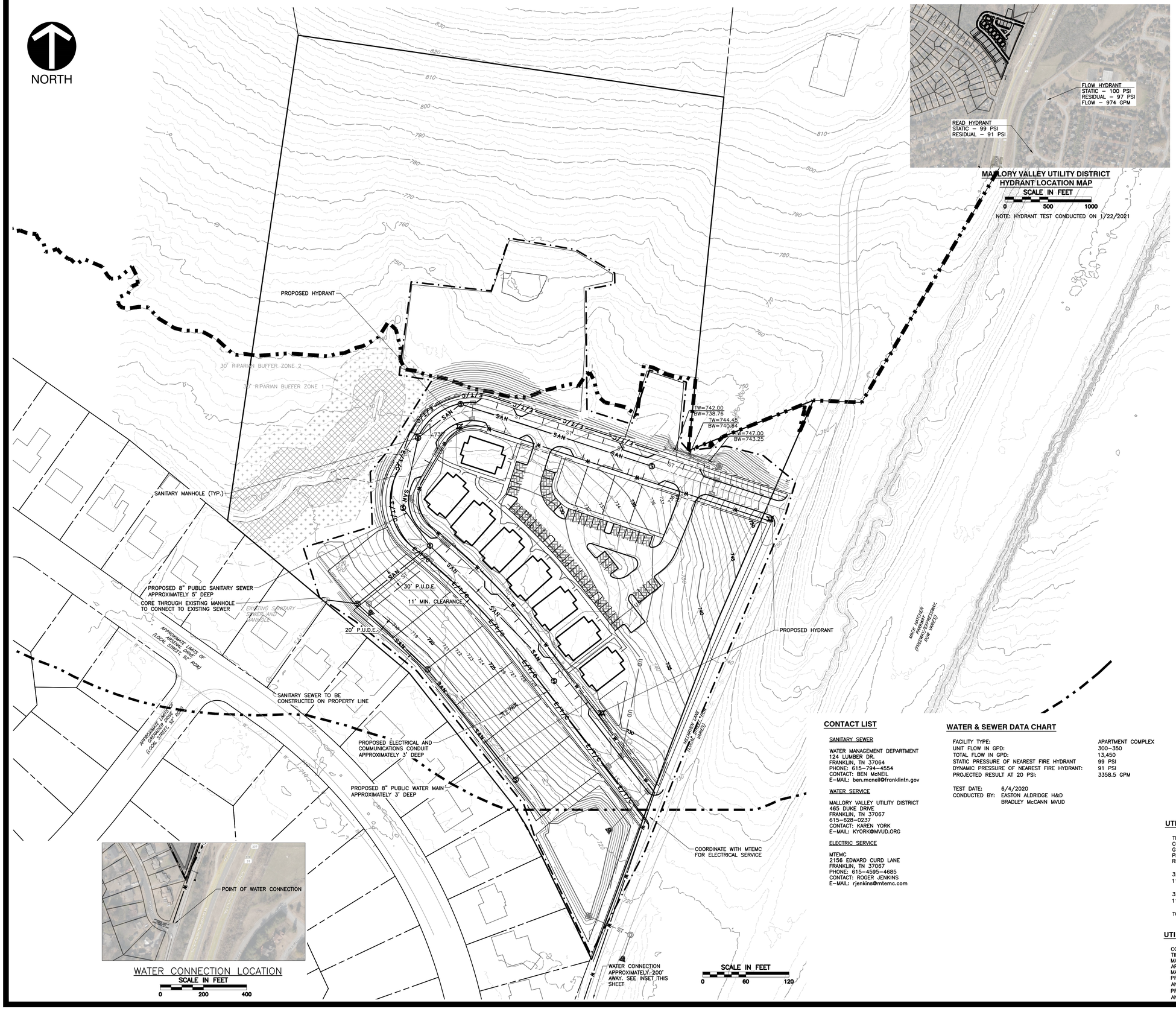
LIBERTY PIKE CONNECTION PLAN
SHEET
C4.0C
COF # 7372

NORTH



MALLORY VALLEY UTILITY DISTRICT
HYDRANT LOCATION MAP
SCALE IN FEET
0 500 1000
NOTE: HYDRANT TEST CONDUCTED ON 1/22/2021

WATER CONNECTION LOCATION
SCALE IN FEET
0 200 400

LEGEND

- EXISTING PROPERTY LINE
- EXISTING RIGHT–OF–WAY
- 385 EXISTING INDEX (MAJOR) CONTOUR
- EXISTING INTERMEDIATE (MINOR) CONTOUR
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GENERAL UTILITY NOTES

1. ALL PERSONS WHO UNDERTAKE THE CONSTRUCTION OF WATER, SEWER AND/OR RECLAIMED WATER LINES LOCATED IN, OR AFFECTING SERVICES PROVIDED BY THE CITY OF FRANKLIN SHALL COMPLY WITH THE REQUIREMENTS AND REGULATIONS SET FORTH IN THE "GENERAL REQUIREMENTS & TECHNICAL SPECIFICATIONS, WATER MANAGEMENT DEPARTMENT, CITY OF FRANKLIN, TENNESSEE" LATEST EDITION, ALONG WITH ANY AMENDMENTS, ADDITIONS, OR ALTERATION THAT MAY THEREAFTER BE ADOPTED BY THE BOARD OF MAYOR AND ALDERMEN BY RESOLUTION.
2. CONTRACTOR SHALL OBTAIN WATER & SEWER INFRASTRUCTURE INSTALLATION PERMIT PRIOR TO SCHEDULING REQUIRED PRE–CONSTRUCTION SITE MEETING. CONTRACTOR SHALL COMPLETE THE PRE–CONSTRUCTION SITE MEETING PRIOR TO COMMENCING WITH CONSTRUCTION.
3. CONTRACTOR SHALL OBTAIN AND KEEP ALL OF THE FOLLOWING ITEMS ON THE JOBSITE AT ALL TIMES DURING CONSTRUCTION:
   A. APPROVED, STAMPED AND SIGNED WATER AND/OR SEWER PLANS
   B. WATER & SEWER INFRASTRUCTURE INSTALLATION PERMIT, WITH ALL STEPS COMPLETED AND SIGNED BY APPROPRIATE CITY EMPLOYEES.
   C. COPY OF APPROVED AVAILABILITY REQUEST RESPONSE LETTER.
   D. A COPY OF ALL APPROVED CUT SHEETS.
4. ACCEPTANCE OF CITY OF FRANKLIN PUBLIC WATER INFRASTRUCTURE, SANITARY SEWER INFRASTRUCTURE AND/OR RECLAIMED WATER INFRASTRUCTURE SHALL BECOME THE RESPONSIBILITY OF THE CITY OF FRANKLIN, TN FOLLOWING APPROVAL FROM THE CITY OF FRANKLIN INSPECTORS AND ACCEPTANCE BY THE FRANKLIN MUNICIPAL PLANNING COMMISSION. THE ACCEPTANCE DATE SHALL BE BASED ON THE DAY MAINTENANCE SURETIES ARE ESTABLISHED BY THE FRANKLIN MUNICIPAL PLANNING COMMISSION.
5. PRIOR TO THE ACCEPTANCE OF CITY OF FRANKLIN PUBLIC WATER INFRASTRUCTURE, SANITARY SEWER INFRASTRUCTURE AND/OR RECLAIMED WATER INFRASTRUCTURE THE CONTRACTOR SHALL BE REQUIRED TO SUBMIT AS–BUILT DRAWINGS TO THE PLANNING AND SUSTAINABILITY DEPARTMENT.
6. ALL OFF–SITE WORK WITHIN THE PUBLIC RIGHT–OF–WAY SHALL REQUIRE AN APPROVED TRAFFIC CONTROL PLAN WHICH COMPLIES WITH THE MUTCD. NO OFF–SITE EXCAVATION MAY BE UNDERTAKEN IN ANY STREET, ROAD, ALLEY OR RIGHT–OF–WAY OF ANY UTILITY OR TEMPORARY CONSTRUCTION EASEMENT OF THE CITY OF FRANKLIN BY ANY ENTITY UNLESS 72–HOUR NOTICE HAS BEEN GIVEN TO THE CITY OF FRANKLIN TRAFFIC OPERATIONS CENTER. THE CONTRACTOR SHALL HAVE AN APPROVED TRAFFIC CONTROL PLAN ONSITE DURING CONSTRUCTION.
7. ANY DAMAGES CAUSED TO EXISTING UTILITIES DURING CONSTRUCTION SHALL, AT HIS OWN EXPENSE, BE REPLACED OR REPAIRED TO ORIGINAL CONDITION AND QUALITY, AS APPROVED BY THE OWNER AND REPRESENTATIVE OF THE APPROPRIATE UTILITY COMPANY, BY THE CONTRACTOR.
8. ALL RESIDENTIAL METERS WILL BE 1" DIAMETER TO ALLOW FOR BUILDINGS TO BE SPRINKLED.

CONTACT LIST

SANITARY SEWER

WATER MANAGEMENT DEPARTMENT
124 LUMBER DR.
FRANKLIN, TN 37064
PHONE: 615–794–4554
CONTACT: BEN McNEIL
E–MAIL: ben.mcneil@franklintn.gov

WATER SERVICE

MALLORY VALLEY UTILITY DISTRICT
465 DUKE DRIVE
FRANKLIN, TN 37067
615–628–0237
CONTACT: KAREN YORK
E–MAIL: KYORK@MVUD.ORG

ELECTRIC SERVICE

MTEMC
2156 EDWARD CURD LANE
FRANKLIN, TN 37067
PHONE: 615–4595–4685
CONTACT: ROGER JENKINS
E–MAIL: rjenkins@mtemc.com

WATER & SEWER DATA CHART

FACILITY TYPE:	APARTMENT COMPLEX
UNIT FLOW IN GPD:	300–350
TOTAL FLOW IN GPD:	13,450
STATIC PRESSURE OF NEAREST FIRE HYDRANT:	99 PSI
DYNAMIC PRESSURE OF NEAREST FIRE HYDRANT:	91 PSI
PROJECTED RESULT AT 20 PSI:	3358.5 GPM
TEST DATE:	6/4/2020
CONDUCTED BY:	EASTON ALDRIDGE H&D
	BRADLEY McCANN MVUD

UTILITY PLAN IMPACT STATEMENT

THE HILL HAVEN LANE DEVELOPMENT IS EXPECTED TO CONSUME 13,450 GALLONS PER DAY OF WATER AND GENERATE 13,450 GALLONS PER DAY OF WASTEWATER PER CITY OF FRANKLIN WATER SEWER AVAILABILITY REQUEST FORM. WORK SHOWN BELOW

32 TWO–BEDROOM APARTMENTS
11 SINGLE–FAMILY UNITS

32 X 300 GPD = 9,600 GPD
11 X 350 GPD = 3,850 GPD

TOTAL = 13,450 GPD

UTILITY PLAN NARRATIVE

CONSTRUCTION PHASING IS NOT ANTICIPATED AT THIS TIME. SANITARY SEWER WILL CONNECT TO EXISTING MANHOLE IN AN EASEMENT LOCATED ADJACENT TO 733 ARSENAL DRIVE. WATER SERVICE WILL TIE TO EXISTING MAIN ON ARSENAL DRIVE NEAR GRENADIER DRIVE. PROPOSED SANITARY SEWER AND WATER LINES ARE ANTICIPATED TO BE AT LEAST 4' BELOW GRADE. PROPOSED SANITARY SEWER AND WATER LINES ARE ANTICIPATED TO BE 8" IN DIAMETER.

ROBERT G. MORTON
REGISTERED ENGINEER
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No. 108080
STATE OF TENNESSEE
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GDC
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CHP -HILL HAVEN PROPERTY MASTER PLAN

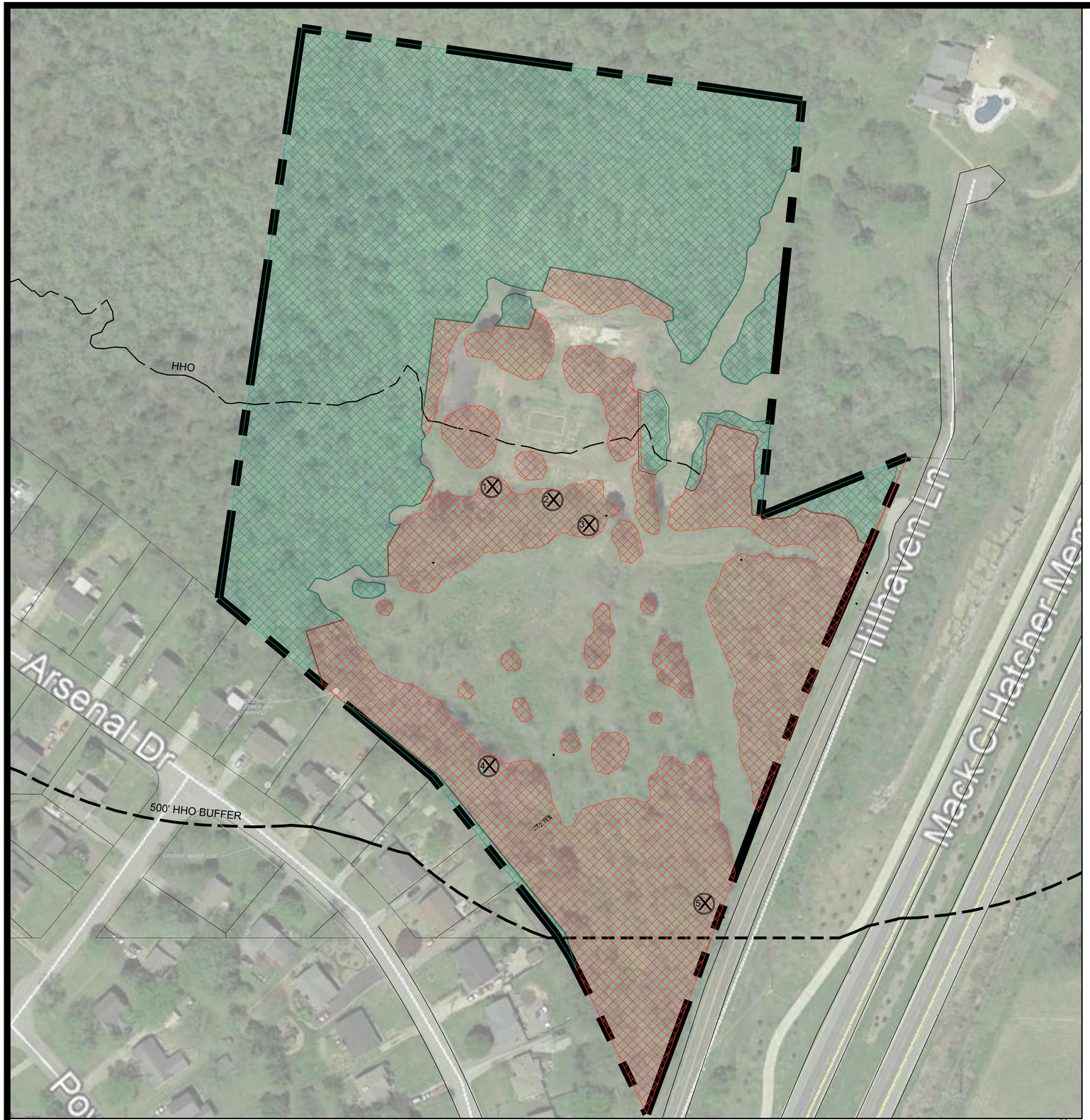
Franklin, Williamson County, Tennessee

CEC
Civil & Environmental Consultants, Inc.
117 Seaboard Lane · Suite E-100 · Franklin, TN 37067
615-333-7797 · 800-763-2326
www.cecinc.com

Revision Date
- △ _____
- △ _____
- △ _____
- △ _____

UTILITY PLAN

SHEET
C5.0
COF # 7372



SITE DATA:

PROJECT NAME:	CHP - HILLHAVEN DEVELOPMENT PLAN
PROJECT NUMBER:	7372
PARCEL ID:	062 00100 00009062
ADDRESS:	171 HILLHAVEN LANE
CITY:	FRANKLIN
COUNTY:	WILLIAMSON
STATE:	TENNESSEE
CIVIL DISTRICT:	9TH CIVIL DISTRICT
SITE ACREAGE:	13.81 AC
EXISTING ZONING:	ER
PROPOSED ZONING:	PD (3.12 DUA)
APPLICABLE OVERLAYS:	HHO, HHO 500' BUFFER
MINIMUM REQUIRED SETBACK LINES:	
65' LOTS	
FRONT YARD SETBACK:	10'
SIDE YARD SETBACK:	7.5'
REAR YARD SETBACK:	20'
40' LOTS	
FRONT YARD SETBACK:	10'
SIDE YARD SETBACK	5'
REAR YARD SETBACK:	5'
OWNER:	CUMBERLAND & WESTERN RESOURCES LLC
ADDRESS:	2200 LAPSLEY LANE BOWLING GREEN, KY 42103
APPLICANT:	GAMBLE DESIGN COLLABORATIVE
ADDRESS:	354 LIBERTY PIKE SUITE 145 FRANKLIN, TN 37064
CONTACT:	GREG GAMBLE 615.975.5765
EMAIL ADDRESS:	greggamble209@gmail.com
BUILDING SQUARE FOOTAGE:	N/A
NUMBER OF RESIDENTIAL UNITS:	11 SINGLE FAMILY 32 TWO-BEDROOM CONDOS (8 MULTIPLEX BUILDINGS WITH 4 CONDOS EACH)
NUMBER OF TOTAL DWELLINGS:	43 UNITS
BUILDING HEIGHT:	2 STORIES
MINIMUM REQUIRED LSR:	.20 / 2.76 AC
MINIMUM PARKING REQUIREMENT:	102 SPACES
11 SINGLE FAMILY DETACHED (2/UNIT)	22 SPACES
32 2 BEDROOM CONDOS (2.5/UNIT)	80 SPACES
PARKING PROVIDED:	102 SPACES
SINGLE FAMILY DETACHED LOTS 1-7, AND 11: PRIVATE PARKING ON LOT:	16 SPACES
SINGLE FAMILY LOTS 8-10 AND MULTIPLEXES: ON-STREET PARKING:	35 SPACES
PARKING LOT SPACES:	51 SPACES
RESIDENTIAL DENSITY:	3.12 DUA
EXISTING TREE CANOPY:	10.13 AC (73.35% OF TOTAL SITE)
OPEN SPACE:	
OPEN SPACE ACREAGE REQUIRED:	5% (0.70 AC)
NATURAL AREA ACREAGE REQUIRED:	10% (1.37 AC)
PARKLAND AGREEMENT	43 UNITS X $4,304=$185,072 REQUEST FEES IN LIEU PAYMENT SHALL BE PAID AT THE FIRST PLAT

KEY

TREE CANOPY

- REMOVED TREE CANOPY
- PRESERVED TREE CANOPY
- TREE PROTECTION FENCE
- SPECIMEN TREE REMOVED

TREE CANOPY RETENTION

OVERALL SITE AREA = 601,563.6 SF (13.81 AC)

EXISTING TREE CANOPY	PRESERVED TREE CANOPY
441,082.5 (10.13 AC)	260,779 SF (5.99 AC)

TREE CANOPY DATA:

TOTAL EXISTING TREE CANOPY:	441,082.5 SF; 10.13 AC (73.35% OF SITE)
REQUIRED CANOPY PRESERVATION:	36% (158,854.6 SF; 3.65 AC)
PROVIDED CANOPY PRESERVATION:	260,779 SF; 5.99 AC (59.18% OF EXISTING TREE CANOPY)

NO.	SIZE	SPECIES	REMOVED	RETAINED
1	35"	OSAGE ORANGE	X	
2	24"	AMERICAN BEECH	X	
3	24"	HACKBERRY	X	
4	25"	AMERICAN BEECH	X	
5	42"	HACKBERRY	X	

TOTAL NUMBER OF INCHES REMOVED	150
NUMBER OF REPLACEMENT INCHES REQUIRED	300

NOTE*: TREE SURVEY PERFORMED BY LANDSCAPE ARCHITECT. SURVEYOR TO PERFORM TREE SURVEY PRIOR TO SITE PLAN. MEASUREMENTS MAY VARY.

TREE PROTECTION NOTES:

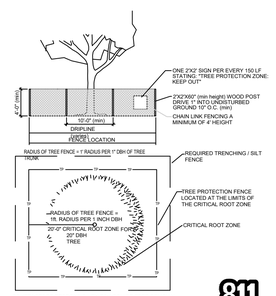
1. The tree protection barriers shall be constructed before the issuance of any permits, and shall remain intact throughout the entire period of construction.

2. The tree protection barrier shall be installed as labeled on this plan or a distance to the radius of the dripline, whichever is greatest, as measured from the trunk of the protected tree.

3. Any required excavation in or around the protection zone to accommodate underground services, footings, etc; shall be indicated on the plan, and shall be excavated by hand. In addition, related root pruning shall be accomplished via ANSI A-300-95 standard so as to minimize impact on the general root system.

4. The storage of building materials or stock piling shall not be permitted within the limits of or against the protection barriers.

5. Trees within the protection barriers must be adequately cared for throughout the construction process (i.e., they must be watered sufficiently). Fill shall not be placed upon the root system as to endanger the health or life of the affected tree.



TREE PROTECTION FENCING DETAIL
NTS

811 Know what's below. Call before you dig.

GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHP - HILLHAVEN DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

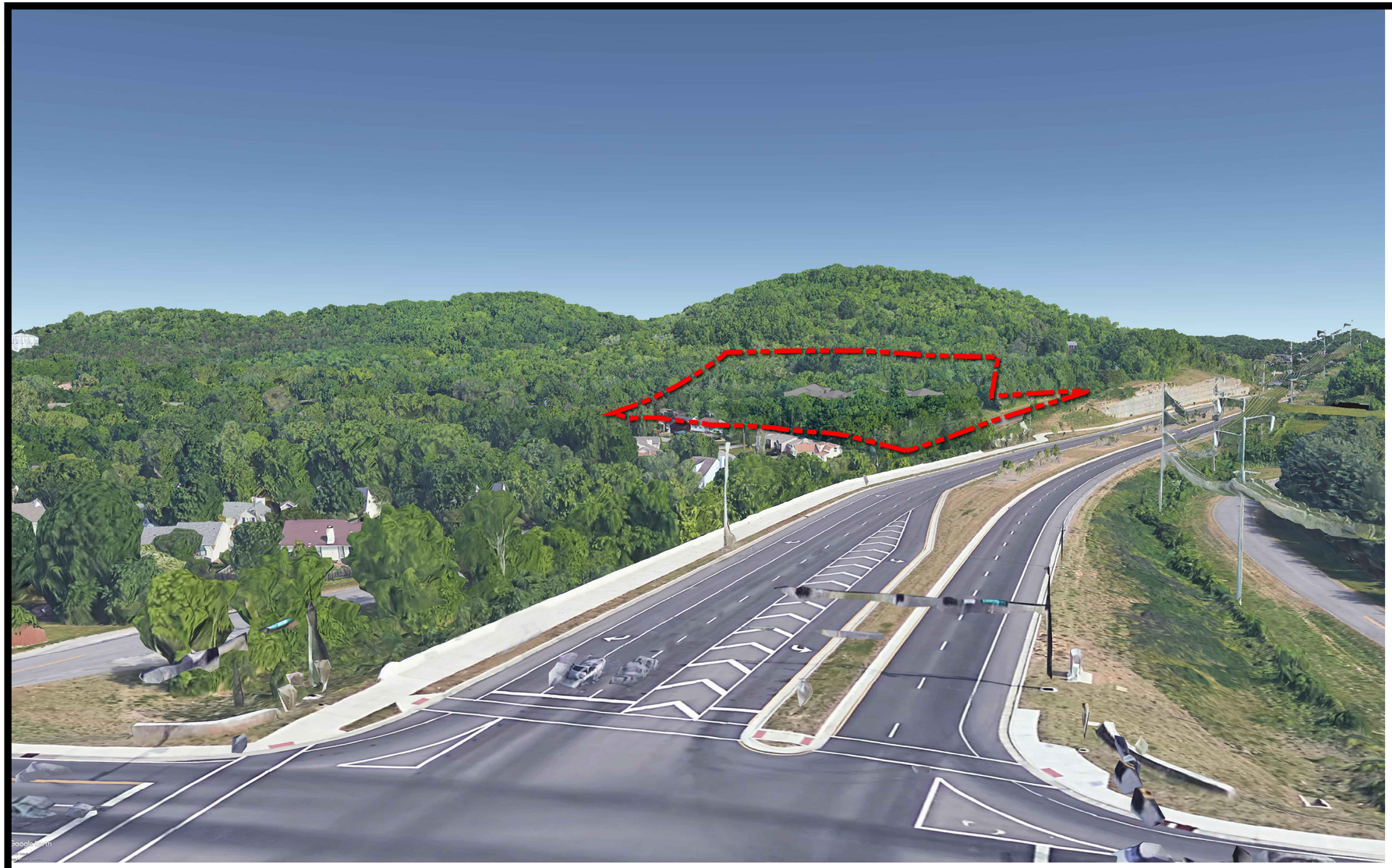
DRAKE A. REEDER REGISTERED LANDSCAPE ARCHITECT TENNESSEE No. 329 05.01.2024

Revision Date

TREE PRESERVATION

SHEET
L1.0

COF # 7372



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CIVIL DISTRICT:	9TH CIVIL DISTRICT
SITE ACREAGE:	13.81 AC
EXISTING ZONING:	ER
PROPOSED ZONING:	PD (3.12 DUA)
APPLICABLE OVERLAYS:	HHO, HHO 500' BUFFER
MINIMUM REQUIRED SETBACK LINES:	
65' LOTS	
FRONT YARD SETBACK:	10'
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	43 UNITS X $4,304=$185,072 REQUEST FEES IN LIEU PAYMENT SHALL BE PAID AT THE FIRST PLAT

GDC
GAMBLE
DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND
LANDSCAPE ARCHITECTURE

CHP - HILLHAVEN DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

DRAKE A. REEDER
REGISTERED
03.04.2021
COMMERCE
TENNESSEE No. 12
LANDSCAPE ARCHITECT

Revision Date

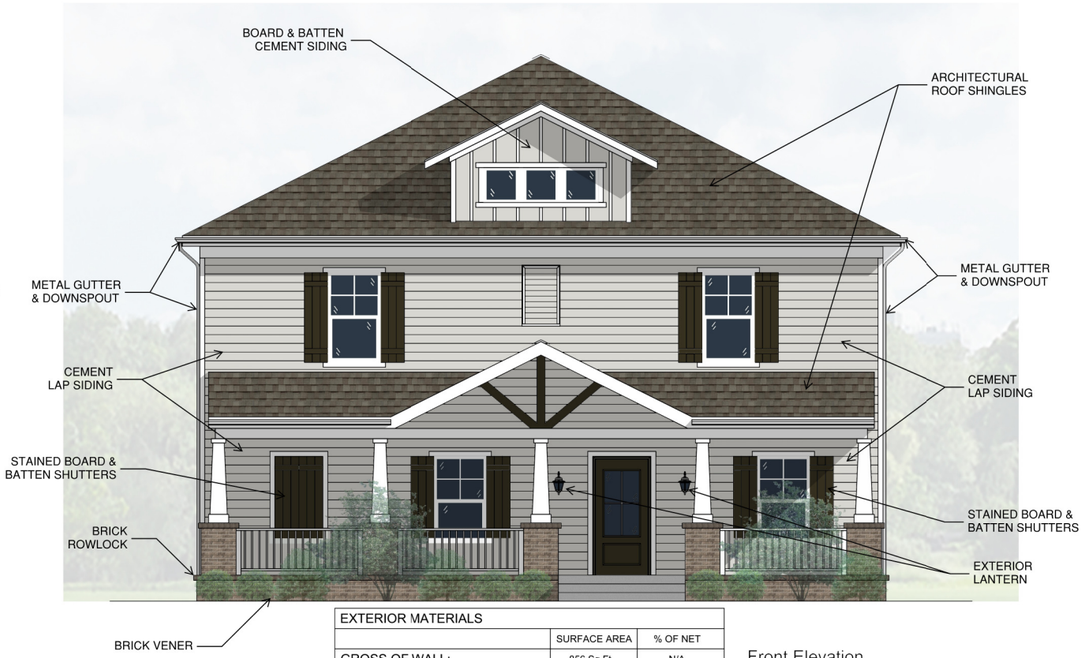
ARCHITECTURAL MODELING

SHEET
A0.0

COF # 7372

EXTERIOR MATERIALS		
	SURFACE AREA	% OF NET
GROSS OF WALL:	831 Sq.Ft.	N/A
NET OF WALL*:	733 Sq.Ft.	100%
NET BRICK:	59 Sq.Ft.	8%
NET CEMENT BOARD & BATTEN:	37 Sq.Ft.	5%
NET CEMENT LAP SIDING:	636 Sq.Ft.	87%
* EXCLUSED DOORS, WINDOWS, AND MINOR TRIM		

Rear Elevation
SCALE: $\frac{1}{4}$" = 1'-0"



EXTERIOR MATERIALS		
	SURFACE AREA	% OF NET
GROSS OF WALL:	856 Sq.Ft.	N/A
NET OF WALL*:	758 Sq.Ft.	100%
NET BRICK:	90 Sq.Ft.	12%
NET CEMENT BOARD & BATTEN:	39 Sq.Ft.	5%
NET CEMENT LAP SIDING:	629 Sq.Ft.	83%
* EXCLUSED DOORS, WINDOWS, AND MINOR TRIM		

Front Elevation
SCALE: $\frac{1}{4}$" = 1'-0"

EXTERIOR MATERIALS		
	SURFACE AREA	% OF NET
GROSS OF WALL:	1,173 Sq.Ft.	N/A
NET OF WALL*:	1,049 Sq.Ft.	100%
NET BRICK:	110 Sq.Ft.	10%
NET CEMENT BOARD & BATTEN:	10 Sq.Ft.	1%
NET CEMENT LAP SIDING:	929 Sq.Ft.	89%
* EXCLUSED DOORS, WINDOWS, AND MINOR TRIM		

Right Elevation
SCALE: $\frac{1}{4}$" = 1'-0"

PRELIMINARY:
NOT FOR
CONSTRUCTION

PAD
Purser Architecture + Design, PLLC
2819 Columbine Place, Suite #5
Nashville, TN 37204
615.943.8615
www.padpllc.com

chp
COMMUNITY HOUSING PARTNERSHIP
OF WILLIAMSON COUNTY
129 W. Fowlkes Street #124
Franklin, TN 37064

Hill Haven Development
Big House 4-Unit Condo
Franklin, TN 37064

JOHN DAVID PURSER
REGISTERED ARCHITECT
No. 103268
STATE OF TENNESSEE
01/06/21

No.	Revision/Issue	Date

Project Number:
Drawn by: TVH
Checked by: DP
Issue: 01/06/2021
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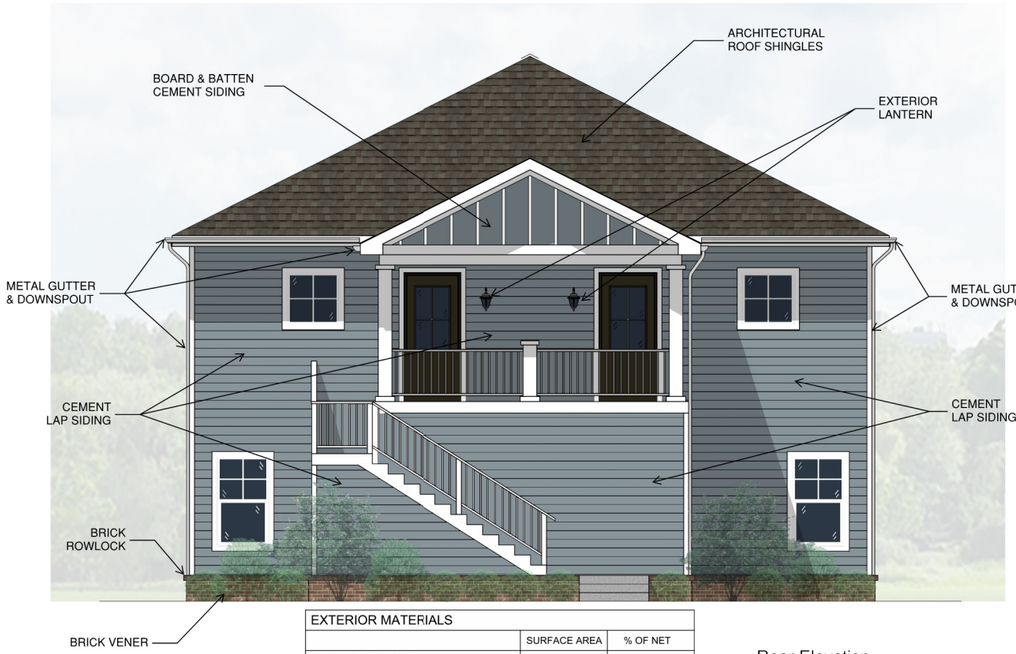
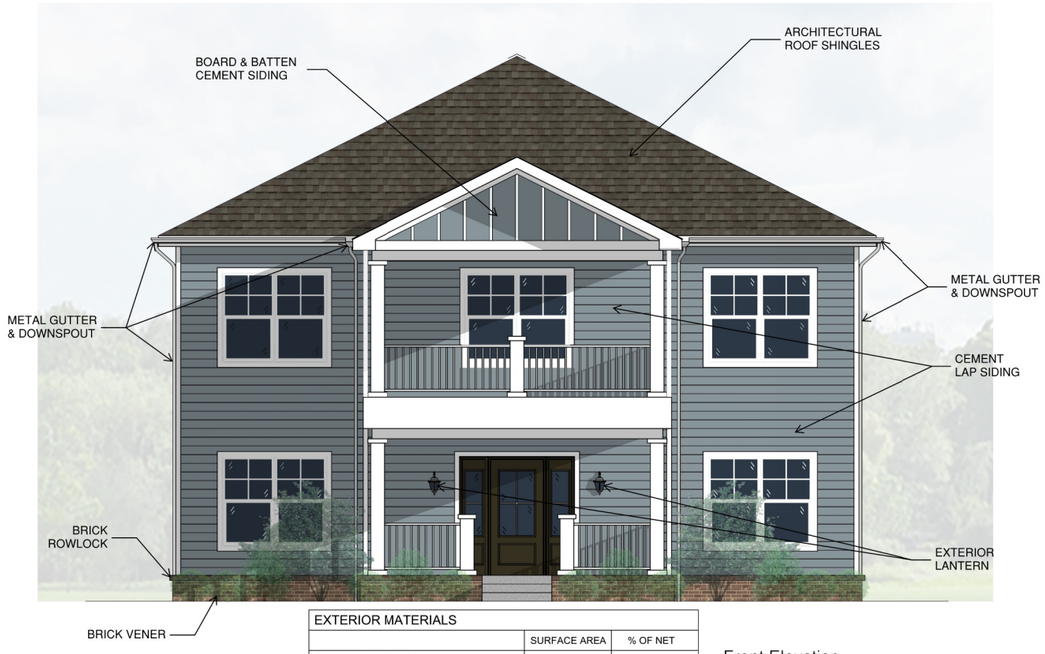
Sheet Title & Number:
Exterior Elevations
Scheme-A

A1.1



EXTERIOR MATERIALS		
	SURFACE AREA	% OF NET
GROSS OF WALL:	831 Sq.Ft.	N/A
NET OF WALL*:	733 Sq.Ft.	100%
NET BRICK:	59 Sq.Ft.	8%
NET CEMENT BOARD & BATTEN:	37 Sq.Ft.	5%
NET CEMENT LAP SIDING:	636 Sq.Ft.	87%
* EXCLUSED DOORS, WINDOWS, AND MINOR TRIM		

Rear Elevation
SCALE: 1/4" = 1'-0"



EXTERIOR MATERIALS		
	SURFACE AREA	% OF NET
GROSS OF WALL:	843 Sq.Ft.	N/A
NET OF WALL*:	643 Sq.Ft.	100%
NET BRICK:	60 Sq.Ft.	9%
NET CEMENT BOARD & BATTEN:	29 Sq.Ft.	5%
NET CEMENT LAP SIDING:	554 Sq.Ft.	86%
* EXCLUSED DOORS, WINDOWS, AND MINOR TRIM		

Front Elevation
SCALE: 1/4" = 1'-0"

EXTERIOR MATERIALS		
	SURFACE AREA	% OF NET
GROSS OF WALL:	1,201 Sq.Ft.	N/A
NET OF WALL*:	1,068 Sq.Ft.	100%
NET BRICK:	107 Sq.Ft.	10%
NET CEMENT BOARD & BATTEN:	0 Sq.Ft.	0%
NET CEMENT LAP SIDING:	961 Sq.Ft.	90%
* EXCLUSED DOORS, WINDOWS, AND MINOR TRIM		

Right Elevation
SCALE: 1/4" = 1'-0"

PRELIMINARY:
NOT FOR
CONSTRUCTION

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Purser Architecture + Design, PLLC
2819 Columbine Place, Suite #5
Nashville, TN 37204
615.943.8615
www.padpllc.com

chp
COMMUNITY HOUSING PARTNERSHIP
OF WILLIAMSON COUNTY
129 W. Fowlkes Street #124
Franklin, TN 37064

Hill Haven Development
Big House 4-Unit Condo
Franklin, TN 37064

JOHN DAVID PURSER
REGISTERED ARCHITECT
No. 103749
STATE OF TENNESSEE
01/06/21

No.	Revision/Issue	Date

Project Number:
Drawn by: TVH
Checked by: DP
Issue: 01/06/2021
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Sheet Title & Number:
Exterior Elevation
Scheme-B

A2.1

TYPICAL ARCHITECTURAL NOTES:

1. THESE ELEVATIONS HAVE BEEN DESIGNED TO MEET THE REQUIREMENTS OF THE CITY OF FRANKLIN'S ARCHITECTURAL DESIGN STANDARDS AND THE APPROVAL OF THE PLANNING COMMISSION/ CITY OF FRANKLIN. CHANGES SHALL NOT BE MADE TO THE APPROVED ELEVATIONS UNLESS APPROVED BY EITHER THE BNS DIRECTOR OR THE PLANNING COMMISSION.

2. THESE ELEVATIONS ARE A SAMPLING OF THE PROPOSED HOME ELEVATIONS. THE APPLICANT ANTICIPATES MULTIPLE VARIATIONS OF MATERIALS OF EACH ELEVATION PROVIDED. MATERIALS AND COLORS ARE SUBJECT TO FINAL APPROVAL BY THE CITY OF FRANKLIN.

3. FINISHED FLOOR ELEVATION (FFE) SHALL BE A MINIMUM 18" ABOVE FINISH GRADE PER CITY OF FRANKLIN REQUIREMENTS.

4. PRIMARY MATERIALS ON A FRONT FACADE SHALL CONTINUE DOWN SIDE FACADES AT LEAST 20 FEET AND THE ENTIRE LENGTH OF SIDE FACADE FACING A FRONTAGE. EXCLUDING TRIM, ANY MATERIAL CHANGES SHALL COINCIDE WITH FORM, STRUCTURAL, OR MASSING CHANGES AND SHALL NOT OCCUR AT THE OUTSIDE CORNER OF SUCH CHANGE.

5. SIDE FACADE FACING FRONTAGE SHALL HAVE A SIMILAR LEVEL OF ARCHITECTURAL DETAILING, WINDOW ALIGNMENT, AND ORGANIZATION AS THE FRONT FACADE.

TYPICAL ARCHITECTURAL STANDARDS:

PROPOSED HEIGHT OF BUILDINGS: 1 STORY
PROPOSED SQUARE FOOTAGE OF BUILDINGS: +/- 1,100 S.F.

ARCHITECTURAL INTENT:

1. THE HOMES WITHIN THE DEVELOPMENT WILL BE OF A COTTAGE STYLE.

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Nashville, TN 37204
615.943.8615
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COMMUNITY HOUSING PARTNERSHIP OF WILLIAMSON COUNTY
129 W. Fowlkes Street #124
Franklin, TN 37064

Hill Haven Development
Single Family Homes
Franklin, TN 37064

JOHN DAVID PURSER — REGISTERED ARCHITECT — STATE OF TENNESSEE — No. 107268 — 10/12/20

No.	Revision/Issue	Date

Project Number:
Drawn by: TVH
Checked by: DP
Issue: 10/12/2020
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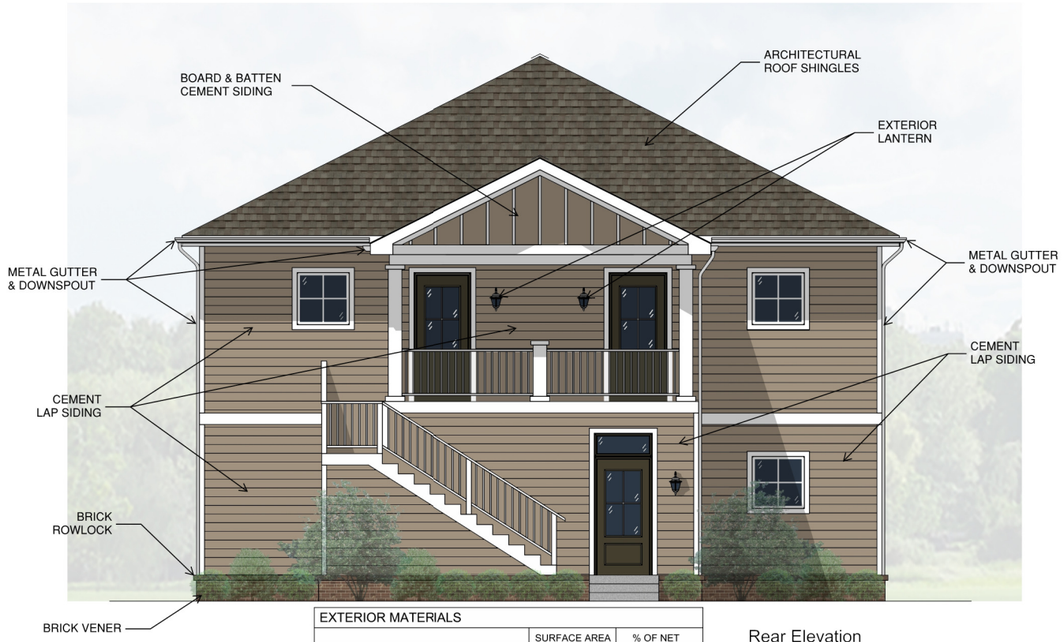
Sheet Title & Number:
Architectural Elevations

PRELIMINARY:
NOT FOR
CONSTRUCTION

A3.0



EXTERIOR MATERIALS		
	SURFACE AREA	% OF NET
GROSS OF WALL:	831 Sq.Ft.	N/A
NET OF WALL*:	733 Sq.Ft.	100%
NET BRICK:	59 Sq.Ft.	8%
NET CEMENT BOARD & BATTEN:	37 Sq.Ft.	5%
NET CEMENT LAP SIDING:	636 Sq.Ft.	87%
* EXCLUSED DOORS, WINDOWS, AND MINOR TRIM		

Rear Elevation
SCALE: $\frac{1}{4}$" = 1'-0"

EXTERIOR MATERIALS		
	SURFACE AREA	% OF NET
GROSS OF WALL:	804 Sq.Ft.	N/A
NET OF WALL*:	688 Sq.Ft.	100%
NET BRICK:	84 Sq.Ft.	12%
NET CEMENT BOARD & BATTEN:	0 Sq.Ft.	0%
NET CEMENT LAP SIDING:	604 Sq.Ft.	88%
* EXCLUSED DOORS, WINDOWS, AND MINOR TRIM		

Front Elevation
SCALE: $\frac{1}{4}$" = 1'-0"

EXTERIOR MATERIALS		
	SURFACE AREA	% OF NET
GROSS OF WALL:	1,163 Sq.Ft.	N/A
NET OF WALL*:	1,031 Sq.Ft.	100%
NET BRICK:	110 Sq.Ft.	11%
NET CEMENT BOARD & BATTEN:	0 Sq.Ft.	0%
NET CEMENT LAP SIDING:	921 Sq.Ft.	89%
* EXCLUSED DOORS, WINDOWS, AND MINOR TRIM		

Right Elevation
SCALE: $\frac{1}{4}$" = 1'-0"

PRELIMINARY:
NOT FOR
CONSTRUCTION

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Hill Haven Development
Big House 4-Unit Condo
Franklin, TN 37064

JOHN DAVID PURSER — REGISTERED ARCHITECT — No. 103268 — STATE OF TENNESSEE — 01/06/21

No.	Revision/Issue	Date

Project Number:
Drawn by: TVH
Checked by: DP
Issue: 01/06/2021
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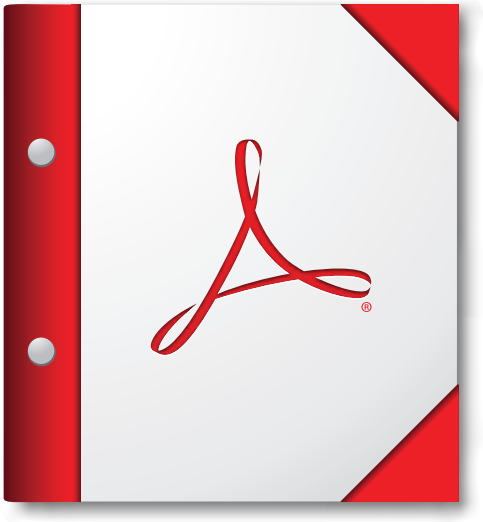
Sheet Title & Number:
Exterior Elevation
Scheme-C

A3.1



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City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01840

DATE: March 25, 2021

TO: Board of Mayor and Aldermen

FROM: Eric Stuckey, City Administrator
Lisa Clayton, Director of Parks

SUBJECT:

Consideration Of COF Contract No. 2021-0002, Parkland Impact Fee Payment Only Agreement Between The City Of Franklin And Community Housing Partnership For CHP - Hillhaven Development.

PURPOSE:

Consideration of COF Contract No. 2021-0002, Parkland Impact Fee Payment Only Agreement Between The City Of Franklin And Community Housing Partnership (CHP) for the CHP - Hillhaven Development.

BACKGROUND/STAFF COMMENTS:

The Community Housing Partnership (CHP) is in the process of developing the property located at 171 HILLHAVEN LANE (the “Development Project”), located in Parkland Quadrant One (1) of the City, consisting of Forty-Four (44) Dwelling Units known as CHP - HILLHAVEN. The development is not requesting any offsets at this time for parkland impact fees and will be paying the full amount based on mathematical formulas and allocations set for the in the City's Parkland Dedication Ordinance (Ordinance 2016-25, Franklin Municipal Code 25-405.

FINANCIAL IMPACT:

The total Parkland Impact Fee obligation for this project is ONE HUNDRED EIGHTY-FIVE THOUSAND HUNDRED SEVENTY-TWO and 00/100 Dollars ($185,072.00) and Twenty-Five Percent (25%) or FORTY-SIX THOUSAND TWO HUNDRED SIXTY-EIGHT and 00/100 Dollars ($46,268.00) of which shall be paid at the final plat or at the issuance of the first building permit when a plat is not required. The remaining Seventy-Five Percent (75%) or ONE HUNDRED THIRTY-EIGHT THOUSAND EIGHT HUNDRED FOUR and 00/100 Dollars ($138,804.00) shall be collected at a pro-rated per permit rate of THREE THOUSAND TWO HUNDRED TWENTY-EIGHT and 00/100 Dollars ($3,228.00) until the full obligation has been paid.

RECOMMENDATION:

Staff recommends approval of COF Contract No. 2021-0002.

Prepared by:
City of Franklin
109 Third Avenue South
Franklin, Tennessee 37064

PARKLAND IMPACT FEE (PAYMENT OF FEE ONLY)
AGREEMENT FOR CHP - HILLHAVEN BETWEEN THE CITY OF FRANKLIN AND COMMUNITY HOUSING PARTNERSHIP
CONTRACT NO. 2021-0002

PARKLAND IMPACT FEE (this "Agreement"), made and entered into this___day of_____2021 by and between THE CITY OF FRANKLIN, TENNESSEE (hereinafter "City") and COMMUNITY HOUSING PARTNERSHIP OF WILLIAMSON COUNTY (hereinafter "COMMUNITY HOUSING PARTNERSHIP") pursuant to Title 25, Chapter 4 of the City of Franklin Municipal Code, and COMMUNITY HOUSING PARTNERSHIP as owner of that certain land known as CHP – HILLHAVEN in Williamson County, Tennessee. The parties join herein for the sole purpose of consenting to and approving this Agreement, and hereby consent to and approve this Agreement.

WITNESSETH:

WHEREAS, COMMUNITY HOUSING PARTNERSHIP is in the process of developing the property located at 171 HILLHAVEN LANE (the "Development Project"), located in Parkland Quadrant One (1) of the City, consisting of Forty-Three (43) Dwelling Units known as CHP - HILLHAVEN; and

WHEREAS, Parkland Impact Fees and Parkland Dedication requirements are based on the mathematical formulas and allocations set forth in the City's Parkland Dedication Ordinance (Ordinance 2016-25, Franklin Municipal Code §25-405, and hereinafter, "Ordinance"); and

WHEREAS, the Parkland Impact Fee as set forth in the Ordinance is FOUR THOUSAND THREE HUNDRED FOUR and 00/100 Dollars ($4,304.00) per dwelling unit; and

WHEREAS, the total Parkland Impact Fee obligation for this project is ONE HUNDRED EIGHTY-FIVE THOUSAND SEVENTY-TWO and 00/100 Dollars ($185,072.00) and Twenty-Five Percent (25%) or FORTY-SIX THOUSAND TWO HUNDRED SIXTY-EIGHT and 00/100 Dollars ($46,268.00) of which shall be paid at the final plat or at the issuance of the first building permit when a plat is not required. The remaining Seventy-Five Percent (75%) or ONE HUNDRED THIRTY-EIGHT THOUSAND EIGHT HUNDRED FOUR and 00/100 Dollars ($138,804.00) shall be collected at a pro-rated per permit rate of THREE THOUSAND TWO HUNDRED TWENTY-EIGHT and 00/100 Dollars ($3,228.00) until the full obligation has been paid.

NOW, THEREFORE, in consideration of the terms, conditions and mutual agreements by and between the parties as hereinafter set forth in detail, the parties do hereby mutually agree as follows:

I. AGREEMENT FOR PAYMENT OF PARKLAND IMPACT FEES

1. The foregoing recitals are incorporated into this Agreement and made a part thereof.

2. This Agreement is non-transferable to the successors or assigns of COMMUNITY HOUSING PARTNERSHIP unless the successor assumes the same obligations of COMMUNITY HOUSING PARTNERSHIP in writing. Such assignment shall be provided to the City within fifteen (15) days of its occurrence. Upon assignment, COMMUNITY HOUSING PARTNERSHIP shall be relieved from further liability under this Agreement.

3. The City and COMMUNITY HOUSING PARTNERSHIP agree that the terms and conditions contained herein shall be binding on and shall insure to their heirs, representatives, successors, and assigns.

4. Applicable Law/Choice of Forum and Venue. This Agreement is made under and will be construed in accordance with the laws of the State of Tennessee without giving effect to that state's choice of law rules. The parties' choice for forum and venue shall be exclusively in the courts of Williamson County, Tennessee.

5. All notices required to be given by any party shall be in writing, addressed to all other parties, and delivered by certified mail or in person to:

In the case of the City:	In the case of Community Housing Partnership of Williamson County:
City of Franklin Attn: Vernon J. Gerth, ACA 109 Third Ave. South P.O. Box 305 Franklin, TN 37065-0305	COMMUNITY HOUSING PARTNERSHIP Attn: Scott Harrison 129 W. Fowlkes St. Suite 124 Franklin, TN 37064

6. This Agreement constitutes the entire agreement between the parties. There are no further or other agreements or understandings, written or oral, in effect between the parties, relating to the subject matter hereof. This Agreement may be amended or modified only be an instrument of equal formality signed by the respective parties.

II. General Terms and Conditions

1. Personal Liability.
No member, Mayor, Alderman, official, or employee of the City shall be personally liable to COMMUNITY HOUSING PARTNERSHIP or any successor in interest, in the event of any default or breach by the City, or for any amount which may become due to COMMUNITY HOUSING PARTNERSHIP or successor or on any obligations hereunder.

2. Warranties /Limitation of Liability/Waiver.
The City reserves all rights afforded to local governments under law for all general and implied warranties. The City does not waive any rights it may have to all remedies provided by law and therefore any attempt by COMMUNITY HOUSING PARTNERSHIP to limit its liability shall be void and unenforceable. The City, being a Tennessee governmental entity, is governed by the provisions of the Tennessee Governmental Tort Liability Act, Tenn. Code Ann. § 29-20-101 et. seq. for causes of action sounding in tort. Further, no contract provision requiring a Tennessee political entity to indemnify or hold harmless the Contractor beyond the liability imposed by law is enforceable because it appropriates public money and nullifies governmental immunity without the authorization of the General Assembly.

3. Severability.
If any term or provision of this Agreement is held to be illegal or unenforceable, the validity or enforceability of the remainder of this Agreement will not be affected.

Prepared by:
City of Franklin
109 Third Avenue South
Franklin, Tennessee 37064

IN WITNESS WHEREOF the said parties have hereunto set their signatures, on this day and date first above written.

CITY OF FRANKLIN, TENNESSEE **Attest:**

By:_____ By: _____
Dr. Ken Moore, Mayor Eric S. Stuckey, City Administrator

Date:_____ Date:_____

STATE OF TENNESSEE)
)
COUNTY OF WILLIAMSON)

Before me,_____, a Notary Public of said State and County, personally appeared, Dr. Ken Moore and Eric S. Stuckey, with whom I am personally acquainted (or proved to me on the basis of satisfactory evidence), and where, upon oath, Dr. Ken Moore acknowledged himself to be Mayor and Eric S. Stuckey acknowledged himself to be City Administrator of the City of Franklin, Tennessee, and that as such, being authorized to do so, have executed the foregoing instrument for the purposes therein contained.

Witness my hand and seal, at office, this_____day of_____, 20____.

_____
NOTARY PUBLIC

My Commission Expires: _____

Approved as to form:

By: _____
Maricruz R. Fincher, Staff Attorney

Prepared by:
City of Franklin
109 Third Avenue South
Franklin, Tennessee 37064

COMMUNITY HOUSING PARTNERSHIP

By:
Name: Wayne O. Weaver
Title: President & CEO

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

STATE OF Tennessee)
COUNTY OF Williamson)

On March 25, 2021, before me, Jeri C. Moore, Notary Public, personally appeared Wayne O. Weaver who proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/~~are~~ subscribed to the within instrument and acknowledged to me that he/~~she~~/~~they~~ executed the same in his/~~her~~/~~their~~ authorized capacity(ies), and that by his/~~her~~/~~their~~ signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of Tennessee that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Jeri C. Moore (seal)
Signature

My Commission Expires: 7/17/2021

Jeri C. Moore
State of Tennessee Notary Public
Williamson County

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01819

DATE: March 24, 2021

TO: Board of Mayor and Aldermen

FROM: Kelly Dannenfelser, Asst. Director of Planning
Amy Diaz-Barriga, Planning Supervisor
Joseph Bryan, Principal Planner

SUBJECT:

*Consideration Of Ordinance 2020-36, An Ordinance To Rezone 35.36 Acres From Planned (PD) District To Planned (PD 0.17/14,300) District For The Property Located South Of Spencer Creek Road And North Of Mack Hatcher Parkway, Located At 285 Spencer Creek Road (Cheekwood North PUD). Establishing A Public Hearing On May 11, 2021.
FMPC 3/25/21, 8-0

PURPOSE:

PROJECT INFORMATION
COF Project Number: 7413
Applicant: Greg Gamble, GDC
Owner: Cheekwood Golf Club LP

BACKGROUND/STAFF COMMENTS:
The applicant is requesting to rezone 35.36 acres from Planned (PD) District to Planned (PD 0.17/14,300) District to accommodate the Cheekwood North PUD Subdivision. The proposed entitlements include density allowances for 6 single-family residential lots and 14,3000 square feet of utility space for equipment storage. Envision Franklin places this parcel into the Single-Family Design Concept, which supports both single-family and recreational uses. The property is maintaining its use as a golf course and adding six residential lots so the proposed zoning with revised entitlements meet the recommendations of Envision Franklin. The corresponding development plan for the Cheekwood North PUD Subdivision will also be heard on this agenda.

FINANCIAL IMPACT:

Unknown.

RECOMMENDATION:

Staff recommends that the Board of Mayor and Aldermen approve Ordinance 2020-36.

ORDINANCE 2020-36

AN ORDINANCE TO REZONE 35.36 ACRES FROM PLANNED (PD) DISTRICT TO PLANNED (PD 0.17/14,300) DISTRICT FOR THE PROPERTY LOCATED SOUTH OF SPENCER CREEK ROAD AND NORTH OF MACK HATCHER PARKWAY, LOCATED AT 285 SPENCER CREEK ROAD (CHEEKWOOD NORTH PUD).

WHEREAS, the City of Franklin, Tennessee, encourages responsible growth and the sensible transition of land uses and densities; and

WHEREAS, the Planned (PD) district provides zoning for land uses compatible with both the Franklin Land Use Plan and surrounding development; and

WHEREAS, the Board of Mayor and Aldermen (BOMA) of the City of Franklin, Tennessee, adopted Resolution 2020-298, approving a Planned Unit Development (PUD) Development Plan as required by the Franklin Zoning Ordinance; and

WHEREAS, the zoning has been reviewed and approved by BOMA after a public hearing and a recommendation by the Franklin Municipal Planning Commission.

NOW THEREFORE, BE IT ORDAINED BY THE BOARD OF MAYOR AND ALDERMEN OF THE CITY OF FRANKLIN, TENNESSEE, AS FOLLOWS:

SECTION I. That the following described property shall be, and is hereby, rezoned from its present zoning classification of **Planned (PD)** District to **Planned (PD 0.17/14,300)** District:

PREMISES CONSIDERED

Map-Parcel	Acres
063-21.02	35.36
Total	35.36

SECTION II. That the attached Location Map and Survey shall serve the purpose of further delimiting the geographical boundaries as described by this Ordinance.

SECTION III. BE IT FINALLY ORDAINED by the Board of Mayor and Aldermen of the City of Franklin, Tennessee, that this Ordinance shall take effect from and after its passage on third and final reading, the health, safety, and welfare of the citizens requiring it.

ATTEST:

By: _____
Eric Stuckey
City Administrator/Recorder

CITY OF FRANKLIN, TENNESSEE:

By: _____
Dr. Ken Moore
Mayor

Approved as to form by:

_____
Shauna R. Billingsley
City Attorney

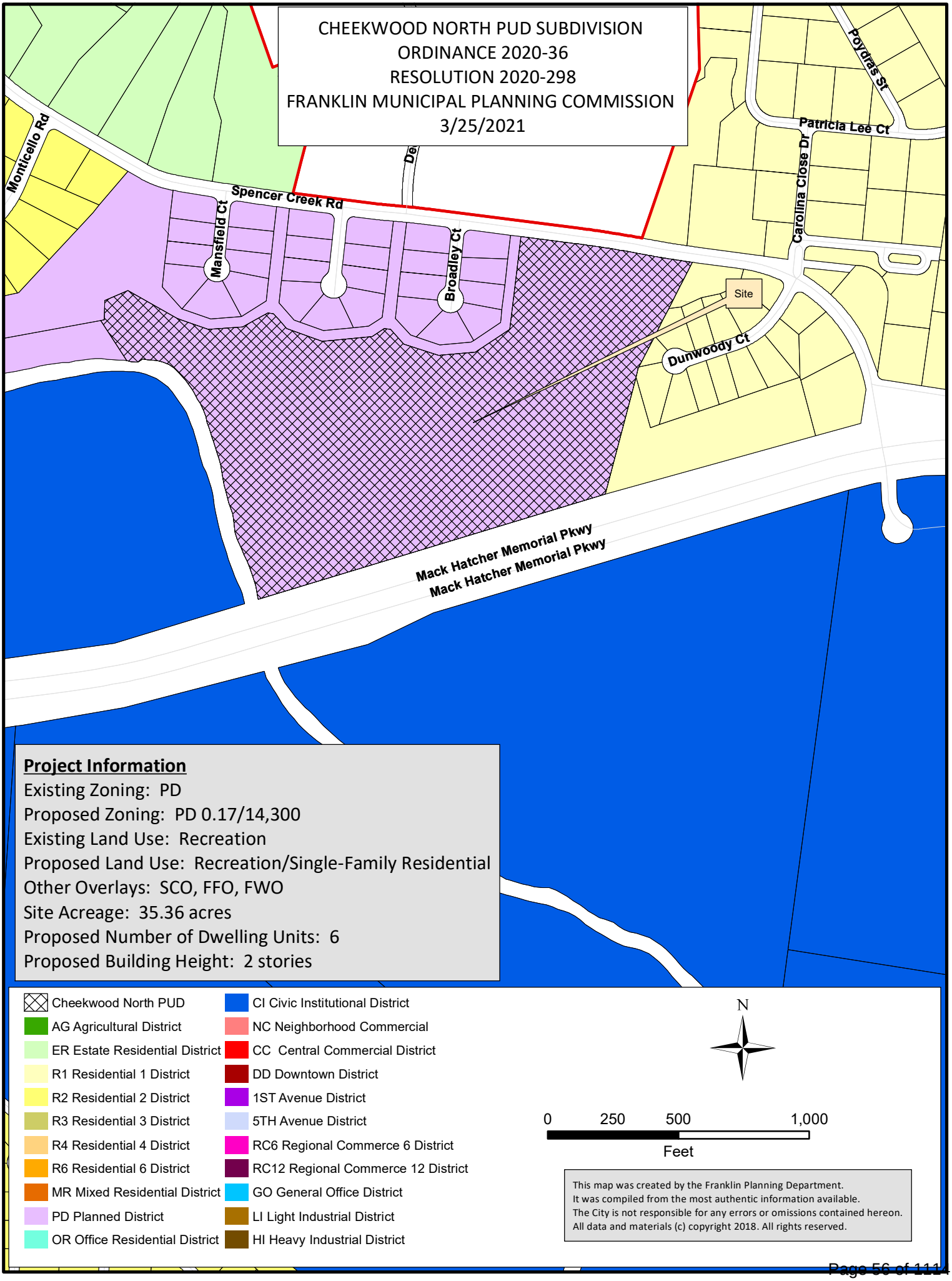
PLANNING COMMISSION RECOMMENDED: _____

PASSED FIRST READING: _____

PUBLIC HEARING HELD: _____

PASSED SECOND READING: _____

PASSED THIRD READING: _____


CHEEKWOOD NORTH PUD SUBDIVISION
ORDINANCE 2020-36
RESOLUTION 2020-298
FRANKLIN MUNICIPAL PLANNING COMMISSION
3/25/2021
Monticello Rd
Spencer Creek Rd
Mansfield Ct
Broadley Ct
Poydras St
Patricia Lee Ct
Carolina Close Dr
Site
Dunwoody Ct
Mack Hatcher Memorial Pkwy
Mack Hatcher Memorial Pkwy
Project Information
Existing Zoning: PD
Proposed Zoning: PD 0.17/14,300
Existing Land Use: Recreation
Proposed Land Use: Recreation/Single-Family Residential
Other Overlays: SCO, FFO, FWO
Site Acreage: 35.36 acres
Proposed Number of Dwelling Units: 6
Proposed Building Height: 2 stories
Cheekwood North PUD
AG Agricultural District
ER Estate Residential District
R1 Residential 1 District
R2 Residential 2 District
R3 Residential 3 District
R4 Residential 4 District
R6 Residential 6 District
MR Mixed Residential District
PD Planned District
OR Office Residential District
CI Civic Institutional District
NC Neighborhood Commercial
CC Central Commercial District
DD Downtown District
1ST Avenue District
5TH Avenue District
RC6 Regional Commerce 6 District
RC12 Regional Commerce 12 District
GO General Office District
LI Light Industrial District
HI Heavy Industrial District
N
0 250 500 1,000
Feet
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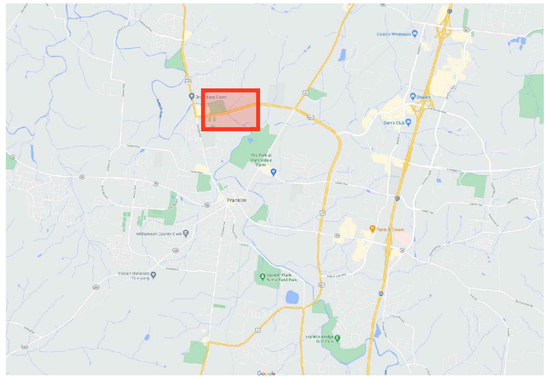

VICINITY MAP

CHEEKWOOD NORTH PD

REZONING PACKET

PLANNED DISTRICT (0.17 DUA, 14,300)
FRANKLIN, WILLIAMSON, TENNESSEE

SITE DATA CHART

PROJECT NAME:	CHEEKWOOD NORTH PD
PROJECT NUMBER:	7413
ADDRESS:	285 SPENCER CREEK ROAD FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02102
ACREAGE / SF OF SITE:	35.36 AC
VESTING (IF APPLICABLE):	
BASE ZONING:	PD (PLANNED DISTRICT)
PROPOSED ZONING:	PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO
DESIGN CONCEPT(S):	SINGLE-FAMILY RESIDENTIAL, CONSERVATION
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

APPLICANT & LANDSCAPE ARCHITECT:

GAMBLE DESIGN COLLABORATIVE
GREG GAMBLE
324 LIBERTY PIKE
SUITE 145
FRANKLIN, TN 37064
615-975-5765
greg.gamble@gdc-tn.com

ENGINEER:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
STEVE CASEY
117 SEABOARD LANE
SUITE E-100
FRANKLIN, TN 37067
615-333-7797
scasey@cecinc.com

OWNER:

CHEEKWOOD HOMEOWNERS ASSOC INC
CONTACT:
1152 COLUMBIA AVENUE
FRANKLIN, TN 37064

JESTER GOLF
GOLF DESIGN AND MASTER PLANNING

NICKLAUS DESIGN

GDC
gamble design collaborative

CEC
Civil & Environmental Consultants, Inc.

STATEMENT OF IMPACTS

WATER FACILITIES
WATER SERVICE WILL BE PROVIDED BY . THE WATER MAINS ARE LOCATED ALONG .
6 UNITS x 250 GPD = 1,500 GPD

SEWER FACILITIES
SEWER SERVICE WILL BE PROVIDED BY THE CITY OF FRANKLIN.

REPURIFIED (REUSE) WATER FACILITIES
AVAILABLE. SEE UTILITY SHEETS.

POLICE, FIRE, AND RECREATIONAL FACILITIES
NEAREST POLICE STATION: HEADQUARTERS (3.11 MILES)
NEAREST FIRE STATION: FIRE STATION #4 (1.7 MILES)
NEAREST RECREATIONAL FACILITY: WILLIAMSON COUNTY RECREATION CENTER (1.7 MILES)

PROJECTED STUDENT POPULATION
6 x 0.33 = 2 STUDENTS

REFUSE STORAGE AND SANITATION COLLECTION FACILITIES
REFUSE COLLECTION FOR THE DEVELOPMENT SHALL BE PROVIDED BY CITY OF FRANKLIN

SHEET INDEX

C0.0	COVER SHEET
C1.0	EXISTING CONDITIONS
C1.1	EXISTING CONDITIONS ENLARGEMENT
C1.2	EXISTING CONDITIONS ENLARGEMENT
C1.3	EXISTING CONDITIONS ENLARGEMENT
C1.4	EXISTING CONDITIONS ENLARGEMENT
C1.5	EXISTING CONDITIONS ENLARGEMENT

COMPREHENSIVE REVIEW OF ROADWAY, STORMWATER, AND UTILITY ELEMENTS BY CITY OF FRANKLIN STAFF WILL OCCUR AT THE SITE PLAN STAGE. PROJECT ENTITLEMENTS APPROVED WITH THIS DEVELOPMENT PLAN DO NOT CONSTITUTE APPROVAL OF THE ROADWAY, STORMWATER, AND UTILITY ELEMENTS SHOWN ON THE DEVELOPMENT PLAN. IF, UPON APPLICATION OF CITY OF FRANKLIN STREET, STORMWATER, AND UTILITY STANDARDS AT THE SITE PLAN STAGE, THE APPLICANT CANNOT ACHIEVE THE MAXIMUM APPROVED ENTITLEMENTS, THE APPLICANT SHALL BE CONFINED TO THE ENTITLEMENTS ACHIEVABLE FROM THE APPLICATION OF SAID STANDARDS.

DRAKE A. REEDER REGISTERED LANDSCAPE ARCHITECT TENNESSEE No. 329 CONFERENCE OF 03.01.21

PRE-APP SUBMITTAL: NOVEMBER 30, 2020

INITIAL SUBMITTAL: DECEMBER 14, 2020

RESUBMITTAL: MARCH 4, 2021

GDC
GAMBLE
DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE
greg.gamble@gdc-tn.com

AREA OWNED BY HOA, TO REMAIN AS IS, NO DEVELOPMENT PROPOSED IN THESE AREAS
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SPENCER CREEK PL
HUNTLEY DR
HUNTLEY CT
HUNTLEY PARK CT
HUNTLEY PARK DR
MATCHLINE DC-3
MATCHLINE DC-4
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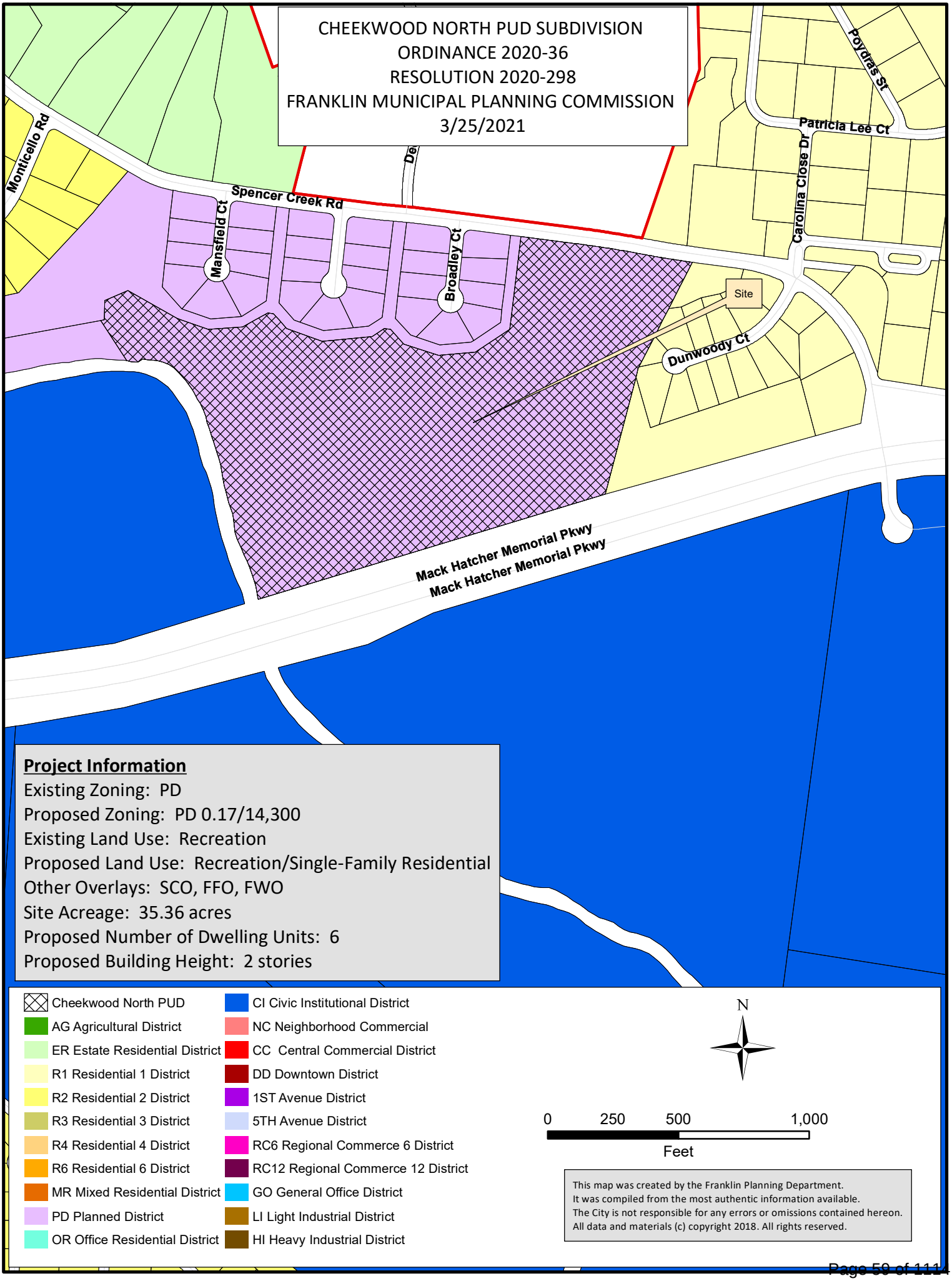
CHEEKWOOD NORTH PUD SUBDIVISION
ORDINANCE 2020-36
RESOLUTION 2020-298
FRANKLIN MUNICIPAL PLANNING COMMISSION
3/25/2021
Monticello Rd
Spencer Creek Rd
Mansfield Ct
Broadley Ct
Poydras St
Patricia Lee Ct
Carolina Close Dr
Site
Dunwoody Ct
Mack Hatcher Memorial Pkwy
Mack Hatcher Memorial Pkwy
Project Information
Existing Zoning: PD
Proposed Zoning: PD 0.17/14,300
Existing Land Use: Recreation
Proposed Land Use: Recreation/Single-Family Residential
Other Overlays: SCO, FFO, FWO
Site Acreage: 35.36 acres
Proposed Number of Dwelling Units: 6
Proposed Building Height: 2 stories
Cheekwood North PUD
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ER Estate Residential District
R1 Residential 1 District
R2 Residential 2 District
R3 Residential 3 District
R4 Residential 4 District
R6 Residential 6 District
MR Mixed Residential District
PD Planned District
OR Office Residential District
CI Civic Institutional District
NC Neighborhood Commercial
CC Central Commercial District
DD Downtown District
1ST Avenue District
5TH Avenue District
RC6 Regional Commerce 6 District
RC12 Regional Commerce 12 District
GO General Office District
LI Light Industrial District
HI Heavy Industrial District
N
0 250 500 1,000
Feet
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It was compiled from the most authentic information available.
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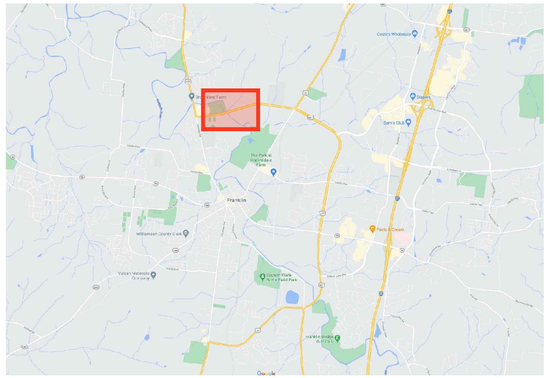
CHEEKWOOD NORTH PD

REZONING PACKET

PLANNED DISTRICT (0.17 DUA, 14,300)
FRANKLIN, WILLIAMSON, TENNESSEE



VICINITY MAP

APPLICANT & LANDSCAPE ARCHITECT:

GAMBLE DESIGN COLLABORATIVE
GREG GAMBLE
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FRANKLIN, TN 37064
615-975-5765
greg.gamble@gdc-tn.com

ENGINEER:

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GOLF DESIGN AND MASTER PLANNING

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STATEMENT OF IMPACTS

WATER FACILITIES
WATER SERVICE WILL BE PROVIDED BY . THE WATER MAINS ARE LOCATED ALONG .
6 UNITS x 250 GPD = 1,500 GPD

SEWER FACILITIES
SEWER SERVICE WILL BE PROVIDED BY THE CITY OF FRANKLIN.

REPURIFIED (REUSE) WATER FACILITIES
AVAILABLE. SEE UTILITY SHEETS.

POLICE, FIRE, AND RECREATIONAL FACILITIES
NEAREST POLICE STATION: HEADQUARTERS (3.11 MILES)
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6 x 0.33 = 2 STUDENTS

REFUSE STORAGE AND SANITATION COLLECTION FACILITIES
REFUSE COLLECTION FOR THE DEVELOPMENT SHALL BE PROVIDED BY CITY OF FRANKLIN

SITE DATA CHART

PROJECT NAME:	CHEEKWOOD NORTH PD
PROJECT NUMBER:	7413
ADDRESS:	285 SPENCER CREEK ROAD FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02102
ACREAGE / SF OF SITE:	35.36 AC
VESTING (IF APPLICABLE):	
BASE ZONING:	PD (PLANNED DISTRICT)
PROPOSED ZONING:	PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO
DESIGN CONCEPT(S):	SINGLE-FAMILY RESIDENTIAL, CONSERVATION
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

SHEET INDEX

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COMPREHENSIVE REVIEW OF ROADWAY, STORMWATER, AND UTILITY ELEMENTS BY CITY OF FRANKLIN STAFF WILL OCCUR AT THE SITE PLAN STAGE. PROJECT ENTITLEMENTS APPROVED WITH THIS DEVELOPMENT PLAN DO NOT CONSTITUTE APPROVAL OF THE ROADWAY, STORMWATER, AND UTILITY ELEMENTS SHOWN ON THE DEVELOPMENT PLAN. IF, UPON APPLICATION OF CITY OF FRANKLIN STREET, STORMWATER, AND UTILITY STANDARDS AT THE SITE PLAN STAGE, THE APPLICANT CANNOT ACHIEVE THE MAXIMUM APPROVED ENTITLEMENTS, THE APPLICANT SHALL BE CONFINED TO THE ENTITLEMENTS ACHIEVABLE FROM THE APPLICATION OF SAID STANDARDS.

DRAKE A. REEDER
REGISTERED
03.04.2021
COMMERCE
TENNESSEE No. 12-0
LANDSCAPE ARCHITECT

PRE-APP SUBMITTAL: NOVEMBER 30, 2020

INITIAL SUBMITTAL: DECEMBER 14, 2020

RESUBMITTAL: MARCH 4, 2021

GDC
GAMBLE
DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE
greg.gamble@gdc-tn.com

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MATCHLINE SEE SHEET C1.1
MATCHLINE SEE SHEET C1.1
MATCHLINE SEE SHEET C1.2
MATCHLINE SEE SHEET C1.2
150' SCENIC CORRIDOR OVERLAY
150' SCENIC CORRIDOR OVERLAY
SPENCER CREEK RD
SPENCER CREEK RD
SPENCER CREEK CT
SPENCER CREEK PL
SPENCER CREEK DR
SPENCER CREEK DR
SPENCER CREEK DR

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01820

DATE: March 24, 2021

TO: Board of Mayor and Aldermen

FROM: Kelly Dannenfelser, Asst. Director of Planning
Amy Diaz-Barriga, Planning Supervisor
Joseph Bryan, Principal Planner

SUBJECT:

Consideration of Resolution 2020-298, A Resolution Approving A Development Plan For Cheekwood North PUD Subdivision, For The Property Located South Of Spencer Creek Road And North Of Mack Hatcher Parkway, Located At 285 Spencer Creek Road. Establishing A Public Hearing For May 11, 2021.
FMPC 3/25/21, 7-1

PURPOSE:

PROJECT INFORMATION
COF Project Number: 7414
Applicant: Greg Gamble, GDC
Owner: Cheekwood Golf Club LP

BACKGROUND/STAFF COMMENTS:
The applicant has submitted a development plan for the Cheekwood North PUD Subdivision to update the existing gold course and add housing on the property located at 285 Spencer Creek Road. The plan proposes six new single-family residential lots and 14,300 square feet of utility space for equipment storage and recreational use. The subject property is located in the Single-Family Design Concept per Envision Franklin. The Single-Family Design Concept allows for single-family, institutional and recreational uses.

The proposed architecture is compatible with that of the surrounding neighborhoods and meets the recommendations of Envision Franklin. All new residential structures will be placed outside of the Floodway Fringe Overlay (FFO). The applicant has also indicated that they will relocate the existing pump station for City Water services away from the proposed residential lots. Specific location and design will be determined with the site plan submittal. The current administrative and recreational services on the property will be relocated to the Cheekwood South PUD Subdivision on the southern side of Mack Hatcher Parkway. That plan is also included on this agenda.

FINANCIAL IMPACT:

Unknown.

RECOMMENDATION:

Staff recommends that the Board of Mayor and Aldermen approve Resolution 2020-298.

RESOLUTION 2020-298

A RESOLUTION APPROVING A DEVELOPMENT PLAN FOR CHEEKWOOD NORTH PUD SUBDIVISION, FOR THE PROPERTY LOCATED SOUTH OF SPENCER CREEK ROAD AND NORTH OF MACK HATCHER PARKWAY, LOCATED AT 285 SPENCER CREEK ROAD.

WHEREAS, the Board of Mayor and Aldermen (BOMA) of the City of Franklin, Tennessee, has, or will, approve the zoning for the property as part of Ordinance 2020-36; and

WHEREAS, the Planned Unit Development (PUD) process is a review procedure that is intended to encourage innovative land planning and design and avoid the monotony sometimes associated with large developments by:

(a) Reducing or eliminating the inflexibility that sometimes results from strict application of zoning standards that were designed primarily for individual lots;

(b) Allowing greater freedom in selecting the means to provide access, light, open space, and design amenities;

(c) Encouraging a sensitive design that respects the surrounding established land use character and natural or man-made features of the site including, but not limited to, trees, historic features, streams, hillsides, and floodplains;

(d) Promoting quality design and environmentally sensitive development by allowing development to take advantage of special site characteristics, locations, and land uses; and

(e) Allowing deviations from certain zoning standards that would otherwise apply if not contrary to the general spirit and intent of this ordinance; and

WHEREAS, the PUD process requires the approval of a Development Plan that is reviewed and approved by BOMA, after a public hearing and a recommendation by the Franklin Municipal Planning Commission; and

WHEREAS, in accordance with the provisions of the City of Franklin, Tennessee, Zoning Ordinance, and as required by Tennessee Code Annotated § 13-4-310, as amended, the approval of the Development Plan by the BOMA will initiate a vesting period during which the development standards adopted by the City and in effect on the date of approval shall remain the standards applicable to the approved Development Plan.

NOW THEREFORE, BE IT RESOLVED BY THE BOARD OF MAYOR AND ALDERMEN OF THE CITY OF FRANKLIN, TENNESSEE, AS FOLLOWS:

SECTION I. That the legal description of the property included in the Development Plan is as follows:

PREMISES CONSIDERED

Map-Parcel	Acres
063-21.02	35.36
Total	35.36

SECTION II. That the attached Location Map and Survey shall serve the purpose of further delineating the geographical boundaries as described by this Resolution.

SECTION III. That the overall entitlements for the Cheekwood North PUD are as follows:

Entitlements	Cheekwood North PUD
Base Zone District	PD
Other Zoning Overlays	FFO, FWO, SCO
Number of Dwelling Units	6
Number of Nonresidential Square Footage	14,300 SF
Number of Hotel Rooms	0
Open Space Requirements	5% (1.77 AC)
Number of Phases in Development	1

SECTION IV. That the Development Plan, the exhibits accompanying the Development Plan, and all conditions and restrictions placed upon the Development Plan by the Franklin Municipal Planning Commission and this Board shall be made a part of this Resolution as though copied verbatim herein, and that a permanent record of the Development Plan, the exhibits accompanying the Development Plan, and all such conditions and restrictions shall be kept in the Franklin Planning and Sustainability Department.

SECTION V. That this Resolution shall take effect from and after the passage of Ordinance 2020-36, on third and final reading, the health, safety, and welfare of the citizens requiring it.

_____
Eric S. Stuckey
City Administrator

_____
Dr. Ken Moore
Mayor

Approved as to form by:

_____
Shauna R. Billingsley
City Attorney

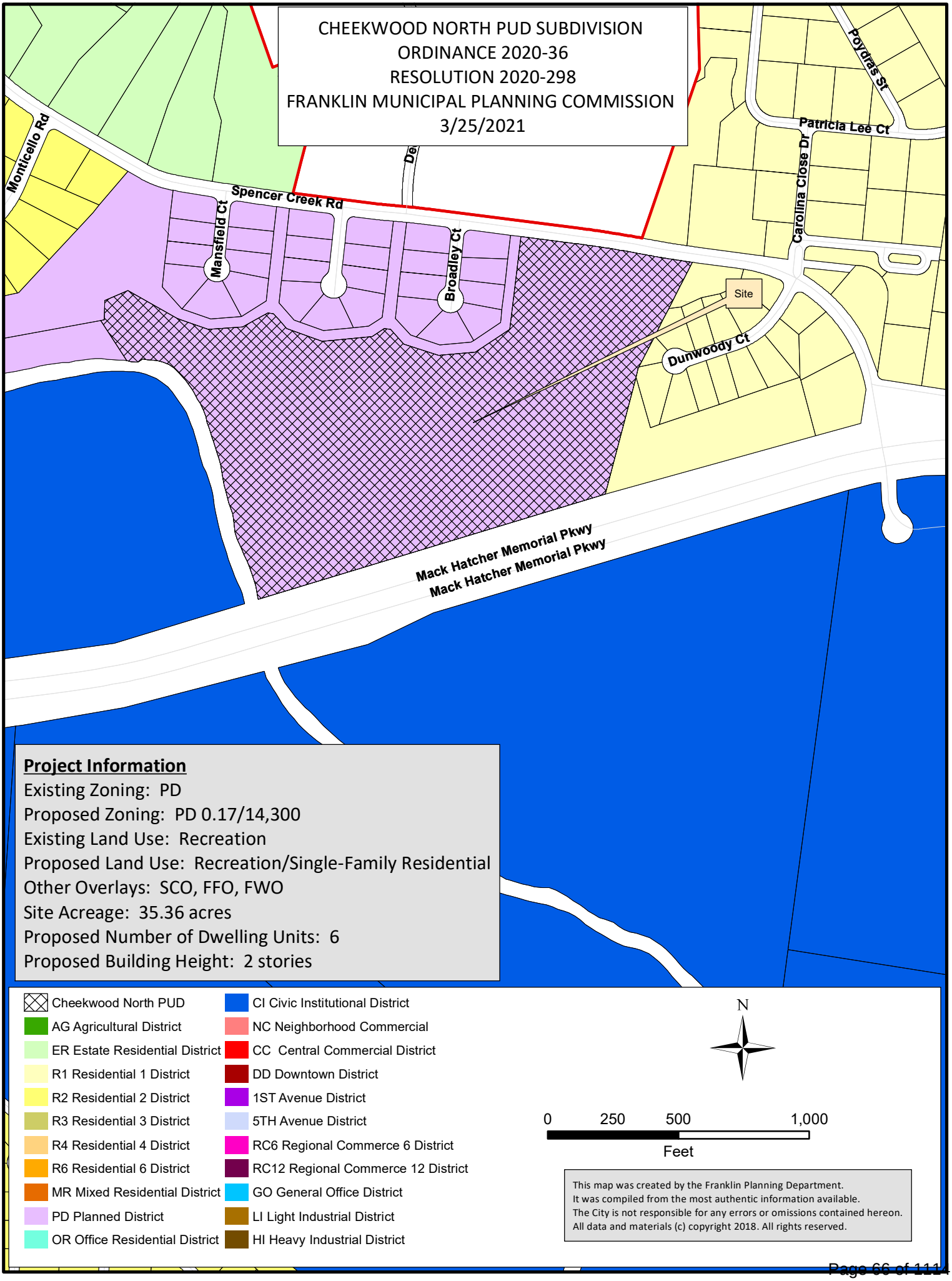
PREAPPLICATION CONFERENCE: _____

BOMA/FMPC JOINT CONCEPTUAL WORKSHOP: _____

NEIGHBORHOOD MEETING: _____

PLANNING COMMISSION RECOMMENDED APPROVAL: _____

PUBLIC HEARING AND BOMA APPROVAL: _____



Project Information

Existing Zoning: PD
Proposed Zoning: PD 0.17/14,300
Existing Land Use: Recreation
Proposed Land Use: Recreation/Single-Family Residential
Other Overlays: SCO, FFO, FWO
Site Acreage: 35.36 acres
Proposed Number of Dwelling Units: 6
Proposed Building Height: 2 stories

- Cheekwood North PUD
- AG Agricultural District
- ER Estate Residential District
- R1 Residential 1 District
- R2 Residential 2 District
- R3 Residential 3 District
- R4 Residential 4 District
- R6 Residential 6 District
- MR Mixed Residential District
- PD Planned District
- OR Office Residential District
- CI Civic Institutional District
- NC Neighborhood Commercial
- CC Central Commercial District
- DD Downtown District
- 1ST Avenue District
- 5TH Avenue District
- RC6 Regional Commerce 6 District
- RC12 Regional Commerce 12 District
- GO General Office District
- LI Light Industrial District
- HI Heavy Industrial District

N

0 250 500 1,000
Feet

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It was compiled from the most authentic information available.
The City is not responsible for any errors or omissions contained hereon.
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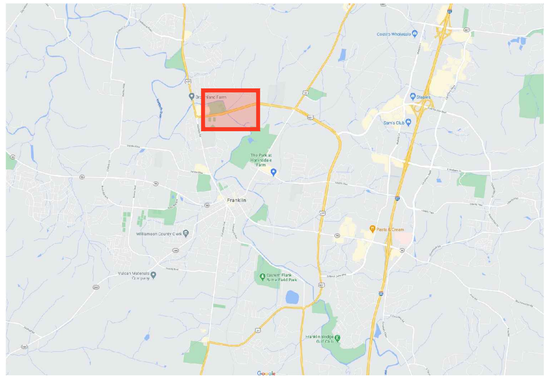
CHEEKWOOD NORTH PD

REZONING PACKET

PLANNED DISTRICT (0.17 DUA, 14,300)
FRANKLIN, WILLIAMSON, TENNESSEE



VICINITY MAP

SITE DATA CHART

PROJECT NAME:	CHEEKWOOD NORTH PD
PROJECT NUMBER:	7413
ADDRESS:	285 SPENCER CREEK ROAD FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02102
ACREAGE / SF OF SITE:	35.36 AC
VESTING (IF APPLICABLE):	
BASE ZONING:	PD (PLANNED DISTRICT)
PROPOSED ZONING:	PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO
DESIGN CONCEPT(S):	SINGLE-FAMILY RESIDENTIAL, CONSERVATION
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

APPLICANT & LANDSCAPE ARCHITECT:

GAMBLE DESIGN COLLABORATIVE
GREG GAMBLE
324 LIBERTY PIKE
SUITE 145
FRANKLIN, TN 37064
615-975-5765
greg.gamble@gdc-tn.com

ENGINEER:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
STEVE CASEY
117 SEABOARD LANE
SUITE E-100
FRANKLIN, TN 37067
615-333-7797
scasey@cecinc.com

OWNER:

CHEEKWOOD HOMEOWNERS ASSOC INC
CONTACT:
1152 COLUMBIA AVENUE
FRANKLIN, TN 37064

JESTER GOLF
GOLF DESIGN AND MASTER PLANNING

NICKLAUS DESIGN

GDC gamble design collaborative

CEC Civil & Environmental Consultants, Inc.

STATEMENT OF IMPACTS

WATER FACILITIES
WATER SERVICE WILL BE PROVIDED BY . THE WATER MAINS ARE LOCATED ALONG .
6 UNITS x 250 GPD = 1,500 GPD

SEWER FACILITIES
SEWER SERVICE WILL BE PROVIDED BY THE CITY OF FRANKLIN.

REPURIFIED (REUSE) WATER FACILITIES
AVAILABLE. SEE UTILITY SHEETS.

POLICE, FIRE, AND RECREATIONAL FACILITIES
NEAREST POLICE STATION: HEADQUARTERS (3.11 MILES)
NEAREST FIRE STATION: FIRE STATION #4 (1.7 MILES)
NEAREST RECREATIONAL FACILITY: WILLIAMSON COUNTY RECREATION CENTER (1.7 MILES)

PROJECTED STUDENT POPULATION
6 x 0.33 = 2 STUDENTS

REFUSE STORAGE AND SANITATION COLLECTION FACILITIES
REFUSE COLLECTION FOR THE DEVELOPMENT SHALL BE PROVIDED BY CITY OF FRANKLIN

SHEET INDEX

C0.0	COVER SHEET
C1.0	EXISTING CONDITIONS
C1.1	EXISTING CONDITIONS ENLARGEMENT
C1.2	EXISTING CONDITIONS ENLARGEMENT
C1.3	EXISTING CONDITIONS ENLARGEMENT
C1.4	EXISTING CONDITIONS ENLARGEMENT
C1.5	EXISTING CONDITIONS ENLARGEMENT

COMPREHENSIVE REVIEW OF ROADWAY, STORMWATER, AND UTILITY ELEMENTS BY CITY OF FRANKLIN STAFF WILL OCCUR AT THE SITE PLAN STAGE. PROJECT ENTITLEMENTS APPROVED WITH THIS DEVELOPMENT PLAN DO NOT CONSTITUTE APPROVAL OF THE ROADWAY, STORMWATER, AND UTILITY ELEMENTS SHOWN ON THE DEVELOPMENT PLAN. IF, UPON APPLICATION OF CITY OF FRANKLIN STREET, STORMWATER, AND UTILITY STANDARDS AT THE SITE PLAN STAGE, THE APPLICANT CANNOT ACHIEVE THE MAXIMUM APPROVED ENTITLEMENTS, THE APPLICANT SHALL BE CONFINED TO THE ENTITLEMENTS ACHIEVABLE FROM THE APPLICATION OF SAID STANDARDS.

DRAKE A. REEDER
REGISTERED
03.04.2021
COMMERCE
TENNESSEE No. 12-0
LANDSCAPE ARCHITECT

PRE-APP SUBMITTAL: NOVEMBER 30, 2020

INITIAL SUBMITTAL: DECEMBER 14, 2020

RESUBMITTAL: MARCH 4, 2021

GDC
GAMBLE
DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE
greg.gamble@gdc-tn.com

AREA OWNED BY HOA, TO REMAIN AS IS, NO DEVELOPMENT PROPOSED IN THESE AREAS
AREA OWNED BY HOA, TO REMAIN AS IS, NO DEVELOPMENT PROPOSED IN THESE AREAS
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SPENCER CREEK RD
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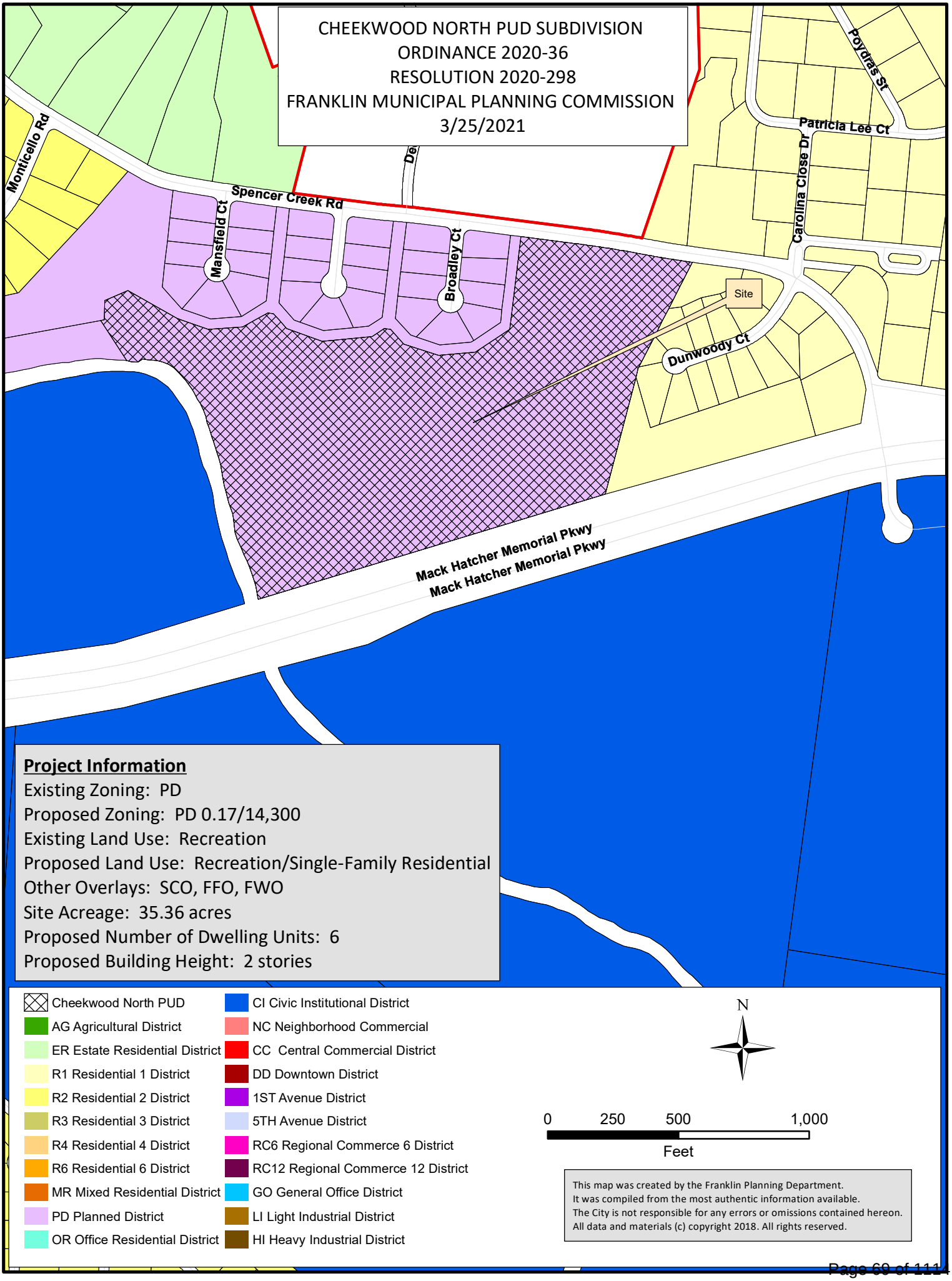
CHEEKWOOD NORTH PUD SUBDIVISION
ORDINANCE 2020-36
RESOLUTION 2020-298
FRANKLIN MUNICIPAL PLANNING COMMISSION
3/25/2021
Monticello Rd
Spencer Creek Rd
Mansfield Ct
Broadley Ct
Poydras St
Patricia Lee Ct
Carolina Close Dr
Site
Dunwoody Ct
Mack Hatcher Memorial Pkwy
Mack Hatcher Memorial Pkwy
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Feet
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COF no: 7414

CONDITIONS OF APPROVAL:

Open Issues: 24 These issues are currently being filtered

Engineering - Development Plan Checklist

General Issues

21. Sidewalk

joe.marlo@franklintn.gov *The DRT cannot waive sidewalk requirements. Upon further inspection, sidewalk fees-in-lieu may be appropriate for frontage west of the drive lane. Portions east of the drive lane do not qualify for sidewalk fees-in-lieu.*

A 6-foot wide sidewalk/curb on the south side of Spencer Creek Road (a Minor Collector) is required per the COF Zoning Ordinance 9.6.1.

Sidewalk to be Constructed

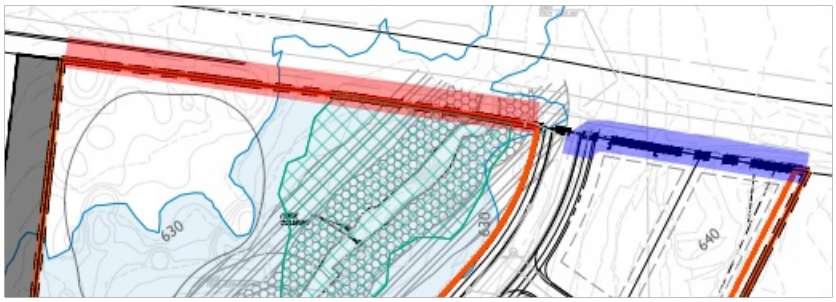
Applicant shall provide sidewalk and curb/gutter along frontage with Spencer Creek Road per ZO 9.6.1. (Blue line in exhibit below)

Sidewalk Fees-in-Lieu

Where site conditions are not suitable for the installation of sidewalks, the Applicant may request to pay fees-in-lieu to the City Sidewalk Fund instead of building the required sidewalk and corresponding street and utility improvements. *[COF Zoning Ordinance 9.6.5]*

The fees-in-lieu amount is $19/sf based on the average cost per square foot bid for the SR 96 West Sidewalk Project, let by the City of Franklin in June 2015.

If the Applicant intends to pursue in-lieu fee contributions instead of constructing the sidewalk/multi-use path, Applicant shall provide a note on the cover sheet with the area of required sidewalk/multi-use path requested to be paid using in-lieu fee contributions ($19/sf x 6ft x 430ft = $49,020). If fees-in-lieu are not requested, Applicant shall provide a 6-foot sidewalk and curb across the full frontage. (Red line in exhibit below)



45. Lots

joe.marlo@franklintn.gov *Comment not adequately addressed.*

Applicant shall show the following on the Development Plan Sheets (C2.xx series):

1. Open Space Lot (unbuildable) with lot number encompassing floodplain.
2. Lot with lot number encompassing the maintenance building.
3. Lot with lot number for the pump station.
4. Lot numbers for all other buildable lots.

A final plat will be required at a later time to dedicate ROW, create easements, buffers, etc., as well as to subdivide the land. The final plat shall encompass the overall Cheekwood parcel. The lot for the pump station shall be deeded to the City of Franklin and shall be provided access to ROW with the final plat.

49. Street Layout

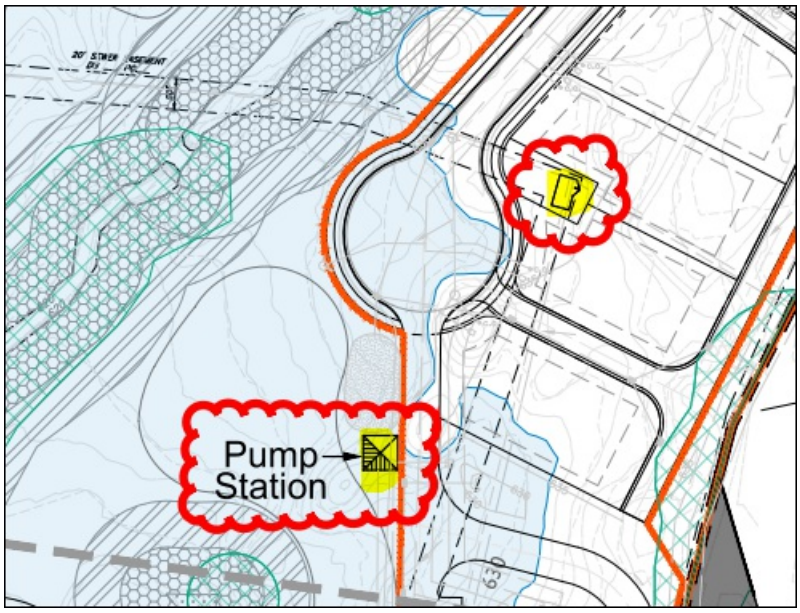
joe.marlo@franklintn.gov Dead-end alleys are not allowed. Applicant shall revise design accordingly.

Recommend investigating extending the lot to allow a private driveway to replace the alley shown.

59. Pump Station

joe.marlo@franklintn.gov *The following is a new comment due to new information shown.*

The drawings now appear to show 2 pump stations. If both stations are to remain, Applicant shall label what each station is for. If only one is to remain, Applicant shall clarify on drawings which station is proposed to remain, and which station is to be removed.



Parks

General Issues

6. Parkland Impact Fee

kevinl@franklintn.gov The draft attached is incorrect on dollar amounts.

I will correct, add the parkland contract number and make sure the density is at 6 units.

The agreement will be submitted to Law for review on 3-12-21.

[Edited By Kevin Lindsey]

Planning

General Issues

60. Residential Lots

joseph.bryan@franklintn.gov — Applicant shall include lot dimensions, lots sizes, and lot numbers on the plans.

61. Setbacks

joseph.bryan@franklintn.gov — Applicant shall revise the setbacks listed in the data chart to reflect what is shown on the plans. Specifically the rear setback minimum.

Stormwater

General Issues

14. Hydrologic Determination

Doug.Noonan@franklintn.gov — All jurisdictional features have not been clearly identified and called out on the plans.

- All stream and wetland features shall be clearly identified on the plans.
- All stream and wetland features shall be appropriately buffered.
- Hatching for buffers does not match up with key.

53. Riparian Buffer

jeff.willoughby@franklintn.gov

1. Provide consultants ESA report which includes water resource evaluations. Ensure what is shown is consistent with the features determined and delineated.
2. Differentiate between existing and proposed encroachments
3. If enhancement details are not to be shown state that buffer enhancement per FMC 23-207, further details and specific areas related to the mitigation efforts shall be shown in the future site plan submittals
4. State that a future variance submittal may be required with site plan submittals.
5. Active playing areas needs to be defined as stated in the site legend. Is this part of the course and what does this mean?
6. Show any utilities located within riparian buffers
7. The green hatching is not reflected in the legend. If this is not related to the buffer management plan please remove it.
8. Zones shall be labeled in the following format, "Width, Riparian Buffer, Zone designation" for example "60' Riparian Buffer Zone 1". Differentiate between the zone 1 30' and 60' on the plan sheets

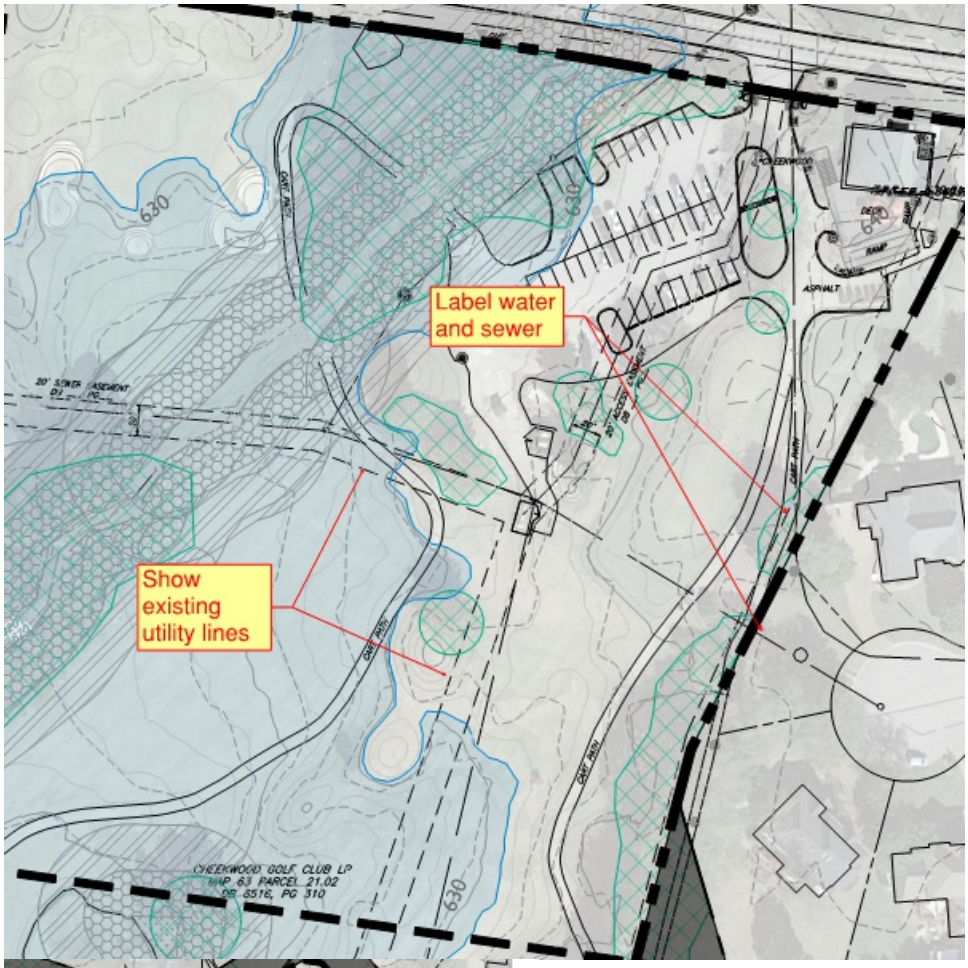
[Edited By Jeff Willoughby]

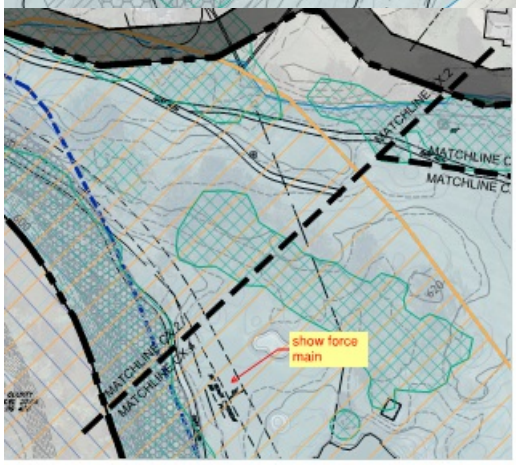
Water/Sewer

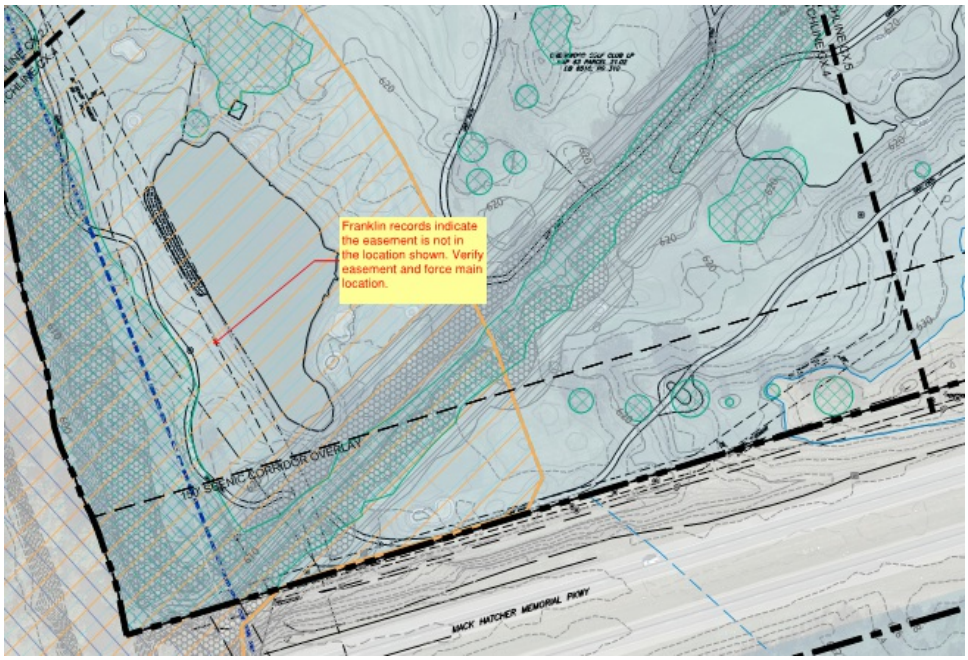
General Issues

7. Existing Conditions

ben.mcneil@franklintn.gov — The existing utility information has not been fully addressed. There are some easement locations called out, but the force main is not shown. The easement and force main may not align and needs to be shown as accurately as possible. The gravity sewer and water also must be shown correctly and have labels shown for review.


Label water and sewer
Show existing utility lines
CHEEKWOOD GOLF CLUB LP
MAP 63 PARCEL 21.02
DB 3516, PG 310


show force main

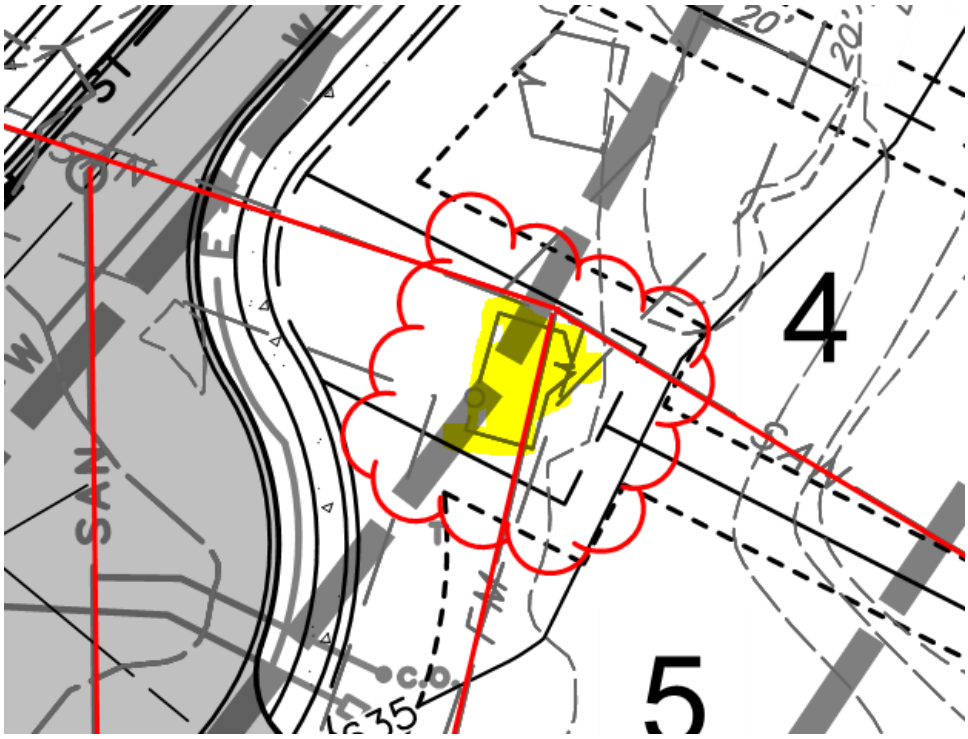


8. Reclaim Water

ben.mcneil@franklintn.gov The proposed reclaim water shall be labeled. The south plan must have continuation of proposed reclaim water that allows north side to stand alone with service. If the south plan does not go, but north does, the reclaim will have to serve this site.

9. Existing utility

ben.mcneil@franklintn.gov The applicant is stating the sanitary sewer pump station will remain as existing. As shown, the proposed lots will not be permitted around the existing pumps station. Future maintenance, potential smell and loud pumps will cause issues with future residents. The pump station being proposed in the lots of residents is not a good idea and should be reconsidered. the applicant shall meet with franklin staff to discuss the issues.



10. Water

ben.mcneil@franklintn.gov The proposed water line layout has to be discussed based on what has been submitted. The applicant shall meet with Franklin water to discuss layout.

11. Overall utility plan

ben.mcneil@franklintn.gov The applicant shall provide a proposed demolition plan for all existing utilities to be relocated. All demo utilities shall be shown and correctly identified. Proposed utilities shall then be shown for review by Water Management.

The current plan is too busy and cannot accurately determine what is being proposed.

12. Proposed utilites

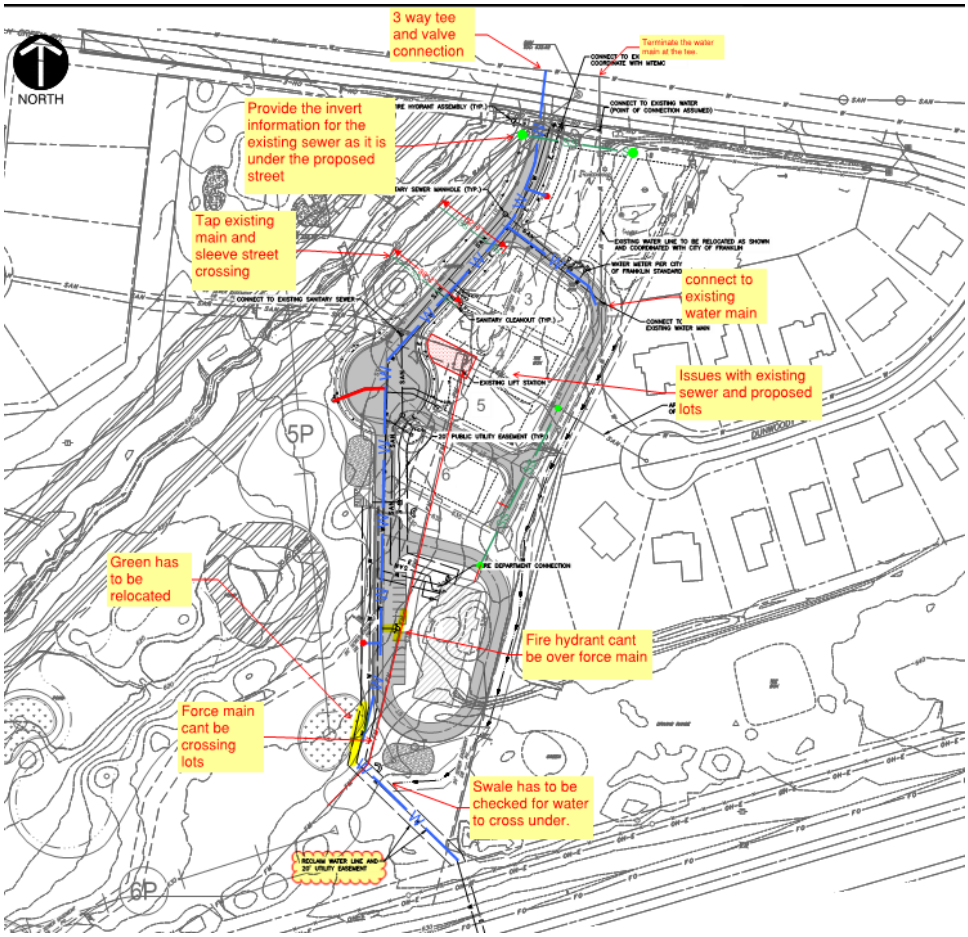
ben.mcneil@franklintn.gov The information on what is staying and being relocated is not clear. Any utility that remains in the current location shall be noted with the appropriate easements shown. The easements and utility lines shall be clear of potential maintenance issues.

46. Water/Sewer availability

ben.mcneil@franklintn.gov The current availability request is under review.

47. Proposed utility plan

ben.mcneil@franklintn.gov The proposed water and sewer plan for the Cheekwood Golf course has issues that need to be discuss further. The applicant shall schedule as meeting with Franklin Water to discuss layout of potential water and sewer as well as proposed lots around pump station. The applicant shall not resubmit until the meeting has occurred and the layout approved by Water management.

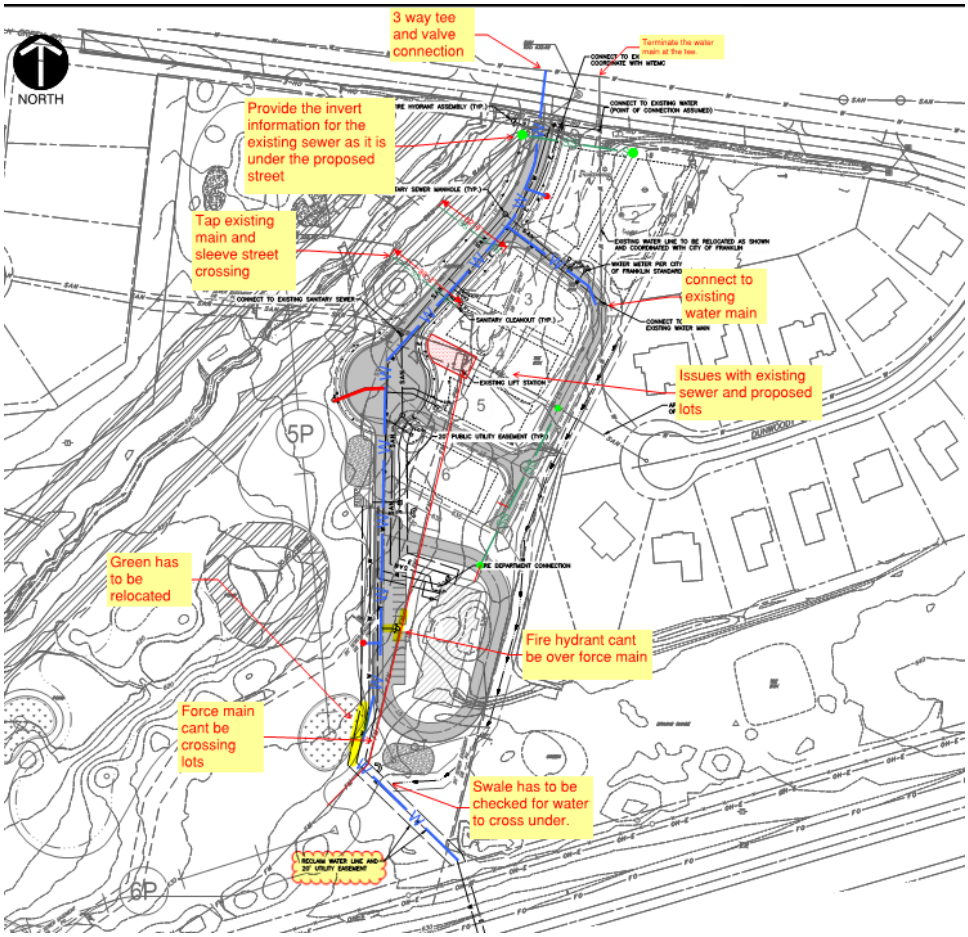


51. Meeting Required prior to re-submittal

ben.mcneil@franklintn.gov

The proposed water and sewer plan for the Cheekwood Golf course has issues that need to be discuss further. The applicant shall schedule as meeting with Franklin Water to discuss layout of potential water and sewer as well as proposed lots around pump station. The applicant shall not resubmit until the meeting has occurred and the layout approved by Water management.

A preliminary meeting was conducted 3/15/21 and the applicant agreed that the sanitary sewer layout would be revised. The station will be relocated at the owners expense and final design would be approved by Franklin Water Management.
A general study of the area will be explored by Franklin water to determine station sizing and potential locations. This will be finalized at site plan. If additional upsizing is required, a cost share agreement may be requested by the applicant at that time.

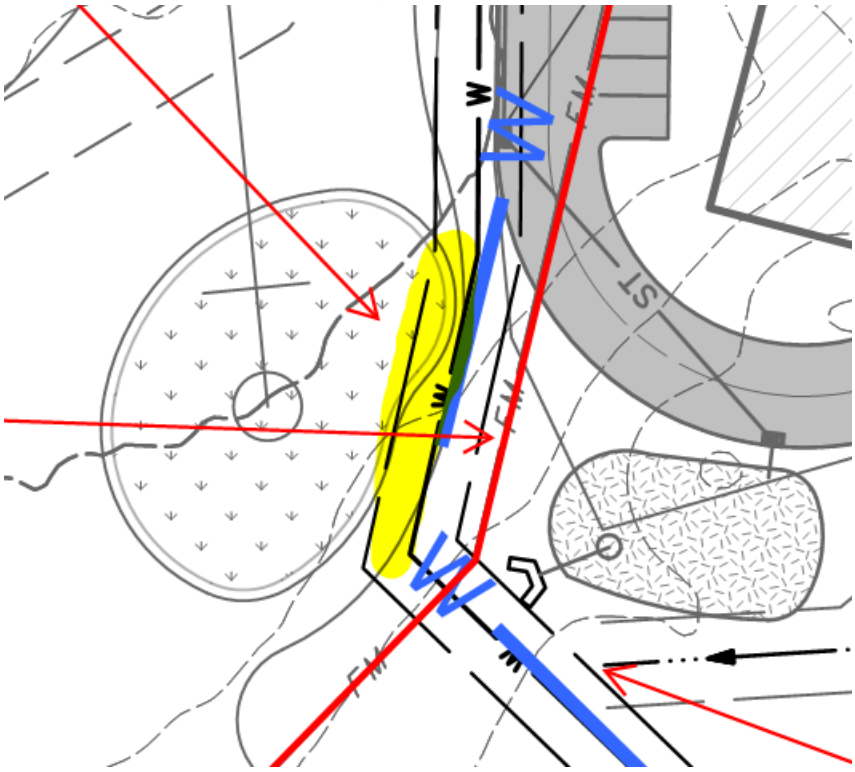


Reply Edit Delete

[Edited By Ben McNeil]

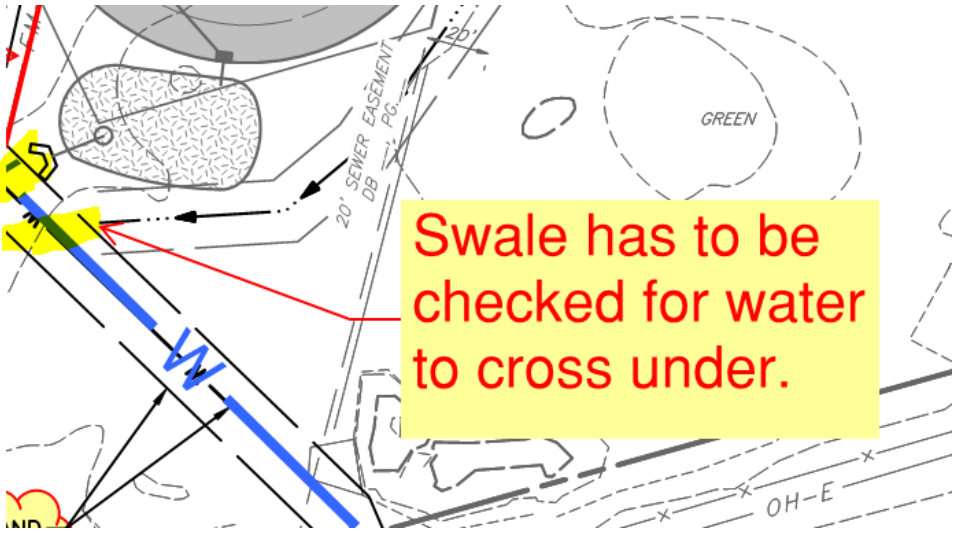
55. Proposed water

ben.mcneil@franklintn.gov The applicant has shown the proposed water line shown next to the green, the green shall be relocated or the water alignment relocated.



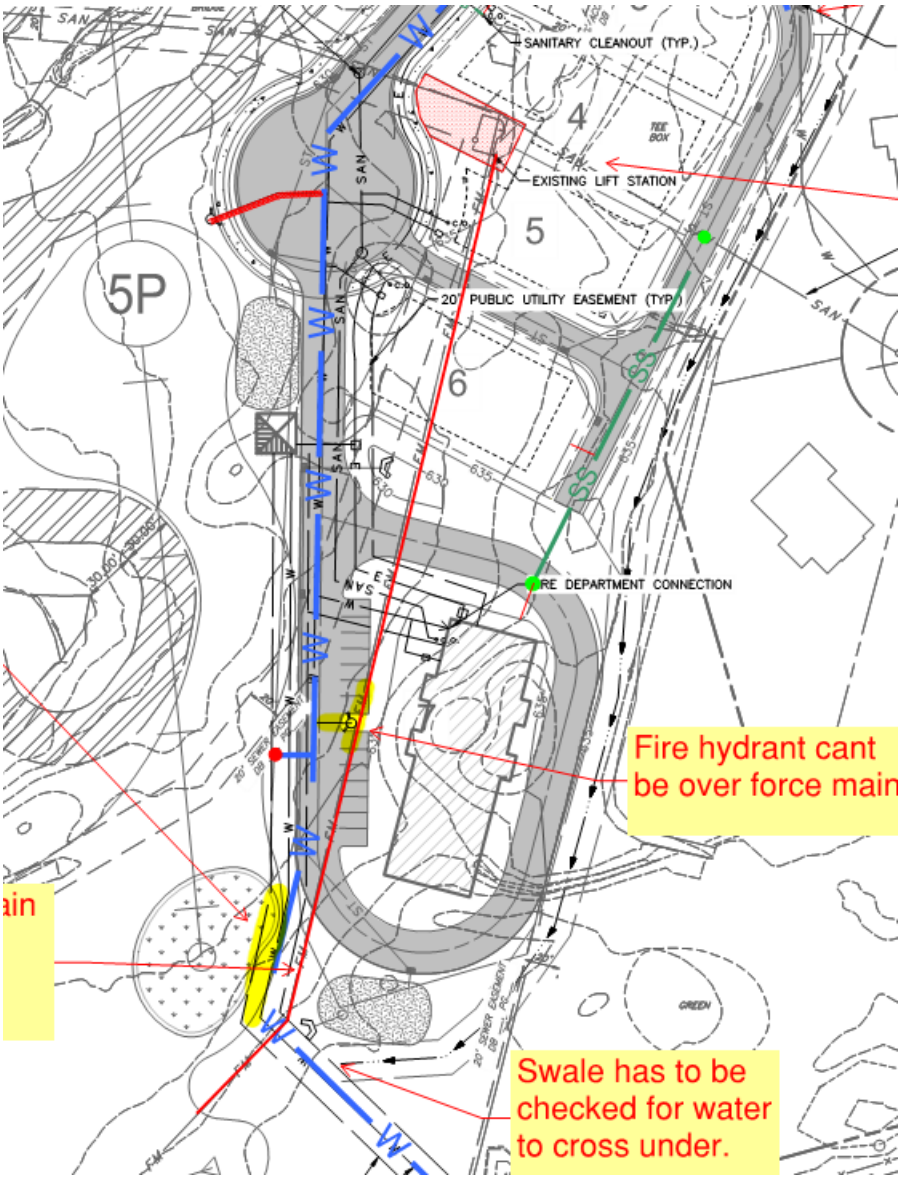
56. Water at swale

ben.mcneil@franklintn.gov The applicant shall verify that the proposed swale does not reduce cover at proposed water main crossing.



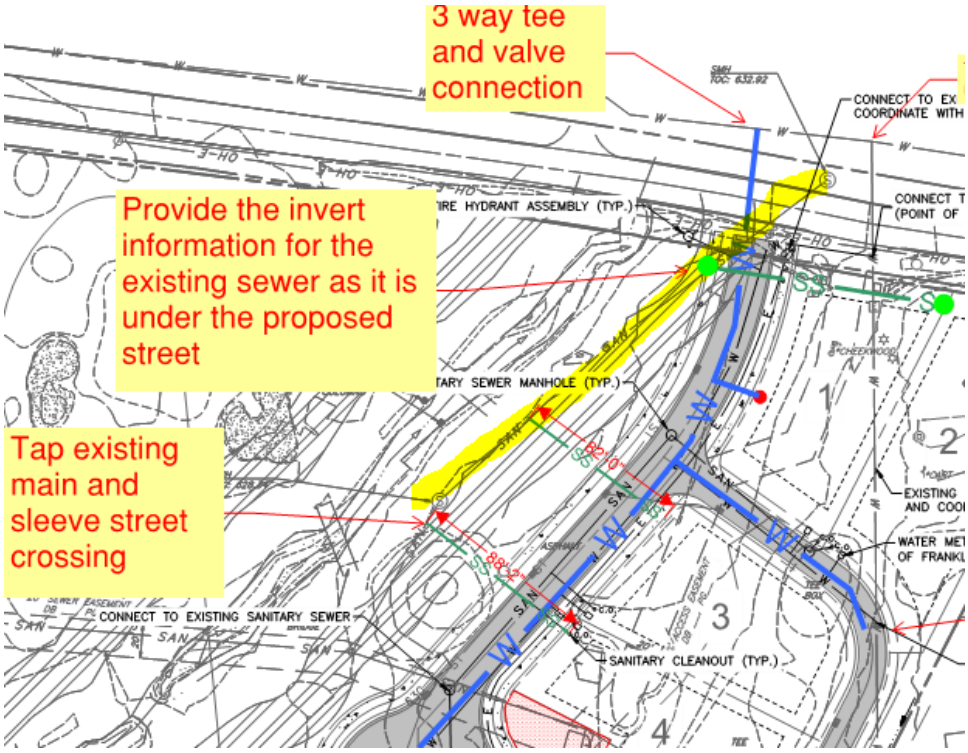
57. Existing force main

ben.mcneil@franklintn.gov The applicant shall show relocating the existing force main as it cannot cross the proposed lots.



58. Existing invert information

ben.mcneil@franklintn.gov The applicant shall provide the existing invert information for the sewer crossing the proposed drive.



Zoning

General Issues

28. Floodway

shanna.mccoy@franklintn.gov	Comment to remain open Encroachments are prohibited, including earthen fill material, new construction, substantial improvements or other development within the regulatory floodway. Development may be permitted; however, provided it is demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practices that the cumulative effect of the proposed encroachments or new development shall not result in any increase in the water surface elevation of the base flood elevation, velocities, or floodway widths during the occurrence of a base flood discharge at any point within the community. A Tennessee registered professional engineer must provide supporting technical data, using the same methodologies as in the effective Flood Insurance Study for the City and certification, thereof;

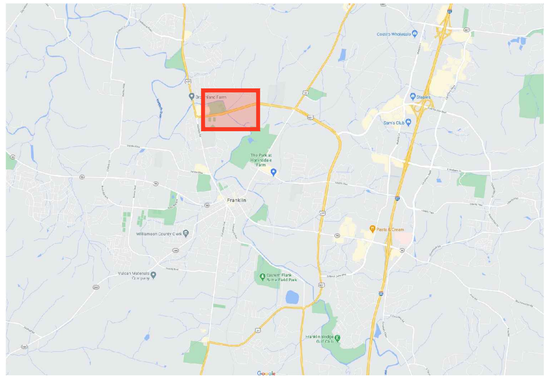
33. FFO

shanna.mccoy@franklintn.gov	Comment to remain open. Advisory note: No new buildable lots shall include FFO.

CHEEKWOOD NORTH PD

DEVELOPMENT PLAN

PLANNED DISTRICT (0.14 DUA, 14,300)
FRANKLIN, WILLIAMSON, TENNESSEE



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GAMBLE DESIGN COLLABORATIVE
GREG GAMBLE
324 LIBERTY PIKE
SUITE 145
FRANKLIN, TN 37064
615-975-5765
greg.gamble@gdc-tn.com

ENGINEER:

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STEVE CASEY
117 SEABOARD LANE
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615-333-7797
scasey@cecinc.com

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CONTACT:
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ADDRESS:	285 SPENCER CREEK ROAD FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02102
ACREAGE / SF OF SITE:	35.36 AC
VESTING (IF APPLICABLE):	
BASE ZONING:	PD (PLANNED DISTRICT) R-1 (RESIDENTIAL 1 DISTRICT)
PROPOSED ZONING:	PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO
BUILDING TYPES APPLIED:	HOUSE
FRONTAGE TYPES APPLIED:	YARD FRONTAGE
LOT WIDTH (RESIDENTIAL):	70'
LOT SIZE (RESIDENTIAL):	9,000 SF MIN
SETBACKS:	
FRONT	15'
SIDE	5'
REAR	7.5'
DWELLING UNIT COUNT (BY TYPE):	
SINGLE FAMILY:	6 UNITS
MULTIFAMILY:	N/A
NON-RESIDENTIAL SF (BY USE):	
PUMP HOUSE:	100 SF
HALF-WAY HOUSE:	1,200 SF
TURF MAINTENANCE FACILITY:	13,000 SF
HOTEL KEYS:	N/A
BUILDING HEIGHT:	MAX 2 STORIES
PARKLAND DEDICATION:	6 UNITS X $4304 = $25,824
MINIMUM LSA:	20%
OPEN SPACE REQUIRED:	5% (1.77 AC)
NATURAL AREA REQUIRED:	10% (NOT REQUIRED)
TREE CANOPY RETENTION ACREAGE:	REQUIRED: 2.28 AC (24% OF TOTAL CANOPY) PROVIDED: 8.16 AC (86% OF TOTAL CANOPY)
PARKING REQUIRED (BY USE):	
SINGLE FAMILY PARKING:	SEE ATTACHED PARKING STUDY
PARKING PROVIDED (BY USE):	
SINGLE FAMILY PARKING:	SEE ATTACHED PARKING STUDY
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

SHEET INDEX

C0.0	COVER SHEET
C1.0	OVERALL EXISTING CONDITIONS
C1.1	EXISTING CONDITIONS ENLARGEMENT
C1.2	EXISTING CONDITIONS ENLARGEMENT
C1.3	EXISTING CONDITIONS ENLARGEMENT
C1.4	EXISTING CONDITIONS ENLARGEMENT
C1.5	EXISTING CONDITIONS ENLARGEMENT
C2.0	OVERALL DEVELOPMENT PLAN
C2.1	DEVELOPMENT PLAN ENLARGEMENT
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C3.0	OVERALL GRADING AND DRAINAGE PLAN
C3.1	GRADING AND DRAINAGE PLAN
C3.2	GRADING AND DRAINAGE PLAN
C3.3	GRADING AND DRAINAGE PLAN
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C4.0	OVERALL ROW AND ACCESS PLAN
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C5.0	OVERALL UTILITY PLAN
C5.1	ENLARGED UTILITY PLAN
L1.0	TREE PRESERVATION
L2.0	STREAM BUFFER MITIGATION
A1.0	ARCHITECTURE
A2.0	ARCHITECTURE
A3.0	ARCHITECTURE

PRE-APP SUBMITTAL: NOVEMBER 30, 2020

INITIAL SUBMITTAL: DECEMBER 14, 2020

RESUBMITTAL: MARCH 4, 2021

GDC
GAMBLE
DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE
greg.gamble@gdc-tn.com

THERE SHALL BE NO MOWING, CLEARING, GRADING, CONSTRUCTION, STORAGE, OR DISTURBANCE OF VEGETATION IN RIPARIAN BUFFERS EXCEPT AS PERMITTED BY THE CITY ENGINEER, OR HIS DESIGNEE.

CART PATH CONNECTION UNDER MACK HATCHER BETWEEN NORTH AND SOUTH

N

0 200 400 600

SITE DATA CHART

PROJECT NAME:	CHEEKWOOD NORTH PD
PROJECT NUMBER:	7414
ADDRESS:	285 SPENCER CREEK ROAD FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02102
ACREAGE / SF OF SITE:	35.36 AC
VESTING (IF APPLICABLE):	
BASE ZONING:	PD (PLANNED DISTRICT)
PROPOSED ZONING:	R-1 (RESIDENTIAL 1 DISTRICT) PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO
BUILDING TYPES APPLIED:	HOUSE
FRONTAGE TYPES APPLIED:	YARD FRONTAGE
LOT WIDTH (RESIDENTIAL):	70'
LOT SIZE (RESIDENTIAL):	9,000 SF MIN
SETBACKS:	
FRONT	15'
SIDE	5'
REAR	7.5'
DWELLING UNIT COUNT (BY TYPE):	
SINGLE FAMILY:	6 UNITS
MULTIFAMILY:	N/A
NON-RESIDENTIAL SF (BY USE):	
PUMP HOUSE:	100 SF
HALF-WAY HOUSE:	1,200 SF
TURF MAINTENANCE FACILITY:	13,000 SF
HOTEL KEYS:	N/A
BUILDING HEIGHT:	MAX 2 STORIES
PARKLAND DEDICATION:	6 UNITS X $4304 = $25.824
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KEY - EXISTING CONDITIONS

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- FWO; PROPOSED
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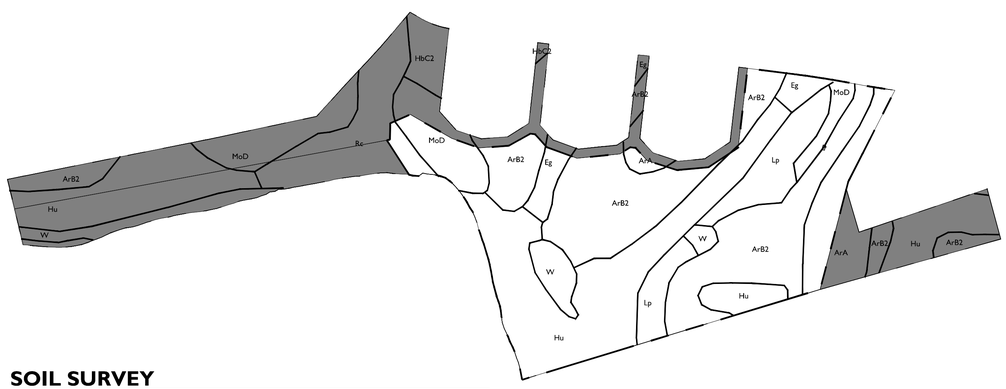
- 30', ZONE 2 RIPARIAN BUFFER



SOIL SURVEY

ArA	Armour silt loam, 0 to 2 percent slopes
ArB	Armour silt loam, 2 to 5 percent slopes
ArB2	Armour silt loam, 2 to 5 percent slopes, eroded
ArC	Armour silt loam, 5 to 12 percent slopes 1.6
ArC2	Armour silt loam, 5 to 12 percent slopes, eroded
BrC2	Braxton cherty silt loam, 5 to 12 percent slopes, eroded
Eg	Egam silt loam, phosphatic
HbC2	Hampshire silt loam, 5 to 12 percent slopes, eroded
HcC3	Hampshire silty clay loam, 5 to 12 percent slopes, severely eroded
Hu	Huntington silt loam, phosphatic
Lp	Lindell silt loam, 0 to 2 percent slopes, occasionally flooded
MbB2	Maury silt loam, 2 to 5 percent slopes, eroded
McC3	Maury silty clay loam, 5 to 12 percent slopes, severely eroded
MoD	Ashwood-Mimosa-Rock outcrop complex, 5 to 15 percent slopes
Rc	Rockland
W	Water

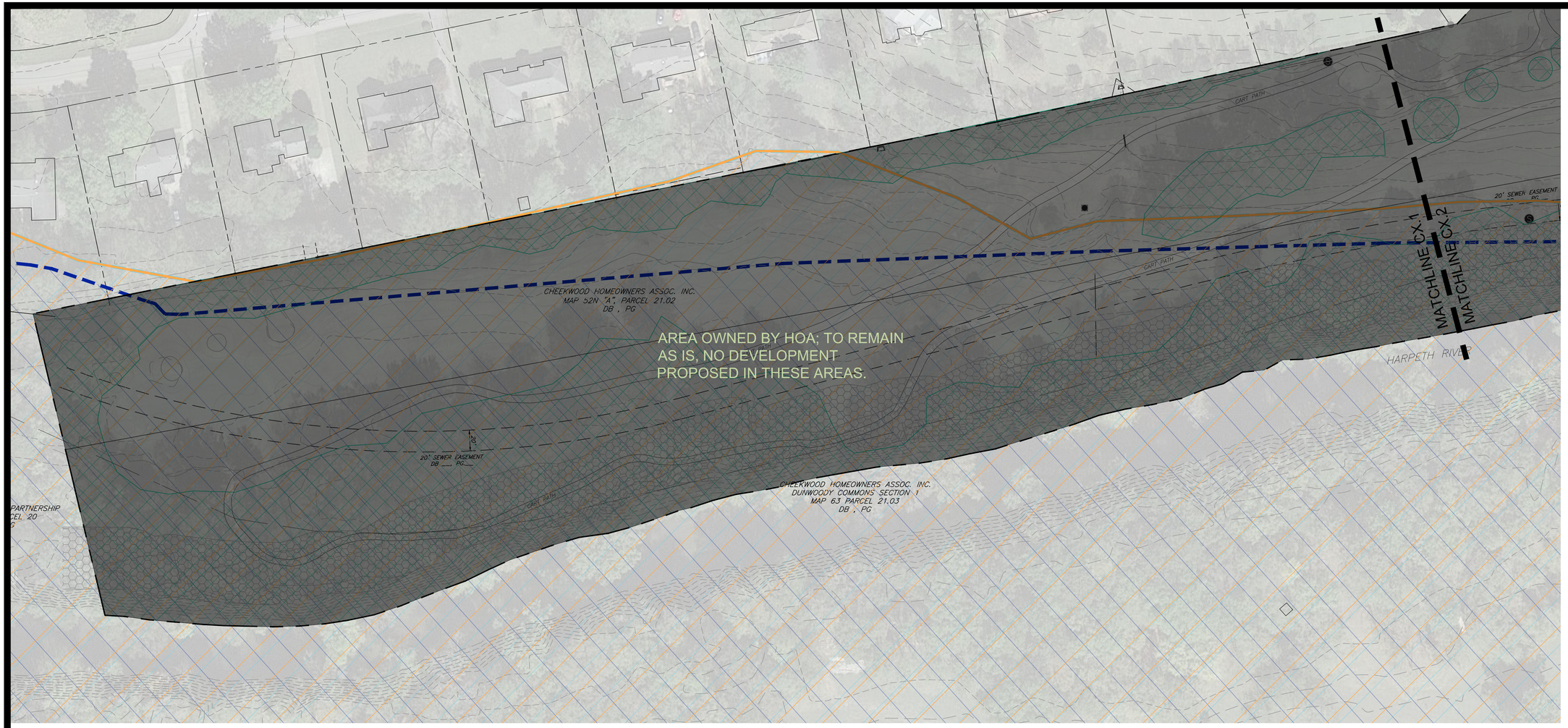
GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD
DEVELOPMENT PLAN
Franklin, Williamson County, Tennessee

DRAKE A. REEDER REGISTERED LANDSCAPE ARCHITECT TENNESSEE No. 03.01.22

Revision Date
- △ _____
- △ _____
- △ _____
- △ _____

OVERALL EXISTING CONDITIONS SHEET
C1.0
COF # 7414



KEY - EXISTING CONDITIONS

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N

0 50 100 150

GDC
GAMBLE
DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND
LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD
DEVELOPMENT PLAN

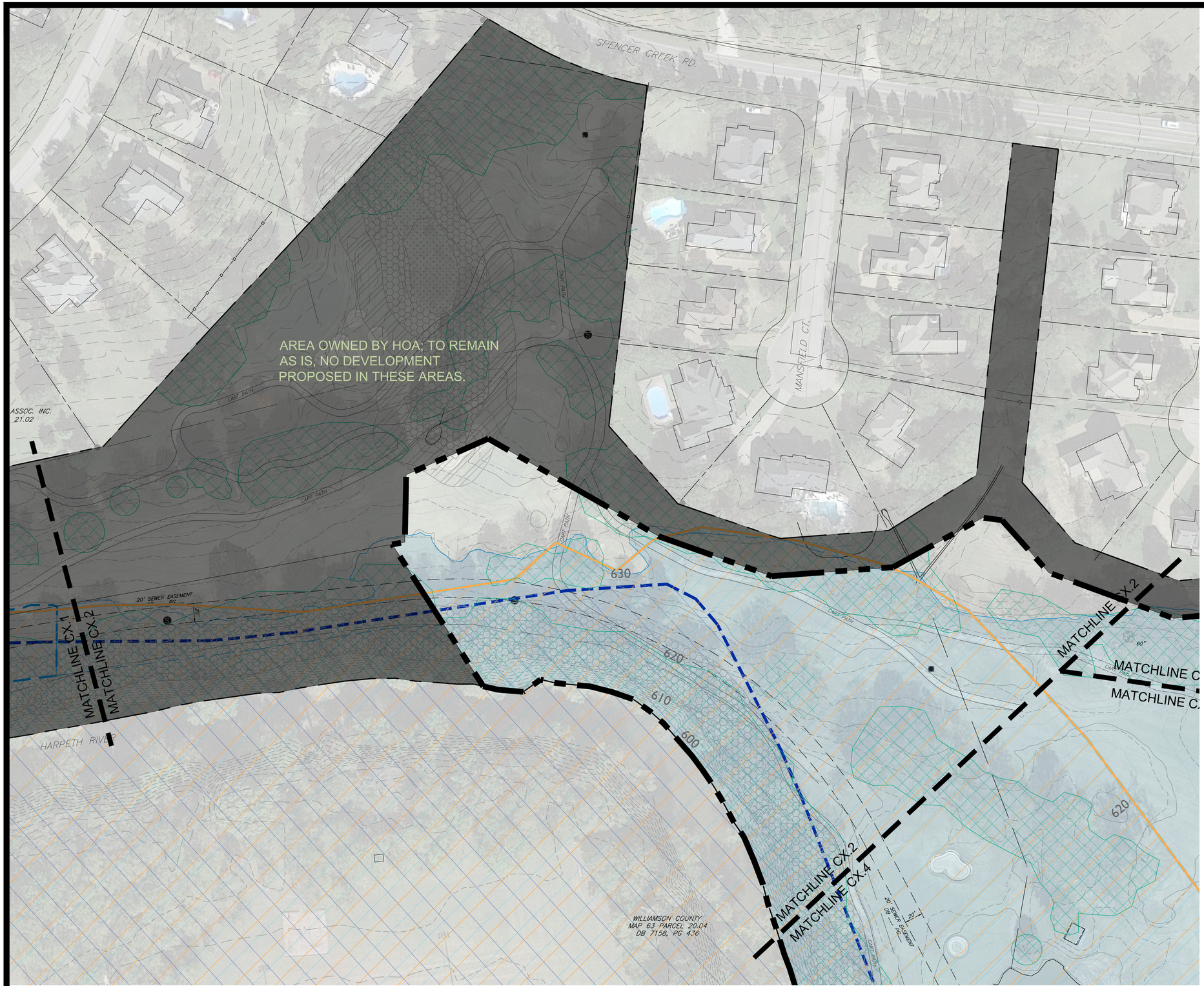
Franklin, Williamson County, Tennessee

DRAKE A. REEDER
REGISTERED
TENNESSEE No. 1
LANDSCAPE ARCHITECT
03.01.2024

Revision Date

EXISTING
CONDITIONS
ENLARGEMENT
SHEET
C1.1

COF # 7414



KEY - EXISTING CONDITIONS

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GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

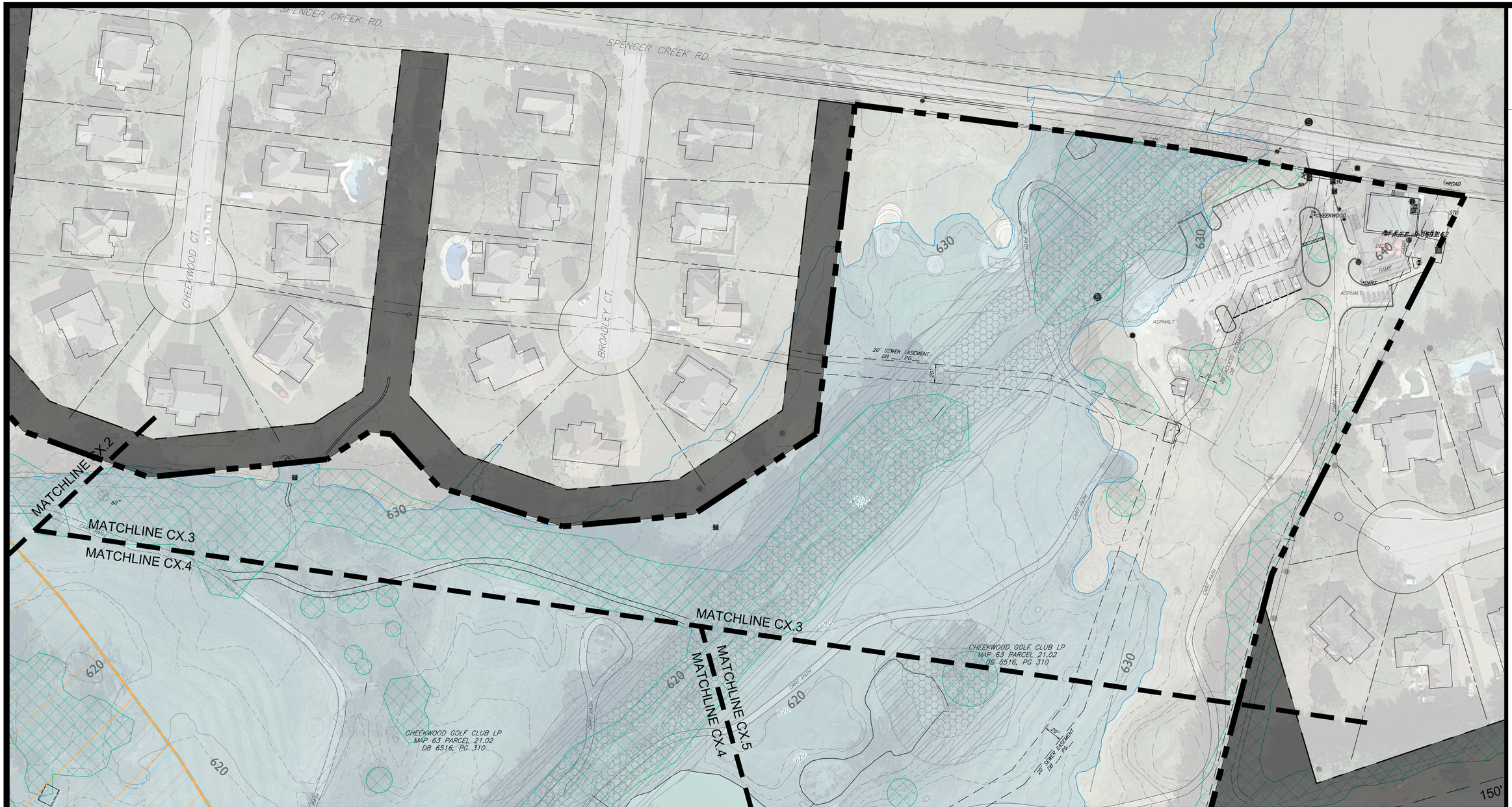
DRAKE A. REEDER
REGISTERED
COMMERCE
TENNESSEE No. 12
LANDSCAPE ARCHITECT
03.01.2021

Revision Date

EXISTING CONDITIONS ENLARGEMENT SHEET

C1.2

COF # 7414



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DEVELOPMENT PLANNING AND
LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

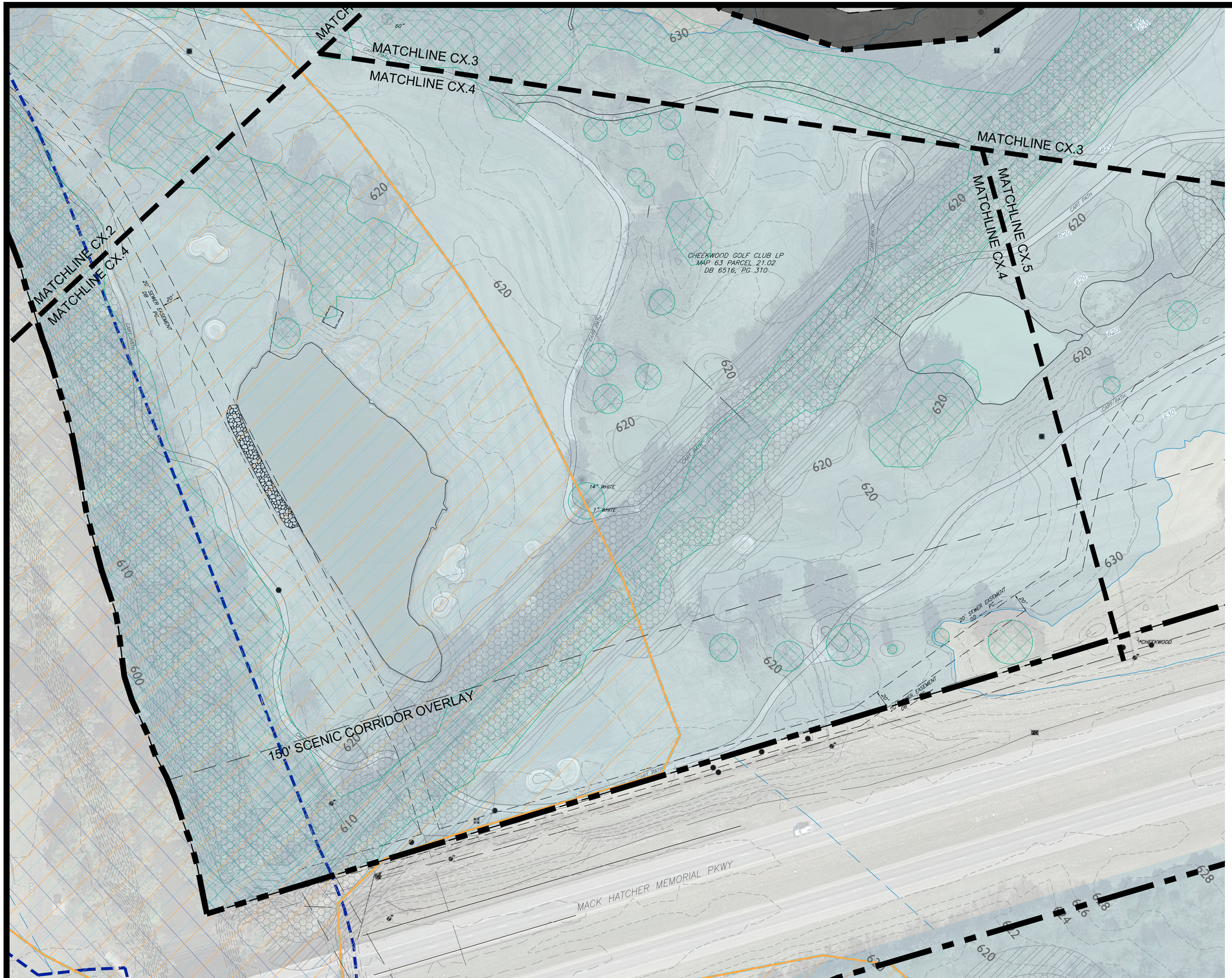
DRAKE A. REEDER
REGISTERED
COMMERCE
TENNESSEE No. 12
LANDSCAPE ARCHITECT
03.04.2021

Revision Date

EXISTING CONDITIONS ENLARGEMENT SHEET

C1.3

COF # 7414



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DEVELOPMENT PLANNING AND
LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

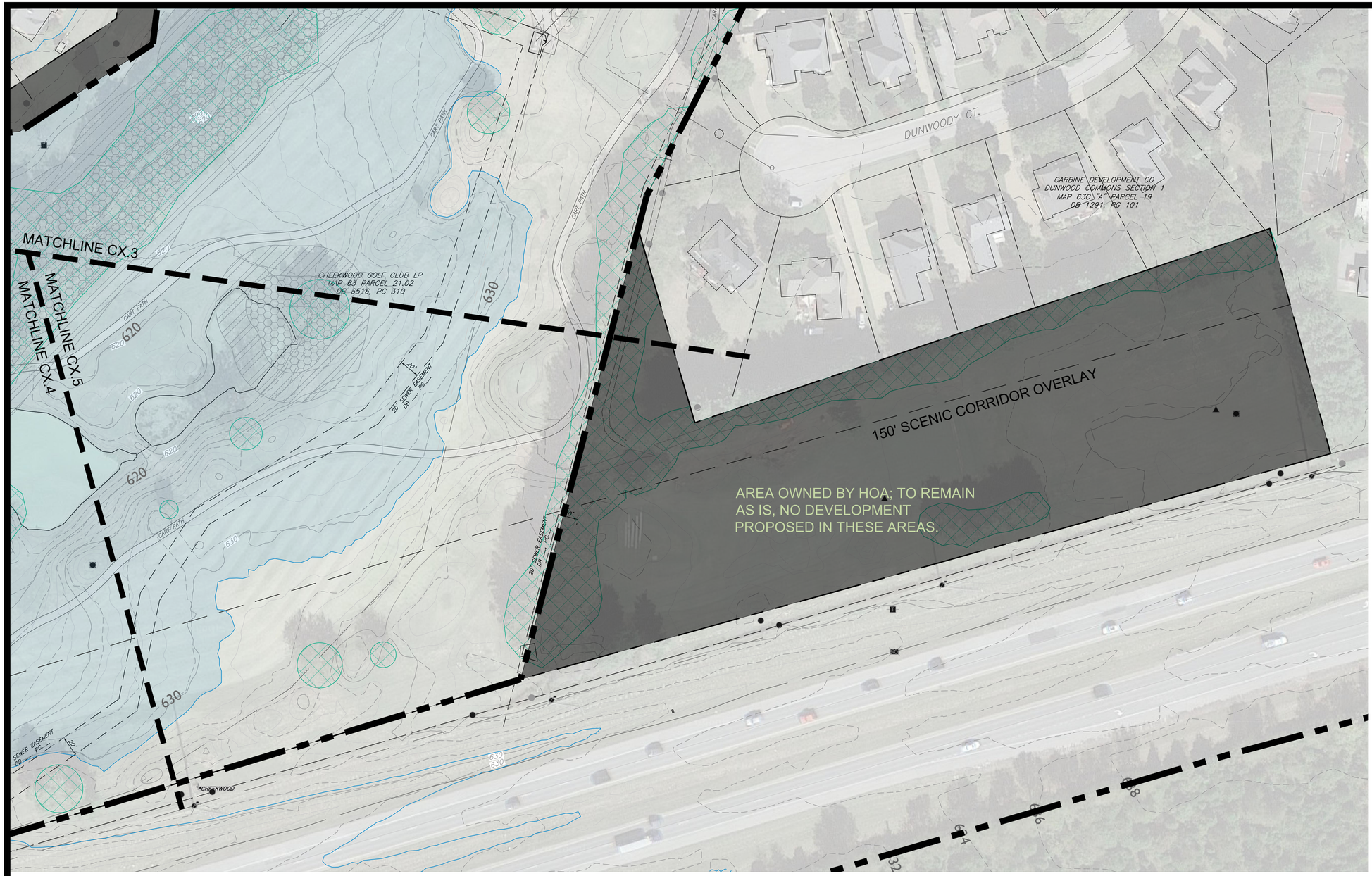
DRAKE A. REEDER
REGISTERED
COMMERCE
TENNESSEE No. 12...
LANDSCAPE ARCHITECT
03.01.2021

Revision Date

EXISTING CONDITIONS ENLARGEMENT SHEET

C1.4

COF # 7414



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CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

DRAKE A. REEDER
REGISTERED
COMMERCE
TENNESSEE No. 12
LANDSCAPE ARCHITECT
03.01.2021

Revision Date

EXISTING
CONDITIONS
ENLARGEMENT
SHEET
C1.5

COF # 7414

THERE SHALL BE NO MOWING, CLEARING, GRADING, CONSTRUCTION, STORAGE, OR DISTURBANCE OF VEGETATION IN RIPARIAN BUFFERS EXCEPT AS PERMITTED BY THE CITY ENGINEER, OR HIS DESIGNEE.

N

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KEY - DEVELOPMENT PLAN

- PRESERVED TREE CANOPY
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- FWO; PRELIMINARY
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- 30'/60' , ZONE 1 RIPARIAN BUFFER
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SITE DATA CHART

PROJECT NAME:	CHEEKWOOD NORTH PD
PROJECT NUMBER:	7414
ADDRESS:	285 SPENCER CREEK ROAD FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02102
ACREAGE / SF OF SITE:	35.36 AC
VESTING (IF APPLICABLE):	
BASE ZONING:	PD (PLANNED DISTRICT) R-1 (RESIDENTIAL 1 DISTRICT)
PROPOSED ZONING:	PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO
BUILDING TYPES APPLIED:	HOUSE
FRONTAGE TYPES APPLIED:	YARD FRONTAGE
LOT WIDTH (RESIDENTIAL):	70'
LOT SIZE (RESIDENTIAL):	9,000 SF MIN
SETBACKS:	
FRONT	15'
SIDE	5'
REAR	7.5'
DWELLING UNIT COUNT (BY TYPE):	
SINGLE FAMILY:	6 UNITS
MULTIFAMILY:	N/A
NON-RESIDENTIAL SF (BY USE):	
PUMP HOUSE:	100 SF
HALF-WAY HOUSE:	1,200 SF
TURF MAINTENANCE FACILITY:	13,000 SF
HOTEL KEYS:	N/A
BUILDING HEIGHT:	MAX 2 STORIES
PARKLAND DEDICATION:	6 UNITS X $4304 = $25,824
MINIMUM LSA:	20%
OPEN SPACE REQUIRED:	5% (1.77 AC)
NATURAL AREA REQUIRED:	10% (NOT REQUIRED)
TREE CANOPY RETENTION ACREAGE:	REQUIRED: 2.28 AC (24% OF TOTAL CANOPY) PROVIDED: 8.16 AC (86% OF TOTAL CANOPY)
PARKING REQUIRED (BY USE):	
SINGLE FAMILY PARKING:	SEE ATTACHED PARKING STUDY
PARKING PROVIDED (BY USE):	
SINGLE FAMILY PARKING:	SEE ATTACHED PARKING STUDY
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

OPEN SPACE REQUIREMENT

MINIMUM OPEN SPACE REQUIREMENT: 5%
REQUIRED: 5% TOTAL = 1.77 AC
(10% 'NATURAL AREA' = NOT REQUIRED)
PROVIDED: 31.61 AC TOTAL (89.4%)

LOT	TYPE	AREA (SF)
OS-1	NEIGHBORHOOD AMENITY	31.61 AC

NOTE: OPEN SPACE PLANTINGS WILL BE BASED ON THE 5% MINIMUM OPEN SPACE REQUIRED BY THE ZONING ORDINANCE. NOT ON THE TOTAL OPEN SPACE PROVIDED.

TREE CANOPY RETENTION

OVERALL SITE AREA = 35.36 AC

TREE CANOPY DATA:

TOTAL EXISTING TREE CANOPY:	414,175 SF; 9.51 AC (27% OF SITE)
REQUIRED CANOPY PRESERVATION:	24% (99,402 SF; 2.28 AC)
PROVIDED CANOPY PRESERVATION:	379,041 SF; 8.7 AC (91.5% OF REQUIRED)

STATEMENT OF IMPACTS

WATER FACILITIES
WATER SERVICE WILL BE PROVIDED BY . THE WATER MAINS ARE LOCATED ALONG .
6 UNITS x 250 GPD = 1,500 GPD

SEWER FACILITIES
SEWER SERVICE WILL BE PROVIDED BY THE CITY OF FRANKLIN.

REPURIFIED (REUSE) WATER FACILITIES
AVAILABLE. SEE UTILITY SHEETS.

POLICE, FIRE, AND RECREATIONAL FACILITIES
NEAREST POLICE STATION: HEADQUARTERS (3.11 MILES)
NEAREST FIRE STATION: FIRE STATION #4 (1.7 MILES)
NEAREST RECREATIONAL FACILITY: WILLIAMSON COUNTY RECREATION CENTER (1.7 MILES)

PROJECTED STUDENT POPULATION
6 x 0.33 = 2 STUDENTS

REFUSE STORAGE AND SANITATION COLLECTION FACILITIES
REFUSE COLLECTION FOR THE DEVELOPMENT SHALL BE PROVIDED BY CITY OF FRANKLIN

GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD
DEVELOPMENT PLAN
Franklin, Williamson County, Tennessee

DRAKE A. REEDER REGISTERED TENNESSEE No. 1... LANDSCAPE ARCHITECT 03.01.22

Revision Date
△ _____
△ _____
△ _____
△ _____

DEVELOPMENT PLAN SHEETS

SHEET
C2.0

COF # 7414

AREA OWNED BY HOA; TO REMAIN
AS IS, NO DEVELOPMENT
PROPOSED IN THESE AREAS.

20' SEWER EASEMENT
DB ___ PG___

20' SEWER EASEMENT
DB ___ PG___

MATCHLINE SEE SHEET C2.2

MATCHLINE SEE SHEET C2.0

HARPETH RIVER

THERE SHALL BE NO MOWING, CLEARING, GRADING, CONSTRUCTION, STORAGE, OR DISTURBANCE OF VEGETATION IN RIPARIAN BUFFERS EXCEPT AS PERMITTED BY THE CITY ENGINEER, OR HIS DESIGNEE.

KEY - DEVELOPMENT PLAN

- PRESERVED TREE CANOPY
- OPEN SPACE
- FWO; PRELIMINARY
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- FFO
- 30'/60' , ZONE 1 RIPARIAN BUFFER
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N

0 50 100 150

GDC
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DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND
LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD
DEVELOPMENT PLAN
Franklin, Williamson County, Tennessee

DRAKE A. REEDER
REGISTERED
CONVERSE, TENNESSEE
LANDSCAPE ARCHITECT
03.04.2021

Revision Date
△ _____
△ _____
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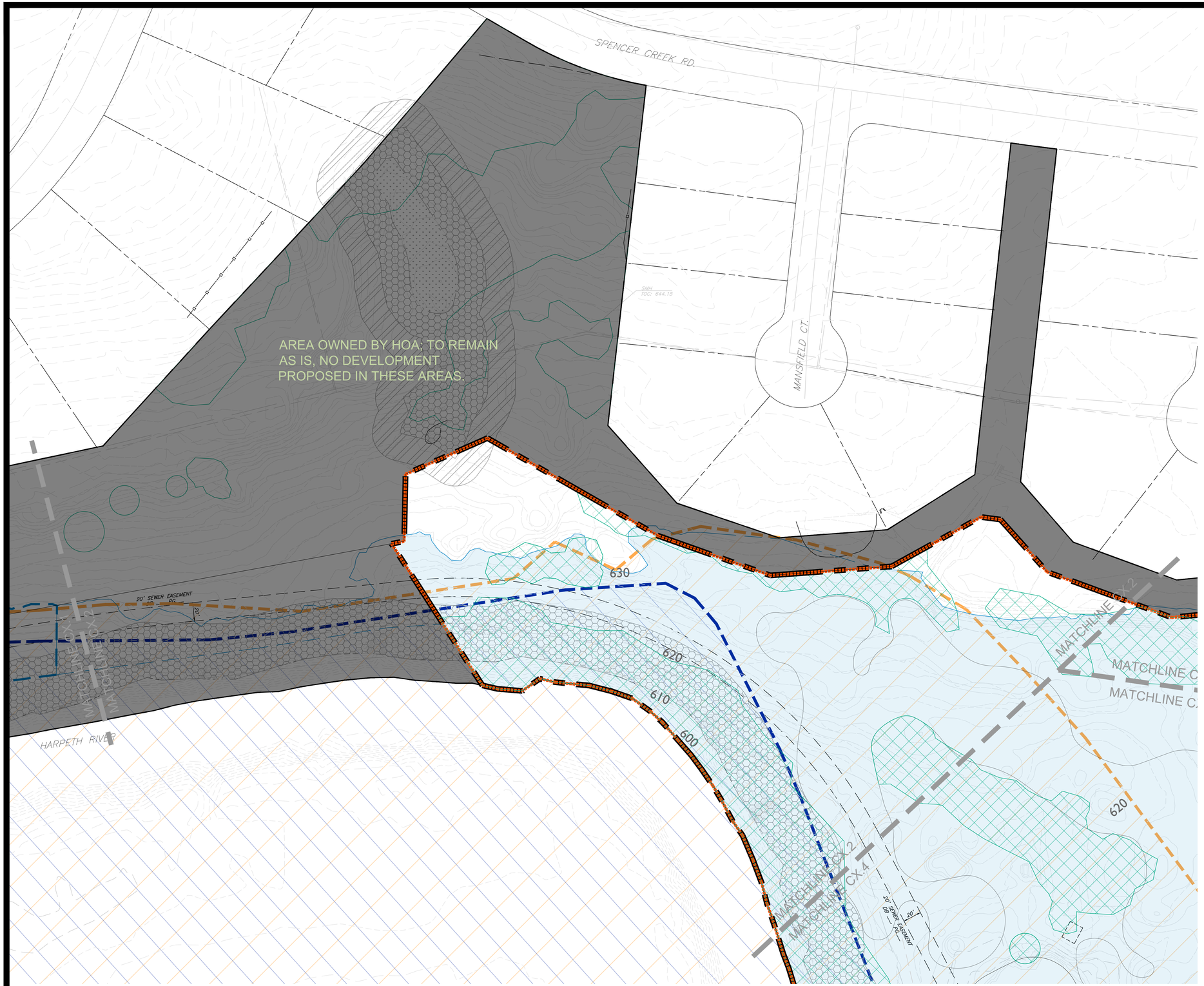
△ _____

DEVELOPMENT PLAN ENLARGEMENTS
SHEET
C2.1
COF # 7414



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GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

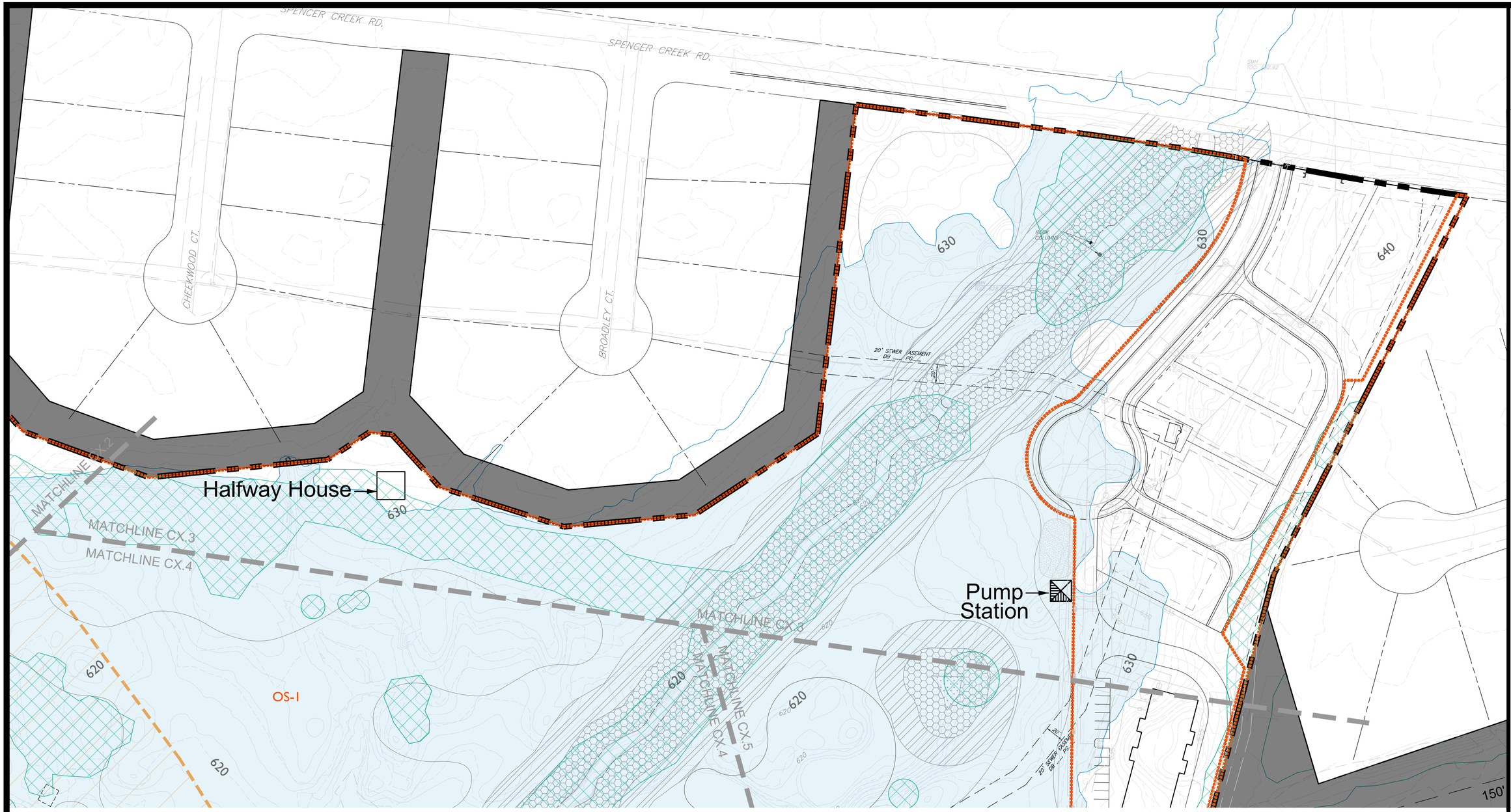
DRAKE A. REEDER
REGISTERED
COMMERCE
TENNESSEE No. 12...
LANDSCAPE ARCHITECT
03.01.2021

Revision Date

DEVELOPMENT PLAN ENLARGEMENTS SHEET

C2.2

COF # 7414



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KEY - DEVELOPMENT PLAN

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GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

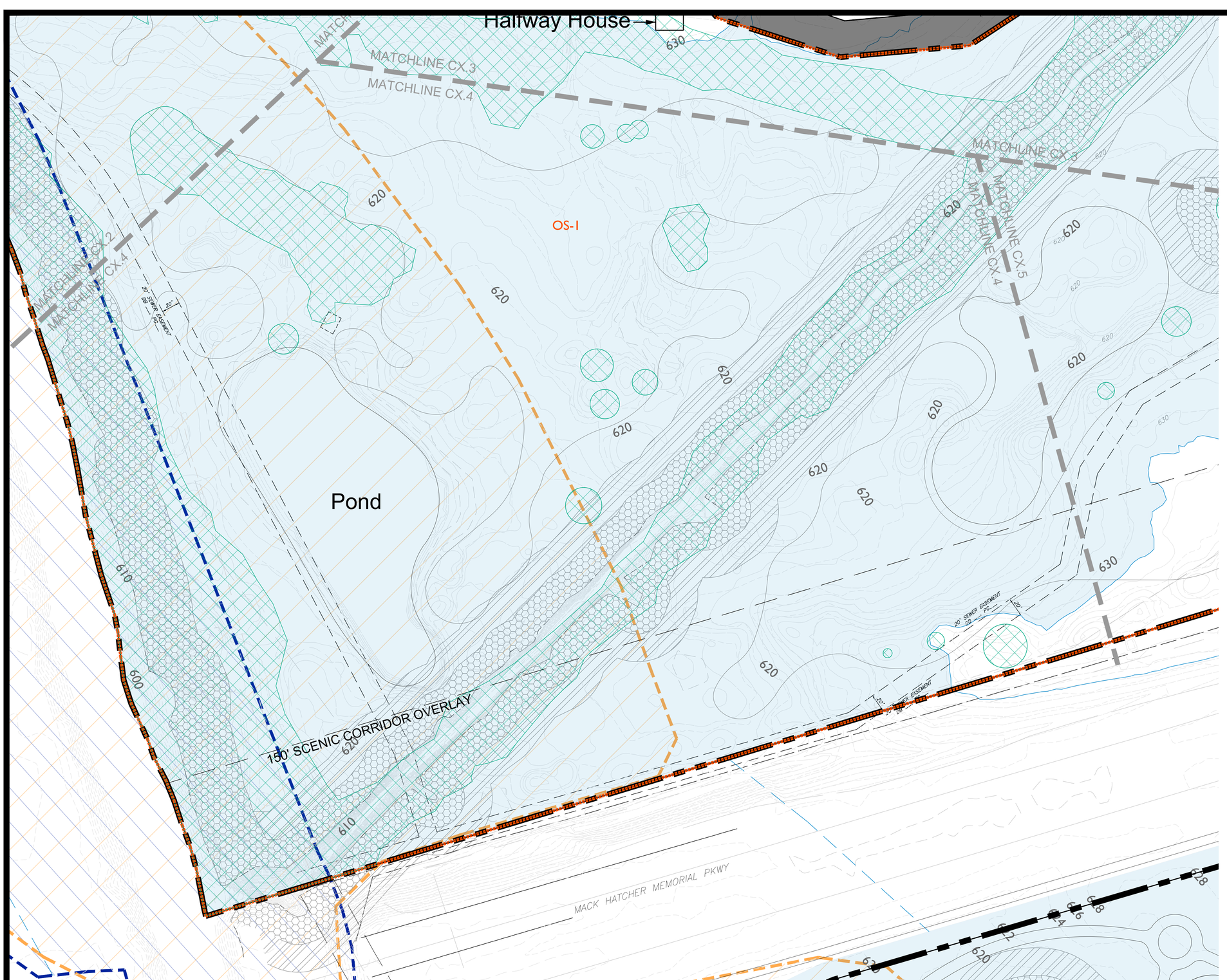
DRAKE A. REEDER REGISTERED COMMERCE TENNESSEE No. 12... LANDSCAPE ARCHITECT 03.04.2021

Revision Date

DEVELOPMENT PLAN ENLARGEMENTS SHEET

C2.3

COF # 7414



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GDC
GAMBLE DESIGN COLLABORATIVE
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CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

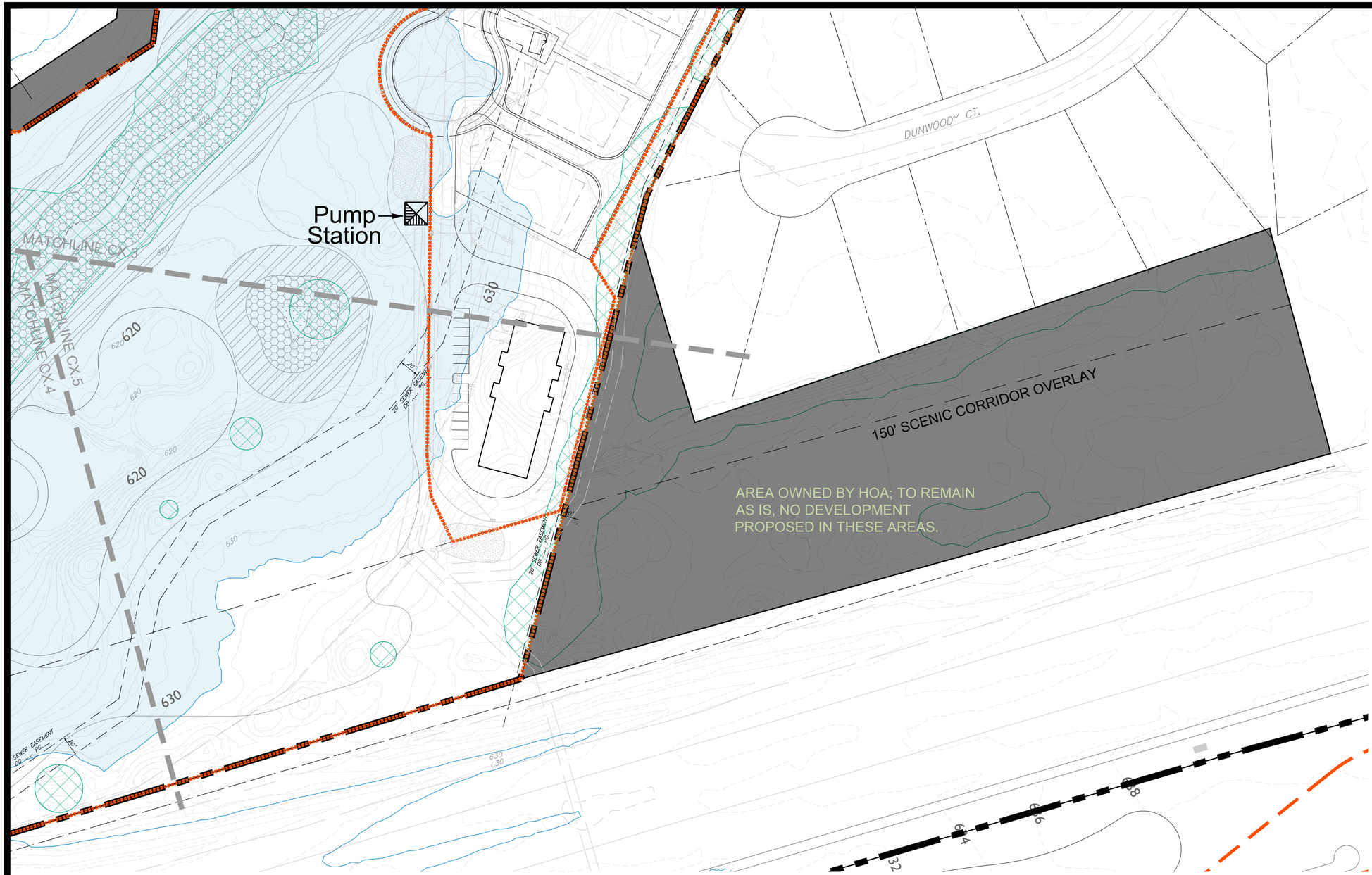
DRAKE A. REEDER
REGISTERED
COMMERCE
TENNESSEE No. 12
LANDSCAPE ARCHITECT
03.01.2021

Revision Date

DEVELOPMENT PLAN ENLARGEMENTS SHEET

C2.4

COF # 7414



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DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

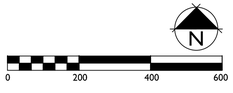
CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

DRAKE A. REEDER REGISTERED LANDSCAPE ARCHITECT TENNESSEE No. 329 03.01.22

Revision Date

DEVELOPMENT PLAN ENLARGEMENTS
SHEET
C2.5
COF # 7414



SITE DATA CHART

PROJECT NAME:	CHEEKWOOD NORTH PD
PROJECT NUMBER:	7414
ADDRESS:	285 SPENCER CREEK ROAD FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02102
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FRONTAGE TYPES APPLIED:	YARD FRONTAGE
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LOT SIZE (RESIDENTIAL):	9,000 SF MIN
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DWELLING UNIT COUNT (BY TYPE):	
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HOTEL KEYS:	N/A
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PARKING PROVIDED (BY USE):	
SINGLE FAMILY PARKING:	SEE ATTACHED PARKING STUDY
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

TREE SPECIMEN REMOVAL

NORTH PARCEL		
TREE #	DIAM"	SPECIES
101	26	MAPLE
102	40	MAPLE
103	50	LOCUST
TOTAL	116	

PROJECTED SPECIMEN TREE REMOVED: 116"
PROJECTED TREE TO BE REPLACED: 232"

NOTE: TREES FIELD SURVEYED BY LANDSCAPE ARCHITECT; SPECIMEN TREE REMOVED IS AN APPROXIMATION, ACTUAL NUMBER TO BE ESTABLISHED AT SITE PLAN

TREE CANOPY RETENTION

OVERALL SITE AREA = 35.36 AC

TREE CANOPY DATA:

TOTAL EXISTING TREE CANOPY:	414,175 SF; 9.51 AC (27% OF SITE)
REQUIRED CANOPY PRESERVATION:	24% (99,402 SF; 2.28 AC)
PROVIDED CANOPY PRESERVATION:	379,041 SF; 8.7 AC (91.5% OF REQUIRED)

KEY - TREE PRESERVATION

- PRESERVED TREE CANOPY
- REMOVED TREE CANOPY
- REMOVED SPECIMEN TREE

TREE PROTECTION NOTES:

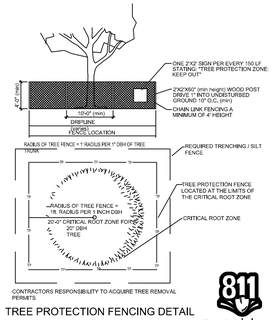
1. The tree protection barriers shall be constructed before the issuance of any permits, and shall remain intact throughout the entire period of construction.

2. The tree protection barrier shall be installed as labeled on this plan or a distance to the radius of the dripline, whichever is greatest, as measured from the trunk of the protected tree.

3. Any required excavation in or around the protection zone to accommodate underground services, footings, etc; shall be indicated on the plan, and shall be excavated by hand. In addition, related root pruning shall be accomplished via ANSI A-300-95 standard so as to minimize impact on the general root system.

4. The storage of building materials or stock piling shall not be permitted within the limits of or against the protection barriers.

5. Trees within the protection barriers must be adequately cared for throughout the construction process (i.e., they must be watered sufficiently). Fill shall not be placed upon the root system as to endanger the health or life of the affected tree.



TREE PROTECTION FENCING DETAIL
NTS

811 Know what's below. Call before you dig.

GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD
DEVELOPMENT PLAN
Franklin, Williamson County, Tennessee

DRAKE A. REEDER REGISTERED LANDSCAPE ARCHITECT TENNESSEE No. CONVERGE 12.31.2024

Revision Date

TREE PRESERVATION

SHEET
L1.0

COF # 7414

PROPOSED BUFFER AVERAGING

DEERFIELD BRANCH:

AREA OF BUFFER ENCROACHMENT:	5,179 SF
AREA OF NEW STREAM BUFFER ZONE 2:	5,185 SF

THERE SHALL BE NO MOWING, CLEARING, GRADING, CONSTRUCTION, STORAGE, OR DISTURBANCE OF VEGETATION IN RIPARIAN BUFFERS EXCEPT AS PERMITTED BY THE CITY ENGINEER, OR HIS DESIGNEE.

KEY - BUFFER MITIGATION

- 30'/60' , ZONE 1 RIPARIAN BUFFER
- 30', ZONE 2 RIPARIAN BUFFER
- BUFFER ENCROACHMENT
- PROPOSED BUFFER AVERAGING

SITE DATA CHART

PROJECT NAME:	CHEEKWOOD NORTH PD
PROJECT NUMBER:	7414
ADDRESS:	285 SPENCER CREEK ROAD FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02102
ACREAGE / SF OF SITE:	35.36 AC
VESTING (IF APPLICABLE):	
BASE ZONING:	PD (PLANNED DISTRICT) R-1 (RESIDENTIAL 1 DISTRICT)
PROPOSED ZONING:	PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO
BUILDING TYPES APPLIED:	HOUSE
FRONTAGE TYPES APPLIED:	YARD FRONTAGE
LOT WIDTH (RESIDENTIAL):	70'
LOT SIZE (RESIDENTIAL):	9,000 SF MIN
SETBACKS:	
FRONT	15'
SIDE	5'
REAR	7.5'
DWELLING UNIT COUNT (BY TYPE):	
SINGLE FAMILY:	6 UNITS
MULTIFAMILY:	N/A
NON-RESIDENTIAL SF (BY USE):	
PUMP HOUSE:	100 SF
HALF-WAY HOUSE:	1,200 SF
TURF MAINTENANCE FACILITY:	13,000 SF
HOTEL KEYS:	N/A
BUILDING HEIGHT:	MAX 2 STORIES
PARKLAND DEDICATION:	6 UNITS X $4304 = $25,824
MINIMUM LSA:	20%
OPEN SPACE REQUIRED:	5% (1.77 AC)
NATURAL AREA REQUIRED:	10% (NOT REQUIRED)
TREE CANOPY RETENTION ACREAGE:	REQUIRED: 2.28 AC (24% OF TOTAL CANOPY) PROVIDED: 8.16 AC (86% OF TOTAL CANOPY)
PARKING REQUIRED (BY USE):	
SINGLE FAMILY PARKING:	SEE ATTACHED PARKING STUDY
PARKING PROVIDED (BY USE):	
SINGLE FAMILY PARKING:	SEE ATTACHED PARKING STUDY

APPLICANT:
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324 LIBERTY PIKE
SUITE 145
GREG GAMBLE
(615) 975-5765
greg.gamble@gdc-tn.com

GDC
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DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND
LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD
DEVELOPMENT PLAN
Franklin, Williamson County, Tennessee

DRAKE A. REEDER
REGISTERED
TENNESSEE No.
LANDSCAPE ARCHITECT
03.01.2021

Revision Date
- △ _____
- △ _____
- △ _____
- △ _____

STREAM BUFFER MITIGATION

SHEET
L2.0

COF # 7414

NORTH

CITY OF FRANKLIN GRADING & DRAINAGE GENERAL NOTES

1. GRADING PERMIT IS REQUIRED FOR ANY PROJECT DISTURBING MORE THAN 10,000 SF, ADDING MORE THAN 5,000 SF OF IMPERVIOUS SURFACE OR FOR ANY SITE GRADING REQUIRING STOCKPILING OF MATERIAL.
2. THE DEVELOPER SHALL PROVIDE THE NECESSARY LABOR AND SUPERVISION REQUIRED TO SUPPORT FIELD TESTING BY THE INDEPENDENT TESTING FIRM AND INSPECTIONS BY CITY OFFICIALS AT NO COST TO THE CITY. TEST REPORTS OF FIELD TESTING IF APPLICABLE SHALL BE SUBMITTED DIRECTLY TO THE STREET DEPARTMENT. DEFECTS DISCLOSED BY TESTS SHALL BE RECTIFIED.
3. AN AUTHORIZED REPRESENTATIVE OF THE CITY SHALL MAKE A FINAL INSPECTION OF THE PROJECT AFTER COMPLETION TO DETERMINE ACCEPTABILITY OF THE WORK AND FOR RELEASE OF PERFORMANCE BONDS IF REQUIRED. BEFORE THIS FINAL INSPECTION CAN BE MADE, THE ENGINEER RESPONSIBLE FOR THE PROJECT SHALL CERTIFY IN WRITING TO THE CITY ENGINEER THAT THE WORK HAS BEEN COMPLETED IN ACCORDANCE WITH APPROVED PLANS AND SPECIFICATIONS.
4. DRAINAGE FACILITIES INCLUDING, BUT NOT LIMITED TO, CULVERTS, DETENTION BASINS AND DITCHES, AS WELL AS THE ROADWAY SUB-GRADE, BASE STONE AND BINDER & SURFACE COARSE SHALL BE INSPECTED, TESTED AND GIVEN APPROVAL AT EACH STAGE OF INSTALLATION PRIOR TO PROCEEDING TO THE NEXT STAGE OF CONSTRUCTION. FINAL CONSTRUCTION INSPECTION FOR APPROVAL AND ACCEPTANCE OF STREETS AND DRAINAGE SYSTEMS WILL NOT BE GRANTED UNTIL ALL WORK HAS BEEN COMPLETED IN ACCORDANCE WITH THE APPROVED PLANS.
5. LOCATING AND COORDINATION FOR THE RELOCATION OF EXISTING UTILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR. TENNESSEE'S ONE-CALL AND THE CITY OF FRANKLIN UTILITY LOCATION SERVICE SHALL BE UTILIZED IN ADDITION TO COORDINATION WITH LOCAL UTILITY OWNERS. THE CONTRACTOR SHALL AT ALL TIMES PROTECT EXISTING UTILITIES AND WILL BE RESPONSIBLE FOR COSTS DUE TO DAMAGE CAUSED TO ANY UTILITY LINES.

GRADING NOTES

1. SEE C3.1-C3.4 FOR ENLARGED GRADING & DRAINAGE PLANS.
2. ALL PROPOSED GRADES SHOWN ARE FINAL GRADES, TOP OF PAVEMENT, OR GRATE ELEVATION AT THE DRAWDOWN POINT, UNLESS INDICATED OTHERWISE.
3. EARTHWORK SHALL INCLUDE CLEARING AND GRUBBING, STRIPPING AND STOCKPILING TOPSOIL, MASS GRADING, EXCAVATION, FILLING, UNDER CUT AND REPLACEMENT (IF REQUIRED), AND COMPACTION.
4. PLACE TOPSOIL OVER THE SUBGRADE OF UNPAVED, DISTURBED AREAS TO A DEPTH INDICATED ON THE LANDSCAPE PLANS (6" MINIMUM).
5. ALL SLOPES IN NON-PAVED AREAS SHALL BE 3:1 (HORIZONTAL:VERTICAL) MAXIMUM UNLESS NOTED OTHERWISE.
6. USE EROSION CONTROL BLANKETS FOR ALL SLOPES 4:1 OR GREATER. USE EROSION CONTROL MATTING ALONG CHANNEL INVERTS.
7. ALL EXCESS SOIL MATERIALS AND OTHER MATERIAL NOT SUITABLE FOR REUSE SHALL BECOME THE PROPERTY OF THE CONTRACTOR UNLESS OTHERWISE DESIGNATED. THESE MATERIALS SHALL BE REMOVED BY THE CONTRACTOR AND DISPOSED OF OFFSITE AT NO ADDITIONAL COST TO THE OWNER, IN ACCORDANCE WITH ALL LOCAL AND STATE CODES AND PERMIT REQUIREMENTS.
8. THE CONTRACTOR IS RESPONSIBLE FOR THE SITE EARTHWORK BY IMPORTING OR EXPORTING AS NECESSARY TO ACHIEVE DESIGN GRADES.
9. THE CONTRACTOR SHALL COMPLY WITH ALL PERTINENT O.S.H.A. PROVISIONS AND THE MANUAL OF ACCIDENT PREVENTION AND CONSTRUCTION, ISSUED BY THE AGC OF AMERICA, INCORPORATED, AND THE SAFETY AND HEALTH REGULATIONS OF CONSTRUCTION ISSUED BY THE U.S. DEPARTMENT OF LABOR.
10. THE CONTRACTOR SHALL PROVIDE POSITIVE DRAINAGE THROUGH THE SITE DURING ALL PHASES OF CONSTRUCTION.
11. ADDITIONAL FILL MATERIAL IS NOT PERMITTED TO BE PLACED IN THE FLOODPLAIN.
12. INFILTRATION TEST RESULTS MAY ALLOW FOR REDUCTION OF STORMWATER PIPING.
13. PROPOSED GRADES TO GENERALLY MATCH EXISTING.

LEGEND

- EXISTING PROPERTY LINE
- EXISTING RIGHT-OF-WAY
- EXISTING ADJOINING PROPERTY LINE
- EXISTING SOIL BOUNDARY
- ArB2 — EXISTING SOIL TYPE LABEL
- EXISTING ROADWAY CENTERLINE
- EXISTING GUARD RAIL
- EXISTING BRIDGE
- EXISTING EDGE OF PAVEMENT
- EXISTING STRUCTURE
- EXISTING TOP OF BANK
- EXISTING 150' MACK HATCHER SETBACK
- FEMA REGULATORY FLOODWAY (EFFECTIVE)
- FEMA REGULATORY FLOODWAY (PRELIMINARY)
- FEMA 1% ANNUAL CHANCE FLOOD HAZARD BOUNDARY
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- EXISTING STREAM
- EXISTING WETLAND
- EXISTING STREAM BUFFER
- EXISTING RIPARIAN BUFFER ZONE 1
- EXISTING RIPARIAN BUFFER ZONE 2
- 800 — PROPOSED MAJOR CONTOUR
- 649 — PROPOSED MINOR CONTOUR
- LOD — PROPOSED LIMITS OF DISTURBANCE
- PROPOSED TREE PROTECTION
- ST — PROPOSED STORM PIPE
- PROPOSED STORM INLET
- PROPOSED ENDWALL
- PROPOSED BIORETENTION BASIN
- PROPOSED EXTRUDED CURB
- PROPOSED CONCRETE CURB AND GUTTER
- PROPOSED BUILDING
- PROPOSED ASPHALT
- PROPOSED SIDEWALK
- PROPOSED ACCESS EASEMENT
- PROPOSED TEE-BOX LIMITS
- PROPOSED FAIRWAY LIMITS
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- PROPOSED ELECTRIC POLE
- PROPOSED TRANSFORMER
- SAN — PROPOSED SANITARY SEWER LINE
- PROPOSED SANITARY SEWER MANHOLE
- PROPOSED SANITARY SEWER CLEANOUT
- W — PROPOSED WATER LINE

IMPACT STATEMENT

CHEEKWOOD GOLF COURSE WILL HANDLE ITS GRADING AND DRAINAGE IN THE FOLLOWING MANNER. ON-SITE STORMWATER DETENTION WILL BE USED ALONG WITH OTHER PERMANENT STORMWATER BMPS AND GREEN INFRASTRUCTURE TO MEET THE INTENT OF THE CURRENT REGULATIONS AT THE TIME OF SUBMITTAL. THE PROJECT INTENT IS TO ACHIEVE STORM WATER QUALITY THROUGH ON-SITE MEASURES. THE DESIGN TEAM WILL SUBMIT A C.O.F. LONG TERM MAINTENANCE PLAN AND AGREEMENT TO C.O.F. WITH CONSTRUCTION DRAWINGS.

STORMWATER NARRATIVE

STORMWATER MANAGEMENT FOR THE CHEEKWOOD GOLF COURSE DEVELOPMENT WILL BE HANDLED IN THE FOLLOWING MANNER. STORMWATER QUALITY FOR THE PROJECT WILL BE PROVIDED ON-SITE UTILIZING BIORETENTION. THIS BMP WILL BE INCORPORATED INTO THE DESIGN OF THE SITE. THE SITE DISCHARGES DIRECTLY INTO DEERFIELD BRANCH AND HARPETH RIVER, WHICH HAVE SUFFICIENT HYDROLOGIC CAPACITY TO HANDLE POST-DEVELOPMENT FLOWS. IN LIGHT OF SIMILAR REQUIREMENTS THE CITY OF FRANKLIN CURRENTLY HAS, AUDUBON INTERNATIONAL (AI) ENVIRONMENTAL MANAGEMENT GUIDELINES WILL BE UTILIZED WITH THE DESIGN OF THE SITE. THE SITE WILL STRIVE FOR AI CERTIFICATION.

SITE BMP SUMMARY CHART

BMP	DRAINAGE AREA TREATED
BIORETENTION	132,344 SQ. FT.

POST-DEVELOPMENT GRADING & DRAINAGE DATA CHART

SITE AREA:	57.6 AC
IMPERVIOUS AREA:	1.4 AC
DISTURBED AREA:	23.1 AC
Rv VALUE:	0.037
WEIGHTED CN:	79

POST-DEVELOPMENT PEAK FLOW EVENTS:

2-YEAR:	141.43 CFS
5-YEAR:	196.27 CFS
10-YEAR:	241.45 CFS
25-YEAR:	306.12 CFS
50-YEAR:	359.14 CFS
100-YEAR:	414.63 CFS

REFERENCE

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PRELIMINARY
NOT FOR CONSTRUCTION

SCALE IN FEET
0 200 400

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DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

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615-333-7797 - 800-763-2326
www.cecinc.com

CHEEKWOOD NORTH PD DEVELOPMENT PLAN

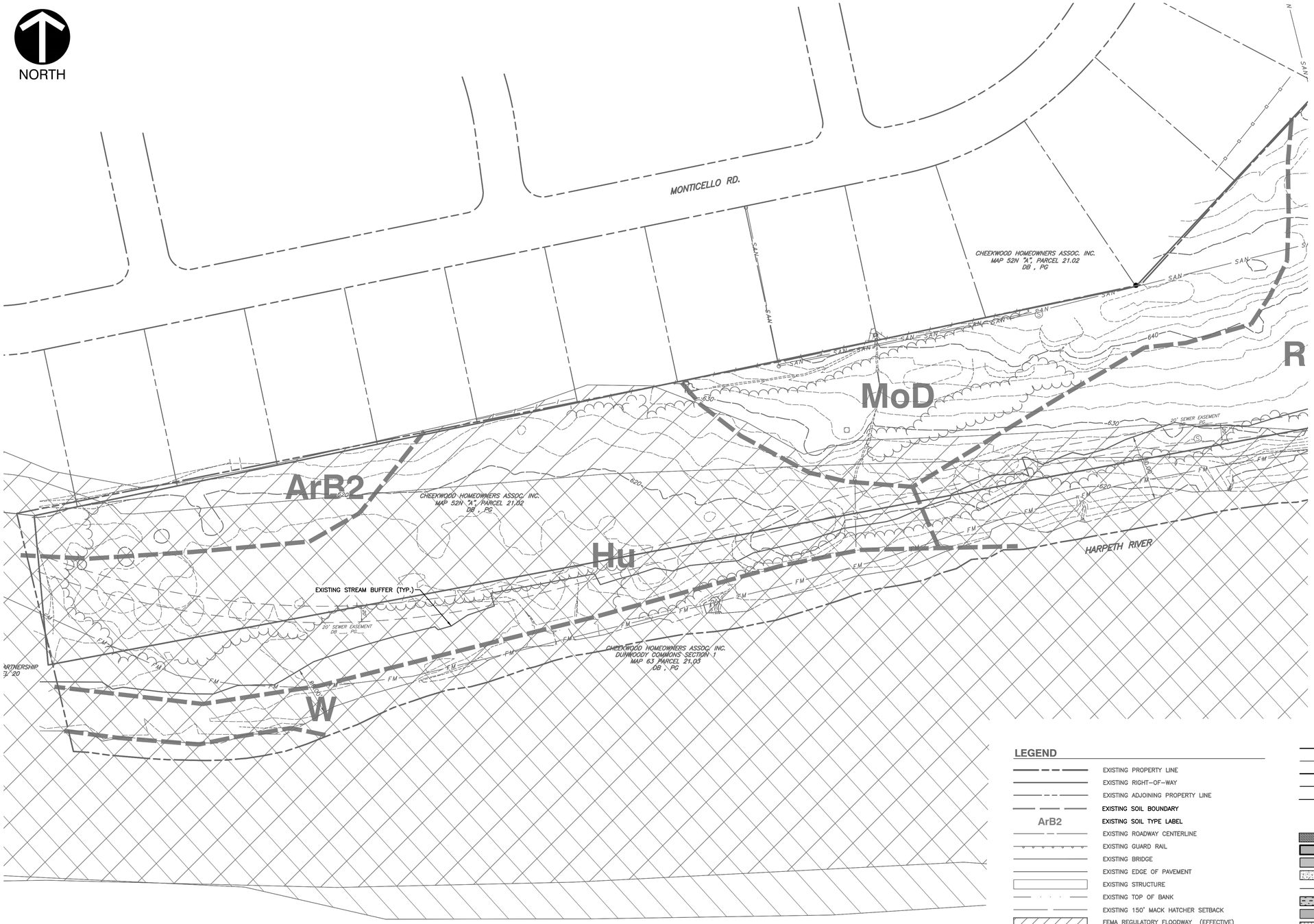
Franklin, Williamson County, Tennessee

SAMANTHA HALEY SEARCY
REGISTERED ENGINEER
AGRICULTURE
DATE: 11/12/2021
No. 120184
STATE OF TENNESSEE

Revision Date
- △ _____
- △ _____
- △ _____
- △ _____

OVERALL GRADING AND DRAINAGE PLAN
SHEET
C3.0
COF # 7414

NORTH



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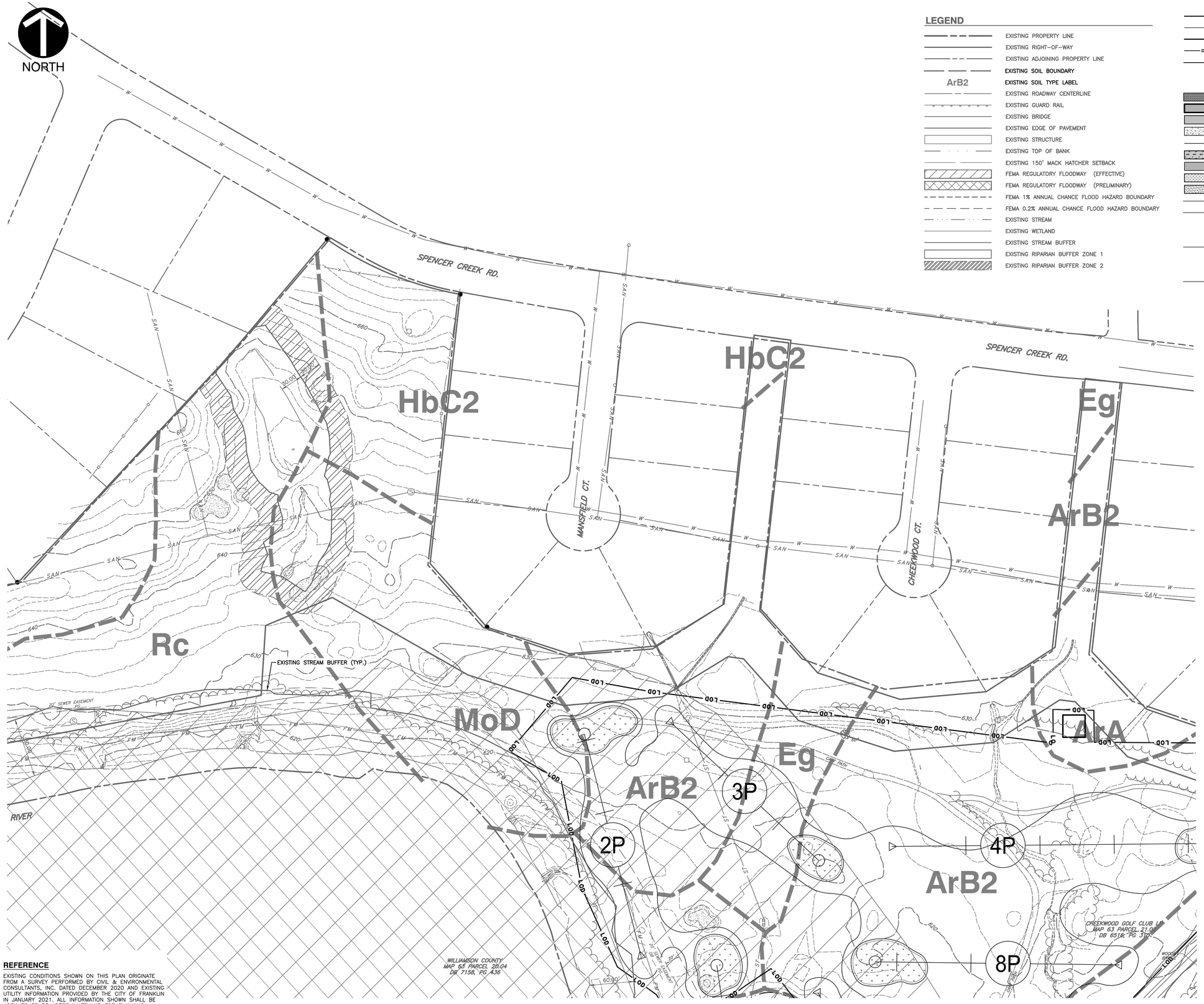
CHEEKWOOD NORTH PD
DEVELOPMENT PLAN
Franklin, Williamson County, Tennessee

SAMANTHA HALEY SCARBROUGH
REGISTERED ENGINEER
AGRICULTURE
01/04/2021
COMMERCE
No. 120144
STATE OF TENNESSEE

Revision Date
- △ _____
- △ _____
- △ _____
- △ _____

GRADING AND DRAINAGE PLAN

SHEET
C3.1
COF # 7414



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CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

SAMANTHA HALEY SEARCY
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No. 120144
STATE OF TENNESSEE

Revision Date

GRADING AND DRAINAGE PLAN

SHEET
C3.2

COF # 7414

LEGEND

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CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

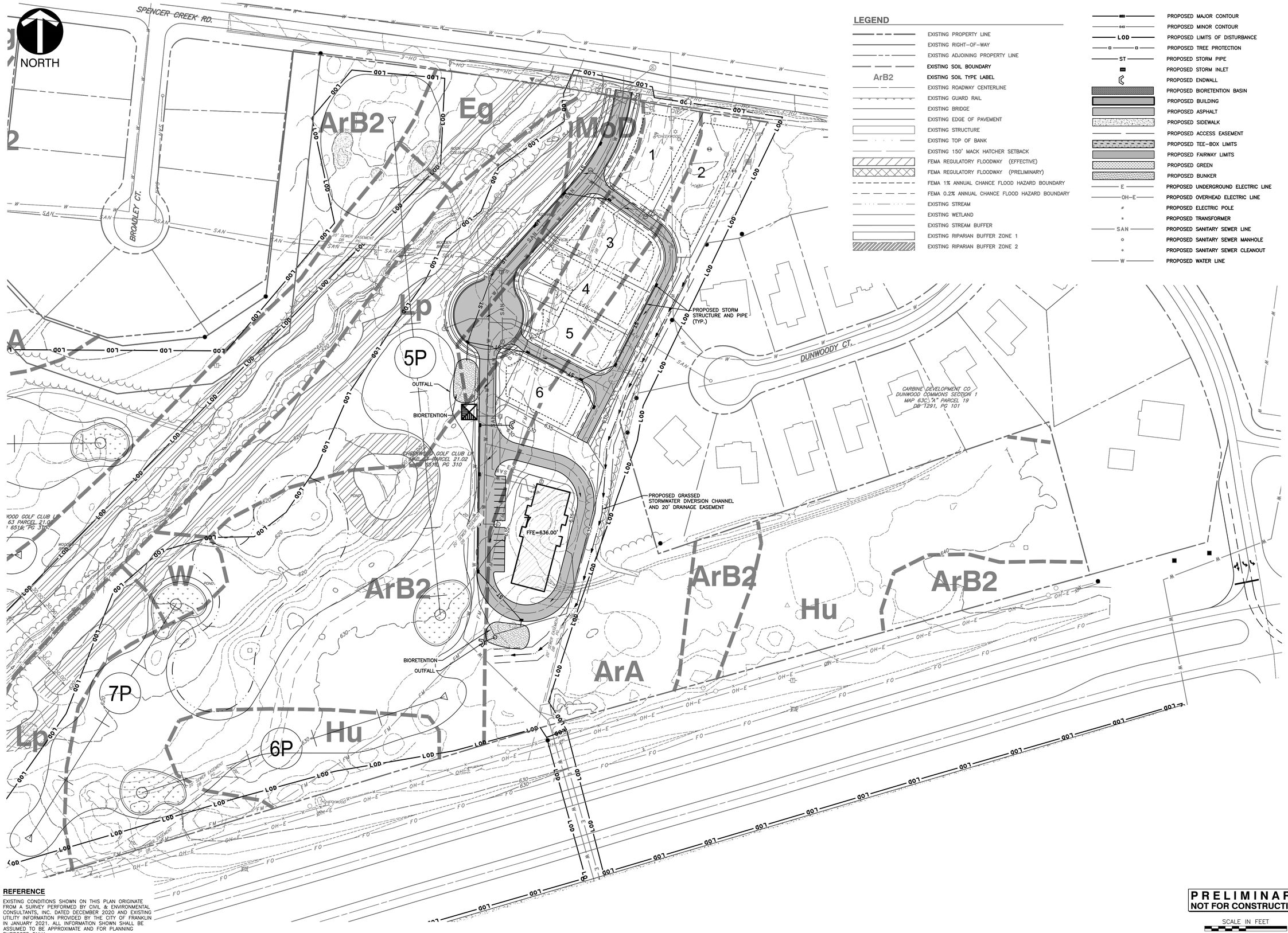
SAMANTHA HALEY SEARCY
REGISTERED ENGINEER
AGRICULTURE
No. 120144
STATE OF TENNESSEE

Revision Date

GRADING AND DRAINAGE PLAN

SHEET
C3.3

COF # 7414



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CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

SAMANTHA HALEY SEARCY
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No. 120144
STATE OF TENNESSEE

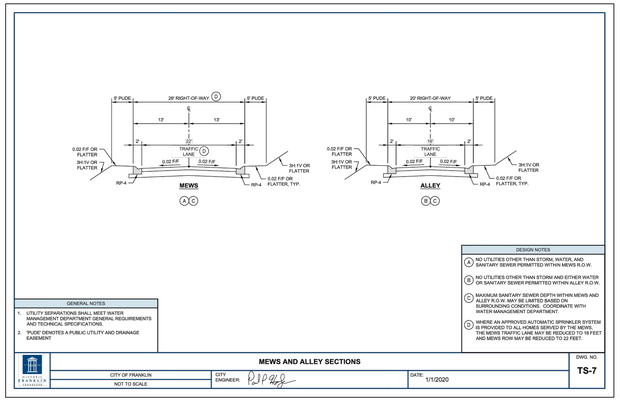
Revision Date

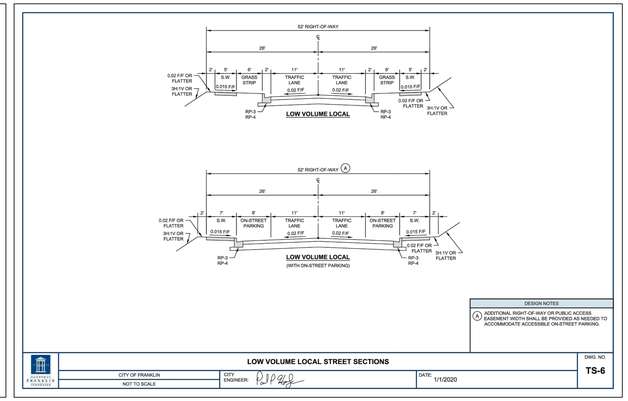
GRADING AND DRAINAGE PLAN

SHEET
C3.4

COF # 7414

NORTH





REFERENCE

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ROADWAY NETWORK NARRATIVE

THE ROADWAY NETWORK ADJACENT TO THE CHEEKWOOD GOLF COURSE HAS BEEN TAKEN INTO ACCOUNT WITH A TRAFFIC STUDY. CONSTRUCTION WILL OCCUR IN TWO PHASES. TRAFFIC CONTROL PLANS WILL BE USED WHEN WORK OCCURS IN THE RIGHT OF WAY. SUBJECT PROPERTY IS LOCATED IN THE CENTRAL FRANKLIN CHARACTER AREA.

ROADWAY NETWORK IMPACT STATEMENT

THE CONSTRUCTION OF THE CHEEKWOOD GOLF COURSE WILL DECREASE TRIPS BY −134 PER DAY AT THE INTERSECTION OF ALDERSGATE WAY AND MACK HATCHER PARKWAY.

R.O.W. AND & ACCESS DATA CHART

DAILY TRIP GENERATION:	−134 VEH. PER DAY
PEAK HOUR TRIP GENERATION:	AM: −6 VEH. PER HOUR PM: −20 VEH. PER HOUR
TRAFFIC IMPACT STUDY REQUIRED:	YES
CIRCULATION PLAN REQUIRED:	NO

ADDITIONAL NOTES

DUMPSTER ACCESS TO BE PROVIDED AT EXISTING CHEEKWOOD GOLF CLUB MAINTENANCE FACILITY ACROSS MACK HATCHER MEMORIAL PARKWAY. ROLLOUT CANS WILL BE PROVIDED AT THE SITE.

CONNECTIVITY INDEX CALCULATION

CONNECTIVITY INDEX = LINES/NODES

4/2 = 2

LEGEND

- EXISTING PROPERTY LINE
- EXISTING RIGHT−OF−WAY
- EXISTING ADJOINING PROPERTY LINE
- EXISTING ROADWAY CENTERLINE
- EXISTING GUARD RAIL
- EXISTING BRIDGE
- EXISTING EDGE OF PAVEMENT
- EXISTING STRUCTURE
- EXISTING TOP OF BANK
- EXISTING 150' MACK HATCHER SETBACK
- FEMA REGULATORY FLOODWAY (EFFECTIVE)
- FEMA REGULATORY FLOODWAY (PRELIMINARY)
- FEMA 1% ANNUAL CHANCE FLOOD HAZARD BOUNDARY
- FEMA 0.2% ANNUAL CHANCE FLOOD HAZARD BOUNDARY
- EXISTING SANITARY SEWER LINE
- EXISTING OVERHEAD WIRE
- EXISTING STREAM
- EXISTING WETLAND
- EXISTING STREAM BUFFER
- EXISTING RIPARIAN BUFFER ZONE 1
- EXISTING RIPARIAN BUFFER ZONE 2
- PROPOSED EXTRUDED CURB
- PROPOSED CONCRETE CURB AND GUTTER
- PROPOSED BUILDING
- PROPOSED ASPHALT
- PROPOSED SIDEWALK
- PROPOSED ACCESS EASEMENT
- PROPOSED TEE−BOX LIMITS
- PROPOSED FAIRWAY LIMITS
- PROPOSED GREEN
- PROPOSED BUNKER
- PROPOSED UNDERGROUND ELECTRIC LINE
- PROPOSED OVERHEAD ELECTRIC LINE
- PROPOSED ELECTRIC POLE
- PROPOSED TRANSFORMER
- PROPOSED SANITARY SEWER LINE
- PROPOSED SANITARY SEWER MANHOLE
- PROPOSED SANITARY SEWER CLEANOUT
- PROPOSED WATER LINE
- CONNECTIVITY LINKS (4)
- CONNECTIVITY NODES (2)

CITY OF FRANKLIN R.O.W. & ACCESS GENERAL NOTES

1. PRIOR TO BEGINNING ANY CONSTRUCTION, THE DEVELOPER AND/OR CONTRACTOR, SHALL OBTAIN ALL NECESSARY PERMITS AS REQUIRED BY LAW. SUCH PERMITS MAY INCLUDE, BUT ARE NOT LIMITED TO, THOSE REQUIRED BY STATE OF TENNESSEE, WILLIAMSON COUNTY AND OTHER CITY OF FRANKLIN AGENCIES.
2. ALL OFF−SITE WORK WITHIN THE PUBLIC RIGHT−OF−WAY SHALL REQUIRE AN APPROVED TRAFFIC CONTROL PLAN WHICH COMPLIES WITH THE MUTCD. NO OFF−SITE EXCAVATION MAY BE UNDERTAKEN IN ANY STREET, ROAD, ALLEY OR RIGHT−OF−WAY OF ANY UTILITY OR TEMPORARY CONSTRUCTION EASEMENT OF THE CITY OF FRANKLIN BY ANY ENTITY UNLESS 72−HOUR NOTICE HAS BEEN GIVEN TO THE CITY OF FRANKLIN TRAFFIC OPERATIONS CENTER. THE CONTRACTOR SHALL HAVE AN APPROVED TRAFFIC CONTROL PLAN ONSITE DURING CONSTRUCTION.
3. LOCATING AND COORDINATION FOR THE RELOCATION OF EXISTING UTILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR. TENNESSEE'S ONE−CALL AND THE CITY OF FRANKLIN UTILITY LOCATION SERVICE SHALL BE UTILIZED IN ADDITION TO COORDINATION WITH LOCAL UTILITY OWNERS. THE CONTRACTOR SHALL AT ALL TIMES PROTECT EXISTING UTILITIES AND WILL BE RESPONSIBLE FOR COSTS DUE TO DAMAGE CAUSED TO ANY UTILITY LINES.

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE IN FEET
0 200 400

GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CEC
Civil & Environmental Consultants, Inc.
117 SEABOARD LANE · FRANKLIN, TN · 37067
615-333-7797 · 800-763-2326
www.cecinc.com

CHEEKWOOD NORTH PD DEVELOPMENT PLAN

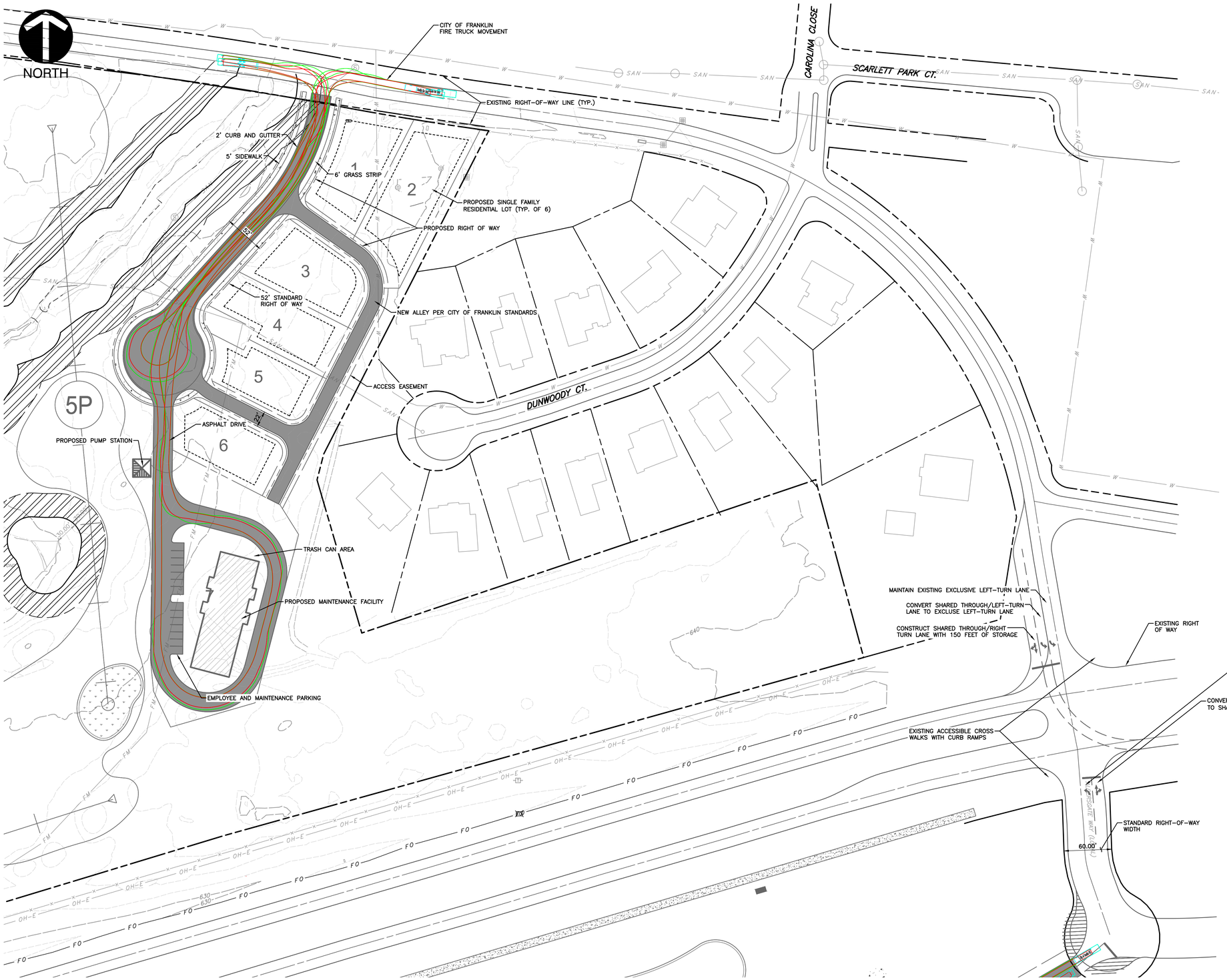
Franklin, Williamson County, Tennessee

SAMANTHA HALEY SEARCY
REGISTERED ENGINEER
STATE OF TENNESSEE
No. 120144
01/04/2021
COMMERCE

Revision Date
- △
- △
- △
- △

OVERALL ROW AND ACCESS PLAN

SHEET
C4.0
COF # 7414



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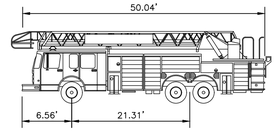

CITY OF FRANKLIN FIRETRUCK DETAIL

N.T.S.

APPARATUS SPECIFICATIONS:

NUMBER OF FRONT AXLES =	1
FRONT TRACK WIDTH =	8'
WHEELS ON EACH FRONT AXLE =	2
NUMBER OF REAR ALES =	2
REAR TRACK WIDTH =	8'
WHEEL BASE =	21.316' (FRONT AXLE TO REAR AXLE)
REAR AXLE SPACING =	4.417'
BODY LENGTH =	50.0417'
WIDTH =	8.333'
REAR OVERHANG =	22.144'
BODY STYLE =	FIRE TRUCK
TURNING RADIUS WALL TO WALL =	42'
MINIMUM DESIGN SPEED =	5 M.P.H.

REFERENCE

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SCALE IN FEET
0 60 120

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CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

SAMANTHA HALEY SEARCY
REGISTERED ENGINEER
AGENT OF RECORD
Samantha Searcy 11/04/2021
COMMERCE No. 129168
STATE OF TENNESSEE

Revision Date
- △ _____
- △ _____
- △ _____
- △ _____

ENLARGED ROW AND ACCESS PLAN

SHEET
C4.1
COF # 7414

NORTH

GENERAL UTILITY NOTES

1. INVESTIGATION, LOCATION, SUPPORT, PROTECTION, AND RESTORATION OF ALL EXISTING UTILITIES AND APPURTENANCES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING THE SEQUENCING OF CONSTRUCTION FOR ALL UTILITY LINES SO THAT WATER LINES, GAS LINES, AND UNDERGROUND ELECTRIC DO NOT CONFLICT WITH SANITARY SEWERS OR STORM SEWERS. INSTALL UTILITIES PRIOR TO PAVEMENT CONSTRUCTION.
3. ALL TRENCH SPOILS SHALL BECOME THE PROPERTY OF THE CONTRACTOR UNLESS OTHERWISE DESIGNATED AND SHALL BE REMOVED BY THE CONTRACTOR AND DISPOSED OF OFF SITE AT NO ADDITIONAL COST TO THE OWNER IN ACCORDANCE WITH ALL LOCAL AND STATE CODES AND PERMIT REQUIREMENTS.
4. ADJUST ALL EXISTING UTILITY SURFACE FEATURES INCLUDING BUT NOT LIMITED TO CASTINGS, VALVE BOXES, PEDESTALS, CLEANOUTS, ETC. TO MATCH PROPOSED FINISHED GRADES, UNLESS OTHERWISE INDICATED.
5. CONTRACTOR SHALL COORDINATE WITH EACH UTILITY PROVIDER THE INSTALLATION OF UTILITY CONDUITS FOR TELEPHONE, ELECTRIC, GAS, IRRIGATION, ETC. CONTRACTOR SHALL PROVIDE ALL MATERIALS AND LABOR FOR THE TRENCHING AND CONDUIT INSTALLATION.
6. THE CONTRACTOR IS RESPONSIBLE FOR REIMBURSING UTILITY DEPARTMENT INSPECTION COSTS.
7. THE CONTRACTOR IS TO PROVIDE AND MAINTAIN THE APPROVED CONSTRUCTION IDENTIFICATION SIGN FOR PRIVATE DEVELOPMENT.
8. THE CONTRACTOR SHALL ENSURE THAT ALL ROOFTOP MECHANICAL EQUIPMENT IS COMPLETELY SCREENED BY THE PROPOSED BUILDING PARAPET FROM ALL DIRECTIONS AND OFF SITE VIEWS. THE CHANGE OUT OF ANY EQUIPMENT TO A LARGER DIMENSIONAL HEIGHT OR MOUNTING HEIGHT WILL REQUIRE THAT THE BUILDING PARAPET BE RAISED TO MEET CITY OF FRANKLIN SCREENING REQUIREMENTS.

WATER UTILITY NOTES

1. WATER MATERIALS AND INSTALLATION WILL BE IN ACCORDANCE WITH SPECIFICATIONS AND STANDARD DETAILS OF THE CITY OF FRANKLIN.
2. BACKFLOW DEVICE TO REMAIN ACCESSIBLE AT ALL TIMES.
3. IRRIGATION TO BE HANDLED VIA EXISTING WITHDRAWAL PERMIT FROM THE HARPETH RIVER.

SANITARY SEWER NOTES

1. ALL SEWER CONSTRUCTION SHALL BE IN ACCORDANCE WITH SPECIFICATIONS AND STANDARD DETAILS OF THE CITY OF FRANKLIN.
2. AFTER COMPLETION OF THE SANITARY SEWER, THE DEVELOPER IS RESPONSIBLE FOR THE TELEVISING OF THE LINES PRIOR TO FINAL ACCEPTANCE. THE VIDEOTAPING MUST BE COORDINATED WITH THE CITY OF FRANKLIN. ALL COSTS WILL BE BORNE BY THE DEVELOPER.
3. ALL CONNECTIONS TO EXISTING MANHOLES SHALL BE BY CORING AND RESILIENT CONNECTOR METHOD.

UTILITY PLAN IMPACT STATEMENT

THE NORTHERN PORTION OF THE CHEEKWOOD GOLF COURSE IS EXPECTED TO CONSUME 2,350 GALLONS PER DAY OF WATER AND GENERATE 2,350 GALLONS PER DAY OF WASTEWATER.

UTILITY PLAN NARRATIVE

MIDDLE TENNESSEE ELECTRIC MEMBERSHIP CORPORATION, CITY OF FRANKLIN, AND ATMOS ENERGY WILL WORK WITH ENGINEERS AND CONTRACTORS.

WATER & SEWER DATA CHART

FACILITY TYPE:	MAINTENANCE FACILITY AND 6 RESIDENTIAL LOTS
UNIT FLOW IN GPD:	2,350
TOTAL FLOW IN GPD:	2,350
STATIC PRESSURE OF NEAREST FIRE HYDRANT	95 PSI
DYNAMIC PRESSURE OF NEAREST FIRE HYDRANT:	92 PSI

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- EXISTING WETLAND
- EXISTING STREAM BUFFER
- EXISTING RIPARIAN BUFFER ZONE 1
- EXISTING RIPARIAN BUFFER ZONE 2
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED TREE PROTECTION
- PROPOSED STORM PIPE
- PROPOSED STORM INLET
- PROPOSED ENDWALL
- PROPOSED BIORETENTION BASIN
- PROPOSED EXTRUDED CURB
- PROPOSED CONCRETE CURB AND GUTTER
- PROPOSED BUILDING
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- PROPOSED TRANSFORMER
- PROPOSED SANITARY SEWER LINE
- PROPOSED SANITARY SEWER MANHOLE
- PROPOSED SANITARY SEWER CLEANOUT
- PROPOSED WATER LINE

CONTACT LIST

ELECTRIC SERVICE
MTEMC
2156 EDWARD CURD LANE
FRANKLIN, TN 37067
PHONE: 615-4595-4685
CONTACT: ROGER JENKINS
E-MAIL: rjenkins@mtemc.com

TELEPHONE SERVICE
AT&T
500 LIBERTY PIKE
FRANKLIN, TN 37064
PHONE: 615-595-7816
CONTACT: DAVID TUTTEROW
E-MAIL: dt8243@att.com

GAS SERVICE
ATMOS ENERGY
200 NOAH DRIVE
FRANKLIN, TN 37064
PHONE: 615-794-2596
CONTACT: FRED NEU
E-MAIL: fred.neu@atmosenergy.com

ENGINEERING
FRANKLIN ENGINEERING DEPARTMENT
109 THIRD AVENUE SOUTH
FRANKLIN, TN 37064
PHONE: 615-550-6676
CONTACT: LANCE FITTRO
E-MAIL: lance.fittro@franklintn.gov

CABLE TV SERVICE
COMCAST CABLE
660 MAINSTREAM DRIVE
NASHVILLE, TN 37228
PHONE: 615-244-7462, EXT. 1115647
CONTACT: MARLON FRIZZELL
E-MAIL: marlon_frizzell@cable.comcast.com

CITY OF FRANKLIN WATER MANAGEMENT
WATER MANAGEMENT
124 LUMBER DR.
FRANKLIN, TN 37064
PHONE: 615-794-4554
CONTACT: BEN MCNEIL
EMAIL : BEN.MCNEIL@FRANKLINTN.GOV

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PRELIMINARY
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SCALE IN FEET
0 200 400

GDC
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615-333-7797 · 800-763-2326
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CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

SAMANTHA HALEY SEFCIK
REGISTERED ENGINEER
AGENT FOR TVRB
STATE OF TENNESSEE
PROFESSIONAL ENGINEER
No. 120148
10/04/2021

Revision Date
- △ _____
- △ _____
- △ _____
- △ _____

OVERALL UTILITY PLAN

SHEET
C5.0
COF # 7414

LEGEND

- EXISTING PROPERTY LINE
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CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

SAMANTHA HALEY SEARCY
REGISTERED ENGINEER
AGREEMENT
04/07/2021
COMMERCE
No. 120114
STATE OF TENNESSEE

Revision Date
- △ _____
- △ _____
- △ _____
- △ _____

ENLARGED UTILITY PLAN

SHEET
C5.1
COF # 7414

HALFWAY HOUSE ELEVATION

HALFWAY HOUSE CHARACTER IMAGES

PUMP HOUSE CHARACTER IMAGES

MATERIALS LIST

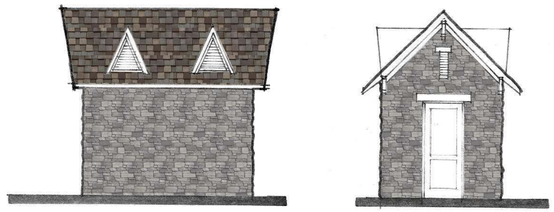
STONE

SIDING

FIXED AND OPERABLE WINDOWS

METAL ROOF

SHINGLE ROOF



PUMP HOUSE ELEVATION

RENDERINGS ARE INTENDED TO SHOW GENERAL DESIGN CHARACTER. FINAL BUILDING DESIGN / CONSTRUCTION MAY VARY

GDC
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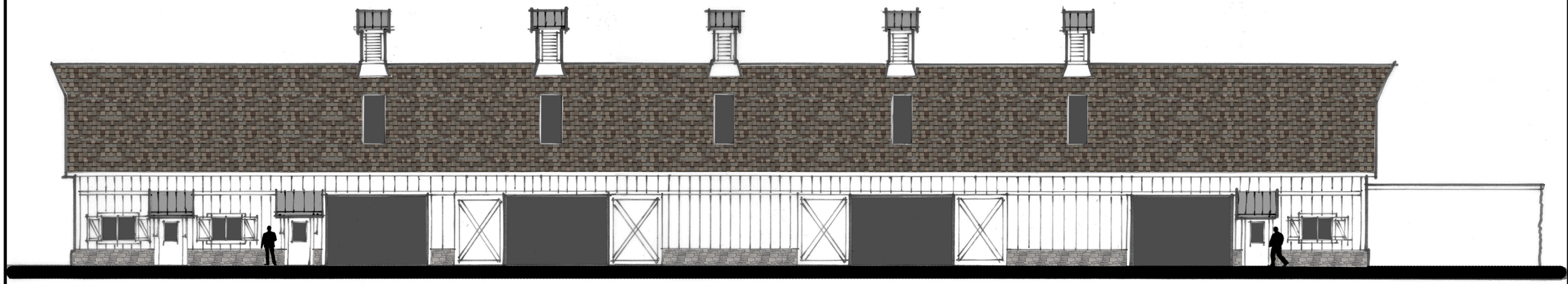
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD DEVELOPMENT PLAN
Franklin, Williamson County, Tennessee

Revision Date

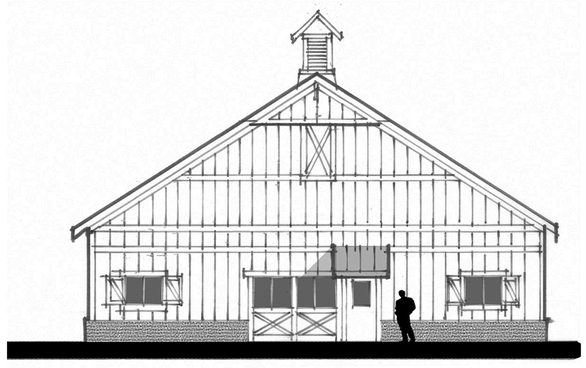
ARCHITECTURE

SHEET
A1.0
COF # xxxx



MAINTENANCE BUILDING : FRONT ELEVATION

MAINTENANCE BUILDING CHARACTER IMAGES



MAINTENANCE BUILDING : SIDE ELEVATION

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GAMBLE
DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD
DEVELOPMENT PLAN
Franklin, Williamson County, Tennessee

Revision Date

ARCHITECTURE

SHEET
A2.0
COF # xxxx

March 24, 2021

I am opposed to adding any homes as provided in the referenced application. My concerns are due to the potential impact on the environment, flooding, traffic on Spencer Creek Road and our experience with the developer(s).

I am also concerned with the destruction of wetlands, vegetation, waterways, and trees that has already taken place. In the past two weeks, crews have destroyed vegetation and trees along Deerfield Branch without a permit. On the first occurrence, my wife and a neighbor were told by the crew that they were instructed to stop if anyone asked them to do so. My wife asked them to stop. A week later, the crew was out again with heavy equipment, removing vegetation and trees from the creek, <u>again</u> without a permit. (See Photos) My wife called the city. An employee came out (Doug Noonan) and halted the destruction.

We often hear golf balls hitting trees along Deerfield Branch as inexperienced golfers try to come over the trees on #9. If those trees are removed as the developer/planner intends, there will be more golf balls in our yard and likely hitting our house.

The details of the development plan seem to be a ruse. The area along Deerfield Branch is labeled "Preserved Tree Canopy" yet the developers / planners have removed trees and continue to do so despite being told by Mr. Noonan to stop. On March 24, a tractor was working along the Branch removing trees and vegetation.

The developers have treated the homeowners disdainfully and have consistently acted without regard for law, regulation, or city ordinance. We do not want a bad neighbor to be allowed to continue with the proposed development. The neighborhood has acted in good faith only to be repaid with the opposite. Experience shows that if the city approves the plan, the developers will continue to act in their own interest, disregarding the environment, city, and neighbors.

Finally, adding five or six homes as proposed will destroy runoff and increase the likelihood of flooding. In the 2010 flood, the Branch spread into our backyard. Making drastic changes as planned would likely have a detrimental impact, increasing flood risk to homeowners.

Chuck Kirkpatrick
116 Broadley Ct

From: Amy Diaz-Barriga
To: Joseph Bryan
Subject: FW: Cheekwood PD
Date: Wednesday, March 24, 2021 3:26:15 PM

AMY DIAZ-BARRIGA, AICP
CURRENT PLANNING SUPERVISOR

Planning and Sustainability Department
City of Franklin
109 Third Avenue South
Franklin, TN 37064

Phone: 615-550-6732

From: Thomas Herbert <thherbert@gmail.com>
Sent: Wednesday, March 24, 2021 7:20 AM
To: Planning Intake <planningintake@franklintn.gov>
Subject: Cheekwood PD

ATTENTION COF staff: This email originated from outside the City of Franklin. Please use discretion when clicking on attachments & links from unknown senders or suspicious emails.

Franklin Planning,
Good morning, my name is Thomas Herbert. I live off Spencer Creek Road and am interested in the Cheekwood N/S proposals. It is a very interesting project and one i could support very much.

BUT, i had a very hard time understanding the proposed changes to the Harpeth River floodway. Since the submittal (attached to the FMPC packet) has there been any clarification of that map/rendering. The etchings used made it impossible to discern where the new proposed floodway extent would be. The existing is quite clear. Unless I missed it, in both the N/S sections the designer proposes to move the right bank floodway by more than 300' in places.

So i figure, that could not be accurate, but wanted to be sure. Is there another rendering that could show that more clearly? Transparent overlap, clearer color differential, e.g. I think that would be pertinent to the community considering all the relevant and potential long term impacts of this proposal.

Respectfully,
Thomas Herbert
Franklin, TN 37069

From:	Amy Diaz-Barriga
To:	Joseph Bryan
Subject:	FW: Deborah Allen Hicks... Fwd: Cheekwood Recent Events-----Before and after pictures creek destruction- Hlighted scale maps-Letter
Date:	Wednesday, March 24, 2021 3:05:33 PM
Attachments:	mime-attachment.msg

AMY DIAZ-BARRIGA, AICP
CURRENT PLANNING SUPERVISOR

Planning and Sustainability Department
City of Franklin
109 Third Avenue South
Franklin, TN 37064

Phone: 615-550-6732

From: Deborah Allen <deborahallen@comcast.net>
Sent: Tuesday, March 23, 2021 11:43 AM
To: Planning Intake <planningintake@franklintn.gov>
Cc: Raymond Hicks <raymondhicks@comcast.net>
Subject: Deborah Allen Hicks... Fwd: Cheekwood Recent Events-----Before and after pictures creek destruction- Hlighted scale maps-Letter

ATTENTION COF staff: This email originated from outside the City of Franklin. Please use discretion when clicking on attachments & links from unknown senders or suspicious emails.

Subject: Cheekwood Recent Events-----Before and after pictures creek destruction- Hlighted scale maps-Letter

Hello...
This is Deborah Allen-Hicks writing to you. My husband, Raymond Hicks and I live next door to Jeff Dykes in Cheekwood at 104 Broadley Court.
Rather than write a long letter... I will just copy you on a couple of emails from Jeff which contain excellent information. Raymond and I completely Agree with Jeff's opinions and findings. We feel very strongly about this. And what makes it even worse the way things have moved forward without permits and in general to the detriment of our properties.
Please know that we love our neighborhood and only want the best for all concerned, but we do feel very violated since our best interest seems to be the least of Mr Jester's concern.
This is our home and out life's investment. Thank you for taking the time to understand our point of view and your voice in helping us protect our properties and investment.
We are praying for your help on this matter.
Love and thank you,
Deborah Allen Hicks
615-476-4095

Dana, I am sorry for sending you so much information on this but I felt like you and others involved in the vote should know these very recent events; Also, I have attached the entire packet that was sent to all Cheekwood H.O.A. members:

Two Mondays ago, March 8th, I received a phone call from a frantic neighbor (Candice Kirpatrick), who said " Jeff, There is a tractor cutting trees down , clearing out along creek banks behind my house " . I told her I would come over and talk to the golf course employee doing the cutting/clearing with her. I went down to where this was happening with Candice. The tractor operator ask if there was a problem and Candice said " Yes " I do not want these trees cleared out behind my house along creek banks. The tractor man was nice and said " I was told to clear all this out unless somebody complained and if anyone complains to stop" . There was no more clearing done that day.

Fast forward to yesterday, March 22nd. The same neighbor called me and said " Jeff, the tractor is back and clearing banks again, but they are on the other side of creek (golf course side) working. My reply to Candice was to call the City of Franklin and let them know. Within 20 minutes a man named Doug, from the City of Franklin came out and put a stop work order on the golf course. Doug then came over to Candice's house to explain what he told the golf course workers. He said that this creek is labeled a blue line creek and a wetland on County, City and Tdec maps.. He said, no one is allowed to work/cut/clear within a 60 foot swath along creek without a permit from state and local municipalities. Doug also said that the owner will have to replace every plant/tree that has been removed in that 60 foot swath.

Attached is the entire packet I sent to all Cheekwood Homeowners. It has pictures before the golf course changed ownership in 2014, of all the Cattails , native wetland plants that were growing in creek before removed by present ownership. There is also pictures of how it looks now. I have other pictures of the recent illegal work done along hundreds of feet of spencer creek banks, of course these are areas with no homes around so nobody knew this was going on except golf course management.
Dana, Can you please forward this email to all planning commissioners, aldermen and alderwomen ad all City of Franklin staff.
Thank You for your service,
Sincerely,
Jeff Dykes

Jeff Dykes Construction, LLC
108 Broadley Court
Franklin, TN 37069
TN Contractor Lic#36071
615-456-7999 (cell)

Hello 40 Cheekwood homeowners and H.O.A. members. I assume by now you all have received the North side Golf Course submittals for the public hearing at City Hall next Thursday March 25th at 7 pm. I know that everyone has their opinion and ideas for the proposed residential streets and homes along with maintenance building with 25 parking spaces. The following is my personal opinion of how this proposal will damage our beautiful neighborhood.

1) We all live on the edge of a huge flood basin. It is wrong to build that much of impervious materials, streets, curbs, sidewalks, alleys, parking lot, rooftops in the mouth of a Blue Line creek. I have lived here 26 yrs. and during several droughts in those times Spencer Creek still had running water headed to the Harpeth River.

2) I have witnessed in the 26 years living here that during moderate rainfalls, flash rains and such, the County and the City of Franklin street departments come out and put up barricades and Danger High Water signs on Spencer Creek Road at the mouth of the creek where the storm water runs over the road several inches deep and causes hydroplaning. I have seen several wrecks due to this issue and one B.G.A. student injured when he hydroplaned and hit the stone pillars. I do not think anybody has lost their life yet and I apologize if that's not the case. I have had multiple City of Franklin and Williamson County employees tell me that the road needs to raise a minimum of 3 feet, maybe more, and larger culverts put in under road to prevent this from happening, basically a Bridge built.

3) If you look at the plan for new city street it enters the proposed subdivision right at this lowest area. Not good engineering in my opinion. I do not see any plans of raising Spencer Creek Road on this plan.

4) The housing they are proposing to build is all siding farmhouse style design and will not blend with our traditional all Brick/Stucco neighborhood. It will actually stick out like a sore thumb. If this proposal was approved, Existing Homes on Dunwoody Ct. will be looking directly at the backyards, garages and alleys as they walked out their Front Door.

5) The original proposal was to move the Maintenance Bldg. to the South Side development so that noise pollution would be away from our neighborhood, this has changed on this proposal. This is a large Maintenance building that has 25 parking spaces. The golf course is proposing doubling in size, with the addition of South portion, I would assume that the maintenance equipment will at least double, as will the noise for nearby residences.

6) It is of the opinion of several experienced well established lawyers that our Lease Agreement with the golf course owners will be in default if this proposed development passes the vote and is approved. Our lease states that the adjacent land as plated that abuts our 24+ acres of common space can only be used for a golf course. It also states that no lighting can be installed/ added to any portion of the land adjacent to our common area. If the proposal passes there will be Street Lighting and multiple home lighting, landscape lighting, Maintenance building lighting, it could be very bright at night.

7) It is a state law that anyone that owns property with a blue line creek running through the property must obtain a permit to work within a 50 ft. area of the banks of the creek. That is to remove any vegetation or disturb any soil within that 50 ft. I have witnessed a large swath of natural filtration cattails and lily pads in the creek removed by the new golf course management. The water used to be crystal clear on the low side of the creek, now it is nothing but mud washing and banks eroding. As late as last week I saw a tractor clearing out trees on the bank of the creek, when I ask him if he had a permit or was using any erosion control, he said "No, but I was told to stop if anybody complained", and he left? There is a right way to work around and in creeks to improve them, but the first thing is to get a permit.

8) The owner of the golf course has also taken down many trees on your / our HOA 24+ acres without any contact to our association, any flagging or study of the trees, no notification whatsoever. Why would somebody who says they want to be a good neighbor do that with no discussion. Would you take down your neighbor's trees?

9) In closing, I do not think that Jack Nicklaus would support any of this development proposal to build a high quality golf course. If he does, my opinion of Nicklaus Design has changed drastically. I have played a few of Nicklaus public courses around Cincinnati and in Florida, and the managers that I have talked to on those courses have said there is nothing more important to them as courtesy to surrounding neighbors and the environment. That does not seem to be the case here. I 100% support the expansion of the Golf Course but 100% disagree with the sub-division/city street/commercial development proposal up for vote next Thursday March 25, 7 pm. This is a public zoom meeting so this is the chance our neighborhood has to speak with Planning Commission who will be voting.

Thank You for your time,
Jeff Dykes

Public Hearing - 3-25-21 7 PM

March 10, 2021

Public Notification Letter – Cheekwood

PUBLIC NOTICE

This letter is written to provide public notice that the Franklin Municipal Planning Commission (FMPC) will be considering a proposed Development Plan and Rezoning for the properties located at Map 063, Parcels 2101, 2102 and 2103, Map 052N A, Parcel 00100 and Map 063C A, Parcel 00100 at 285 Spencer Creek Road in Franklin, TN. The request will be heard by the FMPC on Thursday, March 25, 2021 at 7:00 pm in the Board Room at the Franklin City Hall. Please see the information below for more details.

APPLICANT

Gamble Design Collaborative

APPLICANT'S REPRESENTATIVE

Gamble Design Collaborative — 324 Liberty Pike, Suite 145, Franklin, TN 37064
Greg Gamble — 615-975-5765 — greg.gamble@gdc-tn.com

APPLICATION TYPE

Development Plan and Rezoning

DATE, TIME, AND PLACE OF PUBLIC MEETING

Thursday, March 25, 2021 at 7:00 pm in the City Hall Board Room, located at 109 3rd Avenue in Franklin, Tennessee.

SUBJECT PROPERTY

Map 063, Parcels 2.00, 2.01, 2.02. Map 052, Parcel 7.00 and Map 052O, Group A, Parcel 27.00

NATURE AND SCOPE OF THE APPLICANT REQUEST

Two separate Development Plans and Rezonings, proposing a redesign of the Cheekwood Golf Course. The Development Plan for the north side of Mack Hatcher will redesign the golf course and add six residential lots. The Development Plan for the south side of Mack Hatcher will expand the golf course to the City-leased property. The clubhouse will be rebuilt on the southern property, as well as a golf practice facility with 3 story driving range and an associate restaurant.

WHERE TO VIEW THE PROPOSED PLAN

The application may be viewed in the Planning and Sustainability Department, City Hall, 109 3rd Avenue South, Franklin, TN 37064. The Department phone number is 615-791-3212.

WHERE THE PUBLIC CAN BE HEARD

Accommodations have been made to ensure that the public is able to participate in the meeting on Thursday, March 25, 2021 at 7:00 pm with respect to the application. The public may participate in the following ways:

- Watch the meeting on FranklinTV or the City of Franklin website https://www.franklintn.gov/franklintv
- Watch the live stream through the City of Franklin Facebook https://www.facebook.com/CityOfFranklin and YouTube accounts https://www.youtube.com/user/CityOfFranklin

- Call in to the conference meeting 1-312-626-6799; Meeting ID: 990 0449 6156; Password: 476160. Callers will be unmuted and given the opportunity to comment during the meeting at specific times.

- The public may email comments to planningintake@franklintn.gov to be provided in full to the Commission and included in the minutes, but not read aloud in their entirety during the meeting. Emailed comments will be accepted until 12:00 PM (noon) on the day before the meeting.

- Public comment options will be published with the agenda, or a citizen can call the City of Franklin Planning and Sustainability Department for more information at 615-791-3212.

THERE SHALL BE NO MOWING, CLEARING, GRADING, CONSTRUCTION, STORAGE, OR DISTURBANCE OF VEGETATION IN RIPARIAN BUFFERS EXCEPT AS PERMITTED BY THE CITY ENGINEER, OR HIS DESIGNEE.

SITE DATA CHART

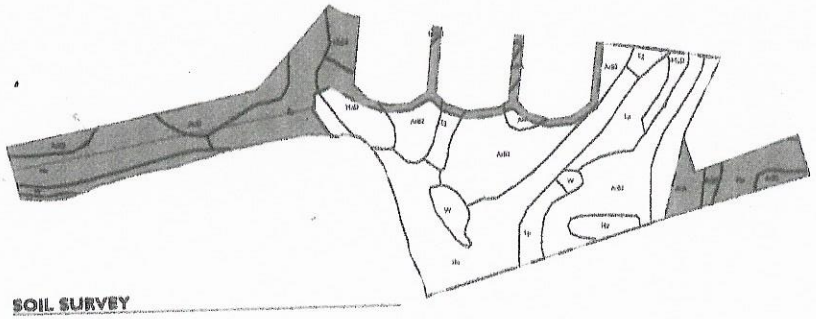
PROJECT NAME:	CHEEKWOOD NORTH PD
PROJECT NUMBER:	7414
ADDRESS	205 PARKER LANE ROAD FRANKLIN, TN 6TH CIVIL DISTRICT
PARCELS:	021.02
ACREAGE OF SITE: VESTING (IF APPLICABLE):	35.34 AC
BASE ZONING:	RD (PLANNED DISTRICT) RM (RESIDENTIAL 1 DISTRICT)
PROPOSED ZONING: ZONING OVERLAY(S):	PD (PLANNED DISTRICT) HCO, FWO, FFO
BUILDING TYPES APPLIED: FRONTAGE TYPES APPLIED: LOT WIDTH (RESIDENTIAL): LOT SIZE (RESIDENTIAL): SETBACKS: FRONT: SIDE: REAR:	HOUSE YARD FRONTAGE 70' 9,800 SF/SIDE 30' 5' 30'
DWELLING UNIT COUNT BY TYPE: SINGLE FAMILY: MULTIFAMILY:	6 UNITS N/A
NON-RESIDENTIAL SF BY TYPE: PUBLIC HOUSE: HALFWAY HOUSE: TURF/HUNTER RANGE MAINT.:	N/A 1,500 SF 12,000 SF
HOTEL KEYS: EVENT CENTER:	N/A MAX 150 GUEST
PARK AND DEDICATION:	6 UNITS X $450 = $2,700
MINIMUM TREE CANOPY REQUIRED: NATURAL AREA REQUIRED: TREE CANOPY RETENTION % ACHIEVED:	10% 15.17 (0.43) 6A (NOT REQUIRED) 8.5 AC (NOT REQUIRED) PROVIDED 9.5 AC (56% OF TOTAL CANOPY)
PARKING REQUIRED BY ORD: SINGLE FAMILY PARKING:	2/ UNIT (12) + 2 PER 3 UNITS OVER 4 (1) = 13
PARKING PROVIDED BY ORD: SINGLE FAMILY PARKING:	2/ UNIT (12) + 2 PER 3 UNITS OVER 4 (1) = 13
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 116 FIFTH AVE NASHVILLE, TN 37219 (615) 242-4464

EXISTING CHEEKWOOD

EXISTING BARN

KEY - EXISTING CONDITIONS

- EXISTING TREE CANOPY
- FWO; PROPOSED
- FWO; EFFECTIVE
- FFO
- 30'/60', ZONE 1 RIPARIAN BUFFER
- 30', ZONE 2 RIPARIAN BUFFER



SOIL SURVEY

ArA	Armour silt loam, 0 to 2 percent slopes
ArB	Armour silt loam, 2 to 5 percent slopes
ArB2	Armour silt loam, 2 to 5 percent slopes, eroded
ArC	Armour silt loam, 5 to 12 percent slopes 1.6
ArC2	Armour silt loam, 5 to 12 percent slopes, eroded
BrC2	Braxton charty silt loam, 5 to 12 percent slopes, eroded
Eg	Egam silt loam, phosphatic
HbC2	Hampshire silt loam, 5 to 12 percent slopes, eroded
HcC3	Hampshire silty clay loam, 5 to 12 percent slopes, severely eroded
Hu	Huntington silt loam, phosphatic
Lp	Lindell silt loam, 0 to 2 percent slopes, occasionally flooded
MbB2	Maury silt loam, 2 to 5 percent slopes, eroded
MoC3	Maury silty clay loam, 5 to 12 percent slopes, severely eroded
MoD	Ashwood-Mimosa-Rock outcrop complex, 5 to 15 percent slopes
Rc	Rockland
W	Water

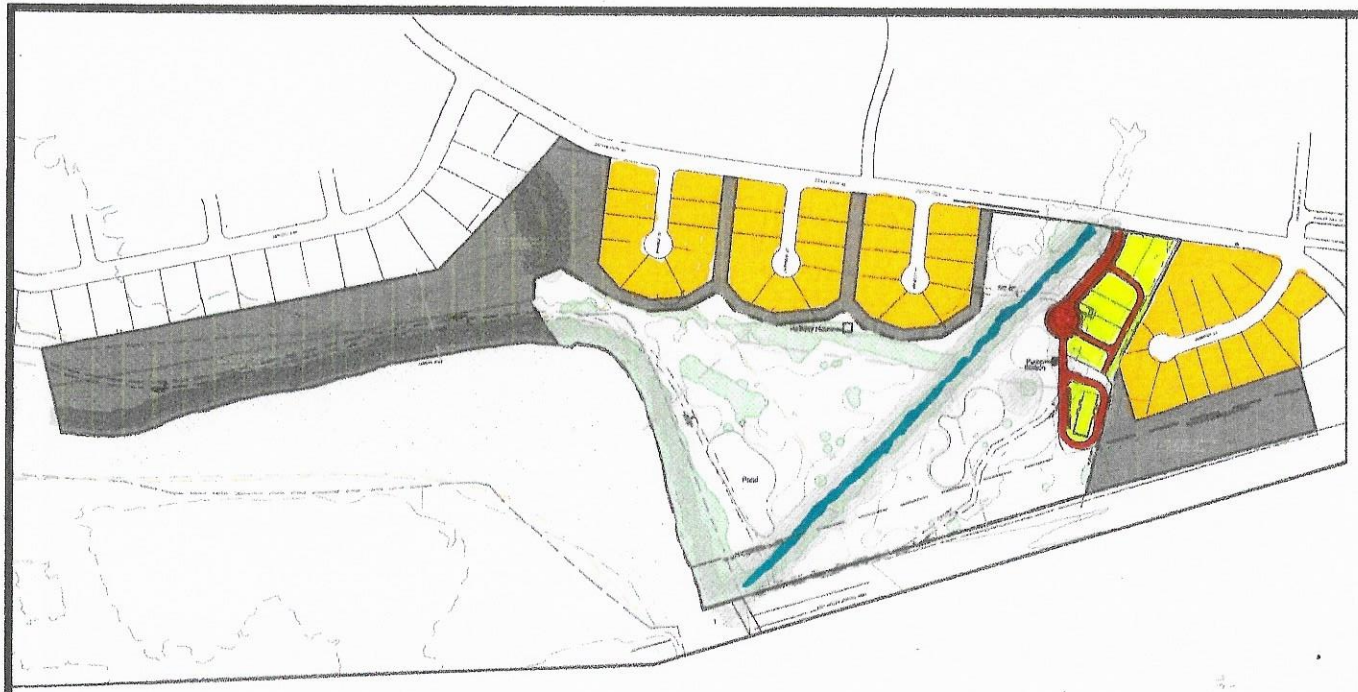
GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD
DEVELOPMENT PLAN
Franklin, Williamson County, Tennessee

GRACE A. RECOR
REGISTERED LANDSCAPE ARCHITECT
TENNESSEE NO. 1301
LANDSCAPE ARCHITECT

Revision Date

OVERALL EXISTING CONDITIONS SHEET
C1.0
COF # 7414



THERE SHALL BE NO MOWING, CLEARING, GRADING, CONSTRUCTION, STORAGE, OR DISTURBANCE OF VEGETATION IN RIPARIAN BUFFERS EXCEPT AS PERMITTED BY THE CITY ENGINEER, OR HIS DESIGNEE.

KEY - DEVELOPMENT PLAN

- PRESERVED TREE CANOPY
- OPEN SPACE
- FWO; PRELIMINARY
- FWO; EFFECTIVE
- FFO
- 30'/60', ZONE 1 RIPARIAN BUFFER
- 30', ZONE 2 RIPARIAN BUFFER

EXISTING CHEEKWOOD

PROPOSED STREETS & ALLEYS

PROPOSED DEVELOPMENT

0 200 400 600

SITE DATA CHART

PROJECT NAME	CHEEKWOOD NORTH PD
PROJECT NUMBER	TBD
ADDRESS	201 SPENCER LYON ROAD FRANKLIN, TN 37064, DISTRICT 7
PARCEL(S)	062 02102
ACREAGE OF SITE / VESTING OF ACREAGE(S)	18.26 AC
BASE ZONING	RD (PLANNED DISTRICT)
PROPOSED ZONING	RM (RESIDENTIAL 1 DISTRICT)
ZONING OVERLAY(S)	RD (PLANNED DISTRICT) SCO, FWO, FFO
BUILDING TYPES ALLOWED	HOUSE
FRONTAGE TYPES ALLOWED	YARD/TERRACE
LOT WIDTH (MINIMUM)	70'
LOT SIZE (MINIMUM)	10,000 SF
SETBACKS	
FRONT	15'
SIDE	5'
REAR	20'
DWELLING UNIT COUNT BY TYPE:	
SINGLE FAMILY:	41 UNITS
MULTIFAMILY:	N/A
NON-RESIDENTIAL SF BY USE:	
RAMP HOUSE:	500 SF
LAUNDRY HOUSE:	1,500 SF
BOAT MAINTENANCE FACILITY:	3,000 SF
HOTEL KEYS:	N/A
PARKING PROVIDED:	PARK'S STUDIES
PARKLAND DEDICATION	41 UNITS X 0.0044 = 0.18 AC
MINIMUM OSR:	35%
OPEN SPACE PROVIDED:	13.11 AC
NATURAL AREA REQUIRED:	5.0 AC (NOT REQUIRED)
TREE CANOPY RETENTION ACREAGE:	REQUIRED 3.75 AC (20% OF TOTAL CANOPY) PROVIDED 4.0 AC (21% OF TOTAL CANOPY)
PARKING REQUIRED BY USE:	
SINGLE FAMILY PARKING:	SEE ATTACHED PARKING STUDY
PARKING PROVIDED BY USE:	
SINGLE FAMILY PARKING:	SEE ATTACHED PARKING STUDY
APPLICANT	GAMBLE DESIGN COLLABORATIVE 1214 SOUTH PINE SUITE 101 CHATTANOOGA, TN 37408 (615) 972-2414 [redacted]

OPEN SPACE REQUIREMENT

MINIMUM OPEN SPACE REQUIREMENT AS REQUIRED: 35 TOTAL = 12.77 AC
LESS: NATURAL AREA = NOT REQUIRED
PROVIDED: 13.44 AC TOTAL (37.0%)

LOT #	TYPE: SINGLE FAMILY	TYPE: MULTIFAMILY	AREA (SF) / (AC)

NOTE: OPEN SPACE PLANTINGS WILL BE BASED ON THE 75 PRIVATE OPEN SPACE REQUIRED BY THE ZONING ORDINANCE, NOT OF THE TOTAL OPEN SPACE PROVIDED.

TREE CANOPY RETENTION

OVERALL SITE AREA = 18.26 AC

TREE CANOPY:

TOTAL EXISTING TREE CANOPY	4.0 AC (21.91% OF SITE)
REQUIRED CANOPY PRESERVATION	3.75 AC (20% OF SITE)
PROPOSED CANOPY PRESERVATION:	4.0 AC (21.91% OF SITE)

STATEMENT OF IMPACTS

WATER FACILITIES
WATER SERVICE WILL BE PROVIDED BY . THE WATER MAINS ARE LOCATED ALONG .
0 UNITS x 250 GPD = 1,000 GPD

SEWER FACILITIES
SEWER SERVICE WILL BE PROVIDED BY THE CITY OF FRANKLIN.

REPURIFIED (REUSE) WATER FACILITIES
AVAILABLE. SEE UTILITY SHEETS.

POLICE, FIRE, AND RECREATIONAL FACILITIES
NEAREST POLICE STATION: HEADQUARTERS (3.1 MILES)
NEAREST FIRE STATION: FIRE STATION #4 (1.7 MILES)
NEAREST RECREATIONAL FACILITY: WILLIAMSON COUNTY RECREATION CENTER (1.7 MILES)

PROJECTED STUDENT POPULATION
0 x 0.39 = 2 STUDENTS

REFUSE STORAGE AND SANITATION COLLECTION FACILITIES
REFUSE COLLECTION FOR THE DEVELOPMENT SHALL BE PROVIDED BY CITY OF FRANKLIN

GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

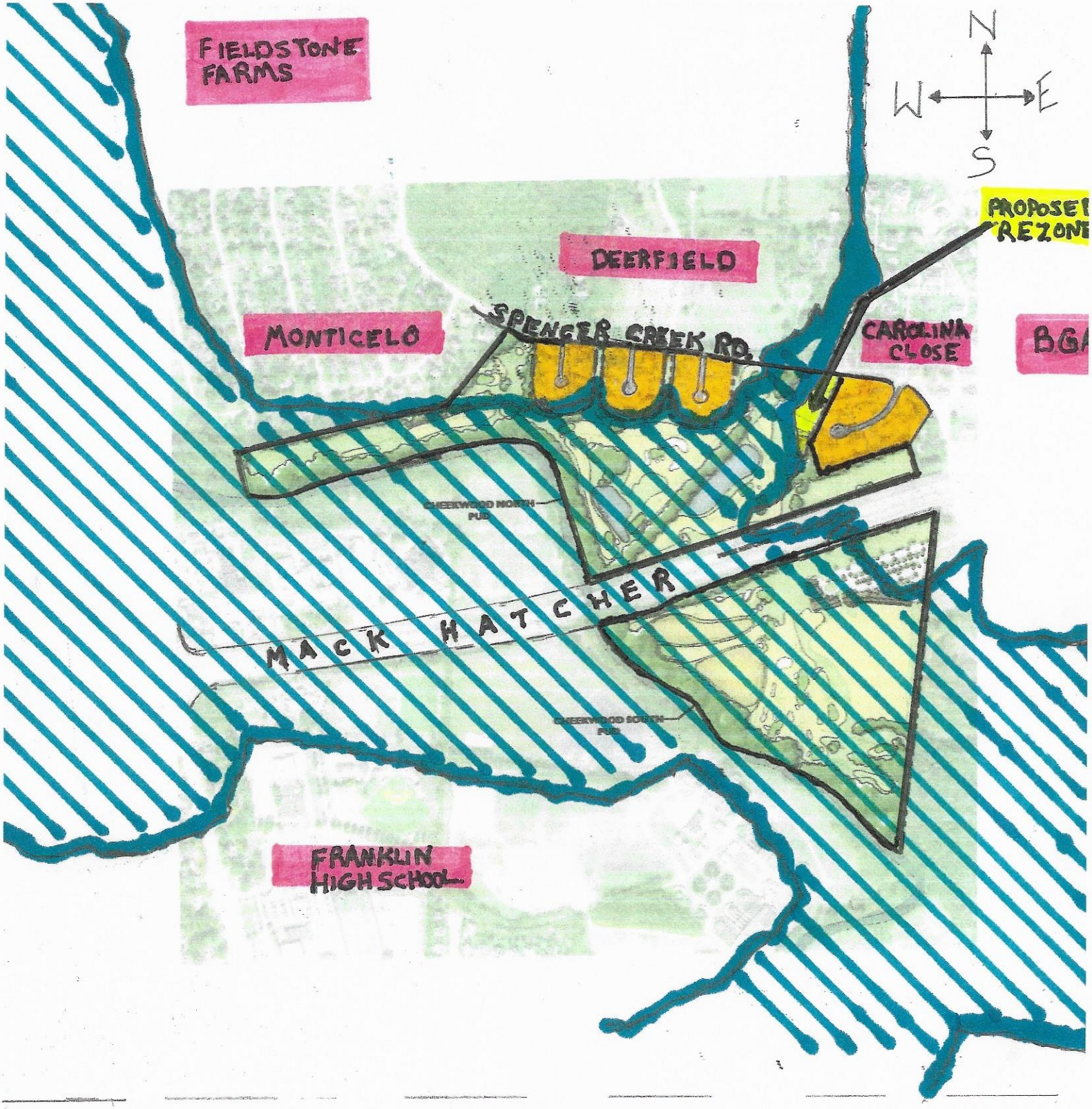
BRUCE A. REEKER REGISTERED LANDSCAPE ARCHITECT

Revision Date

DEVELOPMENT PLAN SHEETS

SHEET C2.0

DOF # 7414

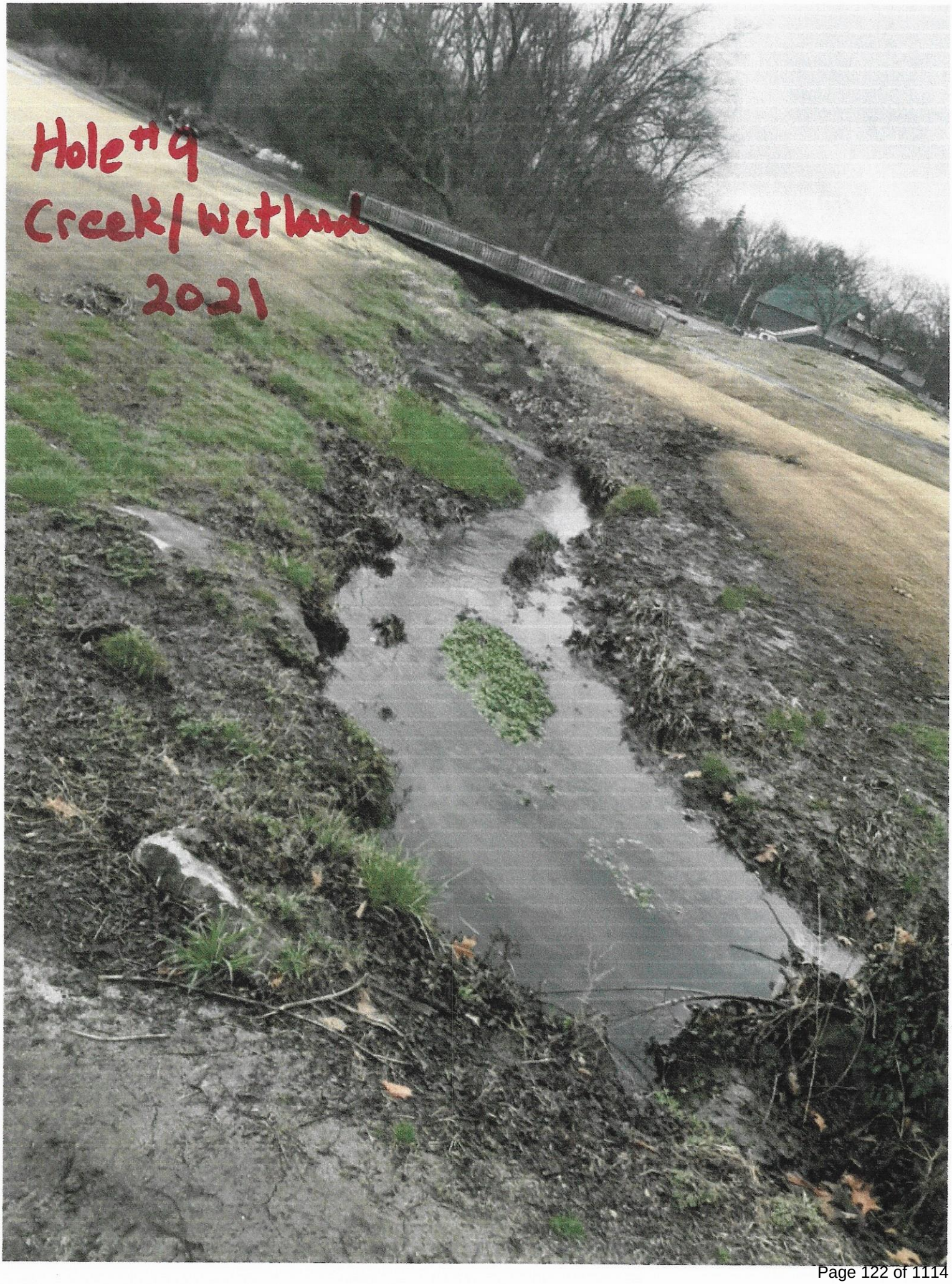


CHEEKWOOD-EXISTING 40 HOMES

NEW FLOOD PLAIN OVERLAY

PROPOSED DEVELOPMENT

Hole #9
Creek/Wetland
2014


Hole #9
Creek/wetland
2021

Hole #9
Creek/Wetland
2021

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01873

DATE: March 25, 2021

TO: Board of Mayor and Aldermen

FROM: Eric Stuckey, City Administrator
Lisa Clayton, Director of Parks

SUBJECT:

Consideration Of COF Contract No. 2021-0059, Parkland Impact Fee (Payment Of Fees Only) Agreement For Cheekwood North PUD Between The City Of Franklin And Cheekwood Golf Club LP.

PURPOSE:

The purpose of this memorandum is to provide information to the Franklin Board of Mayor and Aldermen (BOMA) concerning the consideration of COF Contract No. 2021-0059, Parkland Impact Fee (Payment Of Fees Only) Agreement For Cheekwood North PUD Between The City Of Franklin And Cheekwood Golf Club LP.

BACKGROUND/STAFF COMMENTS:

Cheekwood is in the process of developing the property located at 285 Spencer Creek Road, located in Parkland Quadrant Four (4) of the City, consisting of six (6) units known as Cheekwood North PUD; and Parkland Impact Fees and Parkland Dedication requirements are based on the mathematical formulas and allocations set forth in the City's Parkland Dedication Ordinance (Ordinance 2016-25, Franklin Municipal Code §25-405.) The total Parkland Impact Fee obligation for this project is TWENTY-FIVE THOUSAND EIGHT HUNDRED TWENTY-FOUR DOLLARS ($25,824.00) and Twenty-Five Percent (25%) or SIX THOUSAND FOUR HUNDRED FIFTY-SIX DOLLARS ($6,456.00) of which shall be paid at the final plat or at the issuance of the first building permit when a plat is not required. The remaining Seventy-Five Percent (75%) or NINETEEN THOUSAND THREE HUNDRED SIXTY-EIGHT DOLLARS ($19,368.00) shall be collected at a pro-rated per permit rate of Three Thousand Two Hundred Twenty-Eight and 00/100 Dollars ($3,228.00) until the full obligation has been paid. Cheekwood is electing to pay fees only and not requesting any offsets with this project.

FINANCIAL IMPACT:

Cheekwood is electing to pay fees only and not requesting any offsets with this project. The total Parkland Impact Fee obligation for this project is TWENTY-FIVE THOUSAND EIGHT HUNDRED TWENTY-FOUR DOLLARS ($25,824.00) and Twenty-Five Percent (25%) or SIX THOUSAND FOUR HUNDRED FIFTY-SIX DOLLARS ($6,456.00) of which shall be paid at the final plat or at the issuance of the first building permit when a plat is not required. The remaining Seventy-Five Percent (75%) or NINETEEN THOUSAND THREE HUNDRED

SIXTY-EIGHT DOLLARS ($19,368.00) shall be collected at a pro-rated per permit rate of Three Thousand Two Hundred Twenty-Eight and 00/100 Dollars ($3,228.00) until the full obligation has been paid.

RECOMMENDATION:

Staff recommends that the Board of Mayor and Aldermen approve COF Contract No. 2021-0059.

Prepared by:
City of Franklin
109 Third Avenue South
Franklin, Tennessee 37064

PARKLAND IMPACT FEE (PAYMENT OF FEE ONLY) AGREEMENT FOR CHEEKWOOD NORTH PUD BETWEEN THE CITY OF FRANKLIN AND CHEEKWOOD GOLF CLUB LP

CONTRACT NO. 2021-0059

PARKLAND IMPACT FEE (this "Agreement"), made and entered into this ___ day of _____ 2021 by and between THE CITY OF FRANKLIN, TENNESSEE (hereinafter "City") and CHEEKWOOD GOLF CLUB LP (hereinafter "Cheekwood") pursuant to Title 25, Chapter 4 of the City of Franklin Municipal Code, and Cheekwood as owner of that certain land known as CHEEKWOOD NORTH PUD in the City of Franklin, Williamson County, Tennessee. The parties join herein for the sole purpose of consenting to and approving this Agreement, and hereby consent to and approve this Agreement.

WITNESSETH:

WHEREAS, Cheekwood is in the process of developing the property located at 285 Spencer Creek Road (the "Development Project"), located in Parkland Quadrant Four (4) of the City, consisting of six (6) units known as Cheekwood North PUD; and

WHEREAS, Parkland Impact Fees and Parkland Dedication requirements are based on the mathematical formulas and allocations set forth in the City's Parkland Dedication Ordinance (Ordinance 2016-25, Franklin Municipal Code §25-405, and hereinafter, "Ordinance"); and

WHEREAS, the Parkland Impact Fee as set forth in the Ordinance is Four Thousand Three Hundred Four and 00/100 Dollars ($4,304.00) per dwelling unit; and

WHEREAS, the total Parkland Impact Fee obligation for this project is TWENTY-FIVE THOUSAND EIGHT HUNDRED TWENTY-FOUR and 00/100 DOLLARS ($25,824.00) and Twenty-Five Percent (25%) or SIX THOUSAND FOUR HUNDRED FIFTY-SIX and 00/100 DOLLARS ($6,456.00) of which shall be paid at the final plat or at the issuance of the first building permit when a plat is not required. The remaining Seventy-Five Percent (75%) or NINETEEN THOUSAND THREE HUNDRED SIXTY-EIGHT and 00/100 DOLLARS ($19,368.00) shall be collected at a pro-rated per permit rate of Three Thousand Two Hundred Twenty-Eight and 00/100 Dollars ($3,228.00) until the full obligation has been paid.

NOW, THEREFORE, in consideration of the terms, conditions and mutual agreements by and between the parties as hereinafter set forth in detail, the parties do hereby mutually agree as follows:

I. AGREEMENT FOR PAYMENT OF PARKLAND IMPACT FEES

1. The foregoing recitals are incorporated into this Agreement and made a part thereof.

2. This Agreement is non-transferable to the successors or assigns of Cheekwood unless the successor assumes the same obligations of Cheekwood in writing. Such assignment shall be provided to the City within fifteen (15) days of its occurrence. Upon assignment, Cheekwood shall be relieved from further liability under this Agreement.

3. The City and Cheekwood agree that the terms and conditions contained herein shall be binding on and shall insure to their heirs, representatives, successors, and assigns.

4. Applicable Law/Choice of Forum and Venue. This Agreement is made under and will be construed in accordance with the laws of the State of Tennessee without giving effect to that state's choice of law rules. The parties' choice for forum and venue shall be exclusively in the courts of Williamson County, Tennessee.

5. All notices required to be given by any party shall be in writing, addressed to all other parties, and delivered by certified mail or in person to:

In the case of the City:	In the case of Cheekwood:
City of Franklin	Cheekwood
Attn: Vernon J. Gerth, ACA	Attn: J. Todd Jester
109 Third Ave. South	285 Spencer Creek Road
P.O. Box 305	Franklin, Tennessee 37069
Franklin, TN 37065-0305	

6. This Agreement constitutes the entire agreement between the parties. There are no further or other agreements or understandings, written or oral, in effect between the parties, relating to the subject matter hereof. This Agreement may be amended or modified only be an instrument of equal formality signed by the respective parties.

II. General Terms and Conditions

1. Personal Liability.
No member, Mayor, Alderman, official, or employee of the City shall be personally liable to Cheekwood or any successor in interest, in the event of any default or breach by the City, or for any amount which may become due to Cheekwood or successor or on any obligations hereunder.

2. Warranties /Limitation of Liability/Waiver.
The City reserves all rights afforded to local governments under law for all general and implied warranties. The City does not waive any rights it may have to all remedies provided by law and therefore any attempt by Cheekwood to limit its liability shall be void and unenforceable. The City, being a Tennessee governmental entity, is governed by the provisions of the Tennessee Governmental Tort Liability Act, Tenn. Code Ann. § 29-20-101 et. seq. for causes of action sounding in tort. Further, no contract provision requiring a Tennessee political entity to indemnify or hold harmless the Contractor beyond the liability imposed by law is enforceable because it appropriates public money and nullifies governmental immunity without the authorization of the General Assembly.

3. Severability.
If any term or provision of this Agreement is held to be illegal or unenforceable, the validity or enforceability of the remainder of this Agreement will not be affected.

Prepared by:
City of Franklin
109 Third Avenue South
Franklin, Tennessee 37064

IN WITNESS WHEREOF the said parties have hereunto set their signatures, on this day and date first above written.

CITY OF FRANKLIN, TENNESSEE: **Attest:**

By:_____ By: _____
Dr. Ken Moore, Mayor Eric S. Stuckey, City Administrator

Date:_____ Date:_____

STATE OF TENNESSEE)
)
COUNTY OF WILLIAMSON)

Before me,_____, a Notary Public of said State and County, personally appeared, Dr. Ken Moore and Eric S. Stuckey, with whom I am personally acquainted (or proved to me on the basis of satisfactory evidence), and where, upon oath, Dr. Ken Moore acknowledged himself to be Mayor and Eric S. Stuckey acknowledged himself to be City Administrator of the City of Franklin, Tennessee, and that as such, being authorized to do so, have executed the foregoing instrument for the purposes therein contained.

Witness my hand and seal, at office, this_____day of_____, 20_.

_____
NOTARY PUBLIC

My Commission Expires: _____

Approved as to form:

By: _____
Maricruz R. Fincher, Staff Attorney

Prepared by:
City of Franklin
109 Third Avenue South
Franklin, Tennessee 37064

Cheekwood

By:

Name:

Title:

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

STATE OF _____)
)
COUNTY OF_____)

On_____, before me, _____, Notary Public, personally appeared_____who proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of_____that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

_____
NOTARY PUBLIC

My Commission Expires: _____

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01821

DATE: March 24, 2021

TO: Board of Mayor and Aldermen

FROM: Kelly Dannenfelser, Asst. Director of Planning
Amy Diaz-Barriga, Planning Supervisor
Joseph Bryan, Principal Planner

SUBJECT:

*Consideration of Ordinance 2020-37, An Ordinance To Rezone 53.52 Acres From Civic Institutional (CI) District To Planned (PD 58,909) District For The Property Located West Of Aldersgate Way And South Of Mack Hatcher Parkway (Cheekwood South PUD). Establishing A Public Hearing On May 11, 2021.
FMPC 3/25/21, 8-0

PURPOSE:

PROJECT INFORMATION
COF Project Number: 7415
Applicant: Greg Gamble, GDC
Owner: City of Franklin, TN

BACKGROUND/STAFF COMMENTS:
The applicant is requesting to rezone the subject property from Civic Institutional (CI) District to Planned (PD 58,909) District to accommodate the Cheekwood South PUD Subdivision and construct golf course facilities. The parcel consists of 53.52 acres and is located South of Mack Hatcher Parkway and West of Aldersgate Way. The property is currently vacant. Envision Franklin places this parcel in the Recreation Design Concept which supports both public and private recreational opportunities. The proposed rezoning entitlements include 58,909 square feet of nonresidential space for the club house, driving range, etc. The rezoning is consistent with Envision Franklin and can be supported by Staff.

FINANCIAL IMPACT:

Unknown.

RECOMMENDATION:

Staff recommends that the Board of Mayor and Aldermen approve Ordinance 2020-37.

ORDINANCE 2020-37

AN ORDINANCE TO REZONE 53.52 ACRES FROM CIVIC INSTITUTIONAL (CI) DISTRICT TO PLANNED (PD 58,909) DISTRICT FOR THE PROPERTY LOCATED WEST OF ALDERSGATE WAY AND SOUTH OF MACK HATCHER PARKWAY (CHEEKWOOD SOUTH PUD).

WHEREAS, the City of Franklin, Tennessee, encourages responsible growth and the sensible transition of land uses and densities; and

WHEREAS, the Planned (PD) district provides zoning for land uses compatible with both the Franklin Land Use Plan and surrounding development; and

WHEREAS, the Board of Mayor and Aldermen (BOMA) of the City of Franklin, Tennessee, adopted Resolution 2020-299, approving a Planned Unit Development (PUD) Development Plan as required by the Franklin Zoning Ordinance; and

WHEREAS, the zoning has been reviewed and approved by BOMA after a public hearing and a recommendation by the Franklin Municipal Planning Commission.

NOW THEREFORE, BE IT ORDAINED BY THE BOARD OF MAYOR AND ALDERMEN OF THE CITY OF FRANKLIN, TENNESSEE, AS FOLLOWS:

SECTION I. That the following described property shall be, and is hereby, rezoned from its present zoning classification of **Civic Institutional (CI)** District to **Planned (PD 58,909 SF)** District:

PREMISES CONSIDERED

Map-Parcel	Acres
063-21.01	53.52
Total	53.52

SECTION II. That the attached Location Map and Survey shall serve the purpose of further delimiting the geographical boundaries as described by this Ordinance.

SECTION III. BE IT FINALLY ORDAINED by the Board of Mayor and Aldermen of the City of Franklin, Tennessee, that this Ordinance shall take effect from and after its passage on third and final reading, the health, safety, and welfare of the citizens requiring it.

ATTEST:

By: _____
Eric Stuckey
City Administrator/Recorder

CITY OF FRANKLIN, TENNESSEE:

By: _____
Dr. Ken Moore
Mayor

Approved as to form by:

_____
Shauna R. Billingsley
City Attorney

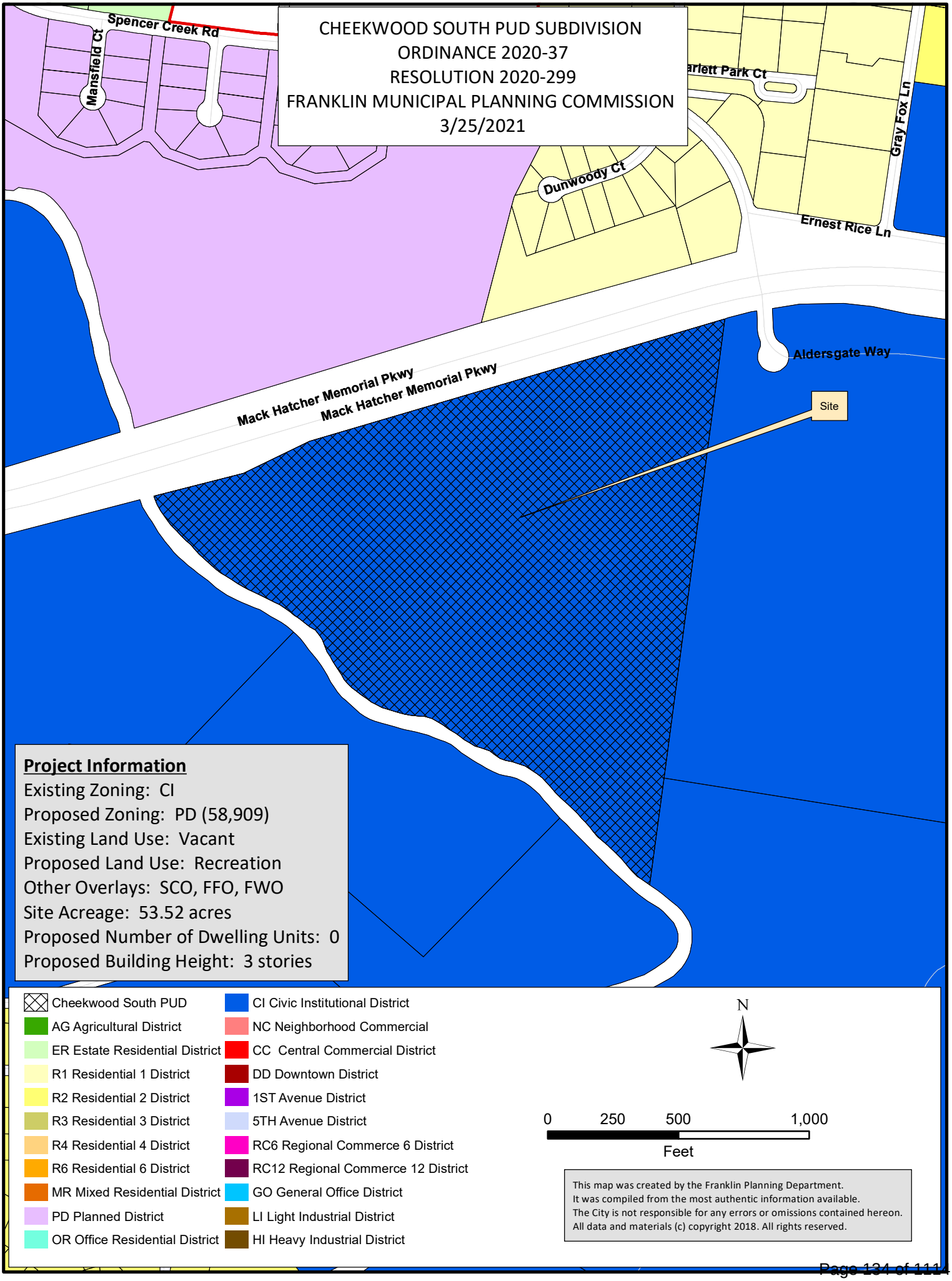
PLANNING COMMISSION RECOMMENDED: _____

PASSED FIRST READING: _____

PUBLIC HEARING HELD: _____

PASSED SECOND READING: _____

PASSED THIRD READING: _____


CHEEKWOOD SOUTH PUD SUBDIVISION
ORDINANCE 2020-37
RESOLUTION 2020-299
FRANKLIN MUNICIPAL PLANNING COMMISSION
3/25/2021
Spencer Creek Rd
Mansfield Ct
arlett Park Ct
Gray Fox Ln
Dunwoody Ct
Ernest Rice Ln
Aldersgate Way
Mack Hatcher Memorial Pkwy
Mack Hatcher Memorial Pkwy
Site
Project Information
Existing Zoning: CI
Proposed Zoning: PD (58,909)
Existing Land Use: Vacant
Proposed Land Use: Recreation
Other Overlays: SCO, FFO, FWO
Site Acreage: 53.52 acres
Proposed Number of Dwelling Units: 0
Proposed Building Height: 3 stories
Cheekwood South PUD
AG Agricultural District
ER Estate Residential District
R1 Residential 1 District
R2 Residential 2 District
R3 Residential 3 District
R4 Residential 4 District
R6 Residential 6 District
MR Mixed Residential District
PD Planned District
OR Office Residential District
CI Civic Institutional District
NC Neighborhood Commercial
CC Central Commercial District
DD Downtown District
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RC12 Regional Commerce 12 District
GO General Office District
LI Light Industrial District
HI Heavy Industrial District
N
0 250 500 1,000
Feet
This map was created by the Franklin Planning Department.
It was compiled from the most authentic information available.
The City is not responsible for any errors or omissions contained hereon.
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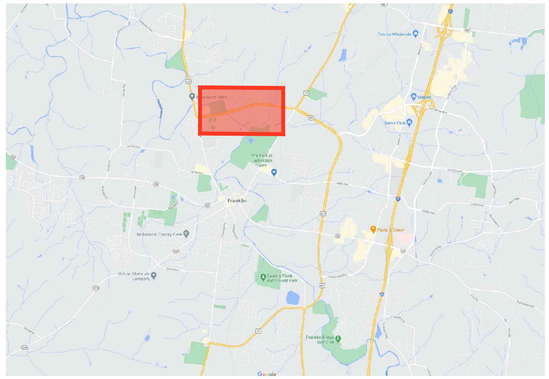


CHEEKWOOD SOUTH PD

REZONING PACKET

PLANNED DISTRICT (0.0 DUA, 58,909 DUA)
FRANKLIN, WILLIAMSON, TENNESSEE

SITE DATA CHART

PROJECT NAME:	CHEEKWOOD SOUTH PD
PROJECT NUMBER:	XXXX
ADDRESS:	MACK HATCHER PKWY FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02101
ACREAGE / SF OF SITE:	53.52 AC
VESTING (IF APPLICABLE):	
BASE ZONING:	CI (CIVIC INSTITUTIONAL)
PROPOSED ZONING:	PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO, CFO
DESIGN CONCEPT(S):	RECREATION, CONSERVATION
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

APPLICANT & LANDSCAPE ARCHITECT:

GAMBLE DESIGN COLLABORATIVE
GREG GAMBLE
324 LIBERTY PIKE
SUITE 145
FRANKLIN, TN 37064
615-975-5765
greg.gamble@gdc-tn.com

ENGINEER:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
STEVE CASEY
117 SEABOARD LANE
SUITE E-100
FRANKLIN, TN 37067
615-333-7797
scasey@cecinc.com

OWNER:

CHEEKWOOD HOMEOWNERS ASSOC INC
CONTACT:
1152 COLUMBIA AVENUE
FRANKLIN, TN 37064

SHEET INDEX

C0.0	COVER SHEET
C1.0	OVERALL EXISTING CONDITIONS
C1.1	EXISTING CONDITIONS ENLARGEMENT
C1.2	EXISTING CONDITIONS ENLARGEMENT
C1.3	EXISTING CONDITIONS ENLARGEMENT

VICINITY MAP

MODIFICATION OF STANDARDS

COMPREHENSIVE REVIEW OF ROADWAY, STORMWATER, AND UTILITY ELEMENTS BY CITY OF FRANKLIN STAFF WILL OCCUR AT THE SITE PLAN STAGE. PROJECT ENTITLEMENTS APPROVED WITH THIS DEVELOPMENT PLAN DO NOT CONSTITUTE APPROVAL OF THE ROADWAY, STORMWATER, AND UTILITY ELEMENTS SHOWN ON THE DEVELOPMENT PLAN. IF, UPON APPLICATION OF CITY OF FRANKLIN STREET, STORMWATER, AND UTILITY STANDARDS AT THE SITE PLAN STAGE, THE APPLICANT CANNOT ACHIEVE THE MAXIMUM APPROVED ENTITLEMENTS, THE APPLICANT SHALL BE CONFINED TO THE ENTITLEMENTS ACHIEVABLE FROM THE APPLICATION OF SAID STANDARDS.

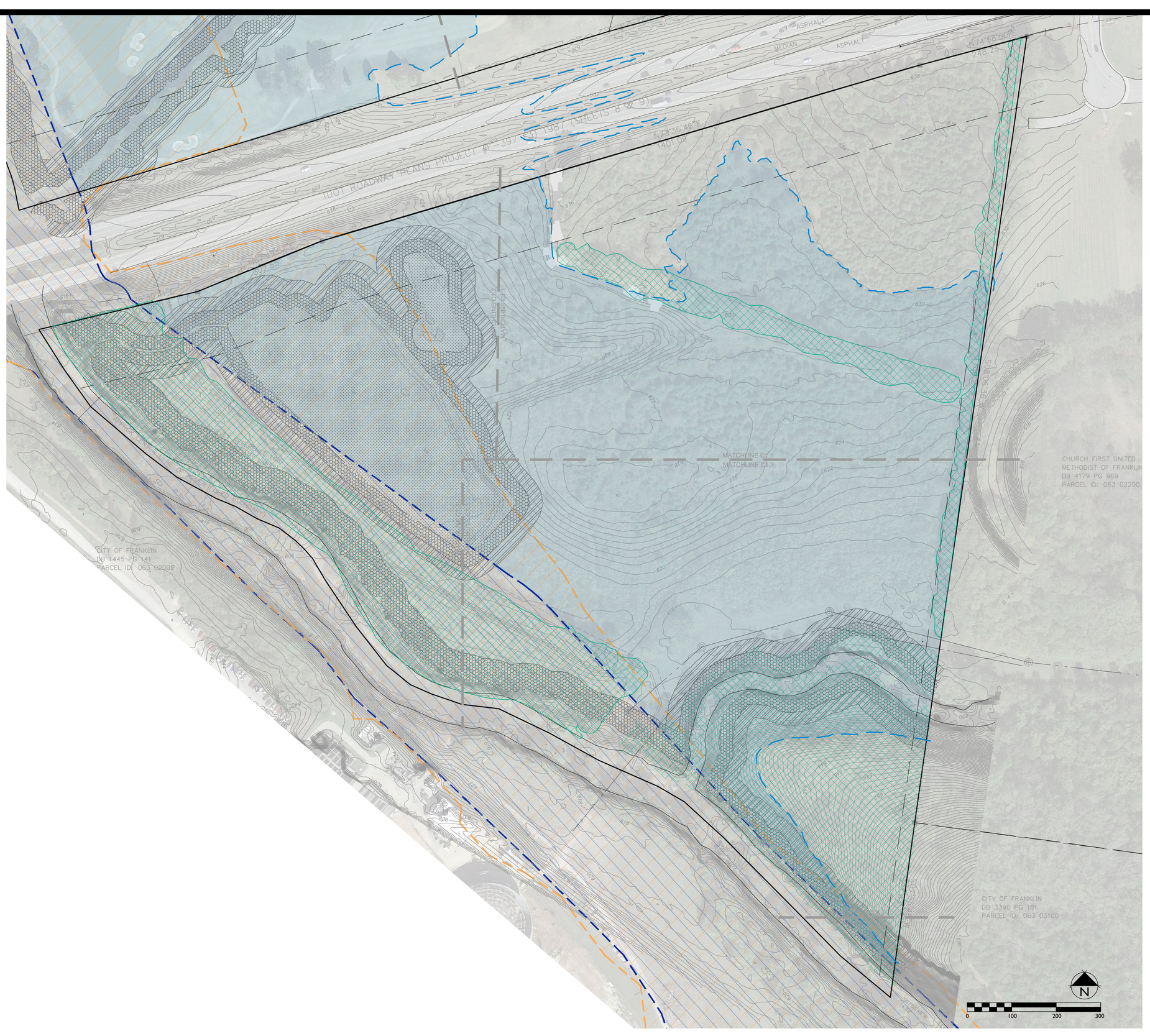
GREGORY C. GAMBLE
REGISTERED
LANDSCAPE ARCHITECT
12.14.20

PRE-APP SUBMITTAL: NOVEMBER 30, 2020

INITIAL SUBMITTAL: DECEMBER 14, 2020

RESUBMITTAL:

GDC
GAMBLE
DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE
greg.gamble@gdc-tn.com



SITE DATA CHART

PROJECT NAME:	CHEEKWOOD SOUTH PD
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ADDRESS:	MACK HATCHER PKWY FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02101
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VESTING (IF APPLICABLE):	
BASE ZONING:	CI (CIVIC INSTITUTIONAL)
PROPOSED ZONING:	PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO, CFO
DESIGN CONCEPT(S):	RECREATION, CONSERVATION
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

KEY - EXISTING CONDITIONS

- EXISTING TREE CANOPY
- FWO; PRELIMINARY
- FWO; EFFECTIVE
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- 30'/60' , ZONE 1 RIPARIAN BUFFER
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- SLOPES - 14 - 20%
- SLOPES - 20% +

SURVEY INFORMATION PROVIDED BY:
HARRAH & ASSOCIATES
FEBRUARY 2018

GDC
GAMBLE
DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD REZONING PACKET

Franklin, Williamson County, Tennessee

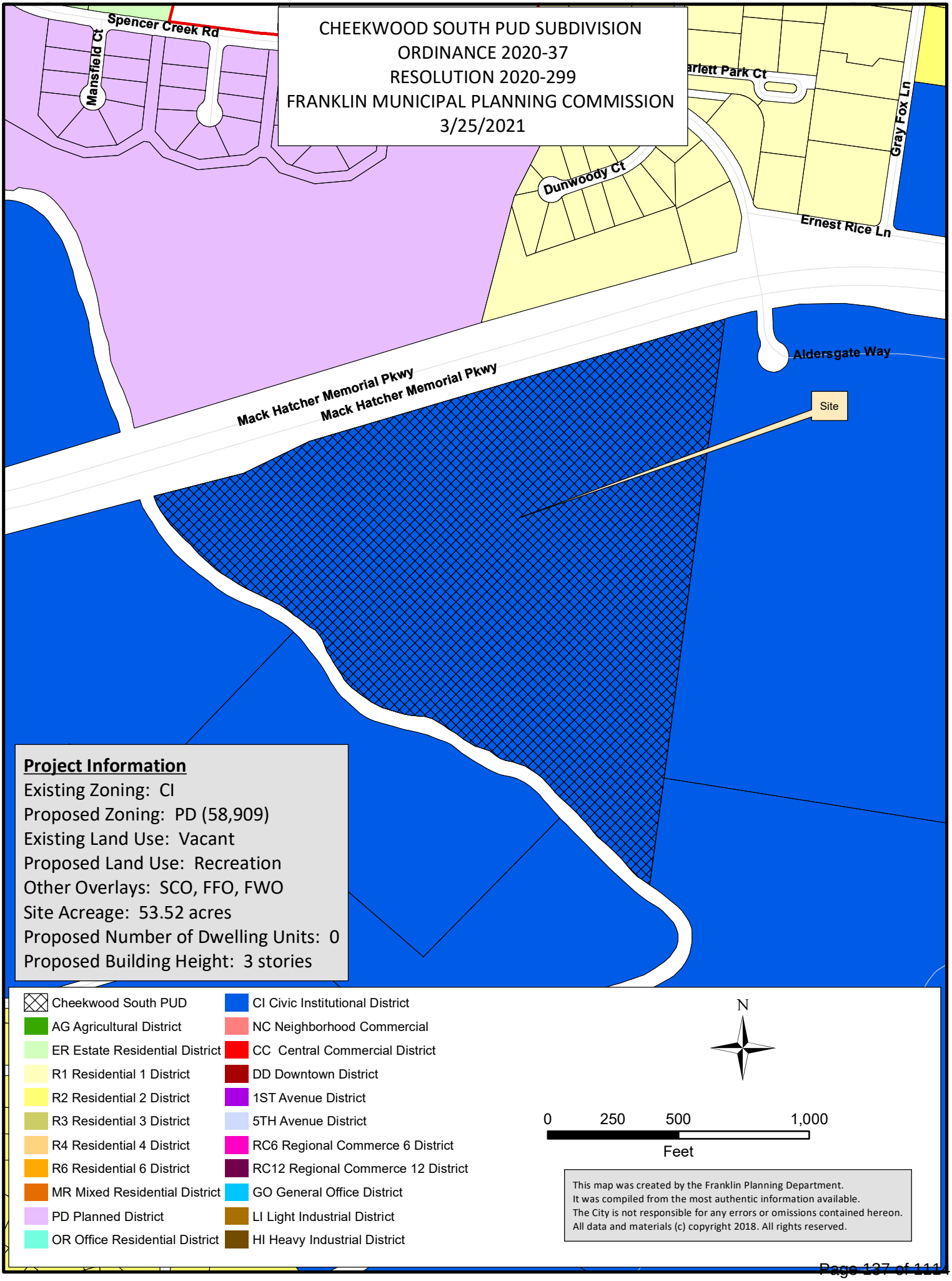
DRAKE A. REEDER
REGISTERED
LANDSCAPE ARCHITECT
03.01.2021
TENNESSEE No. 1210

Revision Date

EXISTING CONDITIONS

SHEET
C1.0

COF # 7415


CHEEKWOOD SOUTH PUD SUBDIVISION
ORDINANCE 2020-37
RESOLUTION 2020-299
FRANKLIN MUNICIPAL PLANNING COMMISSION
3/25/2021
Spencer Creek Rd
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N
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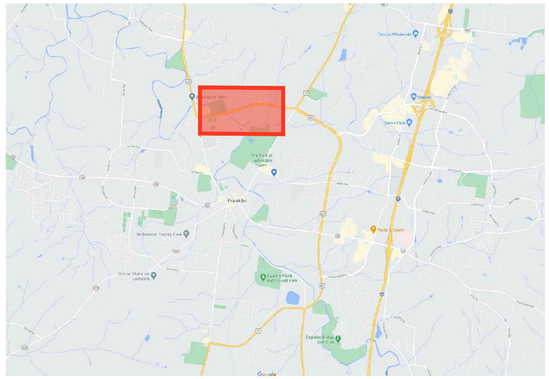

CHEEKWOOD SOUTH PD

REZONING PACKET

PLANNED DISTRICT (0.0 DUA, 58,909 DUA)
FRANKLIN, WILLIAMSON, TENNESSEE

SITE DATA CHART

PROJECT NAME:	CHEEKWOOD SOUTH PD
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APPLICANT & LANDSCAPE ARCHITECT:

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ENGINEER:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
STEVE CASEY
117 SEABOARD LANE
SUITE E-100
FRANKLIN, TN 37067
615-333-7797
scasey@cecinc.com

OWNER:

CHEEKWOOD HOMEOWNERS ASSOC INC
CONTACT:
1152 COLUMBIA AVENUE
FRANKLIN, TN 37064

VICINITY MAP

SHEET INDEX

C0.0	COVER SHEET
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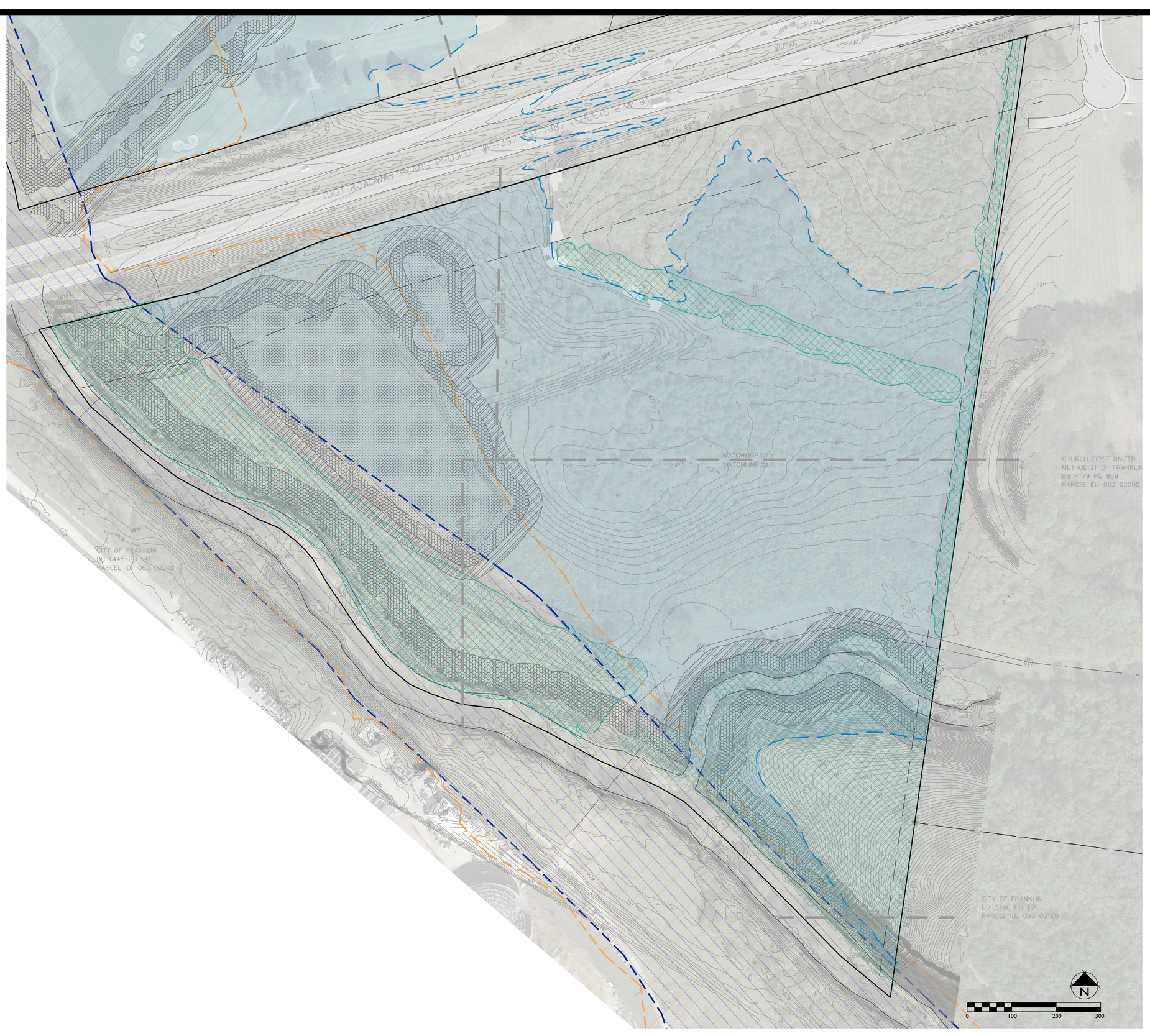
GREGORY C. GAMBLE
REGISTERED
LANDSCAPE ARCHITECT

PRE-APP SUBMITTAL: NOVEMBER 30, 2020

INITIAL SUBMITTAL: DECEMBER 14, 2020

RESUBMITTAL:

GDC
GAMBLE
DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE
greg.gamble@gdc-tn.com



SITE DATA CHART

PROJECT NAME:	CHEEKWOOD SOUTH PD
PROJECT NUMBER:	XXXX
ADDRESS:	MACK HATCHER PKWY FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02101
ACREAGE / SF OF SITE:	53.52 AC
VESTING (IF APPLICABLE):	
BASE ZONING:	CI (CIVIC INSTITUTIONAL)
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KEY - EXISTING CONDITIONS

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- WETLAND
- SLOPES - 14 - 20%
- SLOPES - 20% +

SURVEY INFORMATION PROVIDED BY:
HARRAH & ASSOCIATES
FEBRUARY 2018

GDC
GAMBLE
DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD REZONING PACKET

Franklin, Williamson County, Tennessee

DRAKE A. REEDER
REGISTERED
LANDSCAPE ARCHITECT
03.01.2021
TENNESSEE No. 1210

Revision Date

EXISTING CONDITIONS

SHEET
C1.0

COF # 7415

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01822

DATE: March 24, 2021

TO: Board of Mayor and Aldermen

FROM: Kelly Dannenfelser, Asst. Director of Planning
Amy Diaz-Barriga, Planning Supervisor
Joseph Bryan, Principal Planner

SUBJECT:

Consideration Of Resolution 2020-299, A Resolution Approving A Development Plan For Cheekwood South PUD Subdivision, For The Property Located West Of Aldersgate Way And South Of Mack Hatcher Parkway. Establishing A Public Hearing On May 11, 2021.
FMPC 3/25/21, 8-0

PURPOSE:

PROJECT INFORMATION
COF Project Number: 7416
Applicant: Greg Gamble, GDC
Owner: City of Franklin, TN

BACKGROUND/STAFF COMMENTS:
The applicant has submitted a development plan for the Cheekwood South PUD Subdivision to develop a golf course and driving range. The subject property consists of 53.52 acres and is located South of Mack Hatcher Parkway and West of Aldersgate Way. The property is owned by the City of Franklin and currently vacant. Envision Franklin places this parcel in the Recreation Design Concept. Per Envision Franklin, the Recreation Design Concept supports both private and public recreational opportunities. Envision Franklin states that, " should be interconnected through bike lanes, multi-use paths, and sidewalks." The plan as proposed provides a safe connection to the parcel on the northside of Mack Hatcher and connects with established local trails. In addition to the course itself, the administrative offices, club house, and pro shop for both this development and the Cheekwood North PUD Subdivision are located on the property. The proposed architecture of the site facilities responds to the rural character of the Mack Hatcher corridor and is compatible with existing development in the immediate area.
Any golf balls that are hit into the surrounding jurisdictional features (wetlands, rivers, streams, etc.) shall be considered an illicit discharge followed by Notices of Violation and Civil Penalties per the City of Franklin Stormwater Ordinance, therefore additional information regarding nets for the driving range will be required at the site plan submittal to ensure proper protection of the Harpeth River and surrounding wetlands. There is also a condition of approval to remove the sidewalk currently shown encroaching into a protected wetland.

FINANCIAL IMPACT:

Unknown.

RECOMMENDATION:

Staff recommends that the Board of Mayor and Aldermen approve Resolution 2020-299.

RESOLUTION 2020-299

A RESOLUTION APPROVING A DEVELOPMENT PLAN FOR CHEEKWOOD SOUTH PUD SUBDIVISION, FOR THE PROPERTY LOCATED WEST OF ALDERSGATE WAY AND SOUTH OF MACK HATCHER PARKWAY.

WHEREAS, the Board of Mayor and Aldermen (BOMA) of the City of Franklin, Tennessee, has, or will, approve the zoning for the property as part of Ordinance 2020-37; and

WHEREAS, the Planned Unit Development (PUD) process is a review procedure that is intended to encourage innovative land planning and design and avoid the monotony sometimes associated with large developments by:

(a) Reducing or eliminating the inflexibility that sometimes results from strict application of zoning standards that were designed primarily for individual lots;

(b) Allowing greater freedom in selecting the means to provide access, light, open space, and design amenities;

(c) Encouraging a sensitive design that respects the surrounding established land use character and natural or man-made features of the site including, but not limited to, trees, historic features, streams, hillsides, and floodplains;

(d) Promoting quality design and environmentally sensitive development by allowing development to take advantage of special site characteristics, locations, and land uses; and

(e) Allowing deviations from certain zoning standards that would otherwise apply if not contrary to the general spirit and intent of this ordinance; and

WHEREAS, the PUD process requires the approval of a Development Plan that is reviewed and approved by BOMA, after a public hearing and a recommendation by the Franklin Municipal Planning Commission; and

WHEREAS, in accordance with the provisions of the City of Franklin, Tennessee, Zoning Ordinance, and as required by Tennessee Code Annotated § 13-4-310, as amended, the approval of the Development Plan by the BOMA will initiate a vesting period during which the development standards adopted by the City and in effect on the date of approval shall remain the standards applicable to the approved Development Plan.

NOW THEREFORE, BE IT RESOLVED BY THE BOARD OF MAYOR AND ALDERMEN OF THE CITY OF FRANKLIN, TENNESSEE, AS FOLLOWS:

SECTION I. That the legal description of the property included in the Development Plan is as follows:

PREMISES CONSIDERED

Map-Parcel	Acres
063-21.01	53.52
Total	53.52

SECTION II. That the attached Location Map and Survey shall serve the purpose of further delineating the geographical boundaries as described by this Resolution.

SECTION III. That the overall entitlements for the Cheekwood South PUD are as follows:

Entitlements	Cheekwood South PUD
Base Zone District	PD
Other Zoning Overlays	SCO, CFO, FWO, FFO
Number of Dwelling Units	0
Number of Nonresidential Square Footage	58,909SF
Number of Hotel Rooms	0
Open Space Requirements	5% (2.68 AC)
Number of Phases in Development	1

SECTION IV. That the Development Plan, the exhibits accompanying the Development Plan, and all conditions and restrictions placed upon the Development Plan by the Franklin Municipal Planning Commission and this Board shall be made a part of this Resolution as though copied verbatim herein, and that a permanent record of the Development Plan, the exhibits accompanying the Development Plan, and all such conditions and restrictions shall be kept in the Franklin Planning and Sustainability Department.

SECTION V. That this Resolution shall take effect from and after the passage of Ordinance 2020-37, on third and final reading, the health, safety, and welfare of the citizens requiring it.

_____
Eric S. Stuckey
City Administrator

_____
Dr. Ken Moore
Mayor

Approved as to form by:

_____
Shauna R. Billingsley
City Attorney

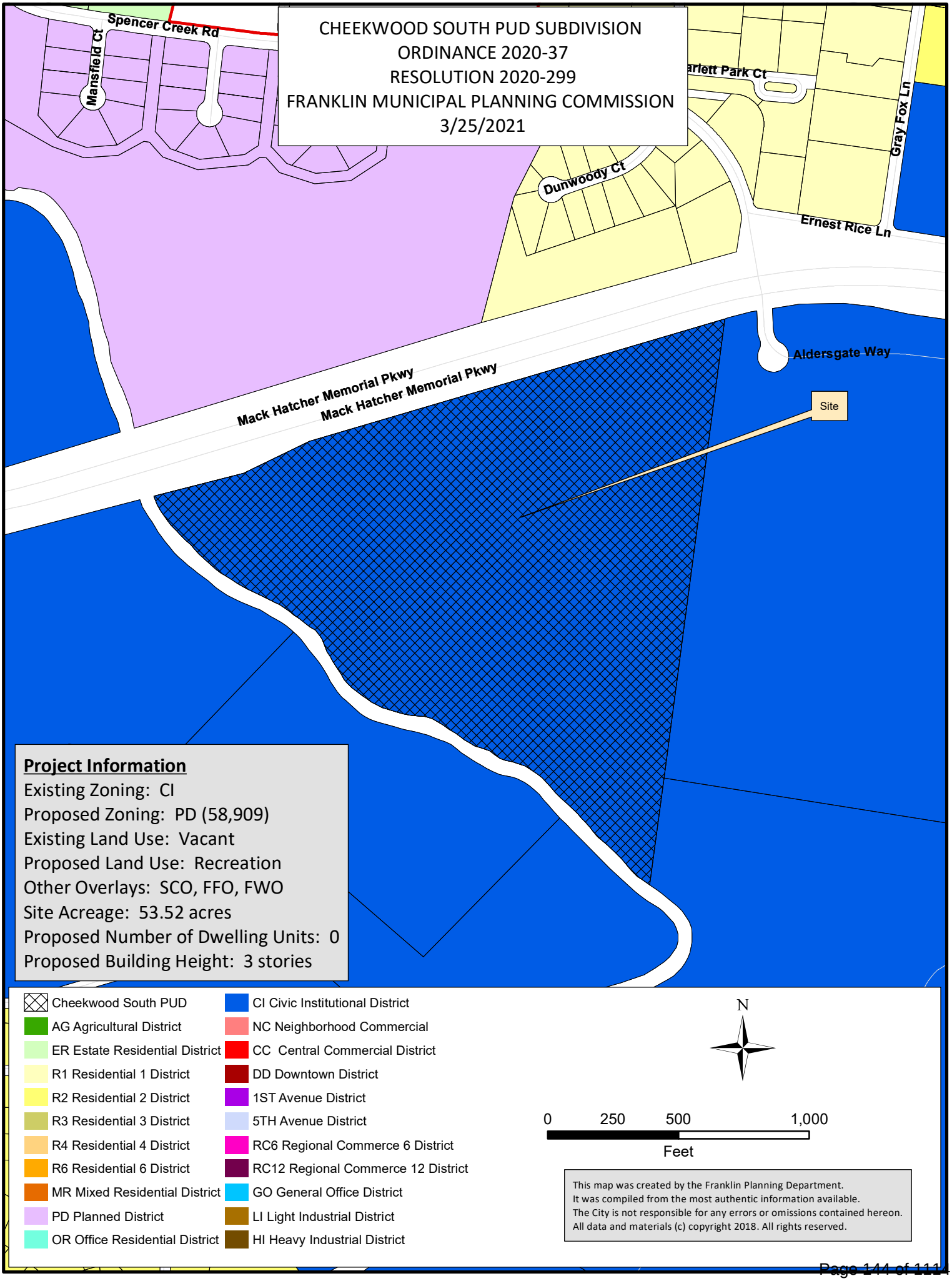
PREAPPLICATION CONFERENCE: _____

BOMA/FMPC JOINT CONCEPTUAL WORKSHOP: _____

NEIGHBORHOOD MEETING: _____

PLANNING COMMISSION RECOMMENDED APPROVAL: _____

PUBLIC HEARING AND BOMA APPROVAL: _____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Existing Zoning: CI
Proposed Zoning: PD (58,909)
Existing Land Use: Vacant
Proposed Land Use: Recreation
Other Overlays: SCO, FFO, FWO
Site Acreage: 53.52 acres
Proposed Number of Dwelling Units: 0
Proposed Building Height: 3 stories
Cheekwood South PUD
AG Agricultural District
ER Estate Residential District
R1 Residential 1 District
R2 Residential 2 District
R3 Residential 3 District
R4 Residential 4 District
R6 Residential 6 District
MR Mixed Residential District
PD Planned District
OR Office Residential District
CI Civic Institutional District
NC Neighborhood Commercial
CC Central Commercial District
DD Downtown District
1ST Avenue District
5TH Avenue District
RC6 Regional Commerce 6 District
RC12 Regional Commerce 12 District
GO General Office District
LI Light Industrial District
HI Heavy Industrial District
N
0 250 500 1,000
Feet
This map was created by the Franklin Planning Department.
It was compiled from the most authentic information available.
The City is not responsible for any errors or omissions contained hereon.
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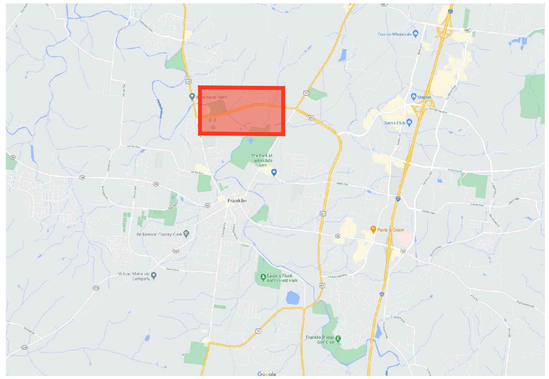


CHEEKWOOD SOUTH PD

REZONING PACKET

PLANNED DISTRICT (0.0 DUA, 58,909 DUA)
FRANKLIN, WILLIAMSON, TENNESSEE

SITE DATA CHART

PROJECT NAME:	CHEEKWOOD SOUTH PD
PROJECT NUMBER:	XXXX
ADDRESS:	MACK HATCHER PKWY FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02101
ACREAGE / SF OF SITE:	53.52 AC
VESTING (IF APPLICABLE):	
BASE ZONING:	CI (CIVIC INSTITUTIONAL)
PROPOSED ZONING:	PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO, CFO
DESIGN CONCEPT(S):	RECREATION, CONSERVATION
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

APPLICANT & LANDSCAPE ARCHITECT:

GAMBLE DESIGN COLLABORATIVE
GREG GAMBLE
324 LIBERTY PIKE
SUITE 145
FRANKLIN, TN 37064
615-975-5765
greg.gamble@gdc-tn.com

ENGINEER:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
STEVE CASEY
117 SEABOARD LANE
SUITE E-100
FRANKLIN, TN 37067
615-333-7797
scasey@cecinc.com

OWNER:

CHEEKWOOD HOMEOWNERS ASSOC INC
CONTACT:
1152 COLUMBIA AVENUE
FRANKLIN, TN 37064

VICINITY MAP

SHEET INDEX

C0.0	COVER SHEET
C1.0	OVERALL EXISTING CONDITIONS
C1.1	EXISTING CONDITIONS ENLARGEMENT
C1.2	EXISTING CONDITIONS ENLARGEMENT
C1.3	EXISTING CONDITIONS ENLARGEMENT

MODIFICATION OF STANDARDS

COMPREHENSIVE REVIEW OF ROADWAY, STORMWATER, AND UTILITY ELEMENTS BY CITY OF FRANKLIN STAFF WILL OCCUR AT THE SITE PLAN STAGE. PROJECT ENTITLEMENTS APPROVED WITH THIS DEVELOPMENT PLAN DO NOT CONSTITUTE APPROVAL OF THE ROADWAY, STORMWATER, AND UTILITY ELEMENTS SHOWN ON THE DEVELOPMENT PLAN. IF, UPON APPLICATION OF CITY OF FRANKLIN STREET, STORMWATER, AND UTILITY STANDARDS AT THE SITE PLAN STAGE, THE APPLICANT CANNOT ACHIEVE THE MAXIMUM APPROVED ENTITLEMENTS, THE APPLICANT SHALL BE CONFINED TO THE ENTITLEMENTS ACHIEVABLE FROM THE APPLICATION OF SAID STANDARDS.

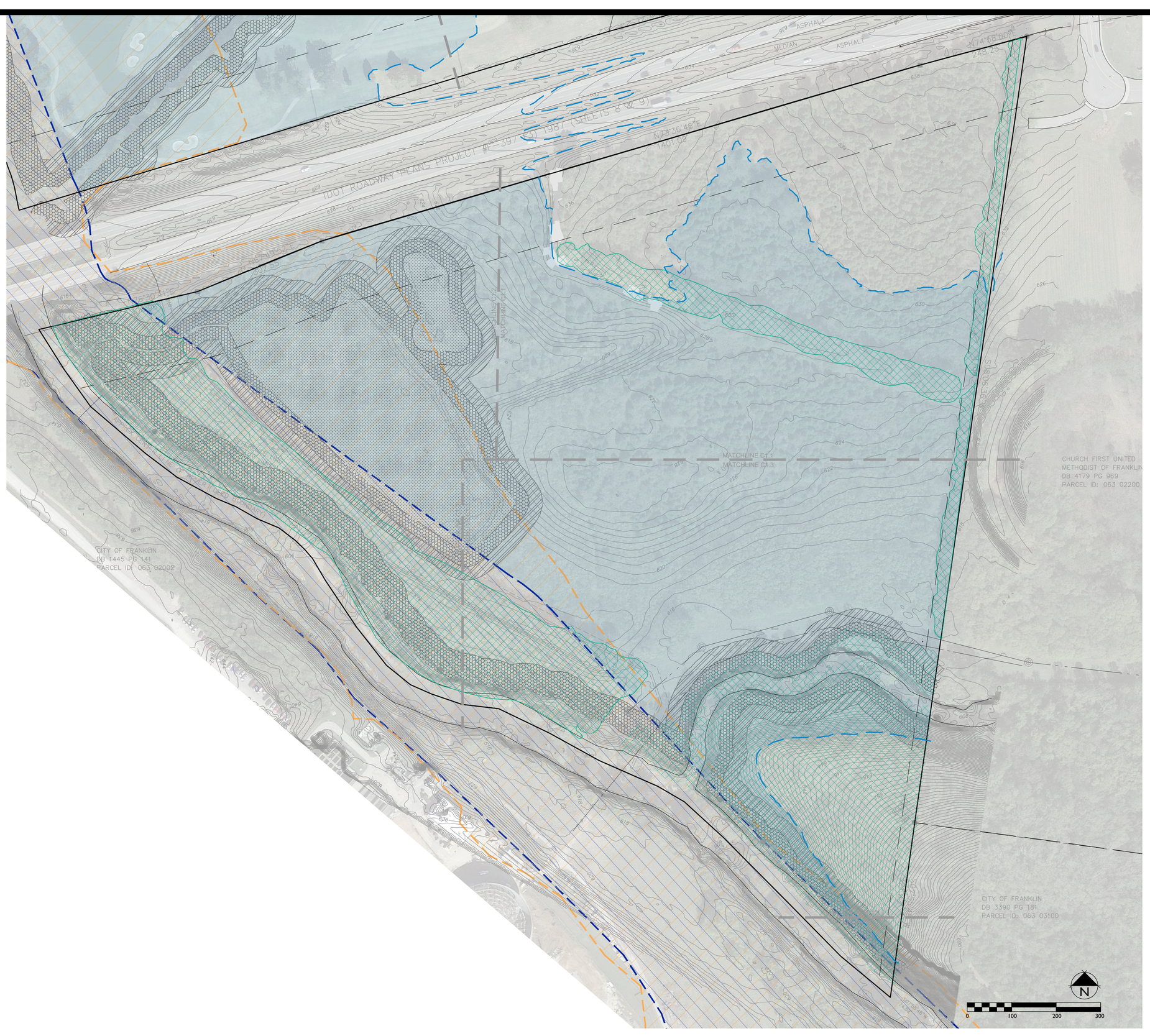
GREGORY C. GAMBLE
REGISTERED
LANDSCAPE ARCHITECT

PRE-APP SUBMITTAL: NOVEMBER 30, 2020

INITIAL SUBMITTAL: DECEMBER 14, 2020

RESUBMITTAL:

GDC
GAMBLE
DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE
greg.gamble@gdc-tn.com



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KEY - EXISTING CONDITIONS

- EXISTING TREE CANOPY
- FWO; PRELIMINARY
- FWO; EFFECTIVE
- FFO
- 30'/60' , ZONE 1 RIPARIAN BUFFER
- 30', ZONE 2 RIPARIAN BUFFER
- WETLAND
- SLOPES - 14 - 20%
- SLOPES - 20% +

SURVEY INFORMATION PROVIDED BY:
HARRAH & ASSOCIATES
FEBRUARY 2018

GDC
GAMBLE
DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND
LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD
REZONING PACKET
Franklin, Williamson County, Tennessee

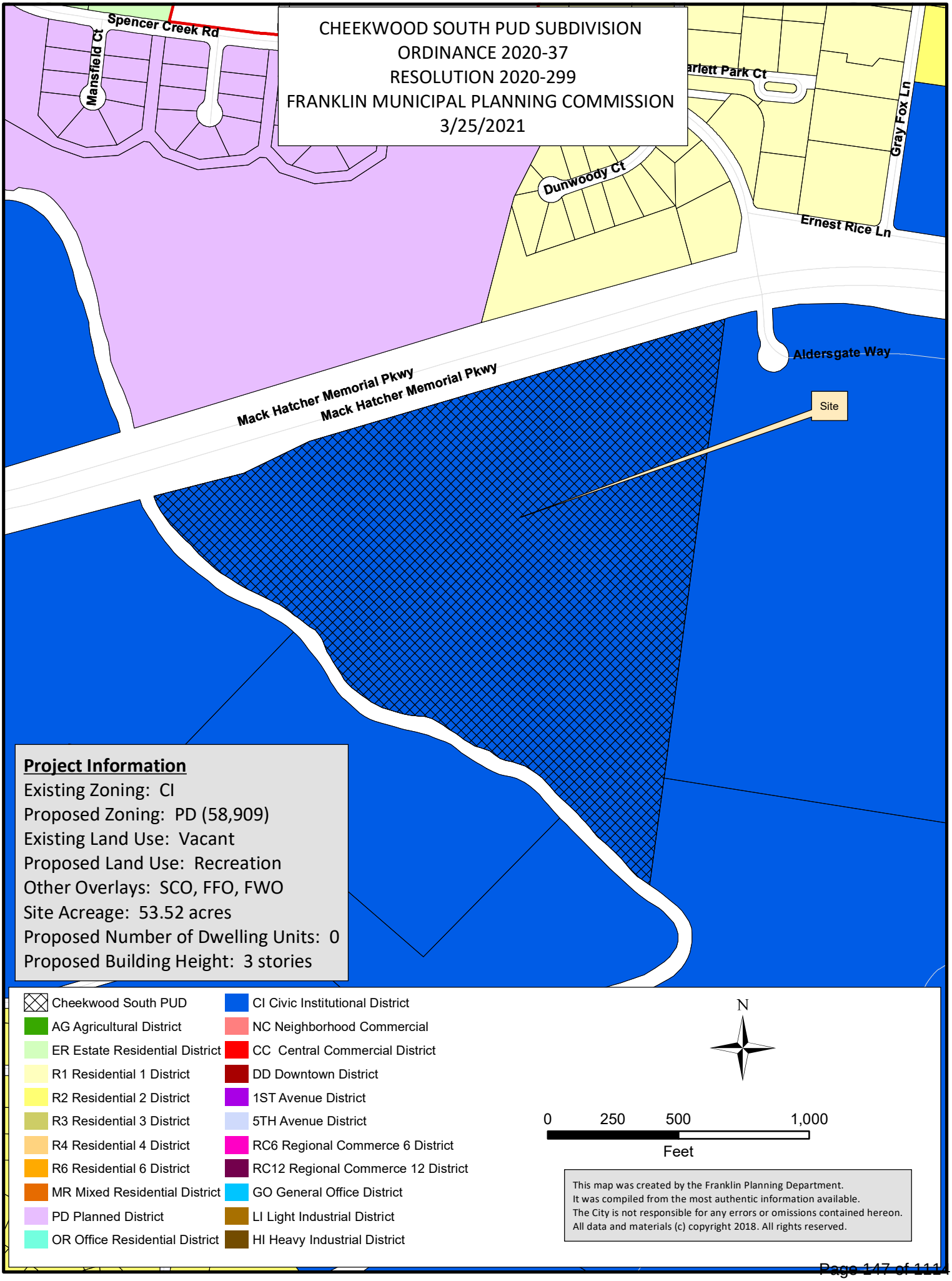
DRAKE A. REEDER
REGISTERED
TENNESSEE No.
LANDSCAPE ARCHITECT
03.01.2018

Revision Date
△
△
△
△

EXISTING
CONDITIONS

SHEET
C1.0

COF # 7415


CHEEKWOOD SOUTH PUD SUBDIVISION
ORDINANCE 2020-37
RESOLUTION 2020-299
FRANKLIN MUNICIPAL PLANNING COMMISSION
3/25/2021
Spencer Creek Rd
Mansfield Ct
Dunwoody Ct
Gray Fox Ln
Ernest Rice Ln
Aldersgate Way
Mack Hatcher Memorial Pkwy
Mack Hatcher Memorial Pkwy
Site
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COF no: 7416

CONDITIONS OF APPROVAL:

Open Issues: 24 These issues are currently being filtered

Engineering - Development Plan Checklist

General Issues

27. Existing Conditions Sheets

joe.marlo@franklintn.gov *Comment not adequately addressed. Requested utilities and easements have not been shown, and elements that had been previously shown/labeled have been removed from the Existing Conditions Plan.*

Applicant shall show and label all existing utilities and associated easements on the Existing Conditions Sheets (C1.xx).

42. Floodway Lines

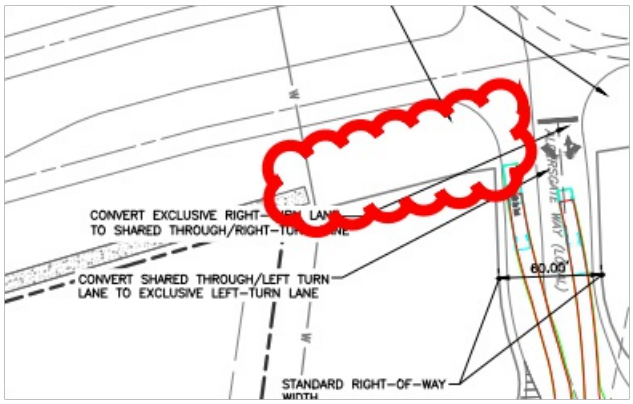
joe.marlo@franklintn.gov *Floodway (FWO) lines corrected, however the floodplain (FFO) lines shown on the previous Development Plan sheets appear to have been removed.*

Applicant shall show and label the FFO lines on the Development Plan Sheets (C2.xx).

44. Multi-Use Path

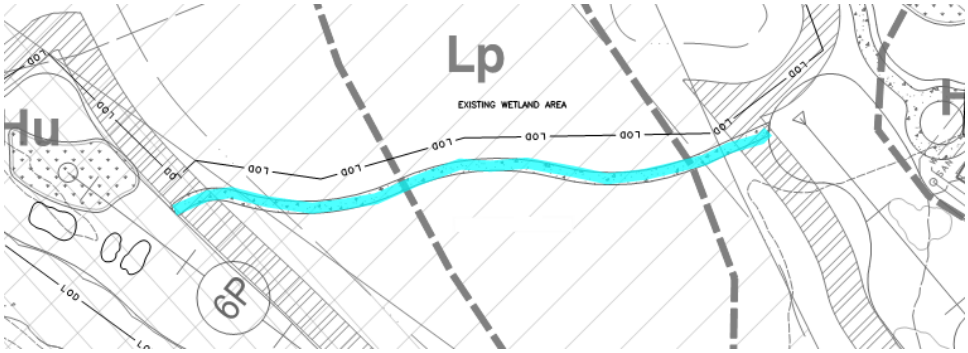
joe.marlo@franklintn.gov *Issue re-opened as connection has been removed in the most recent submittal.*

Applicant shall show the multi-use path extended to the east to Aldersgate Way. This path will tie into any pedestrian improvements at the Aldersgate Way / Mack Hatcher intersection.



62. F. Development Plan

lance.fittro@franklintn.gov Applicant shall remove the proposed sidewalk shown crossing the protected wetland area which has been added with this submittal. There shall be no sidewalks, trails or boardwalks crossing the protected wetland.



64. Golf Ball Netting

jimmy.wiseman@franklintn.gov The applicant shall provide netting within any flight path of golf balls from any part of the property. The height and material of the nets shall be identified on the site plan. Any golf balls that are hit into the surrounding jurisdictional features (wetlands, rivers, streams, etc.) shall be considered an illicit discharge followed by Notices of Violation and Civil Penalties per the City of Franklin Stormwater Ordinance.

FIRE--Planning

General Issues

1. Auto-Turn

curt.edelmann@franklintn.gov The auto-turn drawing still shows the truck driving over curbs in a number of spots. The truck still hits parked cars. For clarity, please remove the utilities and easement lines from the auto-turn drawing.

[Edited By Curt Edelmann]

2. Fire Protection

curt.edelmann@franklintn.gov Please expand the information on the drawing to show the available GPM at 20-psi.

48. Hose lay distance

curt.edelmann@franklintn.gov	All points on the perimeter of a building must be within 150-feet of a parked fire truck. The applicant must provide access before the fire department will permit this plan to move forward. Note that the fire department will consider extending the 150-foot limit if the building is of Type I or Type II construction. [Edited By Curt Edelmann]

Planning

General Issues

38. Setbacks

joseph.bryan@franklintn.gov	Applicant shall include the minimum building setbacks in the site data chart.

47. Project number

joseph.bryan@franklintn.gov	Applicant shall update the project number in the site data chart.

60. Building labels

joseph.bryan@franklintn.gov	Applicant shall revise building labels on architecture sheet to reflect the development plan sheet. Specifically, revise "event center" to "club house."

Preservation/HZC

General Issues

50. Historic Preservation Edge Treatment

amanda.rose@franklintn.gov	Continuation of previous comment: Applicant shall indicate the required 30' farm field boundary on all design sheets. Applicant shall determine the average existing width of existing vegetation along the proposed farm field boundary and note on Tree Preservation Plan sheet. Applicant may include information on how the proposed boundary will be supplemented to meet the standard set forth in 18.4.3 (E) and specifications for proposed fencing, as required, within site plan.

Stormwater

General Issues

54. Riparian Buffer

jeff.willoughby@franklintn.gov	1. Provide consultants ESA report which includes water resource evaluations. Ensure what is shown is consistent with the features determined and delineated. 2. If enhancement details are not to be shown state that buffer enhancement per FMC 23-207, further details and specific areas related to the mitigation efforts shall be shown in the future site plan submittals 3. State that a future variance submittal may be required with site plan submittals. 4. Show any utilities located within riparian buffers 5. The green hatching is not reflected in the legend. If this is not related to the buffer management plan please remove it. 6. Zones shall be labeled in the following format, "Width, Riparian Buffer, Zone designation" for example "60' Riparian Buffer Zone 1". Differentiate between the zone 1 30' and 60' on the plan sheets 7. LOD is shown going through the wetland and encompasses quite a large area and is not shown on the other side of the bridge. Why is this set soo large? 8. The pedestrian bridge shall be allowed but shall be included in the overall encroachment. Details for the bridge shall be provided before final approval will be granted. [Edited By Jeff Willoughby]

59. Water Quality

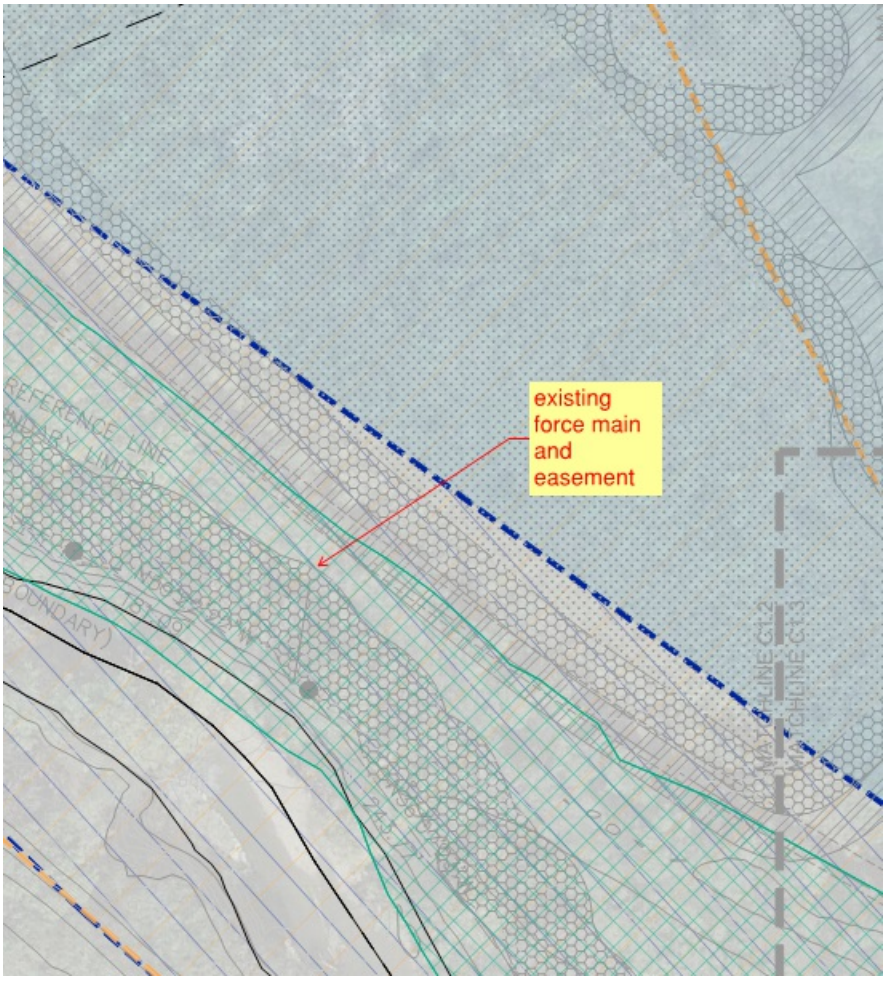
Doug.Noonan@franklintn.gov	LOD shall be removed from all wetland features and buffers unless the disturbance is approved in the stormwater variance. [Edited By Doug Noonan]

Water/Sewer

General Issues

6. Existing utilites

ben.mcneil@franklintn.gov The applicant failed to add the existing force main to existing condition sheets. The force main shall be shown on each sheet that encompasses the easement and line. Grading, buffer mitigation etc. All sizes and labels shall be provided for clarity.



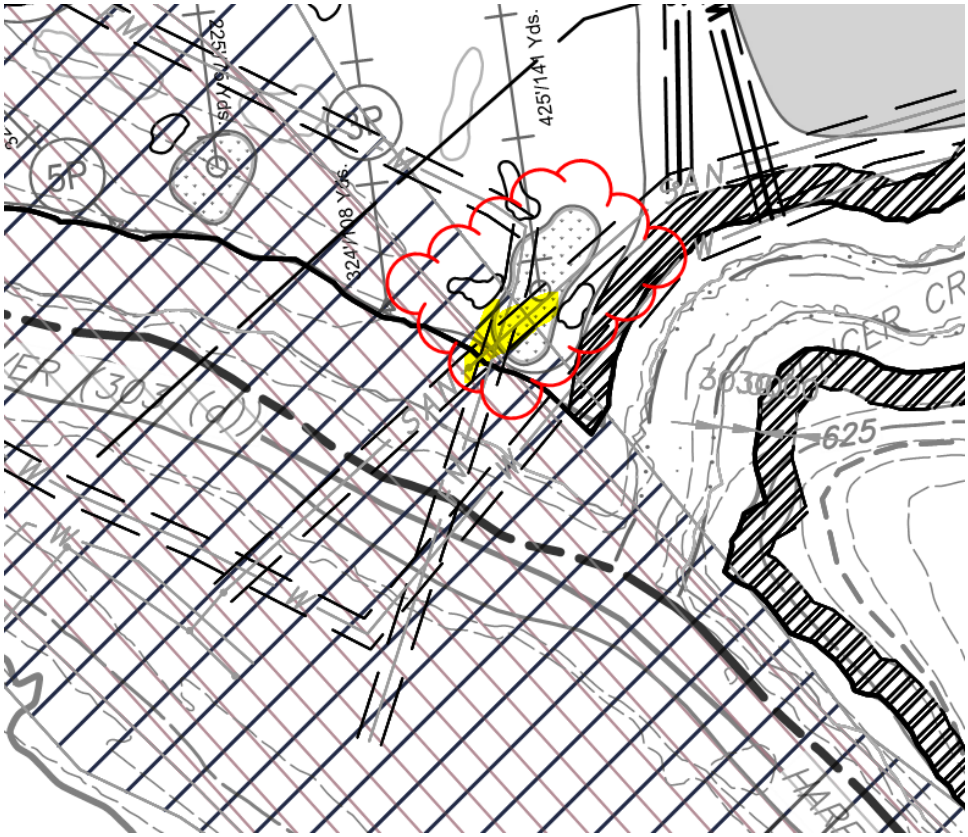
[Edited By Ben McNeil]

7. Sanitary sewer

ben.mcneil@franklintn.gov	Franklin water management is currently designing the upsize and reconstruction of the main trunk sewer interceptor crossing the proposed south east side of the development. This will be phase 2 of a 3 phase project. It is expected to start within the next 2 years as phase 2 is already began and in construction. The applicant shall be aware that the construction project is a major project that is required and very well may come into the time line of the Golf course creation. Franklin Water Management will not be responsible for any additions created during the proposed development plan. The above ground features will be the responsibility of the development to replace. The applicant may contact Ben McNeil with Questions on the timing and progression of this project.

8. Existing utility locations

ben.mcneil@franklintn.gov	The applicant is still showing the green and possible sand traps over the existing 36" line. The manhole shown below is the most likely manhole to overflow in a significant rain event, it is advised that the proposed features be relocated as this would not be good and cleanups do require large vehicles and crews. The greens would be damaged and sand traps littered with debris. Overflows do not happen often, but this is the spot where the overflows would occur. The additional plant capacity would reduce the possibilities of this, but the applicant shall consider this with the design. The applicant shall be aware that the proposed golf course shall be designed around the existing utility features that exist on the property. No greens, sand traps or other constructed items may be placed over the existing utilities. Any proposed features over existing utility lines shall be approved by Franklin Water Management.



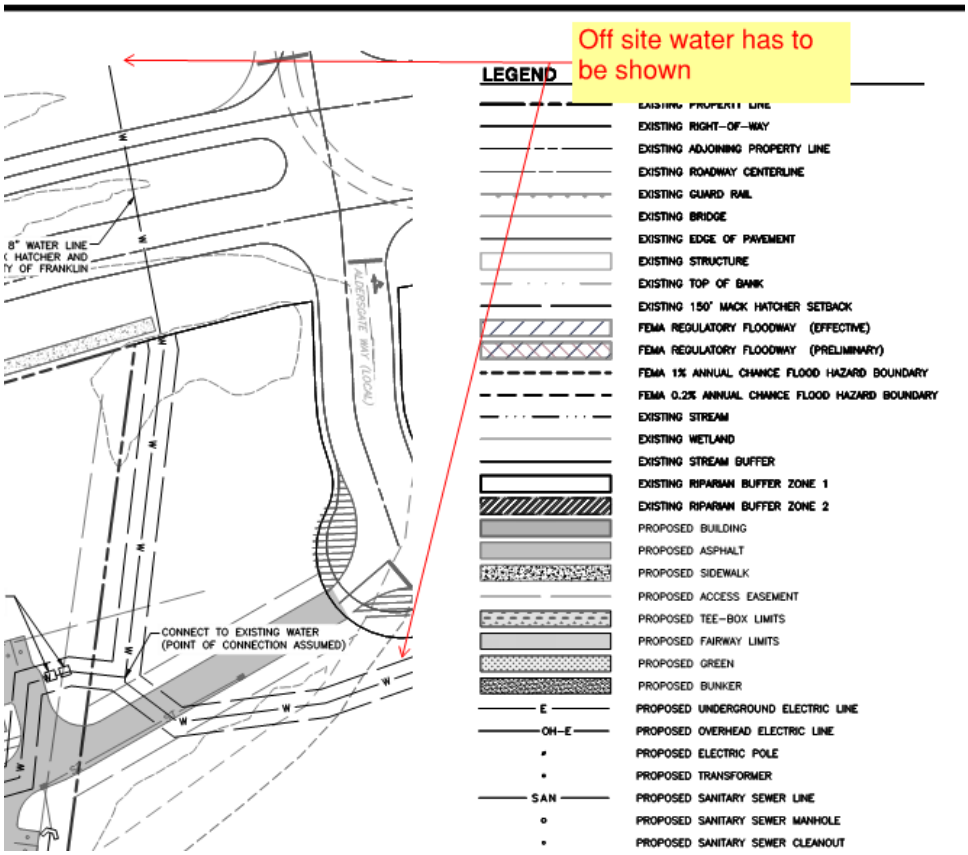
[Edited By Ben McNeil]

9. Sewer availability

ben.mcneil@franklintn.gov	The sanitary sewer and water availability for this development is currently under review.

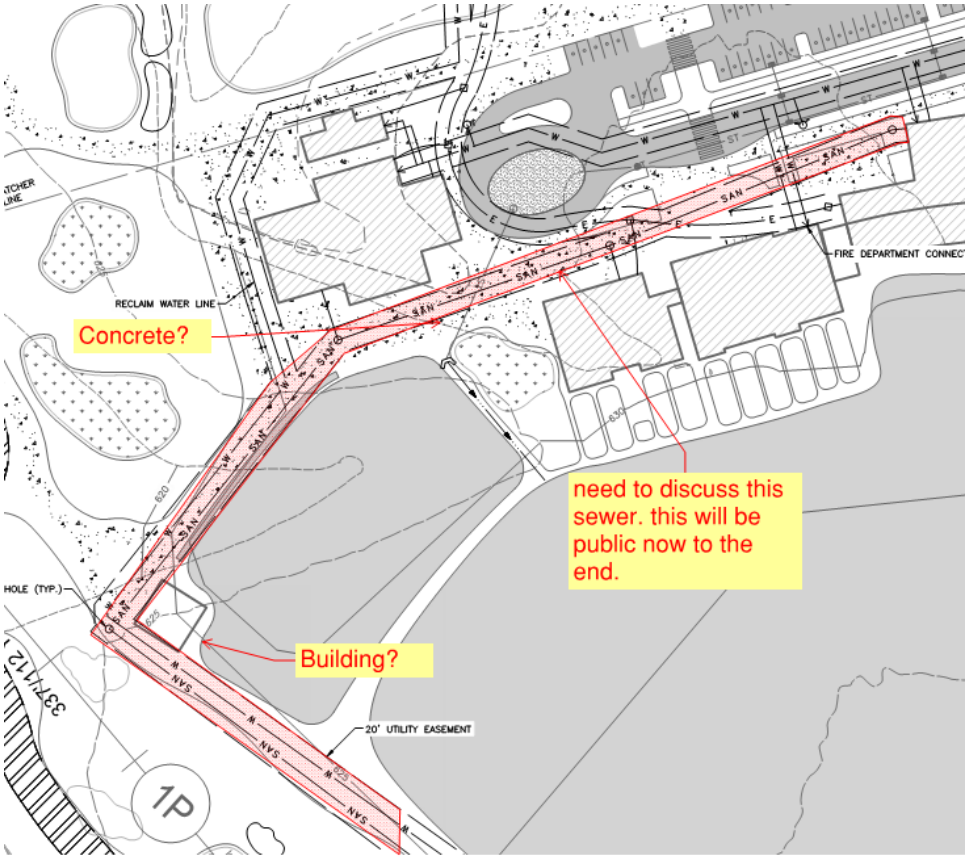
10. Water

ben.mcneil@franklintn.gov The applicant has shown the off site water on the overall utility plan, but the enlarged views must be provided to ensure the route and layout is acceptable.



11. Sanitary sewer

ben.mcneil@franklintn.gov The revised sanitary sewer layout shall be discussed. The additional buildings will require the sanitary sewer to be public and it appears to be under concrete. The layout must be discussed.



12. Reclaim Water

ben.mcneil@franklintn.gov The applicant has added a reclaim water line to the proposed plan, the reclaim is lengthy and appears to be public to cross Mack Hatcher. The reclaim will need to be discussed to minimize the length and location. Also, sharp bends would not be permitted and would cause significant friction loss.

51. Meeting Required prior to re-submittal

ben.mcneil@franklintn.gov An additional meeting shall be held to discuss the sewer and reclaim water. The layout as shown **will not** be accepted by Franklin Water Management due to the amount of infrastructure shown to serve the buildings. **The sanitary sewer, reclaim water and domestic water layout must be revised and approved by Franklin Water prior to submitting to the One Stop review.**

The applicant shall meet with Franklin Water Management prior to submitting to One Stop to revise the alignments and meet all requirements for utility service.

Zoning

General Issues

32. Floodway

shanna.mccoy@franklintn.gov	comment remain open Encroachments are prohibited, including earthen fill material, new construction, substantial improvements or other development within the regulatory floodway. Development may be permitted; however, provided it is demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practices that the cumulative effect of the proposed encroachments or new development shall not result in any increase in the water surface elevation of the base flood elevation, velocities, or floodway widths during the occurrence of a base flood discharge at any point within the community. A Tennessee registered professional engineer must provide supporting technical data, using the same methodologies as in the effective Flood Insurance Study for the City and certification, thereof;

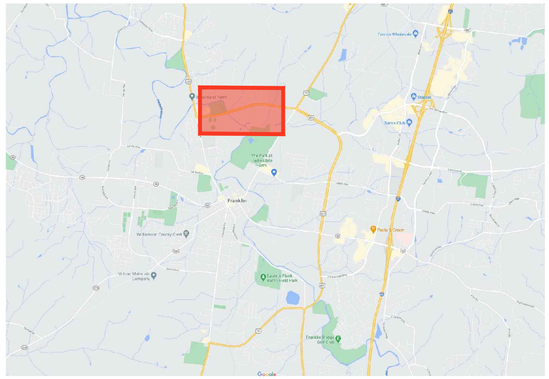
33. FFO

shanna.mccoy@franklintn.gov	Comment to remain open. No portion of a buildable lot shall contain FFO.

CHEEKWOOD SOUTH PD

DEVELOPMENT PLAN

PLANNED DISTRICT (0.0 DUA, 58,909)
FRANKLIN, WILLIAMSON, TENNESSEE



VICINITY MAP

APPLICANT & LANDSCAPE ARCHITECT:

GAMBLE DESIGN COLLABORATIVE
GREG GAMBLE
324 LIBERTY PIKE
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OWNER:

CITY OF FRANKLIN
PO BOX 305
FRANKLIN, TN 37065

JESTER GOLF
GOLF DESIGN AND MASTER PLANNING

NICKLAUS DESIGN

GDC
gamble design collaborative

CEC
Civil & Environmental Consultants, Inc.

STATEMENT OF IMPACTS

WATER FACILITIES
WATER SERVICE WILL BE PROVIDED BY . THE WATER MAINS ARE LOCATED ALONG .
250 GPD = GPD

SEWER FACILITIES
SEWER SERVICE WILL BE PROVIDED BY THE CITY OF FRANKLIN.

REPURIFIED (REUSE) WATER FACILITIES
AVAILABLE. SEE UTILITY SHEETS.

POLICE, FIRE, AND RECREATIONAL FACILITIES
NEAREST POLICE STATION: HEADQUARTERS (3.11 MILES)
NEAREST FIRE STATION: FIRE STATION #4 (1.7 MILES)
NEAREST RECREATIONAL FACILITY: WILLIAMSON COUNTY RECREATION CENTER (1.7 MILES)

PROJECTED STUDENT POPULATION
0 x 0.33 = 0 STUDENTS

REFUSE STORAGE AND SANITATION COLLECTION FACILITIES
REFUSE COLLECTION FOR THE DEVELOPMENT SHALL BE PROVIDED BY CITY OF FRANKLIN

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BUILDING TYPES APPLIED:	COMMERCIAL/MIXED-USE
FRONTAGE TYPES APPLIED:	LANDSCAPE FRONTAGE
LOT WIDTH (RESIDENTIAL):	N/A
LOT SIZE (RESIDENTIAL):	N/A
SETBACKS:	150' SCENIC CORRIDOR OVERLAY 30' HISTORIC FARM HELD BUFFER
DWELLING UNIT COUNT (BY TYPE):	
SINGLE FAMILY:	N/A
MULTIFAMILY:	N/A
NONRESIDENTIAL SF (BY USE):	
DRIVING RANGE BUILDING:	30,496 SF
GOLF SHOP:	6,900 SF
STARTER HOUSE:	100 SF
CLUBHOUSE:	21,413 SF
HOTEL KEYS:	N/A
BUILDING HEIGHT:	MAX 3 STORIES
MINIMUM LSA:	20%
OPEN SPACE REQUIRED:	5% (2.68 AC)
NATURAL AREA REQUIRED:	10% (NOT REQUIRED)
TREE CANOPY RETENTION ACREAGE:	REQUIRED: 3.68 AC (24% OF TOTAL SITE) PROVIDED: 11.63 AC (75.8% OF TOTAL CANOPY)
PARKING REQUIRED (BY USE):	SEE ATTACHED PARKING STUDY
PARKING PROVIDED (BY USE):	SEE ATTACHED PARKING STUDY
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

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C2.2	ENLARGED DEVELOPMENT PLAN
C2.3	ENLARGED DEVELOPMENT PLAN
C3.0	OVERALL GRADING AND DRAINAGE PLAN
C3.1	GRADING AND DRAINAGE PLAN
C3.2	GRADING AND DRAINAGE PLAN
C3.3	GRADING AND DRAINAGE PLAN
C4.0	OVERALL ROW AND ACCESS PLAN
C4.1	ENLARGED ROW AND ACCESS PLAN
C5.0	OVERALL UTILITY PLAN
C5.1	ENLARGED UTILITY PLAN
C5.2	ENLARGED UTILITY PLAN
L1.0	TREE PRESERVATION
L2.0	STREAM BUFFER MITIGATION
A1.0	ARCHITECTURE
A2.0	ARCHITECTURE

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DRAKE A. REEDER
REGISTERED
TENNESSEE NO. 3001
LANDSCAPE ARCHITECT
05.04.2021

PRE-APP SUBMITTAL: NOVEMBER 30, 2020

INITIAL SUBMITTAL: DECEMBER 14, 2020

RESUBMITTAL: MARCH 04, 2021

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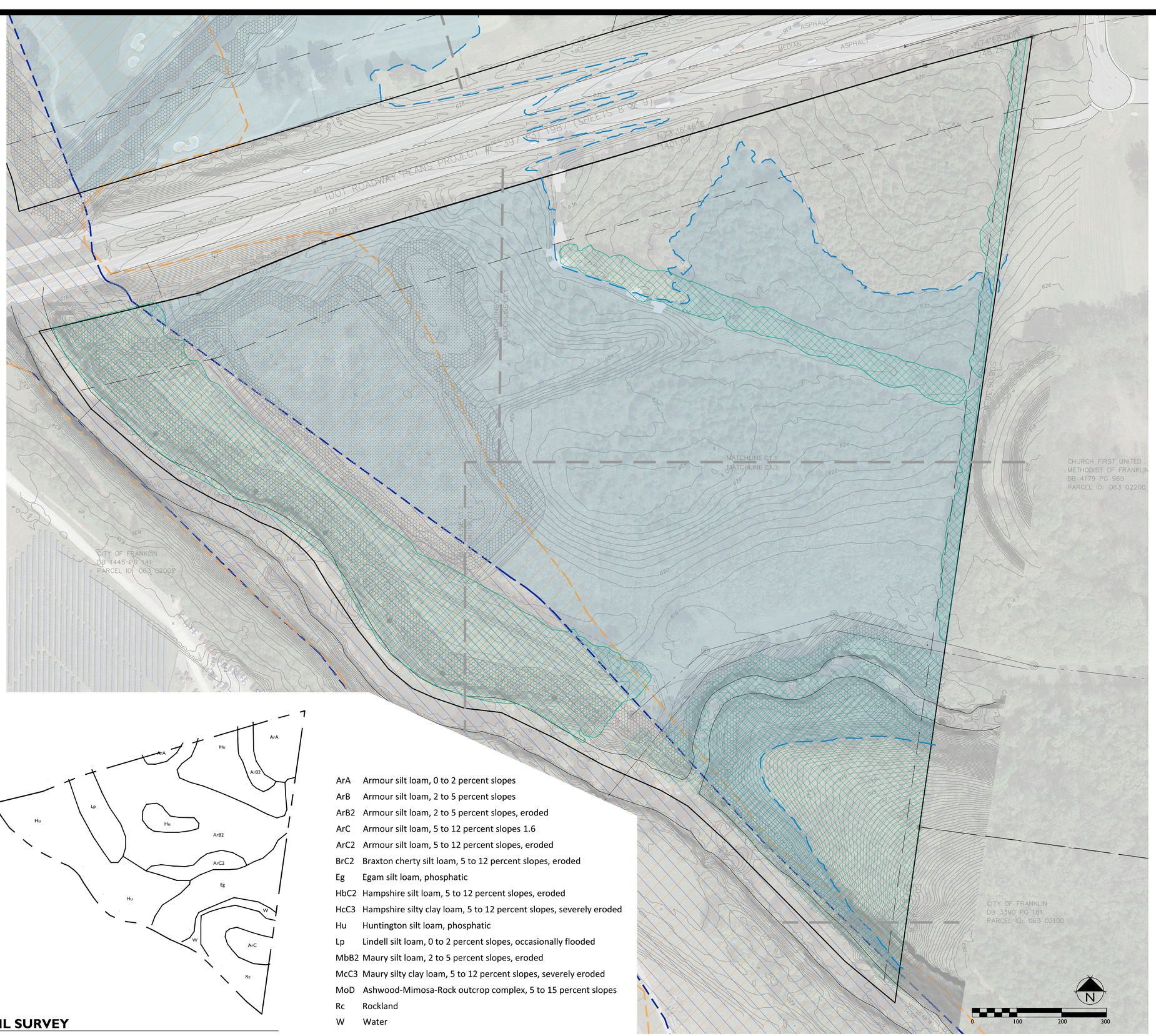

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BUILDING HEIGHT:	MAX 3 STORIES
MINIMUM LSA:	20%
OPEN SPACE REQUIRED:	5% (2.68 AC)
NATURAL AREA REQUIRED:	10% (NOT REQUIRED)
TREE CANOPY RETENTION ACREAGE:	REQUIRED: 3.68 AC (24% OF TOTAL SITE) PROVIDED: 11.63 AC (75.8% OF TOTAL CANOPY)
PARKING REQUIRED (BY USE):	SEE ATTACHED PARKING STUDY
PARKING PROVIDED (BY USE):	SEE ATTACHED PARKING STUDY
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

KEY - EXISTING CONDITIONS

- EXISTING TREE CANOPY
- FWO; PRELIMINARY
- FWO; EFFECTIVE
- FFO
- 30'/60' , ZONE 1 RIPARIAN BUFFER
- 30', ZONE 2 RIPARIAN BUFFER
- WETLAND
- SLOPES - 14 - 20%
- SLOPES - 20% +

SOIL SURVEY

ArA	Armour silt loam, 0 to 2 percent slopes
ArB	Armour silt loam, 2 to 5 percent slopes
ArB2	Armour silt loam, 2 to 5 percent slopes, eroded
ArC	Armour silt loam, 5 to 12 percent slopes 1.6
ArC2	Armour silt loam, 5 to 12 percent slopes, eroded
BrC2	Braxton cherty silt loam, 5 to 12 percent slopes, eroded
Eg	Egam silt loam, phosphatic
HbC2	Hampshire silt loam, 5 to 12 percent slopes, eroded
HcC3	Hampshire silty clay loam, 5 to 12 percent slopes, severely eroded
Hu	Huntington silt loam, phosphatic
Lp	Lindell silt loam, 0 to 2 percent slopes, occasionally flooded
MbB2	Maury silt loam, 2 to 5 percent slopes, eroded
McC3	Maury silty clay loam, 5 to 12 percent slopes, severely eroded
MoD	Ashwood-Mimosa-Rock outcrop complex, 5 to 15 percent slopes
Rc	Rockland
W	Water

SURVEY INFORMATION PROVIDED BY:
HARRAH & ASSOCIATES
FEBRUARY 2018

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GAMBLE
DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

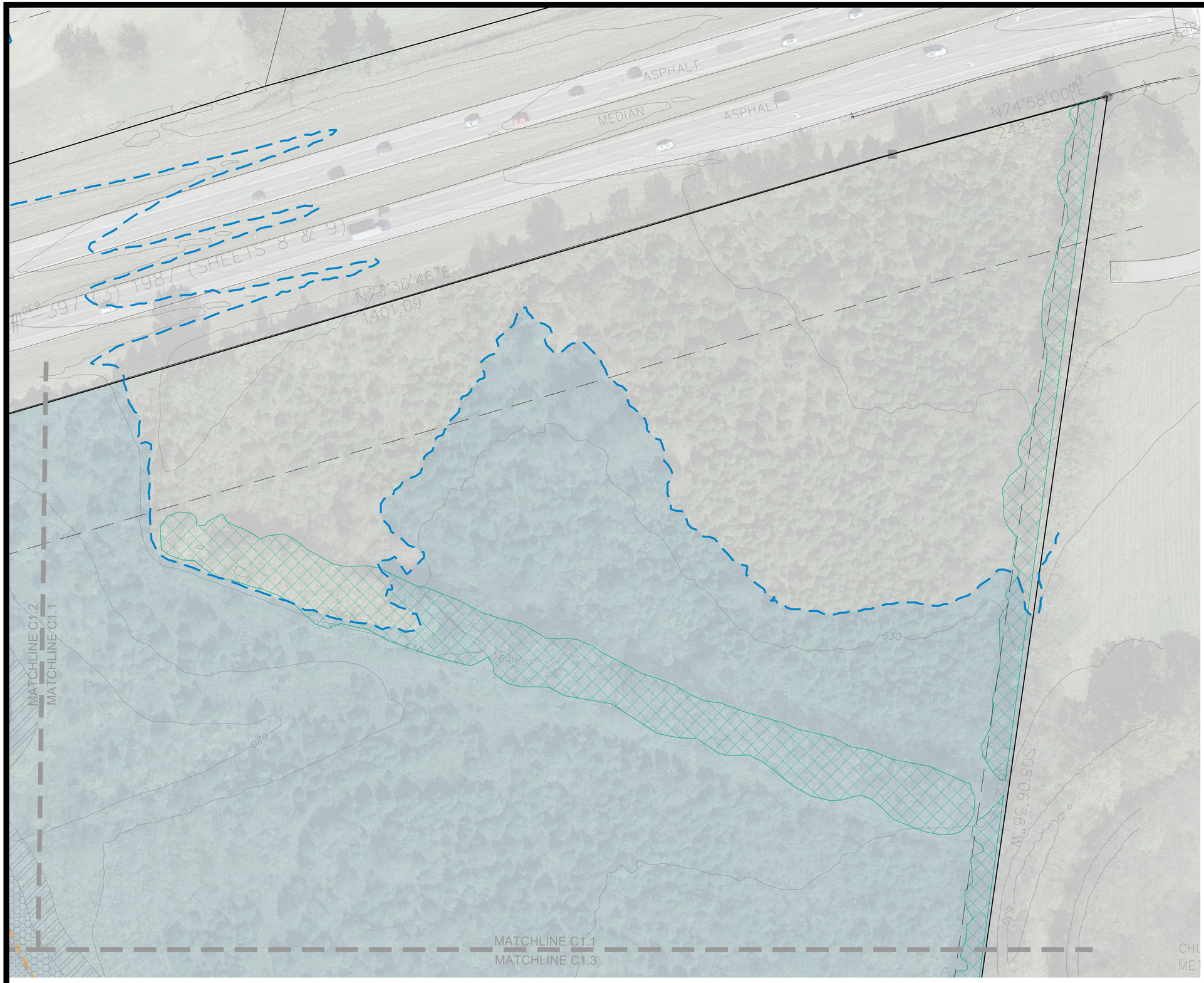
DRAKE A. REEDER
REGISTERED
COMMERCE
TENNESSEE No. 12405
LANDSCAPE ARCHITECT
03.01.2021

Revision Date

EXISTING CONDITIONS

SHEET
C1.0

COF # 7416



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DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND
LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

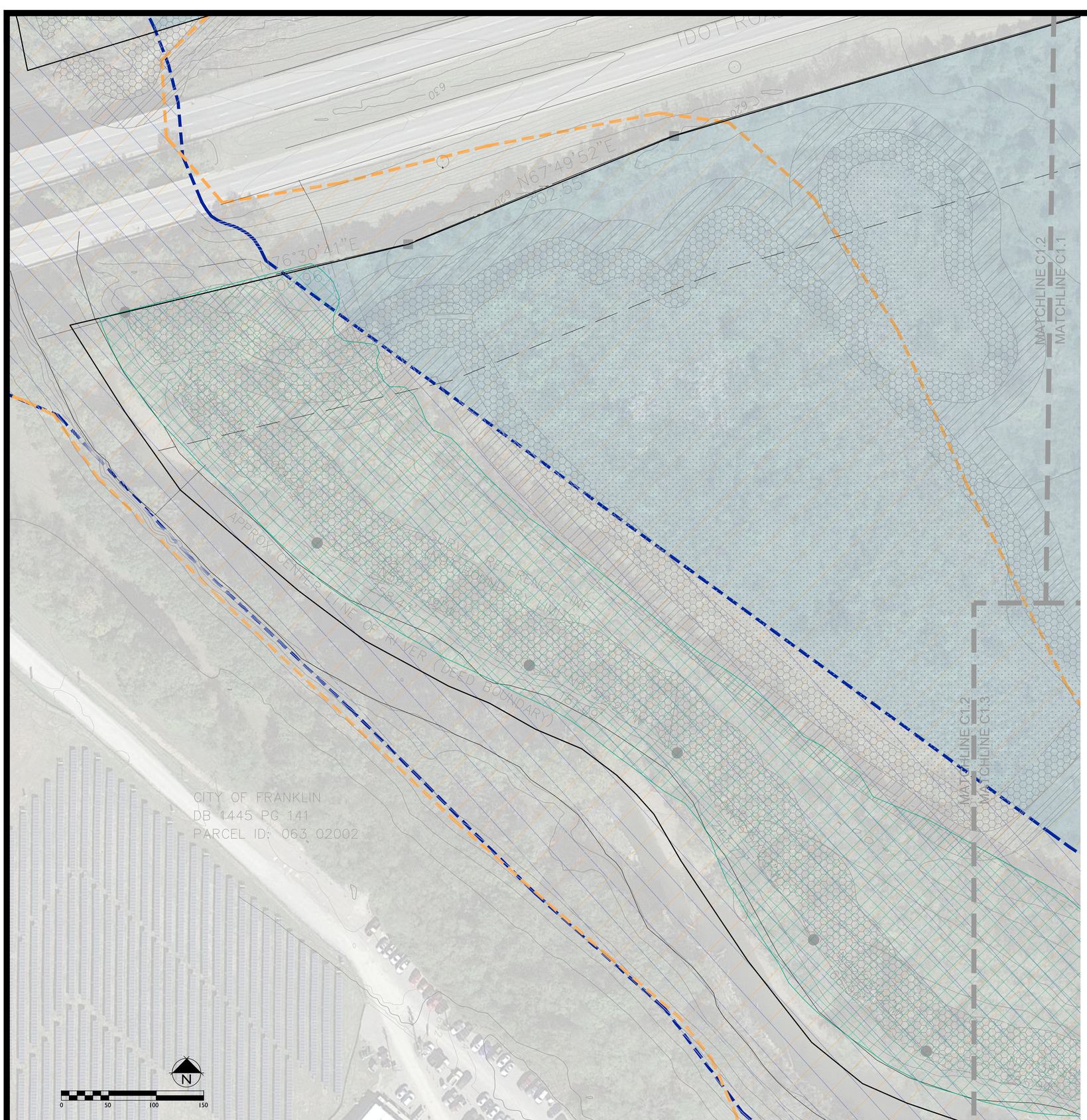
DRAKE A. REEDER
REGISTERED
COMMERCE
TENNESSEE No. 12[illegible]
LANDSCAPE ARCHITECT
03.01.2021

Revision Date

EXISTING CONDITIONS ENLARGEMENT SHEET

C1.1

COF # 7416



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GDC
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DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND
LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

DRAKE A. REEDER
REGISTERED
03.04.2021
TENNESSEE No. 1200
LANDSCAPE ARCHITECT

Revision Date

EXISTING CONDITIONS ENLARGEMENT SHEET

C1.2

COF # 7416

MATCHLINE C1.1
MATCHLINE C1.3

MATCHLINE C1.2
MATCHLINE C1.3

620

MATCHLINE C1.3
MATCHLINE C1.3

KEY - EXISTING CONDITIONS

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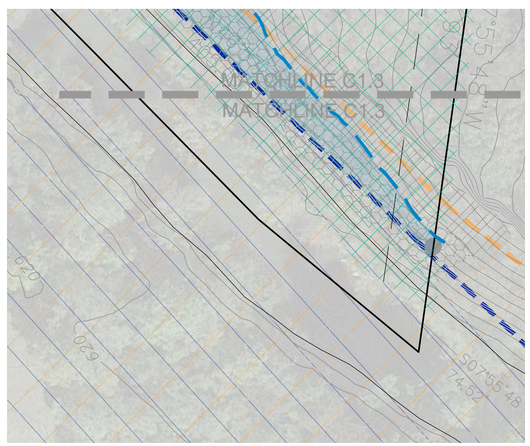

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GAMBLE
DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND
LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD
DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

DRAKE A. REEDER
REGISTERED
TENNESSEE No. 1114
LANDSCAPE ARCHITECT
13.01.22

Revision Date

EXISTING
CONDITIONS
ENLARGEMENT
SHEET
C1.3

COF # 7416

SITE DATA CHART

PROJECT NAME:	CHEEKWOOD SOUTH PD
PROJECT NUMBER:	XXXX
ADDRESS:	MACK HATCHER PKWY FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02101
ACREAGE / SF OF SITE:	53.52 AC
VESTING (IF APPLICABLE):	
BASE ZONING:	CI (CIVIC INSTITUTIONAL)
PROPOSED ZONING:	PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO, CFO
BUILDING TYPES APPLIED:	COMMERCIAL/MIXED-USE
FRONTAGE TYPES APPLIED:	LANDSCAPE FRONTAGE
LOT WIDTH (RESIDENTIAL):	N/A
LOT SIZE (RESIDENTIAL):	N/A
SETBACKS:	150' SCENIC CORRIDOR OVERLAY 30' HISTORIC FARM FIELD BUFFER
DWELLING UNIT COUNT (BY TYPE):	
SINGLE FAMILY:	N/A
MULTIFAMILY:	N/A
NONRESIDENTIAL SF (BY USE):	
DRIVING RANGE BUILDING:	30,496 SF
GOLF SHOP:	6,900 SF
STARTER HOUSE:	100 SF
CLUBHOUSE:	21,413 SF
HOTEL KEYS:	N/A
BUILDING HEIGHT:	MAX 3 STORIES
MINIMUM LSA:	20%
OPEN SPACE REQUIRED:	5% (2.68 AC)
NATURAL AREA REQUIRED:	10% (NOT REQUIRED)
TREE CANOPY RETENTION ACREAGE:	REQUIRED: 3.68 AC (24% OF TOTAL SITE) PROVIDED: 11.63 AC (75.8% OF TOTAL CANOPY)
PARKING REQUIRED (BY USE):	SEE ATTACHED PARKING STUDY
PARKING PROVIDED (BY USE):	SEE ATTACHED PARKING STUDY
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

KEY - DEVELOPMENT PLAN

- PRESERVED TREE CANOPY
- FWO; EFFECTIVE
- FWO; PRELIMINARY
- FFO
- 30'/60' , ZONE 1 RIPARIAN BUFFER
- 30', ZONE 2 RIPARIAN BUFFER
- WETLAND

TREE CANOPY RETENTION

OVERALL SITE AREA = 2,331,331.2 SF (53.52 AC)

EXISTING TREE CANOPY	PRESERVED TREE CANOPY
667,887.81 SF (15.33AC)	506,490 SF (11.63 AC)

TREE CANOPY DATA:

TOTAL EXISTING TREE CANOPY:	667,887.81 SF; 15.33 AC (28.64% OF SITE)
REQUIRED CANOPY PRESERVATION:	24% (160,293.07 SF; 3.68 AC)
PROVIDED CANOPY PRESERVATION:	506,490 SF; 11.63 AC (75.3% OF EXISTING CANOPY)

OPEN SPACE REQUIREMENT

MINIMUM OPEN SPACE REQUIREMENT: 15%
REQUIRED: 5% TOTAL = 2.68 AC
(10% 'NATURAL AREA' = 5.35 AC)
PROVIDED: 2.72 AC TOTAL
NATURAL AREA = xxx SF

LOT	TYPE	AREA (AC)
OS-1	PLAZA	2.72 AC

STATEMENT OF IMPACTS

WATER FACILITIES
WATER SERVICE WILL BE PROVIDED BY . THE WATER MAINS ARE LOCATED ALONG .
250 GPD = GPD

SEWER FACILITIES
SEWER SERVICE WILL BE PROVIDED BY THE CITY OF FRANKLIN.

REPURIFIED (REUSE) WATER FACILITIES
AVAILABLE. SEE UTILITY SHEETS.

POLICE, FIRE, AND RECREATIONAL FACILITIES
NEAREST POLICE STATION: HEADQUARTERS (3.11 MILES)
NEAREST FIRE STATION: FIRE STATION #4 (1.7 MILES)
NEAREST RECREATIONAL FACILITY: WILLIAMSON COUNTY RECREATION CENTER (1.7 MILES)

PROJECTED STUDENT POPULATION
0 x 0.33 = 0 STUDENTS

REFUSE STORAGE AND SANITATION COLLECTION FACILITIES
REFUSE COLLECTION FOR THE DEVELOPMENT SHALL BE PROVIDED BY CITY OF FRANKLIN

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DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

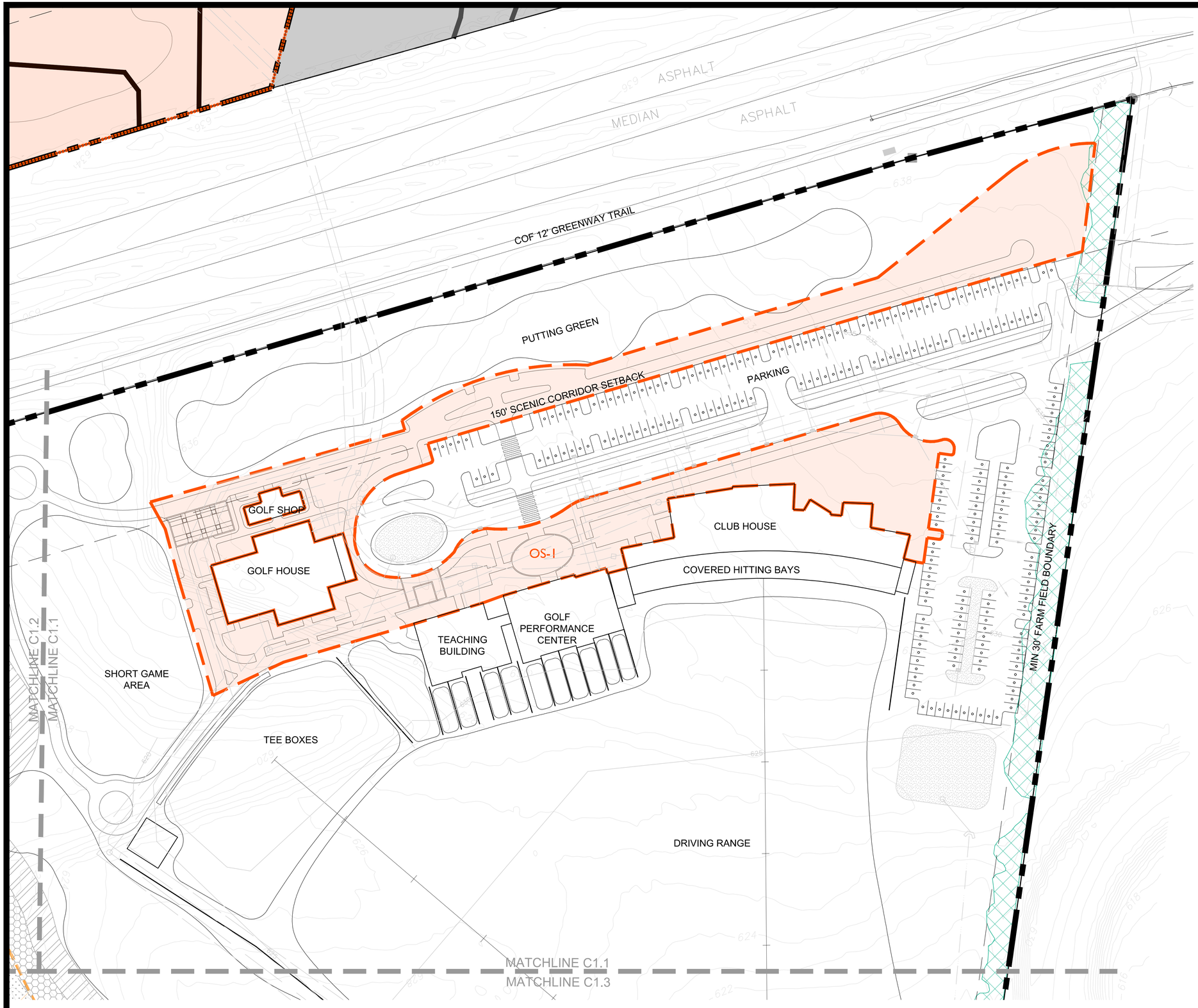
DRAKE A. REEDER
REGISTERED
COMMERCE
TENNESSEE No. 1245
LANDSCAPE ARCHITECT
03.04.2021

Revision Date
△
△
△
△

DEVELOPMENT PLAN SHEETS

SHEET
C2.0

COF # 7416



KEY - DEVELOPMENT PLAN

- PRESERVED TREE CANOPY
- FWO; EFFECTIVE
- FWO; PRELIMINARY
- FFO
- 30'/60' , ZONE 1 RIPARIAN BUFFER
- 30', ZONE 2 RIPARIAN BUFFER
- WETLAND

30' FARM FIELD BOUNDARY REQUIREMENTS

18.4.3 Standards

A. Site features that emphasize the prominence of a historic resource shall be preserved within the spatial setting of the historic resource. Such features include topography, mature vegetation, streams, and historic walls and fences.

B. Farm-field boundaries shall have a minimum width of 30 feet. Development on lots containing or adjacent to a National Historic Landmark shall provide a minimum width of 50 feet.

C. Farm-field boundaries shall be linear in form and shall include a historically-based fence or wall along the length of the boundary. Acceptable types include rail fences, four-board horse fences, or dry stacked stone walls consistent in design and stone type with historic antecedents found in the County.

D. Planting materials shall:

D.1. Be spaced in an informal, irregular manner AMA ed by deciduous trees, although native evergreens, such as cedars, may be included for diversity and visual screening purposes; and

E. Trees shall be required at a rate of one canopy tree per every 400 square feet. Credit for existing vegetation may reduce the planting requirements when located in a suitable location.

F. New buildings within view of the historic resource shall be designed to be similar in scale and architectural character with the historic building.

GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

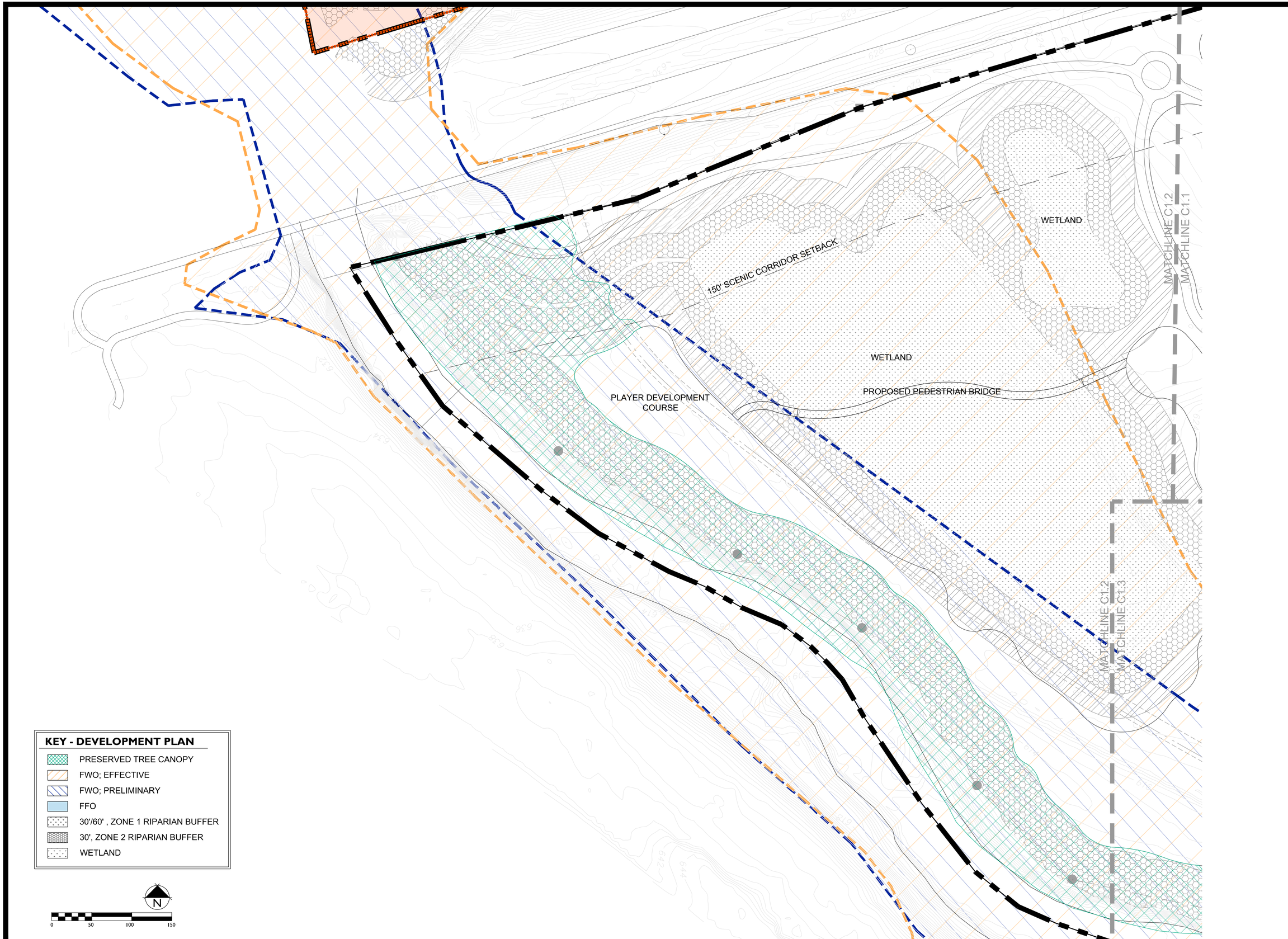
Revision Date

DEVELOPMENT PLAN ENLARGEMENTS

SHEET

C2.1

COF # 7416



GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

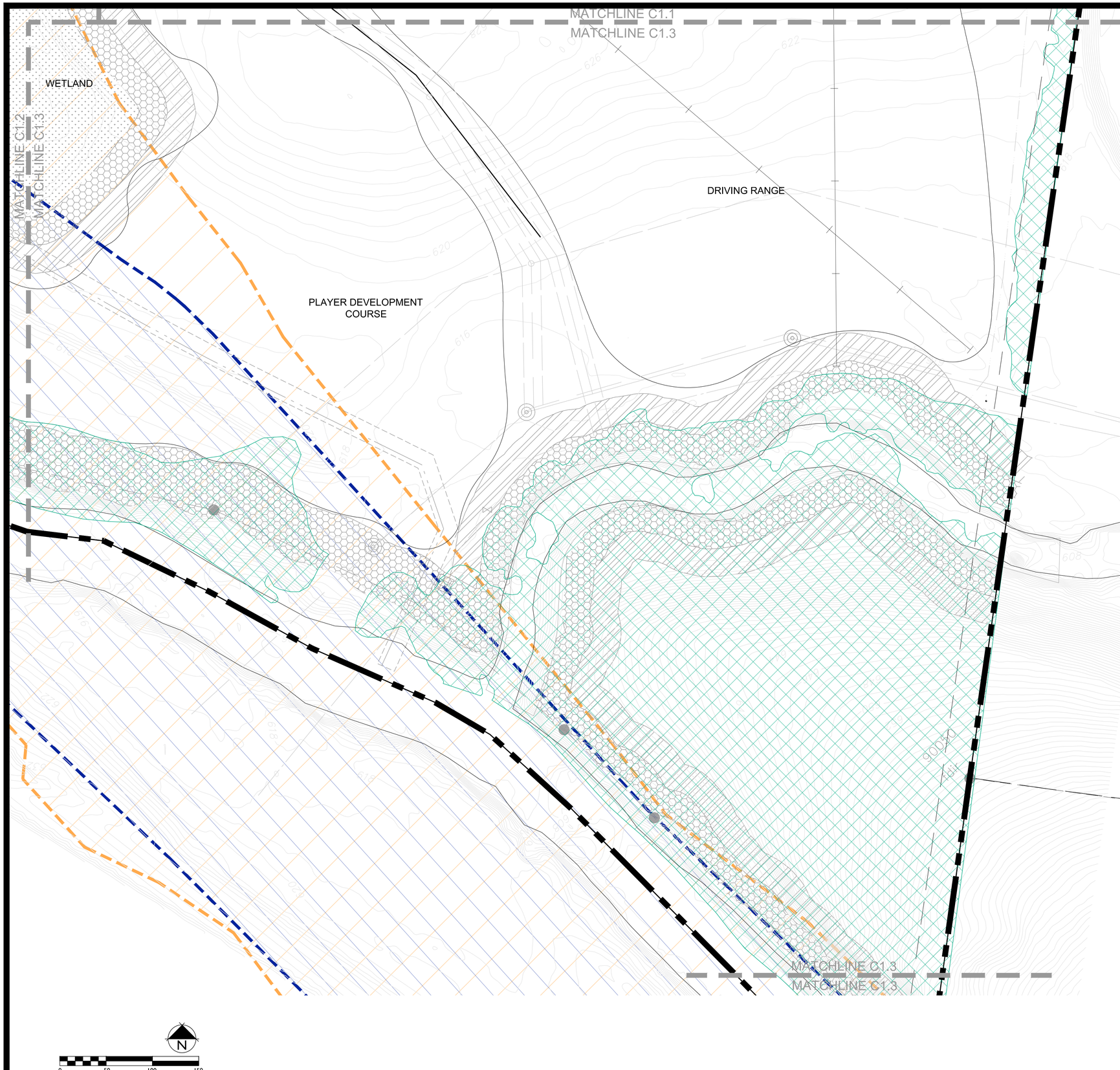
DRAKE A. REEDER
REGISTERED
COMMERCE
TENNESSEE No. 12
LANDSCAPE ARCHITECT
03.04.2021

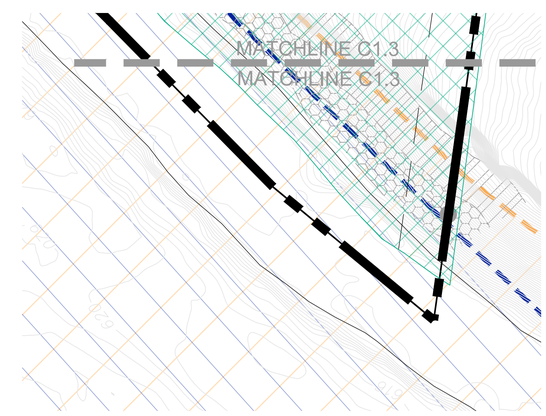
Revision Date

DEVELOPMENT PLAN ENLARGEMENTS SHEET

C2.2

COF # 7416





KEY - DEVELOPMENT PLAN

- PRESERVED TREE CANOPY
- FWO; EFFECTIVE
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- 30'/60' , ZONE 1 RIPARIAN BUFFER
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GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

DRAKE A. REEDER
REGISTERED
COMMERCE
TENNESSEE No. 1243
LANDSCAPE ARCHITECT
03.01.2021

Revision Date

DEVELOPMENT PLAN ENLARGEMENTS SHEET

C2.3

COF # 7416

SITE DATA CHART

PROJECT NAME:	CHEEKWOOD SOUTH PD
PROJECT NUMBER:	XXXX
ADDRESS:	MACK HATCHER PKWY FRANKLIN, TN 8TH CIVIL DISTRICT
PARCEL(S):	063 02101
ACREAGE / SF OF SITE:	53.52 AC
VESTING (IF APPLICABLE):	
BASE ZONING:	CI (CIVIC INSTITUTIONAL)
PROPOSED ZONING:	PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO, CFO
BUILDING TYPES APPLIED:	COMMERCIAL/MIXED-USE
FRONTAGE TYPES APPLIED:	LANDSCAPE FRONTAGE
LOT WIDTH (RESIDENTIAL):	N/A
LOT SIZE (RESIDENTIAL):	N/A
SETBACKS:	150' SCENIC CORRIDOR OVERLAY 30' HISTORIC FARM FIELD BUFFER
DWELLING UNIT COUNT (BY TYPE):	
SINGLE FAMILY:	N/A
MULTIFAMILY:	N/A
NONRESIDENTIAL SF (BY USE):	
DRIVING RANGE BUILDING:	30,496 SF
GOLF SHOP:	6,900 SF
STARTER HOUSE:	100 SF
CLUBHOUSE:	21,413 SF
HOTEL KEYS:	N/A
BUILDING HEIGHT:	MAX 3 STORIES
MINIMUM LSA:	20%
OPEN SPACE REQUIRED:	5% (2.68 AC)
NATURAL AREA REQUIRED:	10% (NOT REQUIRED)
TREE CANOPY RETENTION ACREAGE:	REQUIRED: 3.68 AC (24% OF TOTAL SITE) PROVIDED: 11.63 AC (75.8% OF TOTAL CANOPY)
PARKING REQUIRED (BY USE):	SEE ATTACHED PARKING STUDY
PARKING PROVIDED (BY USE):	SEE ATTACHED PARKING STUDY
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

KEY - TREE PRESERVATION

- PRESERVED TREE CANOPY
- REMOVED TREE CANOPY
- REMOVED SPECIMEN TREE

SOUTH PARCEL		
TREE #	DIAM"	SPECIES
201	42	OAK
202	30	HACKBERRY
203	35	
204	32	
205	24	
206	24	OAK
207	32	
208	24	
209	27	OAK
210	30	MAPLE
211	35	HACKBERRY
212	59	
213	30	OAK
214	25	OAK
215	27	OAK
216	26	OAK
TOTAL	502	

SPECIMEN TREE REMOVED: 502"
SPECIMEN TREE TO BE REPLACED:1004"

NOTE: TREES FIELD SURVEYED BY LANDSCAPE ARCHITECT; SPECIMEN TREE REMOVED IS AN APPROXIMATION, ACTUAL NUMBER TO BE ESTABLISHED AT SITE PLAN

TREE CANOPY RETENTION

OVERALL SITE AREA = 2,331,331.2 SF (53.52 AC)

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PROVIDED CANOPY PRESERVATION:	506,490 SF; 11.63 AC (75.3% OF EXISTING CANOPY)

TREE PROTECTION NOTES:

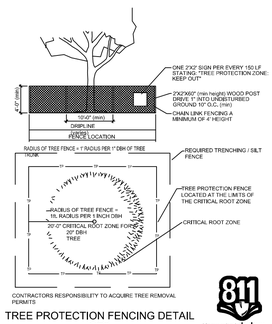
1. The tree protection barriers shall be constructed before the issuance of any permits, and shall remain intact throughout the entire period of construction.

2. The tree protection barrier shall be installed as labeled on this plan or a distance to the radius of the dripline, whichever is greatest, as measured from the trunk of the protected tree.

3. Any required excavation in or around the protection zone to accommodate underground services, footings, etc; shall be indicated on the plan, and shall be excavated by hand. In addition, related root pruning shall be accomplished via ANSI A-300-95 standard so as to minimize impact on the general root system.

4. The storage of building materials or stock piling shall not be permitted within the limits of or against the protection barriers.

5. Trees within the protection barriers must be adequately cared for throughout the construction process (i.e., they must be watered sufficiently). Fill shall not be placed upon the root system as to endanger the health or life of the affected tree.



TREE PROTECTION FENCING DETAIL
NTS

811 Know what's below. Call before you dig.

GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

DRAKE A. REEDER REGISTERED TENNESSEE No. 329 LANDSCAPE ARCHITECT 03.01.22

Revision Date

TREE PRESERVATION

SHEET
L1.0

COF # 7416

SITE DATA CHART

PROJECT NAME:	CHEEKWOOD SOUTH PD
PROJECT NUMBER:	XXXX
ADDRESS:	MACK HATCHER PKWY FRANKLIN, TN 8TH CIVIL DISTRICT
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PROPOSED ZONING:	PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO, CFO
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FRONTAGE TYPES APPLIED:	LANDSCAPE FRONTAGE
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LOT SIZE (RESIDENTIAL):	N/A
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SINGLE FAMILY:	N/A
MULTIFAMILY:	N/A
NONRESIDENTIAL SF (BY USE):	
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APPLICANT:	GAMBLE DESIGN COLLABORATIVE 324 LIBERTY PIKE SUITE 145 GREG GAMBLE (615) 975-5765 greg.gamble@gdc-tn.com

PROPOSED BUFFER AVERAGING

AREA OF BUFFER ENCROACHMENT:	9,578 SF
AREA OF NEW STREAM BUFFER ZONE 2:	9,949 SF

KEY - BUFFER MITIGATION

- 30'/60' , ZONE 1 RIPARIAN BUFFER
- 30', ZONE 2 RIPARIAN BUFFER
- BUFFER ENCROACHMENT
- PROPOSED BUFFER AVERAGING

811 Know what's below. Call before you dig.

GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

DRAKE A. REEDER REGISTERED COMMERCE LANDSCAPE ARCHITECT TENNESSEE No. 1245 03.01.2021

Revision Date

STREAM BUFFER MITIGATION

SHEET
L1.0

COF # 7416

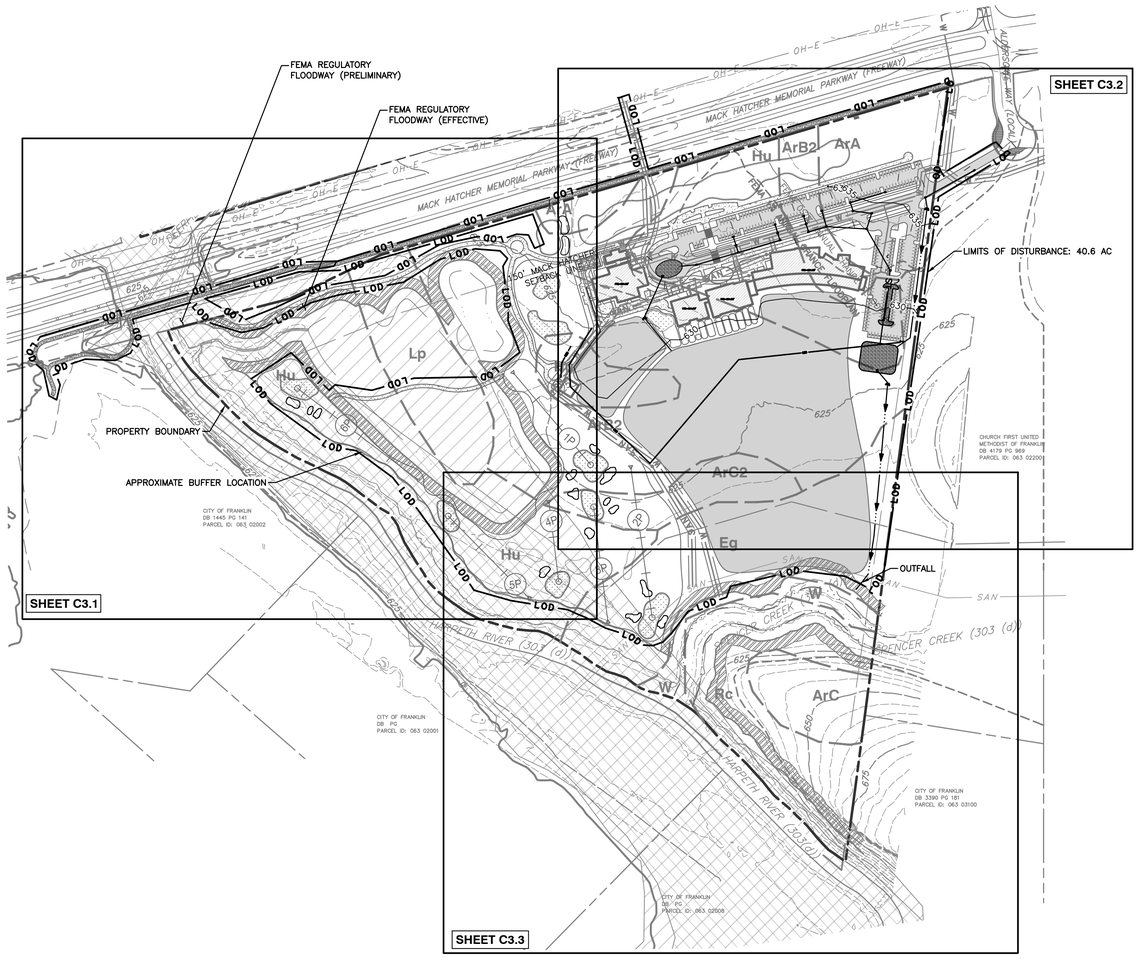
NORTH

CITY OF FRANKLIN GRADING & DRAINAGE GENERAL NOTES

1. GRADING PERMIT IS REQUIRED FOR ANY PROJECT DISTURBING MORE THAN 10,000 SF, ADDING MORE THAN 5,000 SF OF IMPERVIOUS SURFACE OR FOR ANY SITE GRADING REQUIRING STOCKPILING OF MATERIAL.
2. THE DEVELOPER SHALL PROVIDE THE NECESSARY LABOR AND SUPERVISION REQUIRED TO SUPPORT FIELD TESTING BY THE INDEPENDENT TESTING FIRM AND INSPECTIONS BY CITY OFFICIALS AT NO COST TO THE CITY. TEST REPORTS OF FIELD TESTING IF APPLICABLE SHALL BE SUBMITTED DIRECTLY TO THE STREET DEPARTMENT. DEFECTS DISCLOSED BY TESTS SHALL BE RECTIFIED.
3. AN AUTHORIZED REPRESENTATIVE OF THE CITY SHALL MAKE A FINAL INSPECTION OF THE PROJECT AFTER COMPLETION TO DETERMINE ACCEPTABILITY OF THE WORK AND FOR RELEASE OF PERFORMANCE BONDS IF REQUIRED. BEFORE THIS FINAL INSPECTION CAN BE MADE, THE ENGINEER RESPONSIBLE FOR THE PROJECT SHALL CERTIFY IN WRITING TO THE CITY ENGINEER THAT THE WORK HAS BEEN COMPLETED IN ACCORDANCE WITH APPROVED PLANS AND SPECIFICATIONS.
4. DRAINAGE FACILITIES INCLUDING, BUT NOT LIMITED TO, CULVERTS, DETENTION BASINS AND DITCHES, AS WELL AS THE ROADWAY SUB-GRADE, BASE STONE AND BINDER & SURFACE COARSE SHALL BE INSPECTED, TESTED AND GIVEN APPROVAL AT EACH STAGE OF INSTALLATION PRIOR TO PROCEEDING TO THE NEXT STAGE OF CONSTRUCTION. FINAL CONSTRUCTION INSPECTION FOR APPROVAL AND ACCEPTANCE OF STREETS AND DRAINAGE SYSTEMS WILL NOT BE GRANTED UNTIL ALL WORK HAS BEEN COMPLETED IN ACCORDANCE WITH THE APPROVED PLANS.
5. LOCATING AND COORDINATION FOR THE RELOCATION OF EXISTING UTILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR. TENNESSEE'S ONE-CALL AND THE CITY OF FRANKLIN UTILITY LOCATION SERVICE SHALL BE UTILIZED IN ADDITION TO COORDINATION WITH LOCAL UTILITY OWNERS. THE CONTRACTOR SHALL AT ALL TIMES PROTECT EXISTING UTILITIES AND WILL BE RESPONSIBLE FOR COSTS DUE TO DAMAGE CAUSED TO ANY UTILITY LINES.

GRADING NOTES

1. SEE C3.1, 3.2, & 3.3 FOR ENLARGED GRADING & DRAINAGE PLANS.
2. ALL PROPOSED GRADES SHOWN ARE FINAL GRADES, TOP OF PAVEMENT, OR GRATE ELEVATION AT THE DRAWDOWN POINT, UNLESS INDICATED OTHERWISE.
3. EARTHWORK SHALL INCLUDE CLEARING AND GRUBBING, STRIPPING AND STOCKPILING TOPSOIL, MASS GRADING, EXCAVATION, FILLING, UNDER CUT AND REPLACEMENT (IF REQUIRED), AND COMPACTION.
4. PLACE TOPSOIL OVER THE SUBGRADE OF UNPAVED, DISTURBED AREAS TO A DEPTH INDICATED ON THE LANDSCAPE PLANS (6" MINIMUM).
5. ALL SLOPES IN NON-PAVED AREAS SHALL BE 3:1 (HORIZONTAL:VERTICAL) MAXIMUM UNLESS NOTED OTHERWISE.
6. USE EROSION CONTROL BLANKETS FOR ALL SLOPES 4:1 OR GREATER. USE EROSION CONTROL MATTING ALONG CHANNEL INVERTS.
7. ALL EXCESS SOIL MATERIALS AND OTHER MATERIAL NOT SUITABLE FOR REUSE SHALL BECOME THE PROPERTY OF THE CONTRACTOR UNLESS OTHERWISE DESIGNATED. THESE MATERIALS SHALL BE REMOVED BY THE CONTRACTOR AND DISPOSED OF OFFSITE AT NO ADDITIONAL COST TO THE OWNER, IN ACCORDANCE WITH ALL LOCAL AND STATE CODES AND PERMIT REQUIREMENTS.
8. THE CONTRACTOR IS RESPONSIBLE FOR THE SITE EARTHWORK BY IMPORTING OR EXPORTING AS NECESSARY TO ACHIEVE DESIGN GRADES.
9. THE CONTRACTOR SHALL COMPLY WITH ALL PERTINENT O.S.H.A. PROVISIONS AND THE MANUAL OF ACCIDENT PREVENTION AND CONSTRUCTION, ISSUED BY THE AGC OF AMERICA, INCORPORATED, AND THE SAFETY AND HEALTH REGULATIONS OF CONSTRUCTION ISSUED BY THE U.S. DEPARTMENT OF LABOR.
10. THE CONTRACTOR SHALL PROVIDE POSITIVE DRAINAGE THROUGH THE SITE DURING ALL PHASES OF CONSTRUCTION.
11. GRADING OPERATIONS IN THE FLOODPLAIN WILL COMPLY WITH FRAKNLIN'S FLOODPLAIN COMPENSATION REQUIREMENTS.
12. INFILTRATION TEST RESULTS MAY ALLOW FOR REDUCTION OF STORMWATER PIPING.



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- EXISTING ADJOINING PROPERTY LINE
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- EXISTING GUARD RAIL
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- LOD PROPOSED LIMITS OF DISTURBANCE
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- EXISTING SOIL BOUNDARY
- ArB2 EXISTING SOIL TYPE LABEL
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- PROPOSED TRANSFORMER
- SAN PROPOSED SANITARY SEWER LINE
- PROPOSED SANITARY SEWER MANHOLE
- PROPOSED SANITARY SEWER CLEANOUT
- W PROPOSED WATER LINE

IMPACT STATEMENT

CHEEKWOOD GOLF COURSE WILL HANDLE ITS GRADING AND DRAINAGE IN THE FOLLOWING MANNER. ON-SITE STORMWATER DETENTION WILL BE USED ALONG WITH OTHER PERMANENT STORMWATER BMPS AND GREEN INFRASTRUCTURE TO MEET THE INTENT OF THE CURRENT REGULATIONS AT THE TIME OF SUBMITTAL. THE PROJECT INTENT IS TO ACHIEVE STORM WATER QUALITY THROUGH ON-SITE MEASURES. THE DESIGN TEAM WILL SUBMIT A C.O.F. LONG TERM MAINTENANCE PLAN AND AGREEMENT TO C.O.F. WITH FINAL CONSTRUCTION DRAWING.

STORMWATER NARRATIVE

STORMWATER MANAGEMENT FOR THE CHEEKWOOD GOLF COURSE DEVELOPMENT WILL BE HANDLED IN THE FOLLOWING MANNER. STORMWATER QUALITY FOR THE PROJECT WILL BE PROVIDED ONSITE UTILIZING BIORETENTION AND WATER QUALITY SWALE. THESE BMPS WILL BE INCORPORATED INTO THE DESIGN OF THE SITE. THE SITE DISCHARGES DIRECTLY INTO SPENCER CREEK AND THE HARPETH RIVER, WHICH HAVE SUFFICIENT HYDROLOGIC CAPACITY TO HANDLE POST-DEVELOPMENT FLOWS. IN LIGHT OF SIMILAR REQUIREMENTS THE CITY OF FRANKLIN CURRENTLY HAS, AUDUBON INTERNATIONAL (AI) ENVIRONMENTAL MANAGEMENT GUIDELINES WILL BE UTILIZED WITH THE DESIGN OF THE SITE. THE SITE WILL STRIVE FOR AI CERTIFICATION.

SITE BMP SUMMARY CHART

BMP	DRAINAGE AREA TREATED
WATER QUALITY SWALE	257,731 SQ. FT.
BIORETENTION	257,731 SQ. FT.

POST-DEVELOPMENT GRADING & DRAINAGE DATA CHART

SITE AREA:	53.51 AC
IMPERVIOUS AREA:	7.83 AC
DISTURBED AREA:	40.6 AC
Rv VALUE:	0.15
WEIGHTED CN:	82

POST-DEVELOPMENT PEAK FLOW EVENTS:

2-YEAR:	149.33 CFS
5-YEAR:	201.99 CFS
10-YEAR:	244.90 CFS
25-YEAR:	305.80 CFS
50-YEAR:	355.42 CFS
100-YEAR:	407.13 CFS

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0 200 400

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CHEEKWOOD SOUTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

SAMANTHA HALEY SEARCY
REGISTERED ENGINEER
AGRICULTURE
STATE OF TENNESSEE
No. 120168
10/04/2021

Revision Date
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- △
- △
- △

OVERALL GRADING AND DRAINAGE PLAN
SHEET
C3.0
COF # 7416

NORTH

MACK HATCHER MEMORIAL PARKWAY (FREEWAY)

MULTI-USE PATH TO BE ATTACHED TO EXISTING MACK HATCHER BRIDGE OVER HARPETH RIVER. WIDENING OF EXISTING BRIDGE AND COORDINATION WITH TDOT SHALL OCCUR.

APPROXIMATE LOCATION OF BRIDGE OVER HARPETH RIVER

GOLF CART PATH TO EXTEND UNDER MACK HATCHER AND CONNECT TO NORTHERN PROPERTY. COORDINATION WITH THE CITY OF FRANKLIN, TDOT AND FEMA SHALL OCCUR.

MULTI-USE PATH TO BE CONNECTED TO EXISTING GREENWAY PATH ON WEST SIDE OF HARPETH RIVER. COORDINATION WITH TDOT AND PROPERTY OWNER SHALL OCCUR PRIOR TO CONSTRUCTION.

PROPERTY BOUNDARY

APPROXIMATE LOCATION OF RIPARIAN BUFFER (TYP.)

FEMA REGULATORY FLOODWAY (EFFECTIVE)

150' MACK HATCHER SETBACK LINE

APPROXIMATE LOCATION OF EXTENTS OF WETLAND (TYP.)

EXISTING WETLAND AREA

EXISTING WETLAND AREA

FEMA REGULATORY FLOODWAY (PRELIMINARY)

ArA

Lp

Hu

6P

1P

4P

5P

CITY OF FRANKLIN
DB 1445 PG 141
PARCEL ID: 063 02002

HARPETH RIVER (303 (d))

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No. 120144
STATE OF TENNESSEE
11/04/2020

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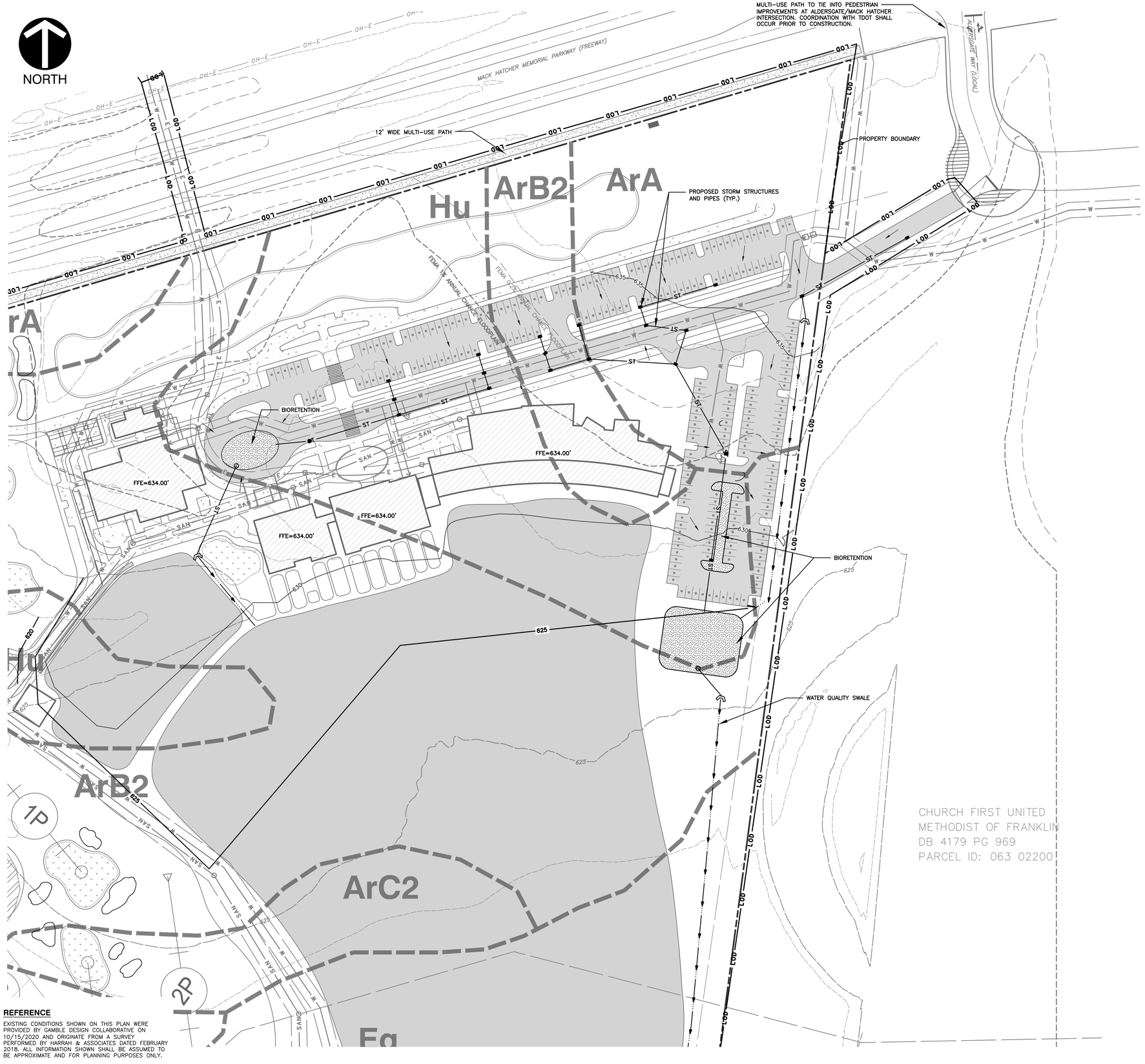
GRADING AND DRAINAGE PLAN

SHEET
C3.1

COF # 7416



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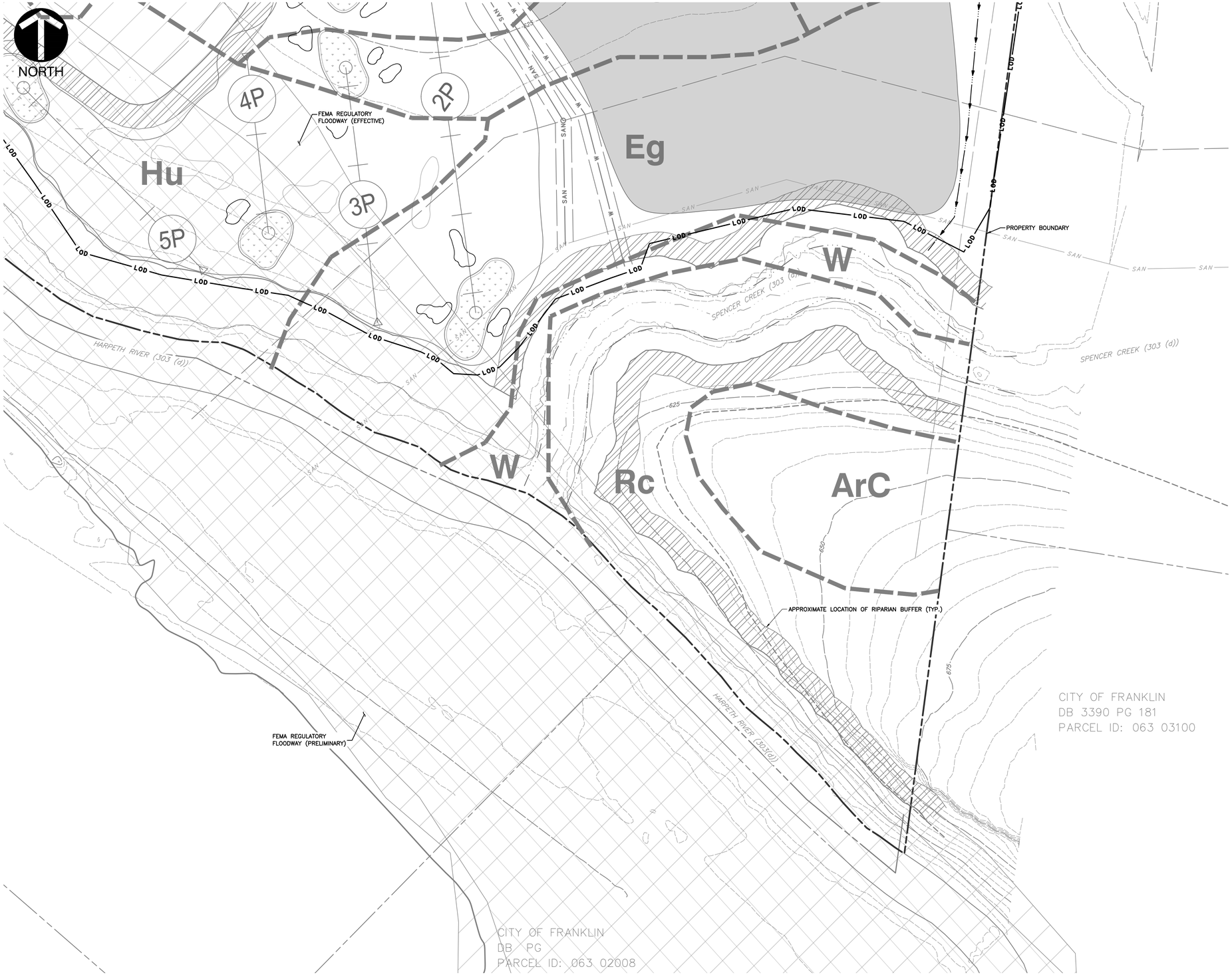
GRADING AND DRAINAGE PLAN

SHEET
C3.2

COF # 7416



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GRADING AND DRAINAGE PLAN

SHEET
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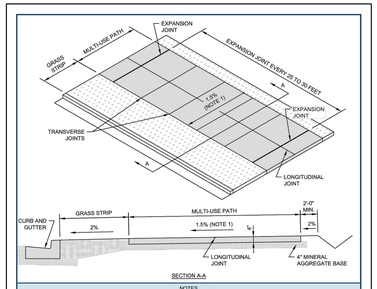
COF # 7416

NORTH



SECTION A-A

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. MINERAL AGGREGATE BASE: 4" MIN. THICK 303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D
3. CONCRETE: 4" MIN. THICK CLASS A (3,000 PSI, 6% AIR) WITH SYNTHETIC FIBER REINFORCEMENT, BROOM FINISH
4. EXPANSION JOINTS: SEE DRAWING RP-10
5. PROVIDE TRANSVERSE JOINTS FORMING BLOCKS AS NEARLY TO SQUARE AS PRACTICAL
6. PROVIDE A LONGITUDINAL JOINT CENTERED ON WALK WHERE SIDEWALK WIDTH IS 8'-0" OR GREATER

CITY OF FRANKLIN TENNESSEE	CONCRETE MULTI-USE PATH		DWG. NO.
	CITY OF FRANKLIN NOT TO SCALE	CITY ENGINEER: RJP	DATE: 1/1/2020	RP-9

CITY OF FRANKLIN R.O.W. & ACCESS GENERAL NOTES

1. PRIOR TO BEGINNING ANY CONSTRUCTION, THE DEVELOPER AND/OR CONTRACTOR, SHALL OBTAIN ALL NECESSARY PERMITS AS REQUIRED BY LAW. SUCH PERMITS MAY INCLUDE, BUT ARE NOT LIMITED TO, THOSE REQUIRED BY STATE OF TENNESSEE, WILLIAMSON COUNTY AND OTHER CITY OF FRANKLIN AGENCIES.
2. ALL OFF-SITE WORK WITHIN THE PUBLIC RIGHT-OF-WAY SHALL REQUIRE AN APPROVED TRAFFIC CONTROL PLAN WHICH COMPLIES WITH THE MUTCD. NO OFF-SITE EXCAVATION MAY BE UNDERTAKEN IN ANY STREET, ROAD, ALLEY OR RIGHT-OF-WAY OF ANY UTILITY OR TEMPORARY CONSTRUCTION EASEMENT OF THE CITY OF FRANKLIN BY ANY ENTITY UNLESS 72-HOUR NOTICE HAS BEEN GIVEN TO THE CITY OF FRANKLIN TRAFFIC OPERATIONS CENTER. THE CONTRACTOR SHALL HAVE AN APPROVED TRAFFIC CONTROL PLAN ONSITE DURING CONSTRUCTION.
3. LOCATING AND COORDINATION FOR THE RELOCATION OF EXISTING UTILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR. TENNESSEE'S ONE-CALL AND THE CITY OF FRANKLIN UTILITY LOCATION SERVICE SHALL BE UTILIZED IN ADDITION TO COORDINATION WITH LOCAL UTILITY OWNERS. THE CONTRACTOR SHALL AT ALL TIMES PROTECT EXISTING UTILITIES AND WILL BE RESPONSIBLE FOR COSTS DUE TO DAMAGE CAUSED TO ANY UTILITY LINES.

ROADWAY NETWORK NARRATIVE

THE ROADWAY NETWORK ADJACENT TO THE CHEEKWOOD GOLF COURSE HAS BEEN TAKEN INTO ACCOUNT WITH A TRAFFIC STUDY. CONSTRUCTION WILL OCCUR IN TWO PHASES. TRAFFIC CONTROL PLANS WILL BE USED WHEN WORK OCCURS IN THE RIGHT OF WAY. SUBJECT PROPERTY IS LOCATED IN THE CENTRAL FRANKLIN CHARACTER AREA.

ROADWAY NETWORK IMPACT STATEMENT

THE CONSTRUCTION OF THE CHEEKWOOD GOLF COURSE WILL INCREASE TRIPS BY 1,304 PER DAY AT THE INTERSECTION OF ALDERSGATE WAY AND MACK HATCHER PARKWAY. A CONNECTION WILL BE PROVIDED TO THE GREENWAY ALONG MACK HATCHER MEMORIAL PARKWAY.

R.O.W. AND & ACCESS DATA CHART

DAILY TRIP GENERATION:	1,304 VEH. PER DAY
TOTAL AM PEAK HOUR TRIP GENERATION:	106 VEH. PER HOUR
TOTAL PM PEAK HOUR TRIP GENERATION:	140 VEH. PER HOUR
TRAFFIC IMPACT STUDY REQUIRED:	YES
CIRCULATION PLAN REQUIRED:	NO

ADDITIONAL NOTES

DUMPSTER ACCESS TO BE PROVIDED AT EXISTING CHEEKWOOD GOLF CLUB MAINTENANCE FACILITY ACROSS MACK HATCHER MEMORIAL PARKWAY. ROLLOUT CANS WILL BE PROVIDED AT THE SITE.

CONNECTIVITY INDEX CALCULATION

CONNECTIVITY INDEX = LINES/NODES

4/2 = 2

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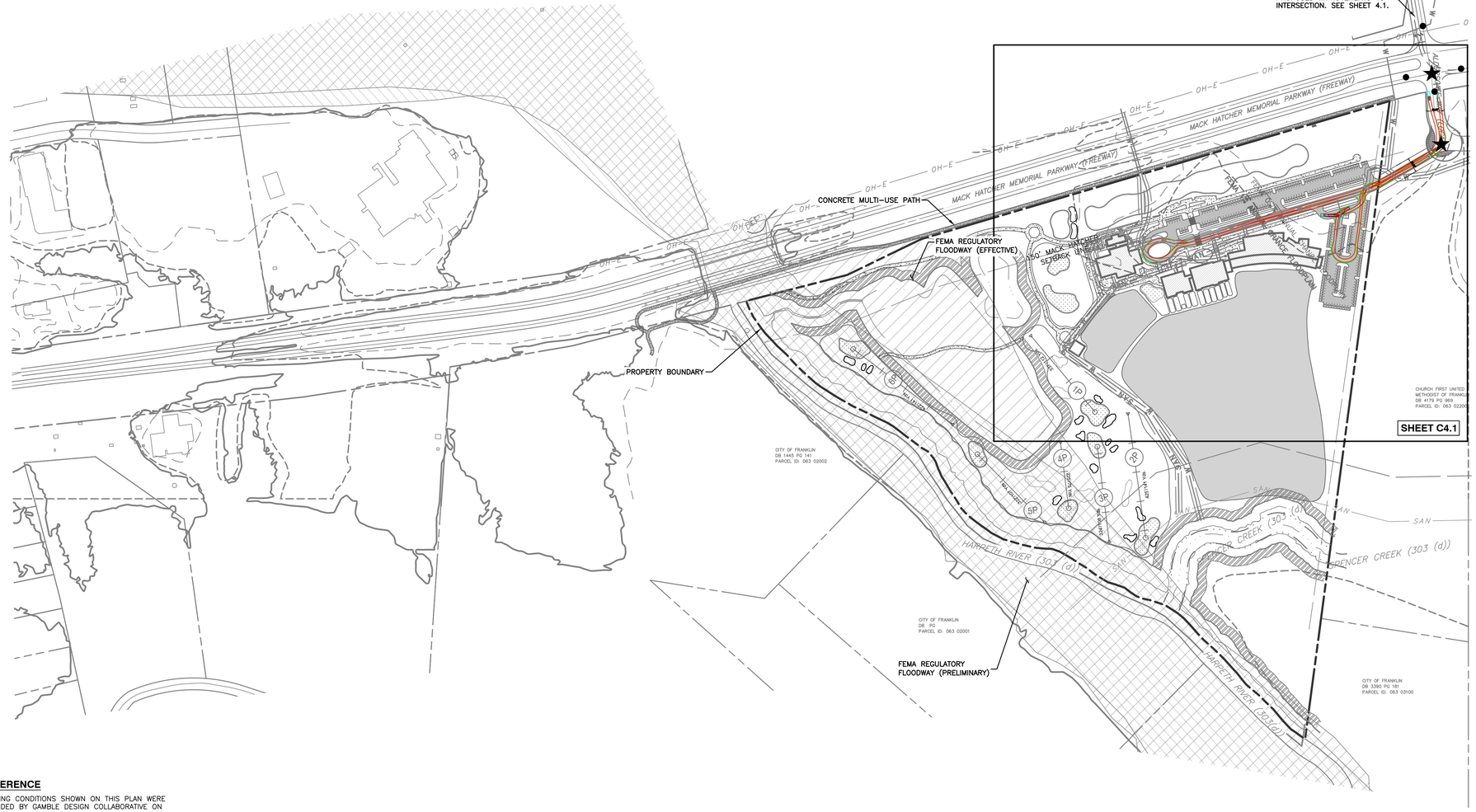
- CONNECTIVITY LINKS (4)
- CONNECTIVITY NODES (2)



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No. 120144
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OVERALL ROW AND ACCESS PLAN

SHEET
C4.0
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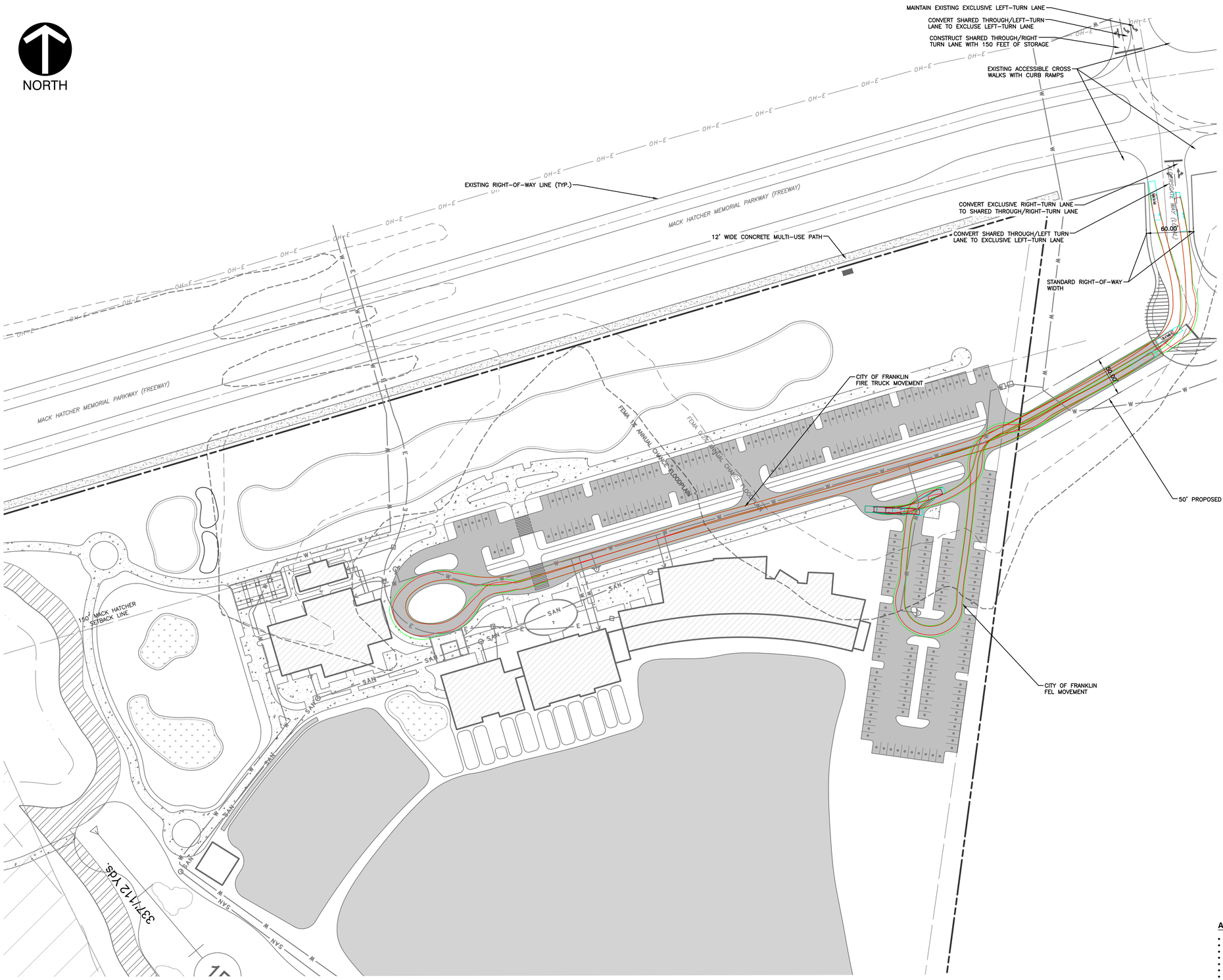

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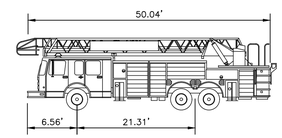
- EXISTING RIPARIAN BUFFER ZONE 1
- EXISTING RIPARIAN BUFFER ZONE 2
- PROPOSED BUILDING
- PROPOSED ASPHALT
- PROPOSED SIDEWALK
- PROPOSED ACCESS EASEMENT
- PROPOSED TEE-BOX LIMITS
- PROPOSED FAIRWAY LIMITS
- PROPOSED GREEN
- PROPOSED BUNKER
- PROPOSED UNDERGROUND ELECTRIC LINE
- PROPOSED OVERHEAD ELECTRIC LINE
- PROPOSED ELECTRIC POLE
- PROPOSED TRANSFORMER
- PROPOSED SANITARY SEWER LINE
- PROPOSED SANITARY SEWER MANHOLE
- PROPOSED SANITARY SEWER CLEANOUT
- PROPOSED WATER LINE

CITY OF FRANKLIN FEL DETAIL
N.T.S.

OVERALL LENGTH	35.000FT
OVERALL WIDTH	8.042FT
OVERALL BODY HEIGHT	10.218FT
MIN BODY GROUND CLEARANCE	1.048FT
TRACK WIDTH	6.500FT
LOCK-TO-LOCK TIME	6.00S
WALL TO WALL TURNING RADIUS	46.000FT



CITY OF FRANKLIN FIRETRUCK DETAIL
N.T.S.

APPARATUS SPECIFICATIONS:

NUMBER OF FRONT AXLES =	1
FRONT TRACK WIDTH =	8'
WHEELS ON EACH FRONT AXLE =	2
NUMBER OF REAR ALES =	2
REAR TRACK WIDTH =	8'
WHEEL BASE =	21.316' (FRONT AXLE TO REAR AXLE)
REAR AXLE SPACING =	4.417'
BODY LENGTH =	50.0417'
WIDTH =	8.333'
REAR OVERHANG =	22.144'
BODY STYLE =	FIRE TRUCK
TURNING RADIUS WALL TO WALL =	42'
MINIMUM DESIGN SPEED =	5 M.P.H.

REFERENCE

EXISTING CONDITIONS SHOWN ON THIS PLAN WERE PROVIDED BY GAMBLE DESIGN COLLABORATIVE ON 10/15/2020 AND ORIGINATE FROM A SURVEY PERFORMED BY HARRAH & ASSOCIATES DATED FEBRUARY 2018. ALL INFORMATION SHOWN SHALL BE ASSUMED TO BE APPROXIMATE AND FOR PLANNING PURPOSES ONLY.

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE IN FEET
0 60 120

GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

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Civil & Environmental Consultants, Inc.
117 SEABOARD LANE - FRANKLIN, TN - 37067
615-333-7797 - 800-763-2326
www.cecinc.com

CHEEKWOOD SOUTH PD DEVELOPMENT PLAN
Franklin, Williamson County, Tennessee

SAMANTHA HALEY SEARCY
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No. 120143
STATE OF TENNESSEE
10/15/2020

Revision Date
- △ _____
- △ _____
- △ _____
- △ _____

ENLARGED ROW AND ACCESS PLAN

SHEET
C4.1
COF # 7416

NORTH

GENERAL UTILITY NOTES

1. INVESTIGATION, LOCATION, SUPPORT, PROTECTION, AND RESTORATION OF ALL EXISTING UTILITIES AND APPURTENANCES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING THE SEQUENCING OF CONSTRUCTION FOR ALL UTILITY LINES SO THAT WATER LINES, GAS LINES, AND UNDERGROUND ELECTRIC DO NOT CONFLICT WITH SANITARY SEWERS OR STORM SEWERS. INSTALL UTILITIES PRIOR TO PAVEMENT CONSTRUCTION.
3. ALL TRENCH SPOILS SHALL BECOME THE PROPERTY OF THE CONTRACTOR UNLESS OTHERWISE DESIGNATED AND SHALL BE REMOVED BY THE CONTRACTOR AND DISPOSED OF OFF SITE AT NO ADDITIONAL COST TO THE OWNER IN ACCORDANCE WITH ALL LOCAL AND STATE CODES AND PERMIT REQUIREMENTS.
4. ADJUST ALL EXISTING UTILITY SURFACE FEATURES INCLUDING BUT NOT LIMITED TO CASTINGS, VALVE BOXES, PEDESTALS, CLEANOUTS, ETC. TO MATCH PROPOSED FINISHED GRADES, UNLESS OTHERWISE INDICATED.
5. CONTRACTOR SHALL COORDINATE WITH EACH UTILITY PROVIDER THE INSTALLATION OF UTILITY CONDUITS FOR TELEPHONE, ELECTRIC, GAS, IRRIGATION, ETC. CONTRACTOR SHALL PROVIDE ALL MATERIALS AND LABOR FOR THE TRENCHING AND CONDUIT INSTALLATION.
6. THE CONTRACTOR IS RESPONSIBLE FOR REIMBURSING UTILITY DEPARTMENT INSPECTION COSTS.
7. THE CONTRACTOR IS TO PROVIDE AND MAINTAIN THE APPROVED CONSTRUCTION IDENTIFICATION SIGN FOR PRIVATE DEVELOPMENT.
8. THE CONTRACTOR SHALL ENSURE THAT ALL ROOFTOP MECHANICAL EQUIPMENT IS COMPLETELY SCREENED BY THE PROPOSED BUILDING PARAPET FROM ALL DIRECTIONS AND OFF SITE VIEWS. THE CHANGE OUT OF ANY EQUIPMENT TO A LARGER DIMENSIONAL HEIGHT OR MOUNTING HEIGHT WILL REQUIRE THAT THE BUILDING PARAPET BE RAISED TO MEET CITY OF FRANKLIN SCREENING REQUIREMENTS.

WATER UTILITY NOTES

1. WATER MATERIALS AND INSTALLATION WILL BE IN ACCORDANCE WITH SPECIFICATIONS AND STANDARD DETAILS OF THE CITY OF FRANKLIN.
2. BACKFLOW DEVICE TO REMAIN ACCESSIBLE AT ALL TIMES.
3. DEVELOPER TO COORDINATE WITH FRANKLIN WATER MANAGEMENT REGARDING USE OF RECLAIM WATER FOR IRRIGATION PURPOSES.

SANITARY SEWER NOTES

1. ALL SEWER CONSTRUCTION SHALL BE IN ACCORDANCE WITH SPECIFICATIONS AND STANDARD DETAILS OF THE CITY OF FRANKLIN.
2. AFTER COMPLETION OF THE SANITARY SEWER, THE DEVELOPER IS RESPONSIBLE FOR THE TELEVISING OF THE LINES PRIOR TO FINAL ACCEPTANCE. THE VIDEOTAPING MUST BE COORDINATED WITH THE CITY OF FRANKLIN. ALL COSTS WILL BE BORNE BY THE DEVELOPER.
3. ALL CONNECTIONS TO EXISTING MANHOLES SHALL BE BY CORING AND RESILIENT CONNECTOR METHOD.

UTILITY PLAN IMPACT STATEMENT

THE CHEEKWOOD GOLF COURSE IS EXPECTED TO CONSUME 15,000 GALLONS PER DAY OF WATER AND GENERATE 15,000 GALLONS PER DAY OF WASTEWATER.

UTILITY PLAN NARRATIVE

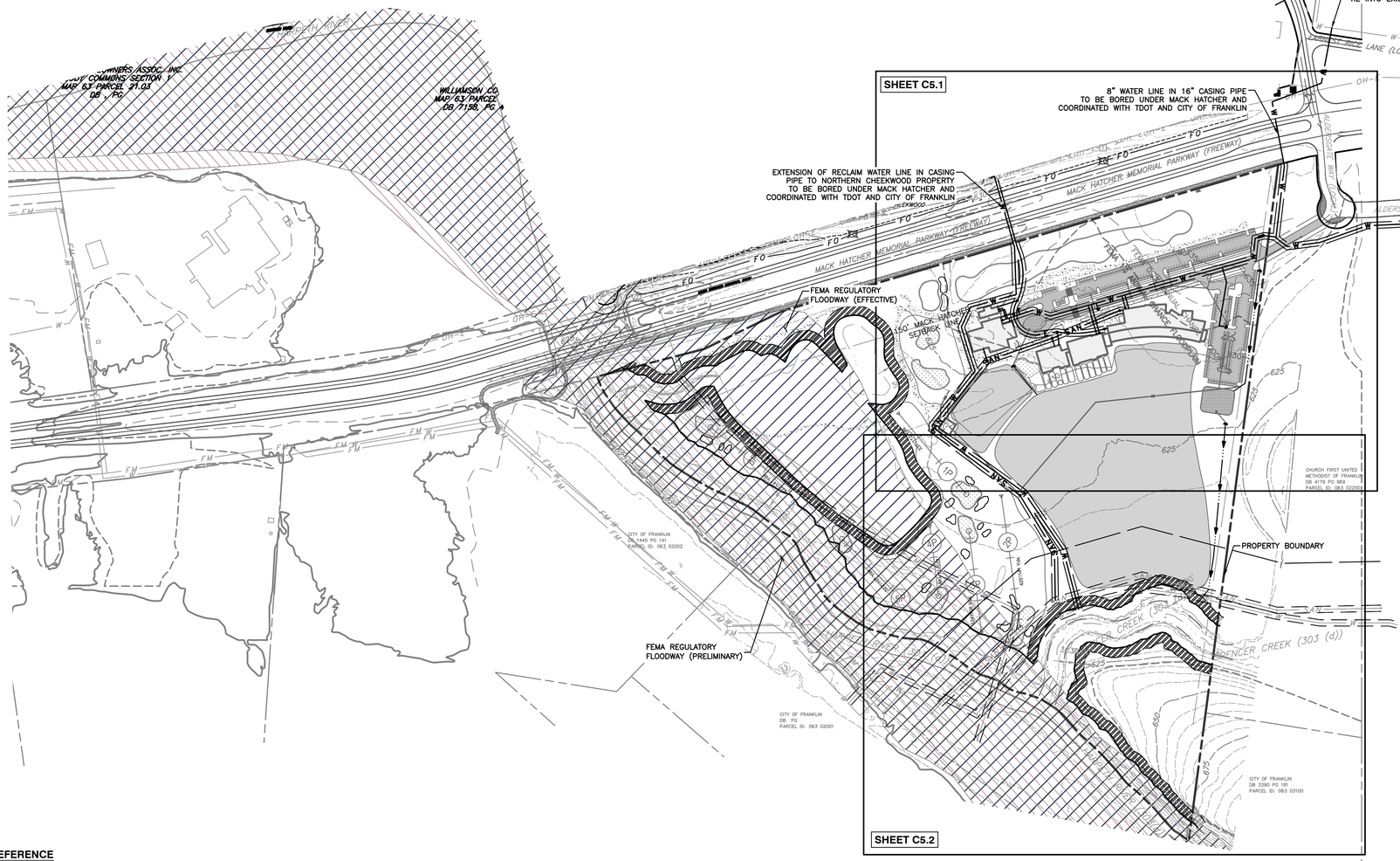
MIDDLE TENNESSEE ELECTRIC MEMBERSHIP CORPORATION, CITY OF FRANKLIN, AND ATMOS ENERGY WILL WORK WITH ENGINEERS AND CONTRACTORS.

WATER & SEWER DATA CHART

FACILITY TYPE:	COUNTRY CLUB
UNIT FLOW IN GPD:	15,000 GPD
TOTAL FLOW IN GPD:	15,000 GPD
STATIC PRESSURE OF NEAREST FIRE HYDRANT:	95 PSI
DYNAMIC PRESSURE OF NEAREST FIRE HYDRANT:	92 PSI

LEGEND

- EXISTING PROPERTY LINE
- EXISTING RIGHT-OF-WAY
- EXISTING ADJOINING PROPERTY LINE
- EXISTING ROADWAY CENTERLINE
- EXISTING GUARD RAIL
- EXISTING BRIDGE
- EXISTING EDGE OF PAVEMENT
- EXISTING STRUCTURE
- EXISTING TOP OF BANK
- EXISTING 150' MACK HATCHER SETBACK
- FEMA REGULATORY FLOODWAY (EFFECTIVE)
- FEMA REGULATORY FLOODWAY (PRELIMINARY)
- FEMA 1% ANNUAL CHANCE FLOOD HAZARD BOUNDARY
- FEMA 0.2% ANNUAL CHANCE FLOOD HAZARD BOUNDARY
- EXISTING STREAM
- EXISTING WETLAND
- EXISTING STREAM BUFFER
- EXISTING RIPARIAN BUFFER ZONE 1
- EXISTING RIPARIAN BUFFER ZONE 2
- PROPOSED STORM PIPE
- PROPOSED STORM INLET
- PROPOSED ENDWALL
- PROPOSED BIORETENTION BASIN
- PROPOSED EXTRUDED CURB
- PROPOSED CONCRETE CURB AND GUTTER
- PROPOSED BUILDING
- PROPOSED ASPHALT
- PROPOSED SIDEWALK
- PROPOSED ACCESS EASEMENT
- PROPOSED TEE-BOX LIMITS
- PROPOSED FAIRWAY LIMITS
- PROPOSED GREEN
- PROPOSED BUNKER
- PROPOSED UNDERGROUND ELECTRIC LINE
- PROPOSED OVERHEAD ELECTRIC LINE
- PROPOSED ELECTRIC POLE
- PROPOSED TRANSFORMER
- PROPOSED SANITARY SEWER LINE
- PROPOSED SANITARY SEWER MANHOLE
- PROPOSED SANITARY SEWER CLEANOUT
- PROPOSED WATER LINE



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CONTACT LIST

ELECTRIC SERVICE
MTEMC
2156 EDWARD CURD LANE
FRANKLIN, TN 37067
PHONE: 615-595-4685
CONTACT: ROGER JENKINS
E-MAIL: rjenkins@mtemc.com

GAS SERVICE
ATMOS ENERGY
200 NOAH DRIVE
FRANKLIN, TN 37064
PHONE: 615-794-2596
CONTACT: FRED NEU
E-MAIL: fred.neu@atmosenergy.com

CITY OF FRANKLIN WATER MANAGEMENT
WATER MANAGEMENT
124 LUMBER DR.
FRANKLIN, TN 37064
PHONE: 615-794-4554
CONTACT: BEN MCNEIL
EMAIL: ben.mcneil@franklintn.gov

CABLE TV SERVICE
COMCAST CABLE
660 MAINSTREAM DRIVE
NASHVILLE, TN 37228
PHONE: 615-244-7462, EXT. 1115647
CONTACT: MARLON FRIZZELL
E-MAIL: marlon_frizzell@cable.comcast.com

TELEPHONE SERVICE
AT&T
500 LIBERTY PIKE
FRANKLIN, TN 37064
PHONE: 615-595-7816
CONTACT: DAVID TUTTEROW
E-MAIL: dt8243@att.com

ENGINEERING
FRANKLIN ENGINEERING DEPARTMENT
109 THIRD AVENUE SOUTH
FRANKLIN, TN 37064
PHONE: 615-550-6676
CONTACT: LANCE FITTRO
E-MAIL: lance.fittro@franklintn.gov

PRELIMINARY NOT FOR CONSTRUCTION

SCALE IN FEET
0 200 400

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CHEEKWOOD SOUTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

SAMANTHA HALEY SEARCY
REGISTERED ENGINEER
AGRICULTURE
10/14/2021
ENGINEER
No. 120144
STATE OF TENNESSEE

Revision Date
- △ _____
- △ _____
- △ _____
- △ _____

OVERALL UTILITY PLAN

SHEET
C5.0
COF # 7416

NORTH

CONNECT TO EXISTING ELECTRIC
COORDINATE WITH MTEMC

RECLAIM WATER LINE EXTENSION FOR NORTHERN CHEEKWOOD PROPERTY TO BE BORED
UNDER MACK HATCHER AND COORDINATED WITH TDOT AND CITY OF FRANKLIN

MACK HATCHER MEMORIAL PARKWAY (FREEWAY)

8" WATER LINE
TO BE BORED UNDER MACK HATCHER AND
COORDINATED WITH TDOT AND CITY OF FRANKLIN

FALLSGATE WAY (LOCAL)

WATER METER AND BACKFLOW PREVENTER
PER CITY OF FRANKLIN STANDARDS

CONNECT TO EXISTING WATER
(POINT OF CONNECTION ASSUMED)

20' UTILITY EASEMENT (TYP.)

FEMA 1% ANNUAL CHANCE FLOODPLAIN

FEMA 0.2% ANNUAL CHANCE FLOODPLAIN

FIRE DEPARTMENT CONNECTION (TYP.)

FIRE HYDRANT ASSEMBLY (TYP.)

150' MACK HATCHER
SETBACK LINE

RECLAIM WATER LINE

SANITARY SEWER MANHOLE (TYP.)

337'-1'-12" W

20' UTILITY EASEMENT

1P

LEGEND

- EXISTING PROPERTY LINE
- EXISTING RIGHT-OF-WAY
- EXISTING ADJOINING PROPERTY LINE
- EXISTING ROADWAY CENTERLINE
- EXISTING GUARD RAIL
- EXISTING BRIDGE
- EXISTING EDGE OF PAVEMENT
- EXISTING STRUCTURE
- EXISTING TOP OF BANK
- EXISTING 150' MACK HATCHER SETBACK
- FEMA REGULATORY FLOODWAY (EFFECTIVE)
- FEMA REGULATORY FLOODWAY (PRELIMINARY)
- FEMA 1% ANNUAL CHANCE FLOOD HAZARD BOUNDARY
- FEMA 0.2% ANNUAL CHANCE FLOOD HAZARD BOUNDARY
- EXISTING STREAM
- EXISTING WETLAND
- EXISTING STREAM BUFFER
- EXISTING RIPARIAN BUFFER ZONE 1
- EXISTING RIPARIAN BUFFER ZONE 2
- PROPOSED BUILDING
- PROPOSED ASPHALT
- PROPOSED SIDEWALK
- PROPOSED ACCESS EASEMENT
- PROPOSED TEE-BOX LIMITS
- PROPOSED FAIRWAY LIMITS
- PROPOSED GREEN
- PROPOSED BUNKER
- E — PROPOSED UNDERGROUND ELECTRIC LINE
- OH-E — PROPOSED OVERHEAD ELECTRIC LINE
- PROPOSED ELECTRIC POLE
- PROPOSED TRANSFORMER
- SAN — PROPOSED SANITARY SEWER LINE
- PROPOSED SANITARY SEWER MANHOLE
- PROPOSED SANITARY SEWER CLEANOUT
- W — PROPOSED WATER LINE
- PROPOSED EXTRUDED CURB
- PROPOSED CONCRETE CURB AND GUTTER

REFERENCE

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SCALE IN FEET
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CHEEKWOOD SOUTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

SAMANTHA HALEY SEARCY
REGISTERED ENGINEER
AGENT OF RECORD
01/04/2021
COMMERCE
No. 120144
STATE OF TENNESSEE

Revision Date
- △ _____
- △ _____
- △ _____
- △ _____

ENLARGED UTILITY PLAN

SHEET
C5.1

COF # 7416

NORTH
1P
2P
3P
4P
5P
NYS
SAN
W
SAN
SAN
SAN

MATERIALS LIST

STONE

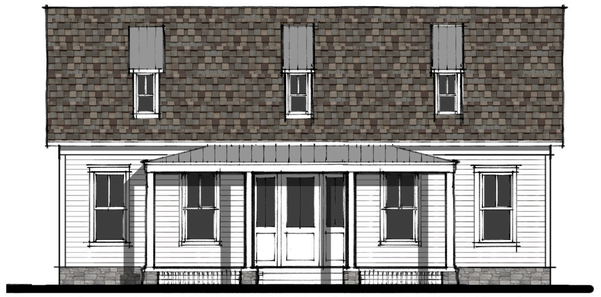
SIDING

FIXED AND OPERABLE WINDOWS

METAL ROOF

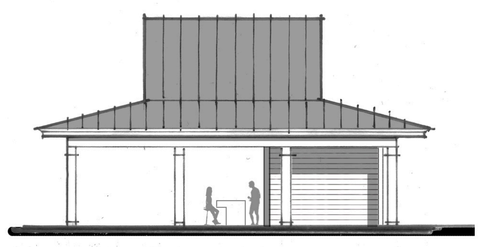
SHINGLE ROOF

CLUBHOUSE ELEVATION



PRO SHOP

CLUBHOUSE CHARACTER IMAGES



COMFORT STATION

GDC
GAMBLE
DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD
DEVELOPMENT PLAN
Franklin, Williamson County, Tennessee

MICHAEL A. HATHAWAY
REGISTERED ARCHITECT
AGRICULTURE
No. 20051
STATE OF TENNESSEE
3.4.2021

Revision Date

ARCHITECTURE

SHEET
A1.0
COF # xxxx

EVENT SPACE ELEVATION

EVENT SPACE CHARACTER IMAGES

STARTER HOUSE CHARACTER IMAGES

STARTER HOUSE ELEVATIONS

GDC
GAMBLE
DESIGN
COLLABORATIVE
DEVELOPMENT PLANNING AND
LANDSCAPE ARCHITECTURE

CHEEKWOOD SOUTH PD
DEVELOPMENT PLAN
Franklin, Williamson County, Tennessee

Revision Date

ARCHITECTURE

SHEET
A2.0
COF # xxxx

March 24, 2021

I am opposed to adding any homes as provided in the referenced application. My concerns are due to the potential impact on the environment, flooding, traffic on Spencer Creek Road and our experience with the developer(s).

I am also concerned with the destruction of wetlands, vegetation, waterways, and trees that has already taken place. In the past two weeks, crews have destroyed vegetation and trees along Deerfield Branch without a permit. On the first occurrence, my wife and a neighbor were told by the crew that they were instructed to stop if anyone asked them to do so. My wife asked them to stop. A week later, the crew was out again with heavy equipment, removing vegetation and trees from the creek, again without a permit. (See Photos) My wife called the city. An employee came out (Doug Noonan) and halted the destruction.

We often hear golf balls hitting trees along Deerfield Branch as inexperienced golfers try to come over the trees on #9. If those trees are removed as the developer/planner intends, there will be more golf balls in our yard and likely hitting our house.

The details of the development plan seem to be a ruse. The area along Deerfield Branch is labeled "Preserved Tree Canopy" yet the developers / planners have removed trees and continue to do so despite being told by Mr. Noonan to stop. On March 24, a tractor was working along the Branch removing trees and vegetation.

The developers have treated the homeowners disdainfully and have consistently acted without regard for law, regulation, or city ordinance. We do not want a bad neighbor to be allowed to continue with the proposed development. The neighborhood has acted in good faith only to be repaid with the opposite. Experience shows that if the city approves the plan, the developers will continue to act in their own interest, disregarding the environment, city, and neighbors.

Finally, adding five or six homes as proposed will destroy runoff and increase the likelihood of flooding. In the 2010 flood, the Branch spread into our backyard. Making drastic changes as planned would likely have a detrimental impact, increasing flood risk to homeowners.

Chuck Kirkpatrick
116 Broadley Ct

From:	Amy Diaz-Barriga
To:	Joseph Bryan
Subject:	FW: Cheekwood PD
Date:	Wednesday, March 24, 2021 3:26:15 PM

AMY DIAZ-BARRIGA, AICP
CURRENT PLANNING SUPERVISOR

Planning and Sustainability Department
City of Franklin
109 Third Avenue South
Franklin, TN 37064

Phone: 615-550-6732

From: Thomas Herbert <thherbert@gmail.com>
Sent: Wednesday, March 24, 2021 7:20 AM
To: Planning Intake <planningintake@franklintn.gov>
Subject: Cheekwood PD

ATTENTION COF staff: This email originated from outside the City of Franklin. Please use discretion when clicking on attachments & links from unknown senders or suspicious emails.

Franklin Planning,
Good morning, my name is Thomas Herbert. I live off Spencer Creek Road and am interested in the Cheekwood N/S proposals. It is a very interesting project and one i could support very much.

BUT, i had a very hard time understanding the proposed changes to the Harpeth River floodway. Since the submittal (attached to the FMPC packet) has there been any clarification of that map/rendering. The etchings used made it impossible to discern where the new proposed floodway extent would be. The existing is quite clear. Unless I missed it, in both the N/S sections the designer proposes to move the right bank floodway by more than 300' in places.

So i figure, that could not be accurate, but wanted to be sure. Is there another rendering that could show that more clearly? Transparent overlap, clearer color differential, e.g. I think that would be pertinent to the community considering all the relevant and potential long term impacts of this proposal.

Respectfully,
Thomas Herbert
Franklin, TN 37069

From:	Amy Diaz-Barriga
To:	Joseph Bryan
Subject:	FW: Deborah Allen Hicks... Fwd: Cheekwood Recent Events-----Before and after pictures creek destruction- Hlighted scale maps-Letter
Date:	Wednesday, March 24, 2021 3:05:33 PM
Attachments:	mime-attachment.msg

AMY DIAZ-BARRIGA, AICP
CURRENT PLANNING SUPERVISOR

Planning and Sustainability Department
City of Franklin
109 Third Avenue South
Franklin, TN 37064

Phone: 615-550-6732

From: Deborah Allen <deborahallen@comcast.net>
Sent: Tuesday, March 23, 2021 11:43 AM
To: Planning Intake <planningintake@franklintn.gov>
Cc: Raymond Hicks <raymondhicks@comcast.net>
Subject: Deborah Allen Hicks... Fwd: Cheekwood Recent Events-----Before and after pictures creek destruction- Hlighted scale maps-Letter

ATTENTION COF staff: This email originated from outside the City of Franklin. Please use discretion when clicking on attachments & links from unknown senders or suspicious emails.

Subject: Cheekwood Recent Events-----Before and after pictures creek destruction- Hlighted scale maps-Letter

Hello...
This is Deborah Allen-Hicks writing to you. My husband, Raymond Hicks and I live next door to Jeff Dykes in Cheekwood at 104 Broadley Court.
Rather than write a long letter... I will just copy you on a couple of emails from Jeff which contain excellent information. Raymond and I completely Agree with Jeff's opinions and findings. We feel very strongly about this. And what makes it even worse the way things have moved forward without permits and in general to the detriment of our properties.
Please know that we love our neighborhood and only want the best for all concerned, but we do feel very violated since our best interest seems to be the least of Mr Jester's concern.
This is our home and out life's investment. Thank you for taking the time to understand our point of view and your voice in helping us protect our properties and investment.
We are praying for your help on this matter.
Love and thank you,
Deborah Allen Hicks
615-476-4095

Dana, I am sorry for sending you so much information on this but I felt like you and others involved in the vote should know these very recent events; Also, I have attached the entire packet that was sent to all Cheekwood H.O.A. members:

Two Mondays ago, March 8th, I received a phone call from a frantic neighbor (Candice Kirpatrick), who said " Jeff, There is a tractor cutting trees down , clearing out along creek banks behind my house " . I told her I would come over and talk to the golf course employee doing the cutting/clearing with her. I went down to where this was happening with Candice. The tractor operator ask if there was a problem and Candice said " Yes " I do not want these trees cleared out behind my house along creek banks. The tractor man was nice and said " I was told to clear all this out unless somebody complained and if anyone complains to stop" . There was no more clearing done that day.

Fast forward to yesterday, March 22nd. The same neighbor called me and said " Jeff, the tractor is back and clearing banks again, but they are on the other side of creek (golf course side) working. My reply to Candice was to call the City of Franklin and let them know. Within 20 minutes a man named Doug, from the City of Franklin came out and put a stop work order on the golf course. Doug then came over to Candice's house to explain what he told the golf course workers. He said that this creek is labeled a blue line creek and a wetland on County, City and Tdec maps.. He said, no one is allowed to work/cut/clear within a 60 foot swath along creek without a permit from state and local municipalities. Doug also said that the owner will have to replace every plant/tree that has been removed in that 60 foot swath.

Attached is the entire packet I sent to all Cheekwood Homeowners. It has pictures before the golf course changed ownership in 2014, of all the Cattails , native wetland plants that were growing in creek before removed by present ownership. There is also pictures of how it looks now. I have other pictures of the recent illegal work done along hundreds of feet of spencer creek banks, of course these are areas with no homes around so nobody knew this was going on except golf course management.
Dana, Can you please forward this email to all planning commissioners, aldermen and alderwomen ad all City of Franklin staff.
Thank You for your service,
Sincerely,
Jeff Dykes

Jeff Dykes Construction, LLC
108 Broadley Court
Franklin, TN 37069
TN Contractor Lic#36071
615-456-7999 (cell)

Hello 40 Cheekwood homeowners and H.O.A. members. I assume by now you all have received the North side Golf Course submittals for the public hearing at City Hall next Thursday March 25th at 7 pm. I know that everyone has their opinion and ideas for the proposed residential streets and homes along with maintenance building with 25 parking spaces. The following is my personal opinion of how this proposal will damage our beautiful neighborhood.

1) We all live on the edge of a huge flood basin. It is wrong to build that much of impervious materials, streets, curbs, sidewalks, alleys, parking lot, rooftops in the mouth of a Blue Line creek. I have lived here 26 yrs. and during several droughts in those times Spencer Creek still had running water headed to the Harpeth River.

2) I have witnessed in the 26 years living here that during moderate rainfalls, flash rains and such, the County and the City of Franklin street departments come out and put up barricades and Danger High Water signs on Spencer Creek Road at the mouth of the creek where the storm water runs over the road several inches deep and causes hydroplaning. I have seen several wrecks due to this issue and one B.G.A. student injured when he hydroplaned and hit the stone pillars. I do not think anybody has lost their life yet and I apologize if that's not the case. I have had multiple City of Franklin and Williamson County employees tell me that the road needs to raise a minimum of 3 feet, maybe more, and larger culverts put in under road to prevent this from happening, basically a Bridge built.

3) If you look at the plan for new city street it enters the proposed subdivision right at this lowest area. Not good engineering in my opinion. I do not see any plans of raising Spencer Creek Road on this plan.

4) The housing they are proposing to build is all siding farmhouse style design and will not blend with our traditional all Brick/Stucco neighborhood. It will actually stick out like a sore thumb. If this proposal was approved, Existing Homes on Dunwoody Ct. will be looking directly at the backyards, garages and alleys as they walked out their Front Door.

5) The original proposal was to move the Maintenance Bldg. to the South Side development so that noise pollution would be away from our neighborhood, this has changed on this proposal. This is a large Maintenance building that has 25 parking spaces. The golf course is proposing doubling in size, with the addition of South portion, I would assume that the maintenance equipment will at least double, as will the noise for nearby residences.

6) It is of the opinion of several experienced well established lawyers that our Lease Agreement with the golf course owners will be in default if this proposed development passes the vote and is approved. Our lease states that the adjacent land as plated that abuts our 24+ acres of common space can only be used for a golf course. It also states that no lighting can be installed/ added to any portion of the land adjacent to our common area. If the proposal passes there will be Street Lighting and multiple home lighting, landscape lighting, Maintenance building lighting, it could be very bright at night.

7) It is a state law that anyone that owns property with a blue line creek running through the property must obtain a permit to work within a 50 ft. area of the banks of the creek. That is to remove any vegetation or disturb any soil within that 50 ft. I have witnessed a large swath of natural filtration cattails and lily pads in the creek removed by the new golf course management. The water used to be crystal clear on the low side of the creek, now it is nothing but mud washing and banks eroding. As late as last week I saw a tractor clearing out trees on the bank of the creek, when I ask him if he had a permit or was using any erosion control, he said "No, but I was told to stop if anybody complained", and he left? There is a right way to work around and in creeks to improve them, but the first thing is to get a permit.

8) The owner of the golf course has also taken down many trees on your / our HOA 24+ acres without any contact to our association, any flagging or study of the trees, no notification whatsoever. Why would somebody who says they want to be a good neighbor do that with no discussion. Would you take down your neighbor's trees?

9) In closing, I do not think that Jack Nicklaus would support any of this development proposal to build a high quality golf course. If he does, my opinion of Nicklaus Design has changed drastically. I have played a few of Nicklaus public courses around Cincinnati and in Florida, and the managers that I have talked to on those courses have said there is nothing more important to them as courtesy to surrounding neighbors and the environment. That does not seem to be the case here. I 100% support the expansion of the Golf Course but 100% disagree with the sub-division/city street/commercial development proposal up for vote next Thursday March 25, 7 pm. This is a public zoom meeting so this is the chance our neighborhood has to speak with Planning Commission who will be voting.

Thank You for your time,
Jeff Dykes

Public Hearing - 3-25-21 7 PM

March 10, 2021

Public Notification Letter – Cheekwood

PUBLIC NOTICE
This letter is written to provide public notice that the Franklin Municipal Planning Commission (FMPC) will be considering a proposed Development Plan and Rezoning for the properties located at Map 063, Parcels 2101, 2102 and 2103, Map 052N A, Parcel 00100 and Map 063C A, Parcel 00100 at 285 Spencer Creek Road in Franklin, TN. The request will be heard by the FMPC on Thursday, March 25, 2021 at 7:00 pm in the Board Room at the Franklin City Hall. Please see the information below for more details.

APPLICANT
Gamble Design Collaborative

APPLICANT'S REPRESENTATIVE
Gamble Design Collaborative 324 Liberty Pike, Suite 145, Franklin, TN 37064
Greg Gamble 615-975-5765 greg.gamble@gdc-tn.com

APPLICATION TYPE
Development Plan and Rezoning

DATE, TIME, AND PLACE OF PUBLIC MEETING
Thursday, March 25, 2021 at 7:00 pm in the City Hall Board Room, located at 109 3rd Avenue in Franklin, Tennessee.

SUBJECT PROPERTY
Map 063, Parcels 2.00, 2.01, 2.02. Map 052, Parcel 7.00 and Map 052O, Group A, Parcel 27.00

NATURE AND SCOPE OF THE APPLICANT REQUEST
Two separate Development Plans and Rezonings, proposing a redesign of the Cheekwood Golf Course. The Development Plan for the north side of Mack Hatcher will redesign the golf course and add six residential lots. The Development Plan for the south side of Mack Hatcher will expand the golf course to the City-leased property. The clubhouse will be rebuilt on the southern property, as well as a golf practice facility with 3 story driving range and an associate restaurant.

WHERE TO VIEW THE PROPOSED PLAN
The application may be viewed in the Planning and Sustainability Department, City Hall, 109 3rd Avenue South, Franklin, TN 37064. The Department phone number is 615-791-3212.

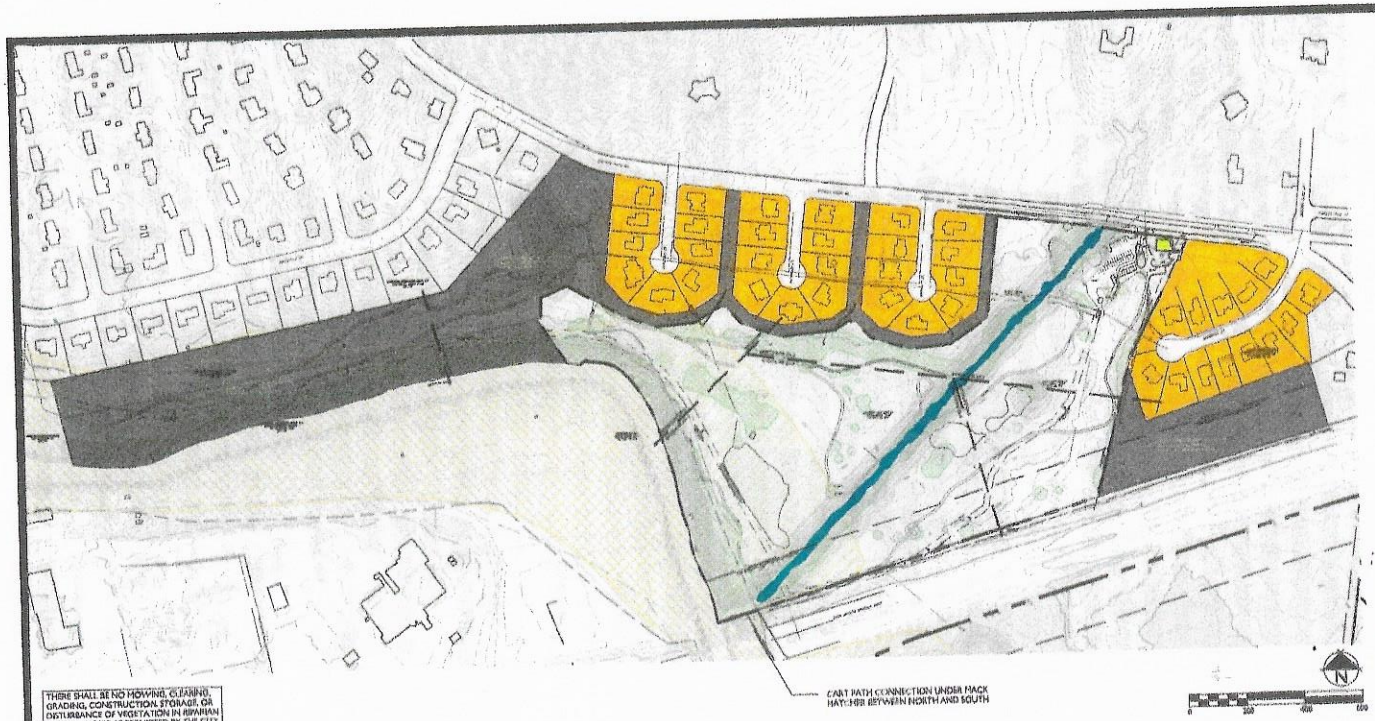
WHERE THE PUBLIC CAN BE HEARD
Accommodations have been made to ensure that the public is able to participate in the meeting on Thursday, March 25, 2021 at 7:00 pm with respect to the application. The public may participate in the following ways:

- Watch the meeting on FranklinTV or the City of Franklin website https://www.franklintn.gov/franklintv
- Watch the live stream through the City of Franklin Facebook https://www.facebook.com/CityOfFranklin and YouTube accounts https://www.youtube.com/user/CityOfFranklin

- Call in to the conference meeting 1-312-626-6799; Meeting ID: 990 0449 6156; Password: 476160. Callers will be unmuted and given the opportunity to comment during the meeting at specific times.

- The public may email comments to planningintake@franklintn.gov to be provided in full to the Commission and included in the minutes, but not read aloud in their entirety during the meeting. Emailed comments will be accepted until 12:00 PM (noon) on the day before the meeting.

- Public comment options will be published with the agenda, or a citizen can call the City of Franklin Planning and Sustainability Department for more information at 615-791-3212.



THERE SHALL BE NO MOWING, CLEARING, GRADING, CONSTRUCTION, STORAGE, OR DISTURBANCE OF VEGETATION IN RIPARIAN BUFFERS EXCEPT AS PERMITTED BY THE CITY ENGINEER, OR HIS DESIGNEE.

SITE DATA CHART

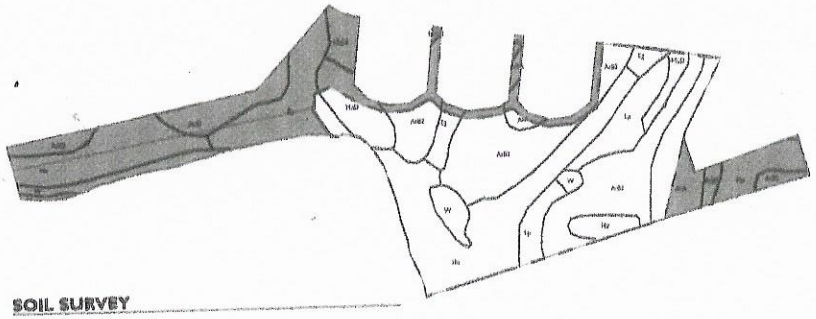
PROJECT NAME:	CHEEKWOOD NORTH PD
PROJECT NUMBER:	7414
ADDRESS	865 PANTHER CREEK ROAD FRANKLIN, TN 37064 (WILLIAMSON CO.)
PARCEL(S):	021.02 (PT.)
ACREAGE OF SITE: VESTING OF APPLICANT:	35.34 AC
BASE ZONING:	RD (PLANNED DISTRICT) RM (RESIDENTIAL 1 DISTRICT)
PROPOSED ZONING: ZONING OVERLAY(S):	RD (PLANNED DISTRICT) HCO, FWO, FFO
BUILDING TYPES APPLIED: FRONTAGE TYPES APPLIED: LOT WIDTH (RESIDENTIAL): LOT SIZE (RESIDENTIAL): SETBACKS: FRONT: SIDE: REAR:	HOUSE YARD FRONTAGE 70' 9,800 SF/EA 15' 5' 20'
DWELLING UNIT COUNT BY TYPE: SINGLE FAMILY: MULTIFAMILY:	91 UNITS N/A
NON-RESIDENTIAL SF BY TYPE: PUBLIC HOUSE: HALFWAY HOUSE: TURF/HUNTER RANGE AMENITY:	N/A 1,500 SF 12,000 SF
HOTEL KEYS: EVENT CENTER SF:	N/A MAX 5,000 SF
PARK AND DEDICATION:	6 UNITS X $450 = $2,700
MINIMUM TREE CANOPY REQUIRED: OPEN SPACE REQUIRED: NATURAL AREA REQUIRED: TREE CANOPY RETENTION CREDIT:	15% 13.17 AC 6A (NOT REQUIRED) 5.26 AC (40% OF TOTAL CANOPY) PROVIDED 6.15 AC (46.7% OF TOTAL CANOPY)
PARKING REQUIRED BY ORD. SINGLE FAMILY PARKING:	182 ATTACHED / PARKED BY LOT
PARKING PROVIDED BY ORD. SINGLE FAMILY PARKING:	182 ATTACHED / PARKED BY LOT
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 116 CROFT PLACE FRANKLIN, TN 37064 (615) 519-4262

KEY - EXISTING CONDITIONS

- EXISTING TREE CANOPY
- FWO; PROPOSED
- FWO; EFFECTIVE
- FFO
- 30'/60', ZONE 1 RIPARIAN BUFFER
- 30', ZONE 2 RIPARIAN BUFFER

EXISTING CHEEKWOOD

EXISTING BARN



SOIL SURVEY

ArA	Armour silt loam, 0 to 2 percent slopes
ArB	Armour silt loam, 2 to 5 percent slopes
ArB2	Armour silt loam, 2 to 5 percent slopes, eroded
ArC	Armour silt loam, 5 to 12 percent slopes 1.6
ArC2	Armour silt loam, 5 to 12 percent slopes, eroded
BrC2	Braxton charty silt loam, 5 to 12 percent slopes, eroded
Eg	Egam silt loam, phosphatic
HbC2	Hampshire silt loam, 5 to 12 percent slopes, eroded
HcC3	Hampshire silty clay loam, 5 to 12 percent slopes, severely eroded
Hu	Huntington silt loam, phosphatic
Lp	Lindell silt loam, 0 to 2 percent slopes, occasionally flooded
MbB2	Maury silt loam, 2 to 5 percent slopes, eroded
McC3	Maury silty clay loam, 5 to 12 percent slopes, severely eroded
MoD	Ashwood-Mimosa-Rock outcrop complex, 5 to 15 percent slopes
Rc	Rockland
W	Water

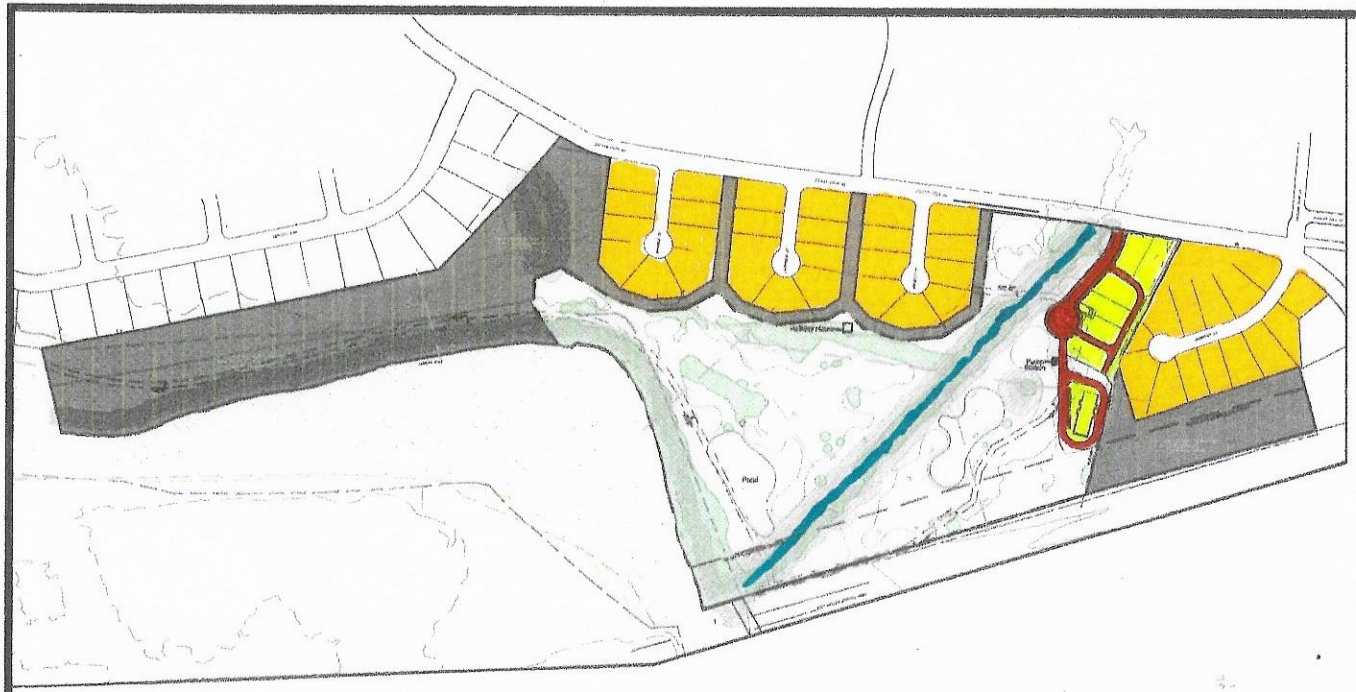
GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD
DEVELOPMENT PLAN
Franklin, Williamson County, Tennessee

GRACE A. RECOR
REGISTERED LANDSCAPE ARCHITECT
STATE OF TENNESSEE NO. 1301

Revision Date

OVERALL EXISTING CONDITIONS SHEET
C1.0
COF # 7414



THERE SHALL BE NO MOWING, CLEARING, GRADING, CONSTRUCTION, STORAGE, OR DISTURBANCE OF VEGETATION IN RIPARIAN BUFFERS EXCEPT AS PERMITTED BY THE CITY ENGINEER, OR HIS DESIGNEE.

KEY - DEVELOPMENT PLAN

- PRESERVED TREE CANOPY
- OPEN SPACE
- FWO; PRELIMINARY
- FWO; EFFECTIVE
- FFO
- 30'/60', ZONE 1 RIPARIAN BUFFER
- 30', ZONE 2 RIPARIAN BUFFER

EXISTING CHEEKWOOD

PROPOSED STREETS & ALLEYS

PROPOSED DEVELOPMENT

0 200 400 600

SITE DATA CHART

PROJECT NAME:	CHEEKWOOD NORTH PD
PROJECT NUMBER:	TBD
ADDRESS:	201 SPENCER CREEK ROAD FRANKLIN, TN 37064, 26TH CIVIL DISTRICT
PARCEL(S):	062 02102
ACREAGE OF SITE:	16.25 AC
EXISTING (IF APPLICABLE):	
BASE ZONING:	PD (PLANNED DISTRICT) RS (RESIDENTIAL 1 DISTRICT)
PROPOSED ZONING:	PD (PLANNED DISTRICT)
ZONING OVERLAY(S):	SCO, FWO, FFO
BUILDING TYPES ALLOWED:	HOUSE
FRONTAGE TYPES ALLOWED:	YARD, TERRACE
LOT WIDTH (MINIMUM):	70'
LOT SIZE (MINIMUM):	10,000 SF
SETBACKS:	
FRONT	25'
SIDE	10'
REAR	25'
DWELLING UNIT COUNT BY TYPE:	
SINGLE FAMILY:	41 UNITS
MULTI-FAMILY:	N/A
NON-RESIDENTIAL SF BY USE:	
RETAIL:	N/A SF
RESTAURANT:	1,500 SF
HOTEL KEYS:	N/A
PARKING PROVIDED:	PARK'S PROPOSED
PARKLAND DEDICATION:	41 UNITS X 0.0044 = 0.18 AC
MINIMUM OSR:	35% (5.7 AC)
OPEN SPACE PROVIDED:	50% (NOT REQUIRED)
NATURAL AREA REQUIRED:	REQUIRED 2.85 AC (50% OF TOTAL CANOPY)
TREE CANOPY RETENTION ACREAGE:	PROVIDED 4.0 AC (70% OF TOTAL CANOPY)
PARKING REQUIRED BY USE:	
SINGLE FAMILY PARKING:	SEE ATTACHED PARKING STUDY
PARKING PROVIDED BY USE:	
SINGLE FAMILY PARKING:	SEE ATTACHED PARKING STUDY
APPLICANT:	GAMBLE DESIGN COLLABORATIVE 104 EAST 7TH AVENUE SUITE 101 COLUMBIA, TN 38401 (615) 481-0014

OPEN SPACE REQUIREMENT

MINIMUM OPEN SPACE REQUIREMENT IS:
REQUIRED: 35 TOTAL = 5.7 AC
UNDISTURBED AREA = NOT REQUIRED
PROVIDED: 50 AC TOTAL (81.5%)

LOT	TYPE	AREA (SF)

NOTE: OPEN SPACE PLANTINGS WILL BE BASED ON THE 75 MINIMUM OPEN SPACE REQUIRED BY THE ZONING ORDINANCE, NOT ON THE TOTAL OPEN SPACE PROVIDED.

TREE CANOPY RETENTION

OVERALL SITE AREA = 16.25 AC

TREE CANOPY:

TOTAL EXISTING TREE CANOPY:	4.0 AC (24.6% OF SITE)
REQUIRED CANOPY PRESERVATION:	2.85 AC (70% OF TOTAL)
PROVIDED CANOPY PRESERVATION:	4.0 AC (24.6% OF SITE)

STATEMENT OF IMPACTS

WATER FACILITIES
WATER SERVICE WILL BE PROVIDED BY . THE WATER MAINS ARE LOCATED ALONG .
0 UNITS x 250 GPD = 1,000 GPD

SEWER FACILITIES
SEWER SERVICE WILL BE PROVIDED BY THE CITY OF FRANKLIN.

REPURIFIED (REUSE) WATER FACILITIES
AVAILABLE. SEE UTILITY SHEETS.

POLICE, FIRE, AND RECREATIONAL FACILITIES
NEAREST POLICE STATION: HEADQUARTERS (3.1 MILES)
NEAREST FIRE STATION: FIRE STATION #4 (1.7 MILES)
NEAREST RECREATIONAL FACILITY: WILLIAMSON COUNTY RECREATION CENTER (1.7 MILES)

PROJECTED STUDENT POPULATION
0 x 0.39 = 2 STUDENTS

REFUSE STORAGE AND SANITATION COLLECTION FACILITIES
REFUSE COLLECTION FOR THE DEVELOPMENT SHALL BE PROVIDED BY CITY OF FRANKLIN

GDC
GAMBLE DESIGN COLLABORATIVE
DEVELOPMENT PLANNING AND LANDSCAPE ARCHITECTURE

CHEEKWOOD NORTH PD DEVELOPMENT PLAN

Franklin, Williamson County, Tennessee

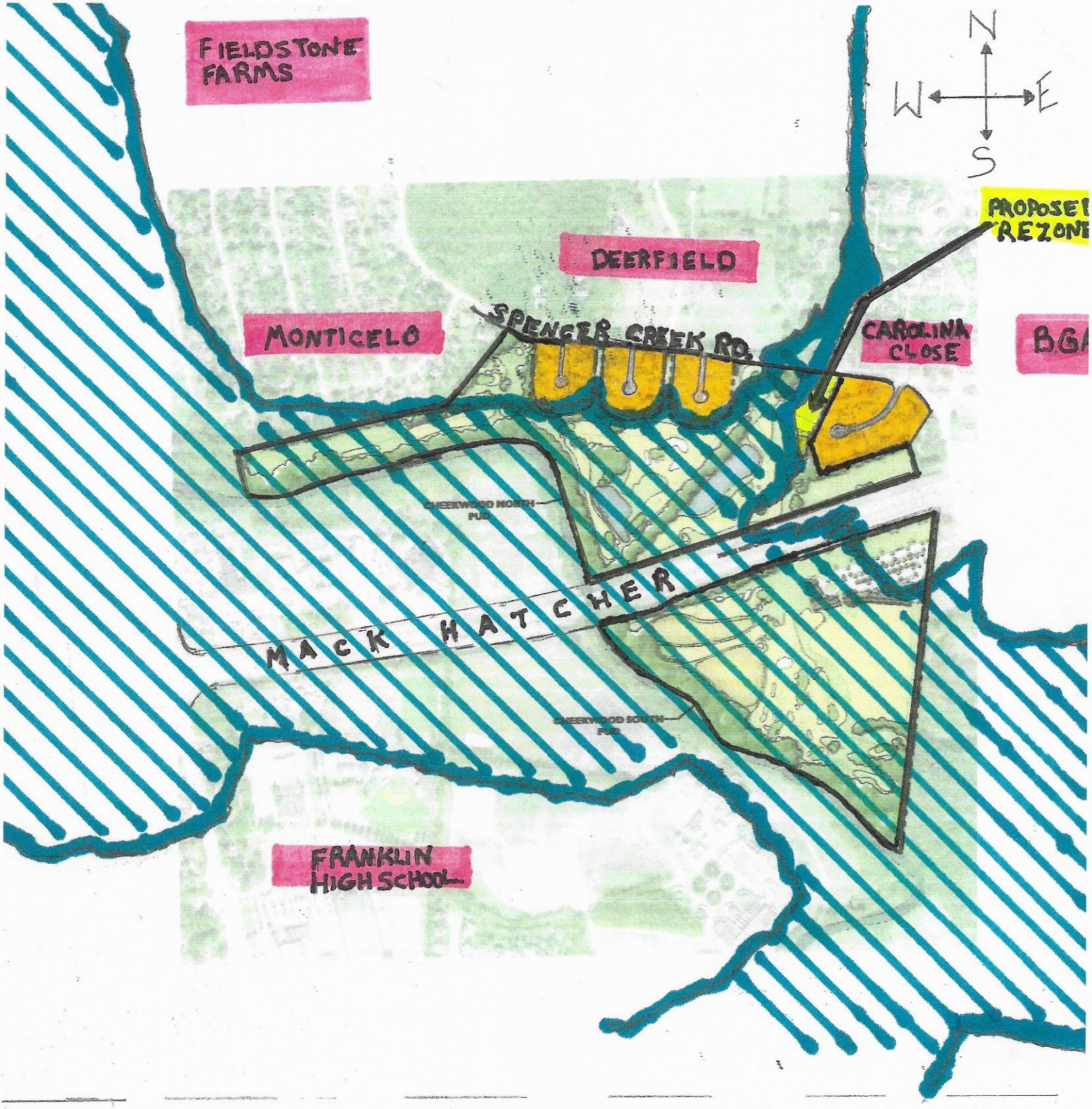
BRUCE A. REEKER REGISTERED LANDSCAPE ARCHITECT

Revision Date

DEVELOPMENT PLAN SHEETS

SHEET C2.0

DOF # 7414

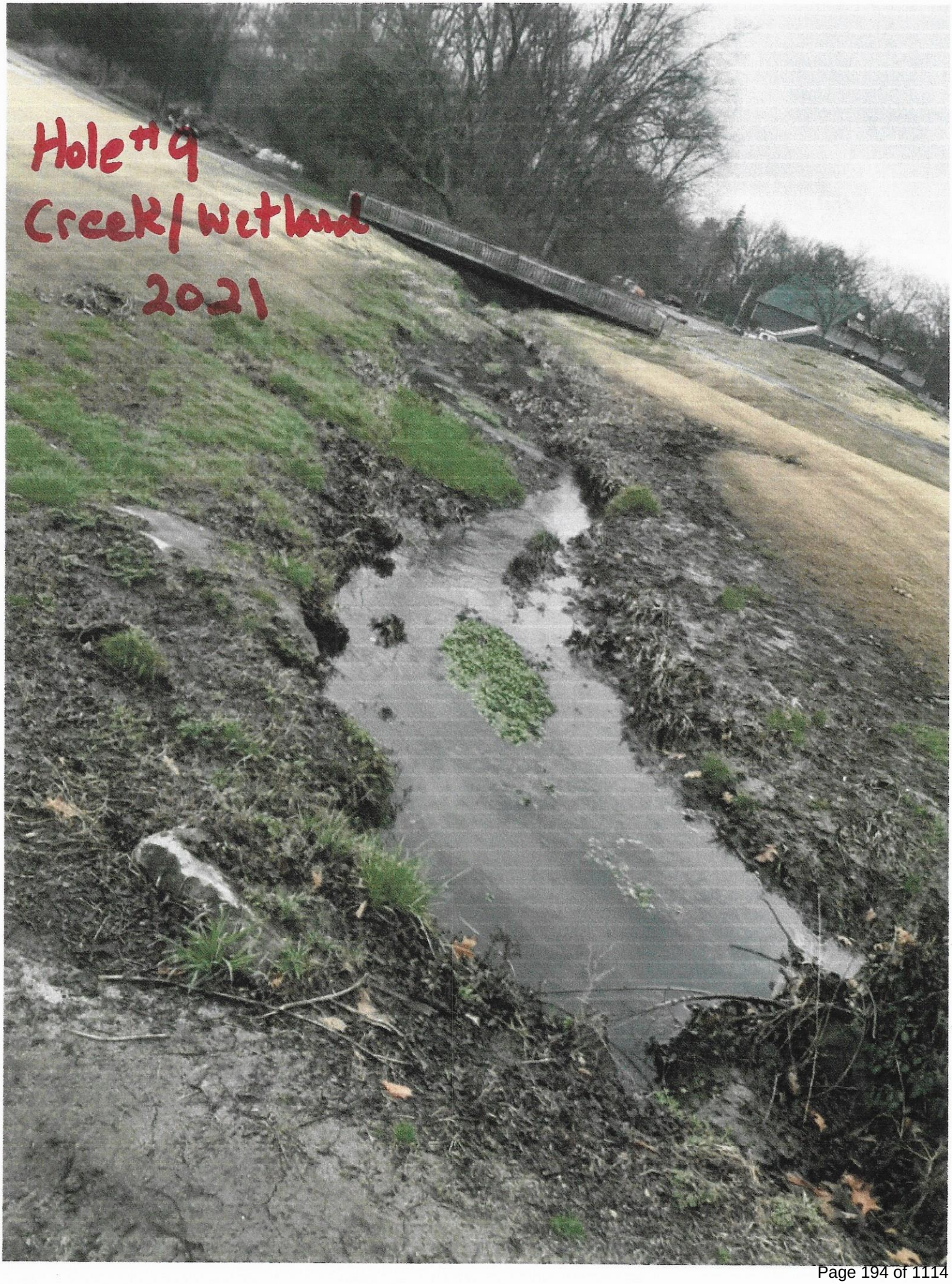


CHEEKWOOD-EXISTING 40 HOMES

NEW FLOOD PLAIN OVERLAY

PROPOSED DEVELOPMENT

Hole #9
Creek/Wetland
2014


Hole #9
Creek/wetland
2021

Hole #9
Creek/Wetland
2021

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01860

DATE: April 1, 2021

TO: Board of Mayor and Aldermen

FROM: Eric Stuckey, City Administrator
Paul Holzen, Director of Engineering
William Banks, Staff Engineer

SUBJECT:

*Consideration Of COF Contract No. 2021-0064, An Agreement Between The Department Of The Army And City Of Franklin, Tennessee, To Provide Real Estate Assistance For The Harpeth River Flood Risk Management Project (U.S. Army Corps Of Engineers Home Raising Program).

PURPOSE:

The purpose of this memorandum is to provide information to the Franklin Board of Mayor and Aldermen (BOMA) concerning the consideration of COF Contract No. 2021-0064, an agreement between The Department of the Army and City Of Franklin, Tennessee, to provide real estate assistance for the Harpeth River Flood Risk Management Project (U.S. Army Corps of Engineers Home Raising Program).

BACKGROUND/STAFF COMMENTS:

Resolution 2020-181, a resolution approving a Project Partnership Agreement (PPA), COF Contract No. 2020-0071, between the Department of the Army, represented by the United States Army Corps of Engineers (USACE), and City of Franklin for the Harpeth River Flood Risk Management Project (Home Raising Program) was approved on October 27, 2020, allowing the program to move in the construction phase. As part of the PPA, the USACE requires certain administrative real estate functions to be provided by the USACE or the City of Franklin. This new agreement, COF Contract No 2021-0064, allows the USACE to perform all real estate functions for the project.

There are two properties in the Ewingville neighborhood that were impacted by the flooding on March 27th and 28th that would benefit by entering into the USACE home raising program as soon as possible. Both properties have previously been identified as eligible for the program and the property owners desire to participate in the project. Entering the USACE program now will allow these residents to include the cost of temporary housing into the project cost (an anticipated and eligible expense). Per Executive Order 2021-01, declaring a local state of emergency for the recent flooding, the City Administrator has the authority to enter into this agreement as it promotes the well-being of the community. This will allow these two property owners to initiate their involvement in the USACE home raising program as soon as possible. The City's Law Department has reviewed and approved the agreement.

FINANCIAL IMPACT:

All costs associated with this new agreement are already built in to the approved PPA. Per PPA Article VI – Payment of Funds: Construction costs are projected to be $4,955,750 if all 35 eligible homeowners participate, with the Corps share of such costs projected to be $3,221,237.50 (65%) and the Non-Federal Sponsor's (City of Franklin/Homeowner) share of such costs projected to be $1,734,512.50 (35%). These amounts are estimates only and are subject to be updated once we have actual contractor estimates in place.

Funding for the city's portion of the project is allocated from the General Fund/Capital Bonding, as approved per Resolution 2019-68 (the adopted FY 2019-2028 CIP).

RECOMMENDATION:

Staff recommends that the Board of Mayor and Aldermen approve COF Contract No. 2021-0064.

COF CONTRACT NO. 2021-0064

AGREEMENT BETWEEN THE DEPARTMENT OF THE ARMY AND CITY OF FRANKLIN, TENNESSEE, TO PROVIDE REAL ESTATE ASSISTANCE FOR THE HARPETH RIVER, FRANKLIN, TENNESSEE SECTION 205 FLOOD RISK MANAGEMENT

THIS AGREEMENT, by and between the Department of the Army, represented by the Nashville District Corps of Engineers, acting though its Chief of Real Estate Division (hereinafter the "Corps"), the City of Franklin, Tennessee, acting through its Mayor (hereinafter the "City");

WITNESSETH, THAT:

WHEREAS, Implementation of the Harpeth River, Franklin, Tennessee Section 205 Flood Risk Management Project, (hereinafter the "Project"), was authorized by Section 205 of the Flood Control Act of 1948, as amended (33 U.S.C. § 701s) (hereinafter "Section 205"), to undertake construction of small nonstructural flood risk management projects not specifically authorized by Congress. The Project includes the elevation of thirty-five (35) residential structures be carried out pursuant to Section 205. The Project includes the Harpeth River Watershed area;

WHEREAS, the Department of the Army and the City of Franklin entered into a project partnership agreement (hereinafter "PPA") on October 27, 2020, for a flood risk management project on Harpeth River in Williamson County, Tennessee, under the authority of Section 205 of the Flood Control Act of 1948, as amended, and Section 103 of the Water Resources Development Act of 1986 (Public Law 99-662); and

WHEREAS, Article II. Section B.1. of the PPA provides that the Non-Federal Sponsor shall provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform all relocations (hereinafter LERRDs) determined by the Government to be necessary for implementation, operation, and maintenance of the structural and nonstructural aspects of the Project;

WHEREAS, Article III. Section D. of the PPA provides that, the Non-Federal Sponsor may request in writing that the Government acquire all or specified portions of such real property interests, construct placement area improvements, perform necessary relocations of facilities or utilities and assist the Non-Federal Sponsor, as part of its acquisition of the required real estate, in providing relocations of the displaced individuals in accordance with Public Law 91-646

(hereinafter "P.L. 91-646"). The Non-Federal Sponsor's payment for all such services shall be in advance of the Government incurring any financial obligation therefore, in accordance with Article VI. Section F. of the PPA;

WHEREAS, the Government and the Non-Federal Sponsor desire to enter into this separate agreement providing for the Government to provide Real Estate assistance, on behalf of the Non-Federal Sponsor.

NOW, THEREFORE, the Government and the Non-Federal Sponsor agree as follows:

1. This Agreement is in support of and in furtherance of the PPA and shall not be interpreted in any manner inconsistent with or in contradiction to the PPA. The mention of any specific provision of the PPA in this Agreement shall not operate to exclude reference to nor negate any other provision of the PPA.

2. The Government shall, on behalf of the Non-Federal Sponsor, provide Real Estate assistance, in accordance with Article III of the PPA, to be necessary for the implementation, operation, and maintenance of the Project. Acquisitions shall include the authority to accept delivery of all instruments of conveyance on behalf of the Non-Federal Sponsor.

3. The Government shall furnish all services and work under this Agreement in accordance with applicable U.S. laws and regulations. Unless otherwise required by law, all contract work undertaken by the Government shall be performed in accordance with Department of the Army procurement and claims policies and procedures. All real estate work shall be performed in accordance with Department of Army real estate regulations as well as other applicable law.

4. The Non-Federal Sponsor shall pay for the services to be provided pursuant to this Agreement in advance of the Government incurring any financial obligation for said services, in accordance with Article VI of the PPA. The Government will draw on the funds provided by the Non-Federal Sponsor such sums as the Government deems necessary to cover contractual and in-house financial obligations attributable to the services provided hereunder, as they are incurred.

5. The procedures for keeping books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the Agreement shall be those developed and used in accordance with Article X of the PPA.

6. The Project Coordination Team appointed in accordance with Article II.L. of the PPA shall, in addition to the tasks specified in Article V of the PPA, generally oversee implementation of the services to be provided pursuant to this Agreement.

7. Either the Government or the Non-Federal Sponsor may terminate this Agreement by providing 60 calendar days written notice to the other party.

8. In the event of termination of this Agreement, the Government and the Non-Federal Sponsor shall consult with each other concerning all claims for termination costs. The Non-Federal Sponsor shall continue to be obligated for payment of costs incurred by the Government under this Agreement, for costs of closing out or transferring any ongoing contracts, and for costs of litigating all civil actions arising pursuant to this Agreement to final resolution.

9. As provided in Article IX of the PPA, before either party to this Agreement may bring suit in any court concerning an issue relating to this Agreement, such party must first seek in good faith to resolve the issue through negotiation or other forms of nonbinding alternative dispute resolution mutually acceptable to the parties.

10. The principal personnel and points of contact for matters relating to this Agreement shall be the representatives of the parties appointed to the Project Coordination Team.

11. This Agreement may be modified or amended only by written agreement of the parties.

12. This Agreement shall be effective upon the date of the signature of the District Engineer.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement on the day and date first above-recited.

THE DEPARTMENT OF THE ARMY CORPS OF ENGINEERS NASHVILLE DISTRICT	CITY OF FRANKLIN, TENNESSEE
BY: _____ Sonny B. Avichal, P.E. Lieutenant Colonel, U.S. Army District Engineer	BY: _____ Dr. Ken Moore City of Franklin, Tennessee Mayor
DATE: _____	DATE: _____

BY: _____
Michael T. Abernathy
District Chief of Real Estate
Real Estate Contracting Officer

DATE: _____

ATTEST:

BY: _____
CLERK

DATE: _____

COF CONTRACT NO. 2021-0064

CERTIFICATE OF AUTHORITY

I, _____, do hereby certify that I am the principal legal officer of the CITY OF FRANKLIN, TENNESSEE, that the CITY OF FRANKLIN, TENNESSEE is a legally constituted public body with full authority and legal capability to perform the terms of the Agreement between the Department of the Army and the CITY OF FRANKLIN, TENNESSEE in connection with the HARPETH RIVER, FRANKLIN, TENNESSEE SECTION 205 FLOOD RISK MANAGEMENT PROJECT, and to pay damages, if necessary, in the event of the failure to perform in accordance with the terms of this Agreement, as required by Section 221 of Public Law 91-611, as amended (42 U.S.C. Section 1962d-5b), and that the person who has executed this Agreement on behalf of the CITY OF FRANKLIN, TENNESSEE, has acted within their statutory authority. The Mayor of the City of Franklin and his successor has the authority to enter into the agreement and any other agreement to accomplish the mission of the project.

IN WITNESS WHEREOF, I have made and executed this certification this _____ day of _____20___.

_____
City Attorney

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01903

DATE: April 1, 2021

TO: Board of Mayor and Aldermen

FROM: Eric Stuckey, City Administrator
Paul Holzen, Director of Engineering
William Banks, Staff Engineer

SUBJECT:

*Consideration Of Resolution 2021-78, A Resolution Authorizing The City Administrator To Execute Department Of The Army Flood Proofing Participation Agreements And City Of Franklin Homeowner Funding Agreements For The Harpeth River Flood Risk Management Project (U.S. Army Corps Of Engineers Home Raising Program).

PURPOSE:

The purpose of this memorandum is to provide information to the Franklin Board of Mayor and Aldermen (BOMA) concerning Resolution 2021-78, a resolution authorizing the City Administrator to execute Department Of The Army Flood Proofing Participation Agreements and City Of Franklin Homeowner Funding Agreements for the Harpeth River Flood Risk Management Project (U.S. Army Corps Of Engineers Home Raising Program).

BACKGROUND/STAFF COMMENTS:

Resolution 2020-181, a resolution approving a Project Partnership Agreement (PPA), COF Contract No. 2020-0071, between the Department of the Army, represented by the United States Army Corps of Engineers (USACE), and City of Franklin for the Harpeth River Flood Risk Management Project (Home Raising Program) was approved on October 27, 2020, allowing the program to move in to the construction phase. As part of the PPA, the USACE requires a construction Flood Proofing Participation Agreement (FPPA) between the USACE, City of Franklin, and homeowners. The FPPA officially brings the homeowners on to the home raising program, gives the specific program details and requirements of all three parties, and will need to be executed with each participating homeowner (35 eligible properties).

Also, in order to create the mechanism for the City of Franklin to receive the homeowner's 17.5% contribution to the construction costs, a separate Homeowner Funding Agreement between the City of Franklin and each participating homeowner (35 eligible properties) is required. This funding agreement states the homeowner must submit their full estimated 17.5% cost share to the City of Franklin before construction can commence.

This proposed Resolution 2021-78 will allow the City Administrator to execute both the Flood Proofing Participation Agreements and Homeowner Funding Agreements with each individual

homeowner. If this resolution is approved, the process of executing the possible 70 construction related agreements will be more efficient, thereby minimizing contract administration and construction delays.

See the attached draft Flood Proofing Participation Agreement and draft Homeowner Funding Agreement that the City Administrator would be executing.

FINANCIAL IMPACT:

All costs associated with this agreement are already built in to the approved PPA. Per PPA Article VI – Payment of Funds: Construction costs are projected to be $4,955,750 if all 35 eligible homeowners participate, with the USACE share of such costs projected to be $3,221,237.50 (65%) and the Non-Federal Sponsor's (City of Franklin/Homeowner) share of such costs projected to be $1,734,512.50 (35%). These amounts are estimates only and are subject to be updated once we have actual contractor estimates in place.

Funding for the city's portion of the project is allocated from the General Fund/Capital Bonding, as approved per Resolution 2019-68 (the adopted FY 2019-2028 Capital Investment Plan).

RECOMMENDATION:

Staff recommends that the Board of Mayor and Aldermen approve Resolution 2021-78.

RESOLUTION NO. 2021-78

A RESOLUTION AUTHORIZING THE CITY ADMINISTRATOR TO EXECUTE DEPARTMENT OF THE ARMY FLOOD PROOFING PARTICIPATION AGREEMENTS AND CITY OF FRANKLIN HOMEOWNER FUNDING AGREEMENTS FOR THE HARPETH RIVER FLOOD RISK MANAGEMENT PROJECT (U.S. ARMY CORPS OF ENGINEERS HOME RAISING PROGRAM).

WHEREAS, the May 2010 flood event created devastation throughout the Harpeth River Watershed and caused 4 fatalities and more than $480 million in direct economic impacts in the Harpeth River Watershed alone. For this reason, the Department of the Army, represented by the United States Army Corps of Engineers (Corps), conducted a preliminary reconnaissance of the Harpeth River Watershed and found more than 850 structures in the regulated floodplain within the basin located in the City of Brentwood, City of Franklin, Williamson County, and Davidson County; and

WHEREAS, on June 13, 2013, the Corps, City of Franklin, Metropolitan Nashville and Davidson County, City of Brentwood, and Williamson County signed an initial Feasibility Study Agreement to analyze alternative flood risk management options. The feasibility study evaluated numerous flood risk management options and provided an analysis of cost and benefits associated with various projects. The Corps determined that one project was considered economically justified, that being a home raising program; and

WHEREAS, on September 12, 2016, the City of Franklin entered in to a second agreement with the Corps to fully develop the flood risk management project/home raising program; and

WHEREAS, on July 10, 2018, the Board of Mayor and Aldermen approved Resolution 2018-53, "A Resolution Authorizing Staff to Proceed with the Home Raising Project Developed by the United States Army Corps of Engineers as part of the Harpeth River Feasibility Study"; and

WHEREAS, on April 23, 2019, the Board of Mayor and Aldermen approved Resolution 2019-53, agreeing to participate in the project as the Non-Federal Sponsor, with the source funding for the project being: the Corps agrees to pay for 65% of the construction, temporary relocation, and project administration costs, and the 35% of remaining Non-Federal Sponsor project costs are split 50/50 between the City of Franklin and eligible home raising property homeowner (65% Corps / 17.5% City of Franklin / 17.5% homeowner); and

WHEREAS, on October 27, 2020, the Board of Mayor and Aldermen approved Resolution 2020-181, a resolution approving a Project Partnership Agreement (PPA), COF Contract No. 2020-0071, between the Corps and City of Franklin which outlined the cost share/contributions of both the Corps and City of Franklin for the home raising construction and project administration, thereby allowing the project to move in to the construction phase; and

WHEREAS, a required construction Flood Proofing Participation Agreement (FPPA) between the Corps, City of Franklin, and homeowners officially brings the homeowners into the home raising program, gives the specific program details and requirements of all three parties, and will need to be executed with each participating homeowner (35 eligible properties); and

WHEREAS, in order to create the mechanism for the City of Franklin to receive the homeowner's 17.5% contribution to the construction costs, a separate Homeowner Funding Agreement between the City of Franklin and each participating homeowner (35 eligible properties) is required and states the homeowner must submit their full estimated 17.5% cost share to the City of Franklin before construction can commence; and

WHEREAS, the Board of Mayor and Aldermen desire to make the process of executing the possible 70 construction related agreements expeditious, thereby minimizing contract administration and construction delays.

NOW THEREFORE, BE IT RESOLVED, BY THE BOARD OF MAYOR AND ALDERMEN OF THE CITY OF FRANKLIN, TENNESSEE, AS FOLLOWS: The City Administrator is authorized to execute all Home Raising Program related Flood Proofing Participation Agreements and City of Franklin Homeowner Funding Agreements with the Corps and eligible homeowners.

IT IS SO RESOLVED AND DONE on this ____ day of _____ 2021.

ATTEST:

By:_____
ERIC S. STUCKEY
City Administrator

CITY OF FRANKLIN, TENNESSEE:

By:_____
DR. KEN MOORE
Mayor

Approved as to Form:

By: _____
Shauna R. Billingsley
City Attorney

Law Dept. approved 04.05.21

Agreement Number:_____

HARPETH RIVER, FRANKLIN, TENNESSEE
SECTION 205 FLOOD RISK MANAGEMENT
FLOOD PROOFING PARTICIPATION AGREEMENT

THIS AGREEMENT, by and between the Department of the Army, represented by the Nashville District Corps of Engineers, acting though its Chief of Real Estate Division (hereinafter the "Corps"), the City of Franklin, Tennessee, acting through its Mayor (hereinafter the "City") and *XXXXX X. XXXXXX* and wife *XXXXX X. XXXXXX* (Owners),

WHEREAS, the Department of the Army and the City of Franklin entered into a project partnership agreement (hereinafter "PPA") on ~~X XX~~October 27, 2020, for a flood risk management project on Harpeth River in Williamson County, Tennessee, under authority of Section 205 of the Flood Control Act of 1948, as amended, and the Water Resources Development Act of 1986 (Public Law 99-662); and,

WHEREAS, the PPA sets forth the following cost sharing requirements: the Corps shall contribute 65% and the City shall contribute 35% of the total project costs and,

WHEREAS, in accordance with the PPA, the City shall provide the Corps its share of funds required to implement the project. The Corps shall be responsible for managing the project funds and issuing payments for completed work.

WHEREAS, the Owners' residence at _____ Franklin, TN is eligible for flood proofing under the voluntary non-structural component of said flood risk management project, said residence being located on a tract of land described in a deed from *XXXXX X. XXXXXX*, dated *XXXXX X,* 20*XX*, recorded in Book *XXXX*, page *XXX*, in the records of Williamson County, Tennessee; and,

WHEREAS, the Owners are responsible to share the cost of the City's contribution, and shall reimburse the City the 17.5% or contribute 17.5% of total costs associated with flood proofing of their residence via raising-in-place as outlined in a separate agreement between the Owners and the City; and

WHEREAS, the Owners wish to participate in the non-structural program and receive the benefits of said flood proofing; and,

WHEREAS the Owners have solicited estimates for performing work identified herein from at least three contractors from a pre-approved list provided to the Owners by the Corps, and have furnished the Corps and the City copies of all such estimates received,

NOW, THEREFORE, it is mutually agreed as follows:

1. The Owners agree to raise-in-place, consistent with approved building codes and the Harpeth River Flood Risk Management Project Homeowner Guide, the first habitable floors of the above

DRAFT

identified residence a minimum of XXX feet above the present elevation, by the addition of foundation blocks in a manner which will permit the movement of flood waters beneath the structure to equalize hydrostatic pressures.

2. The Owners agree to execute a recordable instrument which will provide that no part of the raised structure below the level of the first habitable floor will be subsequently converted to a living area for human habitation, or otherwise altered to impede the movement of waters beneath the structure.

3. The Owners agree to allow the City or their authorized representative access to their land and residence at all reasonable times to ensure that this agreement is in compliance with by the Owners, their heirs and assigns.

4. All work shall be completed within 6 months from the date of this agreement. Upon completion of the work as set forth above, and inspection by the Corps and the City, and delivery to the Corps of:

(a) an invoice for payment,
(b) a certificate that the construction meets applicable building codes and the requirements set forth in the Homeowner Guide, and
(c) the executed recordable instrument set forth in paragraph 2,

the Corps agrees to issue a check from available project funds, payable jointly to the Owners and XXXXXXXXXX XXXXXX XXXXXXXXXXX, the Owner's contractor, not to exceed $XX,XXX as full consideration therefore.

5. The Owners, and the City, agree to accept said sum in full satisfaction and in complete discharge of all obligations of the Corps and the City under this agreement.

6. The Owners agree to reimburse the City 17.5% of the total costs associated with the flood proofing of their residence.

7. The Owners agree that unforeseen or unanticipated conditions encountered during performance of the work shall be immediately brought to the attention of the Corps and the City. After investigation, and subject to a determination that such conditions should not have been anticipated and were outside the control of either the Owners or their Contractor, the Corps and the City may consent to an equitable supplementation and modification of this agreement for any costs of performance increased thereby.

8. The Owners agree that they may void this agreement without penalty at their option but that in doing so, they will receive no payment from the Corps and the City. Payment will be made only upon completion of the work and as stipulated in paragraph 4 above.

DRAFT

9. The Owners agree to forever save and hold harmless the City of Franklin or the Department of the Army and its successors and assigns from all claims for damages of any kind arising from or attributable to the flood proofing work authorized under this agreement.

EXECUTED this the _____ day of _____, 20*XX*

_____ _____

<homeowner> *<homeowner>*

ACCEPTED on behalf of the City of Franklin, Tennessee, this the ____ day of _____, 20__.

By: _____
Dr. Ken Moore
City of Franklin, Tennessee
Mayor

ACCEPTED on behalf of the Corps of Engineers, this the ____ day of _____, 20__.

By: _____
Michael T. Abernathy,
Chief, Real Estate Division
Real Estate Contracting Officer
Nashville District

DRAFT

DRAFT HARPETH RIVER FLOOD RISK MANAGEMENT PROJECT (HOME RAISING PROGRAM) –
HOMEOWNER FUNDING AGREEMENT FOR (INSERT ADDRESS)
COF CONTRACT NO. 2021-XXXX

THIS AGREEMENT is by and between the **City of Franklin, Tennessee** (hereinafter the "City") and homeowners ***XXXXX X. XXXXXX*** and wife ***XXXXX X. XXXXXX*** (hereinafter the "Owners").

WITNESSETH:

WHEREAS, the Department of the Army, represented by the Nashville District Corps of Engineers, acting though its Chief of Real Estate Division (hereinafter the "Corps"), and the City entered into a project partnership agreement, COF Contract No. 2020-0XXX, (hereinafter the "PPA") on X XX, 2020, for a flood risk management (home raising) project on the Harpeth River in Williamson County, Tennessee, (hereinafter the "Project"); and,

WHEREAS, the PPA sets forth the following cost sharing requirements: the Corps shall contribute 65% and the Non-Federal Sponsor/City shall contribute 35% of the total Project costs; and,

WHEREAS, in accordance with the PPA, the City shall provide the Corps its share of funds required to implement the project. The Corps shall be responsible for managing the Project funds and issuing payments for completed work; and,

WHEREAS, the Owners' residence at _____ Franklin, TN is eligible for participation within the Project, said residence being located on a tract of land described in a deed from *XXXXX X. XXXXXX*, dated *XXXXX X,* 20*XX*, recorded in Book *XXXX*, page *XXX*, in the records of Williamson County, Tennessee; and,

WHEREAS, the Corps, City, and Owners must enter into a flood proofing participation agreement, COF Contract No. 2020-0XXX, (hereinafter the "FPPA"), for the Project, in order for Corps and City to appropriate the required fiscal year funding; and,

WHEREAS, per the FPPA and City Resolution 2020-53, the City agreed to split the 35% Non-Federal Sponsor/City portion of Project costs 50/50 with the Owners, requiring the Owners to contribute 17.5% of total Project costs, which includes administrative, construction, inspection, permitting, and other associated costs required to flood proof their residence; and

WHEREAS, the Owners wish to participate in the Project and receive the flood proofing benefits of said Project and agree to contribute 17.5% towards the total Project costs.

NOW THEREFORE, in consideration of these premises and the mutual promises contained herein, it is agreed by and between the parties as follows:

1. The foregoing recitals are incorporated by reference as if fully stated herein.

2. The Owner agrees to deposit with the City the total Project costs payment required for the Owner's 17.5% share within sixty (60) days after execution of this Agreement. Payment shall be based on the estimated Project costs as specified by the Corps and City through this Agreement, the PPA, and FPPA. In the event said Owners' payment exceeds the aggregate amount of the Owners' actual total Project costs once construction is complete, the difference will be refunded to the Owners during Project closeout. In the event said Owners' actual total Project costs exceed the Owners' initial payment, the Owners agree to reimburse the City for such additional costs. Within sixty (60) days of completion of the Owners' Project work, the City and Owners shall settle on a final billing. The City and Owners will provide reasonable documentation to reconcile all such costs. The initial Project payment to the City is detailed within Attachment A.

3. If the Owners' initial Project costs deposit is not paid within the sixty (60) days after Agreement execution, the City can initiate the process of dissolving both this Agreement and the Owners participation in the Project.

4. This Agreement is subject to the appropriation and availability of City funds. In the event that the funds are not appropriated or are otherwise unavailable or the City cancels the Project for any reason prior to authorizing the Project's construction, the City reserves the right to terminate this Agreement upon written notice to the Corps and Owner. Said termination shall not be deemed a breach of contract by the City.

5. It is agreed that in participating within the Project, the City is acting solely in accommodation of the Owners and shall have no liability to the Owners for any damages or claims arising out of acts or omissions on the part of the Owners or the Owners' contractors. The Owners agree that it will not hold the City responsible for any claims arising out of the Project work. Under this Agreement, the "City" shall include any and all officers and employees of the City of Franklin, Tennessee, acting within the scope of their employment with the City.

6. The Owners agrees, to the extent provided by law, that it will be solely responsible for any and all claims, liabilities, losses, and causes of action which may arise, accrue, or result to any person, firm, corporation, or other entity which may be injured or damaged as a result of acts, omissions, or negligence on the part of the Owners' contractors or their employees in the performance of the Project work relating to this Agreement, the PPA, and FPPA. Under this Agreement, the "City" shall include any and all officers and employees of the City of Franklin, Tennessee acting within the scope of their employment with the City.

7. The City shall have no liability except as specifically provided in this Agreement, the PPA, and the FPPA.

8. Failure by any party to this Agreement to insist in any one or more cases upon the strict performance of any of the terms, covenants, conditions, or provisions of this Agreement shall not be construed as a waiver or relinquishment of any such term, covenant, condition, or provision. No term, covenant, condition or provision of this Agreement shall be held to be waived, modified, or deleted except by written amendment specifically citing the paragraph within the Agreement to be amended and signed by the parties hereto.

9. The Owners shall comply with all applicable federal, state and City laws and regulations in the performance of its duties under this Agreement. The parties agree that failure of the Owners to comply with this provision shall constitute a material breach of this Agreement and subject the Owners to the repayment of all City funds expended, or expenses incurred, under this Agreement.

10. This Agreement shall be binding upon and shall inure to the benefit of the parties hereto, their respective heirs, legal representatives, successors and assigns.

11. This Agreement is made under and will be construed in accordance with the laws of the State of Tennessee without giving effect to that state's choice of law rules. The parties' choice of forum and venue shall be exclusively in the courts of Williamson County, Tennessee. The Owners acknowledge and agree that any rights or claims against the City of Franklin or its officials, contractors, agents or employees hereunder, and any remedies arising therefrom, shall be subject to and limited to those rights and remedies, if any, available to the City under law.

12. If any terms, covenants, conditions or provisions of this Agreement are held to be invalid or unenforceable as a matter of law, the other terms, covenants, conditions and provisions hereof shall not be affected thereby and shall remain in full force and effect. To this end, the terms and conditions of this Agreement are declared severable.

13. The City and the Owners agree that any notice provided for in this Agreement or concerning this Agreement shall be in writing and shall be made by personal delivery, by certified mail (return receipt requested), by nationally recognized overnight delivery service (such as FedEx or UPS), or by facsimile transmission (provided that notice shall also be given in one of the other methods prescribed herein) addressed to the respective

party at the appropriate facsimile number or address as set forth below or to such other party, facsimile number, or address as may be hereafter specified by written notice.

The Board of Mayor and Aldermen Approved this Agreement on the _____Day of _____, 2021.

IN WITNESS WHEREOF, the parties have executed this Agreement on the dates as indicated below.

CITY OF FRANKLIN, TENNESSEE

By: _____
Dr. Ken Moore
Mayor
Date: _____

_____
Eric S. Stuckey
City Administrator
Date: _____

HOMEOWNER(S)

By: _____
Print: _____
Date: _____

By: _____
Print: _____
Date: _____

Approved as to form:

_____
Shauna R. Billingsley, City Attorney

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01809

DATE: March 4, 2021

TO: Board of Mayor and Aldermen

FROM: Eric Stuckey, City Administrator
Tom Marsh, Director of BNS
Kathleen Sauseda, Housing Development Coordinator

SUBJECT:

Consideration Of COF Contract No. 2021-0053, A Contract with the Franklin Housing Authority (FHA) For The Receipt Of Up To $28,836 of Community Development Block Grant Funds From The City Of Franklin As Reimbursement For Costs Associated With Construction of Public Facilities That Benefit Low To Moderate Income Residents.

PURPOSE:

The purpose of this memorandum is to provide information to the Franklin Board of Mayor and Aldermen (BOMA) concerning COF Contract No. 2021-0053, a contract with the Franklin Housing Authority.

BACKGROUND/STAFF COMMENTS:

The City of Franklin is eligible for entitlement funds through the federal Community Development Block Grant ("CDBG") program. The Board of Mayor and Aldermen encourages and supports the production of affordable housing throughout the community. This contract will offset the public facilities costs of the Chickasaw Project that is being developed in partnership with Franklin Housing Authority. This project does meet the definition of affordable housing as defined by the U.S. Department of Housing and Urban Development.

FINANCIAL IMPACT:

Franklin Housing Authority will receive up to Twenty-Eight Thousand Eight Hundred Thirty-Six and No/100 Dollars ($28,836.00) toward the costs of the Chickasaw Development. The costs are eligible to be reimbursed per Community Development Block Grant program guidelines.

RECOMMENDATION:

Staff recommends that the Board of Mayor and Aldermen approve COF Contract No. 2021-0053.

CONTRACT FOR THE RECEIPT OF COMMUNITY DEVELOPMENT BLOCK GRANT FUNDS FROM THE CITY OF FRANKLIN AS REIMBURSEMENT FOR COSTS ASSOCIATED WITH CONSTRUCTION OF PUBLIC FACILITIES THAT BENEFIT LOW TO MODERATE INCOME RESIDENTS
COF Contract No. 2021-0053

This Contract is by and between the City of Franklin, (hereinafter "CITY") and Franklin Housing Authority (hereinafter called "ORGANIZATION").

WHEREAS, CITY is eligible for entitlement funds through the federal Community Development Block Grant ("CDBG") program; and

WHEREAS, the construction, reconstruction, rehabilitation, or installation of public facilities and improvements are eligible activities under CDBG and can be carried out by a grantee, subrecipient, or other nonprofit; and

WHEREAS, ORGANIZATION is constructing an Affordable Housing project as defined by the United States Department of Housing and Urban Development; and

WHEREAS, the construction of this project includes the construction and installation of public facilities to support the Chickasaw Senior Project which will support the 48-unit multi-family development.

NOW, THEREFORE, in consideration of the mutual promises as contained herein, the parties hereto have agreed and hereby enter into this Contract according to the provisions as set forth herein.

SECTION 1 - SCOPE OF SERVICES

ORGANIZATION will carry out activities necessary to construct a residential structure for low to moderate income senior occupants in the City of Franklin. Low to moderate income is defined as households with incomes equal to or less that 80% of median family income for the Metropolitan Statistical Area.

SECTION 2 - RESPONSIBILITIES OF PARTIES

A. ORGANIZATION will perform the duties described above and take other actions necessary to accomplish the spirit of this Contract.

B. ORGANIZATION will submit regular reports (not less often than quarterly) as directed by CITY detailing the progress of their project.

C. At the request of CITY, ORGANIZATION will periodically send a representative to neighborhood or other public meetings to discuss and promote their project.

D. CITY will provide funding for the program from the Community Development Block Grant program as set forth in Section 3 of this contract.

Law Dept. approved 03.24.21

SECTION 3 – COMPENSATION

ORGANIZATION will receive up to Twenty-Eight Thousand Eight Hundred Thirty-Six and No/100 Dollars **($28,836.00)** for the services outlined above from the approved Community Development Block Grant program for eligible expenses.

SECTION 4 – TIME OF PERFORMANCE

Services shall start upon execution of this Contract and shall be completed within twenty-four (24) months of the execution of this Contract.

SECTION 5 - PAYMENT TERMS AND CONDITIONS

A. CITY shall reimburse ORGANIZATION for services rendered based on submittal of valid invoices for project costs with a description and documentation of work performed. CITY has the option of inspecting the completed work prior to making any payments.

B. Invoices may be submitted while the project is in progress as work is performed. CITY may choose to reimburse the organization for incremental expenses incurred as work is completed and inspected for satisfactory progress.

C. Final payment will be subject to receipt of a final report that is satisfactory to CITY.

SECTION 6 - NOTICES

All notices under this Contract shall be in writing and sent by certified mail to the address listed below for each party.

Kathleen L. Sauseda
City of Franklin – City Hall
109 3rd Avenue South
Franklin, TN 37064

Franklin Housing Authority
100 Springs Street
Franklin, TN 37064

SECTION 7 - REVERSION OF ASSETS.

Any real property under ORGANIZATION control that was acquired or improved in whole or in part with program funds in excess of $25,000.00 shall be either: (i) used to meet one of the national objectives in 24 CFR 570.208 until five years after expiration of the agreement; or (ii) not used in accordance with the above paragraph (i) of this section, in which event ORGANIZATION shall pay to the City of Franklin an amount equal to the current market value of the property less any portion of the value attributable to expenditures of non-program funds for the acquisition of, or improvement to, the property.

SECTION 8 - STANDARD TERMS AND CONDITIONS

A. COMPLIANCE WITH FEDERAL LAWS/REGULATIONS

ORGANIZATION shall comply with all applicable Federal and State laws and regulations in the performance of this Contract, including, but not limited to Federal Code 2 CFR 200.318, 2 CFR 200.326, and 2 CFR 200.318 (c)(1).

B. ANTIDISCRIMINATION/AFFIRMATIVE ACTION AND EQUAL EMPLOYMENT OPPORTUNITY

No person on the grounds of handicap, age, race, color, religion, sex, national origin, disability, or marital/familial status or any other classification protected by Federal and/or State of Tennessee constitutional and/or statutory law-shall be excluded from participation in, or be denied benefits or, or be otherwise subjected to discrimination in the performance of this Contract.

C. AUDIT REQUIREMENTS

i. This Contract, as well as any sub-agreement made with other participating agencies, is subject to all administrative requirements in OMB Circulars A-110 and A-122.

ii. CITY hereby notifies ORGANIZATION that a single audit is required for non-profit agencies receiving $300,000.00 or more in federal funds in any single fiscal year. This requirement is in accordance with OMB Circulars A-110 and A-133. If required, a copy of the single audit report will be kept on file and made available to CITY staff during sub-recipient monitoring visits and appropriate officials as requested.

D. CONFLICT OF INTEREST

ORGANIZATION agrees to abide by the following requirements with respect to conflicts of interest, and covenants that it presently has no interest, direct or indirect, and shall not acquire any interest, direct or indirect, which would conflict in any manner or degree with the performance of services required under this Agreement. ORGANIZATION further covenants that in the performance of this Agreement no person having such an interest, direct or indirect, shall be employed or retained by ORGANIZATION hereunder. These conflict of interest provisions apply to any person who is an employee, agent, consultant, officer, or elected official or appointed official of ORGANIZATION or of any designated public agencies or sub-recipients that are receiving funds under this program.

E. PROCUREMENT STANDARDS AND METHODS

ORGANIZATION shall comply with CITY's current policy concerning the purchase of equipment and shall maintain inventory records of all non-expendable personal property as defined by such policy as may be procured with funds herein.

ORGANIZATION shall procure all materials, property, or services in accordance with the requirements of Attachment O of OMB Circular A-110, Procurement Standards.

F. VENUE

In the event of a dispute or litigation arising out of said Contract, it is understood and agreed and that this Contract was executed and performed in Williamson County, Tennessee, and as such, it is agreed by both parties that venue of said litigation, including an action for Declaratory Judgment, will be in Williamson County, Tennessee.

G. ASSIGNMENT

Neither CITY nor ORGANIZATION may assign its rights or delegate its responsibilities under this contract.

H. ENTIRE CONTRACT AND MODIFICATION

The Contract between the parties supersedes any prior or contemporaneous communications, representations or agreements between the parties, whether oral or written, regarding the subject matter of the entire Contract. The terms and conditions of this Contract may not be changed except by an amendment expressly referencing this Contract by section number and signed by an authorized representative of each party.

If seeking any addition or modification to the Contract, the parties agree to reference the specific paragraph number sought to be changed on any future document or purchase order issued in furtherance of the Contract, however, an omission of the reference to same shall not affect its applicability. In no event shall either party be bound by any terms contained in any purchase order, acknowledgement, or other writings unless: (a) such purchase order, acknowledgement, or other writings specifically refer to the Contract or to the specific clause they are intended to modify; (b) clearly indicate the intention of both parties to override and modify the Contract; and (c) such purchase order, acknowledgement, or other writings are signed, with specific material clauses separately initialed, by authorized representatives of both parties.

I. SEVERABILITY

If any provision of this Contract is held invalid, the remainder of the Contract shall not be affected thereby, and all other parts of this Contract shall nevertheless be in full force and effect.

J. TIME OF THE ESSENCE

The parties agree that TIME IS OF THE ESSENCE with respect to the parties' performance of all provisions of the Contract.

K. NO TAXES, NO INTEREST PAYMENTS

As a tax-exempt entity, CITY shall not be responsible for sales or use taxes incurred for products or services. CITY shall supply ORGANIZATION with its Sales and Use Tax Exemption Certificate upon ORGANIZATION's request. ORGANIZATION shall bear the burden of providing its suppliers with a copy of CITY's tax exemption certificate and shall assume all liability for such taxes, if any,

that should be incurred. CITY does not agree to pay any interest for late payments, having agreed to pay in a timely manner.

L. **WAIVER**

Neither party's failure or delay to exercise any of its rights or powers under the Contract will constitute or be deemed a waiver or forfeiture of those rights or powers. For a waiver of a right or power to be effective, it must be in writing signed by the waiving party. An effective waiver of a right or power shall not be construed as either (a) a future or continuing waiver of that same right or power, or (b) the waiver of any other right or power.

M. **TERMINATION**

This Agreement may be terminated upon thirty (30) days written notice by either party.

Upon deliberate breach of the Contract by either party, the non-breaching party shall be entitled to terminate the Contract without notice, with all the remedies it would have in the event of termination and may also have such other remedies as it may be entitled to in law or in equity.

SECTION 9 – SIGNATURES

THE CITY OF FRANKLIN

By: _____ **Date:** _____
Dr. Ken Moore, Mayor

Attest:

_____ **Date:** _____
Eric S. Stuckey, City Administrator

Approved as to Form:

_____ **Date:** _____
William E. Squires
Assistant City Attorney

FRANKLIN HOUSING AUTHORITY:

By: [signature] **Date:** 3/25/21
Its: President/CEO

Law Dept. approved 03.24.21

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01844

DATE: March 24, 2021

TO: Board of Mayor and Aldermen

FROM: Eric Stuckey, City Administrator
Paul Holzen, Director of Engineering
Jimmy Wiseman, Asst. Director of Engineering

SUBJECT:

Consideration Of Resolution 2021-56, A Resolution To Adopt The 2021 Best Management Practice Stormwater Manual.

PURPOSE:

The purpose of this memorandum is to provide an update to the Board of Mayor and Aldermen on proposed revisions to the City of Franklin, TN Best Management Practices (BMP) Stormwater Manual.

BACKGROUND/STAFF COMMENTS:

Over the past year, staff has been working to update the BMP Stormwater Manual to current standards.

The City Engineer has rule-making authority to implement revisions to the regulations per the City of Franklin Ordinance 2017-41. The revised manual includes numerous administrative changes and updates that improve functionality and design of green infrastructure practices. Primary revisions to the standard include the following:

- A reduction in the required runoff reduction value for sites that qualify for the redevelopment credit.
- Updates to as-built requirements.
- Update to increase the amount of impervious acreage to a bioretention area.
- Update to not allow bedrock within any green infrastructure BMPs.
- Update to the amended soil requirements to match the State of Tennessee requirements.
- Updated pretreatment requirements for green infrastructure BMPs.
- Updated setbacks to hardscapes to prevent settling around the BMPs.

FINANCIAL IMPACT:

There is no direct financial impact to the City of Franklin.

RECOMMENDATION:

Staff recommends that the Board of Mayor and Aldermen approve Resolution 2021-56.

RESOLUTION 2021-56

A RESOLUTION TO ADOPT THE 2021 BEST MANAGEMENT PRACTICES STORMWATER MANUAL

WHEREAS, pursuant to City of Franklin Ordinance 2017-41, the City Engineer shall have rule-making authority to implement revisions to the regulations, guidance, or other related materials; and

WHEREAS, the City Engineer in this regard may modify technical, administrative, or procedural matters as needed to meet the objectives and policies defined above, so long as such modifications as to technical, administrative, or procedural matters are not contrary or beyond the intent of the objectives and policies defined in Ordinance 2017-41; and

WHEREAS, Staff has completed administrative revisions to the Best Management Practices Stormwater Manual to include numerous updates that improve functionality and design; and

WHEREAS, the Board of Mayor and Aldermen finds that it is in the best interest of the City of Franklin to accept the revisions to the Best Management Practices Stormwater Manual, with changes to be adopted on July 1, 2021.

NOW THEREFORE, BE IT RESOLVED BY THE BOARD OF MAYOR AND ALDERMEN OF THE CITY OF FRANKLIN, TENNESSEE, AS FOLLOWS: Revisions to the City of Franklin Best Management Practices Stormwater Manual as depicted in Exhibit A are accepted by the Board of Mayor and Aldermen with an implementation date of July 1, 2021.

IT IS SO RESOLVED AND DONE on this _____day of_____, 2021.

ATTEST:

By:_____
Eric S. Stuckey
City Administrator

CITY OF FRANKLIN, TENNESSEE:

By:_____
Dr. Ken Moore
Mayor

Approved as to Form:

By:_____
Shauna R. Billingsley
City Attorney

Law Dept. approved 03.24.21

Section 1 – Policies and Procedures

1 Introduction

1.1 Background And Purpose

1.2 How To Use This Manual

1.3 Sources Of Pollution And Its Impacts

2 Principles Of Managing Stormwater Quality And Quantity

2.1 Introduction To Green Infrastructure Practices

2.2 Introduction To Best Management Practice Selection

2.3 Integrated Site Design

3 Post Construction Water Quality

3.1 The Runoff Reduction Method

3.2 The Runoff Reduction Method And 80% Tss Combined Methodology

4 References

Section 2 – Construction Management Practices

2.1 Introduction

2.2 Management Practice Fact Sheets

Section 3 – Temporary Construction Site Runoff Management Practices

3.1 Introduction

3.2 Management Practice Fact Sheets

Section 4 – Permanent Erosion Prevention and Sediment Controls

4.1 Introduction

4.2 Management Practice Fact Sheets

Section 5 – Permanent Stormwater Treatment Controls

5.1 Introduction

5.2 Management Practice Fact Sheets

5.3 Long Term Maintanence Agreement

Section 6 – Industrial & Commercial Runoff Management Practices

6.1 Introduction

6.2 Management Practice Fact Sheets

Section 7 – Other Source Controls

7.1 Introduction

7.2 Management Practice Fact Sheets

Section 1 – Policies and Procedures

1 Introduction

1.1 Background and Purpose

New developments and redevelopments typically increase the amount of impervious area on a site which affects the flow of water as it rains by increasing the volume and rate of stormwater runoff. If not properly managed, increased peak flows and volumes could result in flooding and channel erosion. In addition, typical stormwater runoff from urban sites contains pollutants such as litter, sediment, oils and greases, nutrients and metals, bacteria, fertilizers and debris. These pollutants are commonly transported through municipal separate storm sewer systems (MS4s), from which they are often discharged untreated into local waterbodies. The City of Franklin has been designated by the U.S. Environmental Protection Agency (EPA) as a small MS4, and urbanized areas like the City of Franklin are required under Federal and State law, through the National Pollutant Discharge Elimination System (NPDES) Phase II Rule, to develop a stormwater management program in order to reduce the discharge of these stormwater pollutants and to achieve the stormwater treatment goals set forth by the U.S. EPA. The City of Franklin's Stormwater Management Ordinance gives authority to this Stormwater Management Manual in its municipal code.

> **Therefore, all new development and redevelopment within the City of Franklin must design, install and maintain stormwater quantity and quality controls as set forth within this Stormwater Management Manual as part of the City of Franklin's stormwater management program.**

The State of Tennessee NPDES MS4 Permit requires the development and implementation of permanent (post-construction) stormwater controls comprised of runoff reduction and pollutant removal from new development and redevelopment projects that disturb one acre or more. The Runoff Reduction Method (RRM) is the preferred control practice as it can achieve both volume control and pollutant removal. Site design standards require, in combination or alone, management measures that are designed, installed and maintained to infiltrate, evapotranspire, harvest and/or use, at a minimum, the first inch of every rainfall event preceded by 72 hours of no measurable precipitation. The first inch of rainfall must be 100% managed with no stormwater runoff being discharged from the site. For projects that cannot meet 100% of the runoff reduction requirements, the remainder of the stipulated amount of rainfall must be treated prior to discharge with a technology expected to remove 80% total suspended solids (TSS) in order to meet water quality requirements.

This Stormwater Management Manual has been compiled by the City of Franklin to assist planners, developers, contractors and various businesses and industries in complying with the guidelines set forth by the NPDES Phase II Rule. This manual is designed to support the stormwater management language set forth within the Ordinance by way of providing specific guidance for selection of Best Management Practices (BMPs) and elaborating on various practices. This manual will assist the City of Franklin in stormwater pollution prevention and water quality protection through impact-reducing site design, BMP selection, construction management, post-construction management, and good housekeeping measures.

1.2 How to Use This Manual

This Stormwater Management Manual contains the following sections:

Section 1 provides an introduction to the NPDES MS4 Permit requirements and the City of Franklin's stormwater management program. This section discusses the principles of site layout and the policies and procedures for selecting and designing water quality and water quantity controls required for all new development and redevelopment within the City. This section also presents an introduction to Low Impact Development (LID) design and Green Infrastructure Practices (GIPs).

Section 2 contains construction management practices (CP) that should be used for contractor and construction site operations. These management practices focus on good housekeeping measures and capturing pollutants from typical contractor and construction site activities.

Section 3 contains temporary construction site runoff management practices (TCP) that are consistent with those described in TDEC's Erosion and Sediment Control (E&SC) Handbook. The NPDES MS4 Permit requires the development and implementation of temporary construction site stormwater controls. This section provides guidance on the BMPs that have been approved for use by the City of Franklin.

Section 4 contains permanent erosion prevention and sediment control (PESC) measures which should be selected during the early planning phase of a project and included in the initial site design.

Section 5 contains permanent stormwater treatment controls (PTP) that are focused on green infrastructure practices and accepted 80% TSS treatment controls. These management practices should be selected during the site layout and early planning phase of the project in order to achieve the required runoff reduction.

Section 6 contains industrial and commercial treatment practices (ICP). These practices are similar to the construction management practices found within Section 2, but are intended for use in an industrial environment rather than on a construction site.

Section 7 contains other source control measures (SC) that predominately focus on the management of hazardous materials. These measures can be used in addition to the construction management practices and the industrial and commercial practices.

When planning and designing a site for development or redevelopment within the City of Franklin, this manual is best used in the order shown in Figure 1.

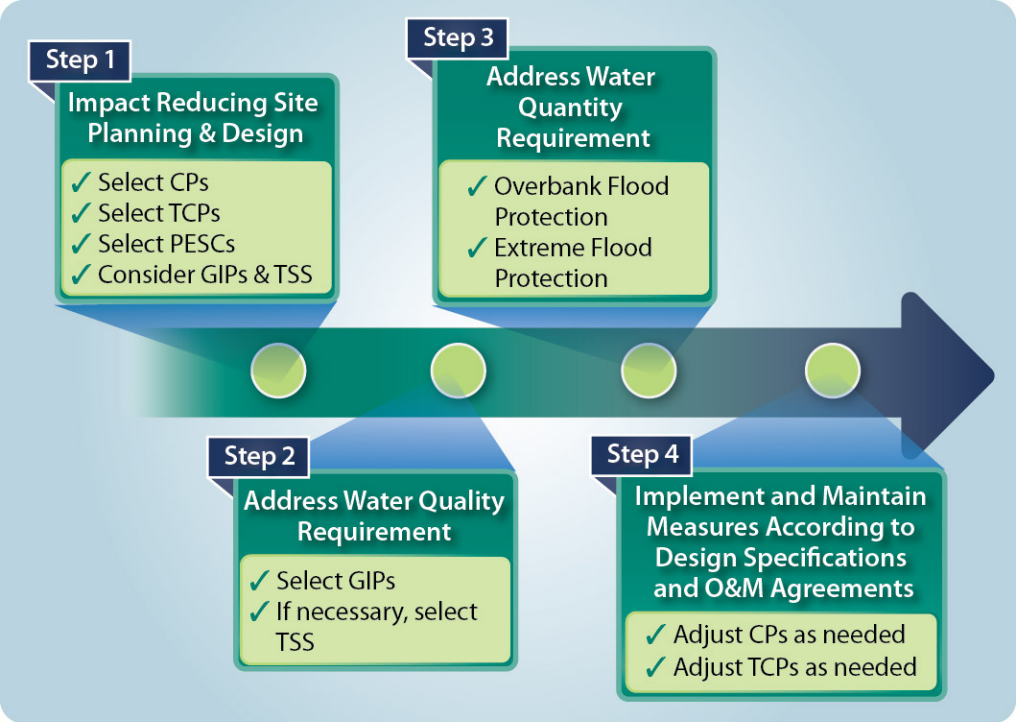


Figure 1 – Site Planning and Development Process

The fact sheets in this manual are designed for easy reference. They are categorized, focused, and concise to allow easy access and expedient use. Each fact sheet can be used as a stand-alone document that may be distributed to facilitate focused discussion about design and/or implementation of each management practice. However, the goals of Franklin's stormwater management program will not be met by simply installing BMPs. This manual is intended to guide the design of a project from start to finish, and stormwater management should be part of the site design considerations in the initial phase of conceptual design. There are some BMPs that require structural practices, though many are non-structural practices where everyday activities may be performed in a manner that limits the impact of stormwater runoff to surface water quality.

1.3 Sources of Pollution and Its Impacts

General Pollution Overview

Pollution entering Franklin's streams and channels has many sources and entry paths. Pollutants are generally either washed into surface waters by rainfall runoff or they enter through human activities such as connecting non-stormwater drains to the stormwater drainage system or by someone dumping waste into drains or streams directly. Franklin has programs of education, prevention and inspection to address the illicit connections or illegal dumping by individuals. This manual articulates Franklin's standards to reduce rainfall runoff of pollutants into our natural stream system.

Rainfall induced pollution enters primarily by two methods. The first is erosion and sedimentation (deposition) of sediment and the pollutants sediment contains. The second is the simple washoff of pollution that may lie on paved (impervious) surfaces. The following briefly describes these two general pollution sources.

Erosion and Sedimentation Overview

Short-term stormwater quality management predominately focuses on E&SC for construction sites; however, E&SC can also be a concern for fully developed sites. Soil erosion is the process by which soil particles are removed from land surfaces by wind, water or gravity. Natural erosion generally occurs at slow rates. However, the rate of erosion increases when land is cleared or altered and left disturbed. Erosion rates will increase when flow rates and velocities discharged from a site exceed the erosive range.

Clearing and grubbing activities during construction remove vegetation and disrupt the structure of the soil surface, leaving the soil susceptible to rainfall erosion, stream and channel erosion, and wind erosion if left untreated. Ultimately, the material suspended by erosion settles during sedimentation in downstream reaches.

Once eroded, soil particles may travel anywhere from a few inches to many miles before gravity causes them to settle. The settling of soil particles is a process known as sedimentation. Excessive levels of sedimentation can create problems such as clogging of storm drains, blockage in streams and channels, damage to existing habitat, and in some cases, formation of habitats in undesirable locations.

There are negative influences on channels, streams and rivers when sediment enters the waterways. As sediment volumes increase in waterways, the overall capacity decreases. This causes an increase in flooding as well as creates excessive maintenance needs.

1.3.1 Water Erosion

Rainfall events begin the water erosion process by dislodging minute soil particles. These soil particles then become suspended in the water droplet. The sediment laden water droplets accumulate on the soil until a sufficient quantity has developed to begin flowing under the forces of gravity.

The initial flow of sediment laden water generally consists of a thin, slow-moving sheet, known as sheet flow. In most cases, sheet flow does not prove to be highly erosive; however, it does begin the transport of the sediment that was previously suspended. Irregularities in soil surface and uneven topography will usually cause sheet flow to become concentrated into rivulets where flow causes an increase in velocity

and erosive energy. This increase in erosive energy of water flowing in rivulets creates small grooves, or rills, in the soil surface.

Rill erosion of the soil surface concentrates flows, which increases flow velocity and erosive energy due to gravitational forces. This results in deeper and wider rills that may join together with adjacent rills. Typically, rills run parallel to the slope and each other. In addition, rills are small enough to be stepped across, and are usually enlarged by direct erosion of the rill's sides and bottom by the action of flowing water.

Severe Gully Erosion

The joining together of several adjacent rills, or sufficient enlargement of a single rill, begins gully erosion. In most cases gullies run parallel to the slope and may have one or more lateral branches. Gullies are enlarged by the following four key actions:

1. Gullies often have a "head cut" at the upstream end, which progresses its way upstream as water flowing into the gully erodes away the lip of the head. A waterfall working its way upstream can exemplify this. This can be seen in the picture above.
2. The flow in a gully tends to undercut the banks. Once the banks are sufficiently under cut, the banks will collapse into the gully where the collapsed soil is then washed away.
3. The collapse of banks into the gully causes flowing water to be diverted around the temporary blockage of soil. This temporary blockage of soil increases the velocity along one or both banks, which results in increased bank erosion.
4. The concentration of flows in the gully may result in scour of the gully floor until a stable slope is obtained.

1.3.2 Stream and Channel Erosion

Construction activities often require the disturbance of streams and channels. Once vegetation or other bank protection measures are disturbed, flows may begin to erode the unprotected soil.

Construction activities often result in the disturbance of channel and stream flow. However, this should only happen when traversing banks such as a temporary channel and stream crossing, culvert installation, bridge construction, etc. By diverting flows within the channel, velocities are generally increased in some areas to compensate for decreases in other areas. The increase in velocity may exceed those normally experienced by the channel, resulting in bank erosion and bottom scour.

Construction activities and the construction of facilities that increase the quantity and rate of runoff as well as how runoff is conveyed often increases the quantity and flow rate to streams and channels. The increased quantity and rate of flow can cause bank erosion and bottom scour.

1.3.3 Wind Erosion

Dust is defined as solid particles or particulate matter small enough to remain suspended in the air for a period of time and large enough to eventually settle out of the air. Dust from a construction site originates as inorganic particulate matter from rock and soil surfaces and material storage piles. The majority of dust

generated and emitted into the air at a construction site is related to earth moving operations, demolition, construction traffic on unpaved surfaces, and wind over disturbed soil surfaces.

1.3.4 Factors Influencing Erosion

There are five primary factors that influence erosion: soil characteristics, vegetative cover, topography, climate, and rainfall.

Soil Characteristics – Particle size, particle gradation, organic content, soil structure, and soil permeability are all characteristics that contribute to the determination of a soil's erodibility. These characteristics affect the stability and infiltration capacity of the soil. Less permeable soil has an increased risk of runoff and erosion. Typically, soils that contain high percentages of silts and clays are the most erodible.

Channel flow is also affected by soil characteristics in that tractive-force or shear stress developed by flowing water over the channel banks and bottom may cause soil particles to move and become suspended into the runoff. The "permissible shear" stress indicates the stress that the channel banks and bottom can sustain without jeopardizing stability. It is possible to increase the allowable shear stress in the channel by utilizing "soft/green" or "hard" armoring on the channel bottom and banks.

Vegetative Cover – Vegetative cover creates an erosion shield by stabilizing the soil. In addition, vegetative cover protects soil from direct rain, and also decreases the velocity of runoff. This allows greater infiltration as well as maintains the soil's capacity to absorb water. Vegetative root structures create a favorable soil structure, improving its stability and permeability.

Topography – Slope is a key element in determining the volume and velocity of runoff. An increase in the slope length, and/or steepness causes an increase in the runoff rate, and consequently, an increase in the potential for erosion.

Climate – High precipitation areas as well as areas with freeze/thaw cycles have significant effects on soil stability and structure.

Rainfall – Frequency, intensity, and duration are fundamental factors in determining the amounts of erosion produced. In Tennessee, the erosion risk period is typically highest in the wet season (typically December through May), which coincides with a period of minimal vegetative cover.

Pollution Washoff Overview

There are a number of pollutants that wash off into streams. The following describes the most common.

1.3.5 Nutrients

Fertilizers, pesticides, construction chemicals, and solid waste contain phosphorus and nitrogen, which can result in excessive or accelerated growth of vegetation or algae. This increase in vegetation results in the impairment of lakes and other water resources and the growth of algae results in the depletion of dissolved oxygen, potentially resulting in fish kills.

1.3.6 Oxygen Demanding Substances

The biological decomposition of organic matter in stormwater depletes the amount of dissolved oxygen (DO), which causes biochemical oxygen demand (BOD). BOD measures the degree of dissolved oxygen depletion by expressing the amount of easily oxidized organic matter present in water. In addition, certain non-organics materials in the water can intensify DO depletion.

1.3.7 Metals

Artificial surfaces such as galvanized metal, paint, or preserved wood contain metals that can enter stormwater as their surfaces corrode, flake, dissolve, decay, or leach. These metals that are found in urban stormwater often originate from passenger vehicles. Over half the trace metal load carried in stormwater is associated with sediments to which these eroded metals attach. Heavy metals are of concern because they are toxic to aquatic organisms, can be bioaccumulative, and have the potential to contaminate drinking water supplies.

1.3.8 Pesticides

Pesticides are herbicides, insecticides, and rodenticides that are commonly used on construction sites, lawns, parks, golf courses, etc. Excessive or improper application of theses pesticides may result in direct water contamination, indirect water pollution by aerosol drift, or erosion of treated soil and subsequent transport into surface waters.

1.3.9 Oil, Grease, and Fuels

These products are widely used and may spill, leak, or be dumped on the ground where they can wash into waterways. Sources include leaks during normal vehicle use, hydraulic line failure, spills during fueling, and inappropriate disposal of drained fluids. These products can cause harm to plant and animal life.

1.3.10 Other Toxic Chemicals

Synthetic organic compounds such as adhesives, cleaners, sealants, and solvents are often improperly applied, and may also be improperly stored and disposed of. Accidental spills, improper storage or deliberate dumping of these chemicals onto the ground or into storm drains causes environmental harm to receiving waters.

1.3.11 Miscellaneous Wastes

Miscellaneous wastes include wash water from concrete mixers, paints and painting equipment cleaning activities, solid organic wastes resulting from trees and shrubs removed during land clearing, wood and paper materials, food and containers, such as paper, aluminum, and metal cans, industrial or heavy commercial process wash/cooling water, vehicle washing, other commercial or industrial wastes and sanitary wastes.

2 Principles of Managing Stormwater Quality and Quantity

Successful and effective stormwater management is a two-fold process: one management principle is related to the quality of runoff and the potential pollutants that can be carried within stormwater runoff and deposited untreated into local surface waters; the other is related to the increased quantity of stormwater runoff and related flooding and maintenance issues. Stormwater volume in itself is a potential trigger for stormwater pollution as an increase in the volume of stormwater runoff can also increase the likelihood for pollutant transport and channel erosion.

An increase in development has led to an increase in impervious area and therefore an increase in runoff volume, flow rate and pollution. Stormwater quality management involves reduction of runoff volume and appropriate treatment of any polluted stormwater that that does run off. Stormwater quantity management involves slowing, detaining, and/or controlling the volume and flow rate of runoff from "major" storm events ranging from the 2 to the 500-year statistical storm frequency.

Communities are increasingly moving towards Green Infrastructure Practices (GIPs) – or a combination of green and conventional stormwater management practices – to manage stormwater. Green Infrastructure (GI), as used in this Manual, is a term that refers to a subset of Low Impact Development (LID) structural systems and practices that support the principles of LID and make use of volume-reducing designs and calculations. Green Infrastructure systems are an innovative approach to urban stormwater management that do not rely on the conventional end-of-pipe structural methods. Rather, they are an ecosystem-based approach that strategically integrates stormwater controls throughout an urban landscape to attempt to maintain a site's pre-development conditions. Targeted community or watershed goals and objectives are addressed through the use of structural and non-structural techniques such as permeable pavement, bioretention/rain gardens, rain barrels, and public outreach.

This chapter discusses the principles of managing stormwater quality and quantity. The technical details for designing for stormwater quality and quantity requirements are described in Chapters 3 and 4 of this section, respectively.

2.1 Introduction to Green Infrastructure Practices

The overall goal of GIPs is to reduce stormwater runoff volume and to treat pollutant loads close to the source where they are generated. In doing so, GIPs provide many stormwater management benefits; such as improved water quality, flow management, groundwater recharge, and channel protection. GIPs minimize the hydrologic impacts of urban development on the surrounding environment by intrinsically linking stormwater management to urban design and landscape architecture. This is accomplished with appropriate site planning and through the direction of stormwater towards small-scale systems dispersed throughout the site. These systems should be carefully selected based on the site's topographic and climatic conditions. Correctly pairing land uses with GIPs is an important first step in site planning. GIPs, located in Section 5, should be matched with land use and setting, as listed in the GIP criteria fact sheets and detailed in each GIP discussion.

Why Green / Low Impact Development

Current development patterns and traditional storm water management techniques have resulted in large amounts of impervious surfaces in cities across the country. Conventional development approaches to stormwater management often use practices to quickly and efficiently convey water away from developed

areas. This results in larger volumes of runoff flowing directly to channels, streams, rivers and combined sewer systems as well as any pollutants contained in the runoff.

In contrast, LID utilizes a system of source controls and small-scale, decentralized treatment practices to help maintain the hydrologic function of the landscape by allowing water to infiltrate, evapotranspire, or be reused onsite. The conservation of open space, the reduction of impervious surfaces, and the use of small-scale storm water controls, such as green roofs, are just a few of the LID practices that can help maintain predevelopment conditions and keep greater volumes of runoff from routing to the stormwater system. LID techniques can offer the following many benefits to the City of Franklin:

Community

- Protect flora and fauna
- Balance growth needs with environmental protection
- Reduce municipal infrastructure and utility maintenance costs (streets, curbs, gutters, sidewalks, storm sewers)
- Encourage private sector participation in green stormwater infrastructure at residential, commercial, and industrial facilities
- Decrease flooding risks for small storms
- Create attractive, natural and multifunctional public spaces

Developers

- Reduce land clearing and grading costs
- Potentially reduce infrastructure costs (streets, curbs, gutters, sidewalks)
- Reduce storm water management costs
- Potentially reduce municipal permitting fees and increase lot yields
- Increase lot and community marketability

Environment

- Preserve integrity of ecological and biological systems
- Protect site and regional water quality by reducing sediment, nutrient, and pollutant loads to water bodies
- Reduce impacts to terrestrial and aquatic plants and animals
- Preserve trees and natural vegetation
- Mitigate the heat island effect and reduce energy use

2.2 Introduction to Best Management Practice Selection

Stormwater management measures must be applied in the form of structural and non-structural BMPs as detailed within this manual. This section is in two parts. Temporary BMPs are designed to address construction activities, while permanent BMPs are designed to address long-term stormwater management objectives. Effective planning for both short and long term goals allows for an easy transition from

temporary to permanent controls and favorable results with respect to cost and performance. Each unique project has specific risks that can be addressed through properly selected BMPs. In order to reach this goal, specific project risks must first be identified, BMP objectives defined, BMPs determined, and lastly the appropriate BMPs selected.

Define BMP Objectives

The initial step in the selection and use of BMPs is to define objectives. BMP objectives must address development and construction activities as well as existing industry, businesses, and private parties whose activities may contribute to overall water quality. These activities are all unique and require specific knowledge of the pollution risks associated with each activity. This knowledge is essential in selecting BMPs effectively. The following BMP objectives supplement the standards set forth by the City's Stormwater Management Ordinance:

1. **Practice Good Housekeeping**: Proper management of pollutant sources and modification of construction activities can prevent pollutants from draining or being transported off-site.
2. **Contain Waste**: Dispose of all construction waste in designated areas, and prevent stormwater run-on and run-off from these areas.
3. **Minimize Disturbed Areas**: Land clearing should take place only in areas that will be under active construction within a few months of the time of clearing. Phased clearing of a large development is recommended. Land clearing during the rainy season should be avoided if at all possible. Sensitive areas such as steep slopes, riparian buffers, and natural watercourses should never be disturbed if at all possible.
4. **Stabilize Disturbed Areas**: Temporary stabilization techniques should be utilized in areas where there are disturbed soils that are not undergoing active construction. Upon final completion of a construction activity, permanent landscaping, and stabilization should be applied.
5. **Protect Slopes and Channels**: Steep and unstable slopes should not be disturbed if they are outside of the approved grading plan area. Runoff should be conveyed from the top of the slope in a safe manner ensuring that the slope is stabilized as soon as possible. Natural channels should not be disturbed if at all possible. Temporary and permanent channel crossings require stabilizing as quickly as possible to ensure that increases in runoff velocity caused by the project do not erode the channel.
6. **Control Site Perimeter:** Upstream runoff should be diverted either around or through the construction project in a safe manner. These diversions should be designed to ensure that downstream property would not be damaged. In addition, all runoff exiting the construction site should be free of excessive sediment, and other pollutants.
7. **Control Internal Erosion:** Sediment laden water should be detained or otherwise treated within the site to avoid potential pollution to water resources.

Site characteristics and specific contractor activities affect the potential for erosion and pollution by other potential pollutants contained in materials and chemicals used on the construction site. While determining BMP objectives, the following factors should be considered:

1. **Site conditions including the following:**

- Soil type, including underlying soil strata that are likely to be exposed to stormwater.
- Natural terrain and slope.
- Final slopes and grades.
- Location of concentrated flows, storm drains, channels, and streams.
- Existing vegetation and ground cover.

2. **Climatic factors including the following:**
   - Seasonal rainfall patterns.
   - Appropriate design storm, which takes into account quantity, intensity, and duration of rainfall.
3. **Type of construction activity.**
4. **Construction schedules, construction sequencing, and phasing of construction.**
5. **Size of construction project and areas to be graded.**
6. **Location of the construction activity relative to adjacent uses and public improvements.**
7. **Types of construction materials and potential pollutants present or that will be brought on-site.**
8. **Floodplain, Floodway, and riparian buffer requirements.**

Determine BMPs

Once the BMP objectives are defined, specific BMPs should be determined. In order to determine the appropriate BMPs to use, a plan for the project will be needed. This plan should contain enough detail that drainage patterns, topography, and existing and permanent stormwater control structures can be located with ease. The plan will be required in order to obtain a Stormwater Management Permit, which is required for all development and redevelopment as identified in the City of Franklin Municipal Code. The plan should identify the following information, in addition to any plan requirements set forth by the Code:

1. Stormwater entrance and exiting locations. Sheet and Channel flow for the existing and final grading contours should be included. This should be in accordance with the master stormwater management plan for the specific watershed.
2. Identify locations of steep slopes and unlined channels that are subject to high rates of erosion. Long, steep slopes over 100 feet in length are considered as areas of moderate to high erosion potential. Soil bioengineering is preferred for stabilization over rip rap, and other hard armoring techniques. (See City of Franklin Municipal Code)
3. Categorize slopes as:
   a. Low Erosion Potential (0 to 5 percent slope)
   b. Moderate Erosion Potential (5 to 10 percent slope)
   c. High Erosion Potential (slope greater than 10 percent)

4. Identify sensitive areas and water resources that should not be disturbed such as wetlands, springs, sinkholes, floodplains, floodways, areas to be used for infiltrative GIPs for post construction, sensitive areas or riparian buffers,including other areas where site improvements will not be constructed. Clearing limits should be identified to prevent disturbance of these areas during construction activities.
5. Identify tributary areas for each outfall location. The approximate area of each tributary should be calculated.
6. Identify locations where contractor activities may have a risk of causing a runoff or polluted discharge. (See Section 2, Construction Management Practices, for additional information.)

This plan will allow easy identification of BMPs that need to be considered on a particular construction project. Planning prior to the commencement of construction and phasing construction activities always prove to be more cost effective than treatment of stormwater after the fact. Preventative maintenance is simpler and less costly than correcting a problem that has already occurred.

Once BMP objectives have been determined, the BMP selection process illustrated in Figure 2 below should be utilized. The BMP selection process is used to determine the BMP objectives that will be met by the various BMPs. Many BMPs can achieve more than one objective, which should be taken into account during the selection process. This allows for selecting the most cost-effective BMP. For example, it is not always necessary to install extensive sediment trapping controls during construction. In fact, sediment trapping should be used only as a short-term measure for active construction areas, and replaced by permanent stabilization measures as soon as possible. However, it should be noted that perimeter/outfall control in the form of permanent detention ponds should be built first and used as temporary sediment control during construction. After construction is complete and the tributary area is stabilized, the permanent outlet configuration can be reestablished.

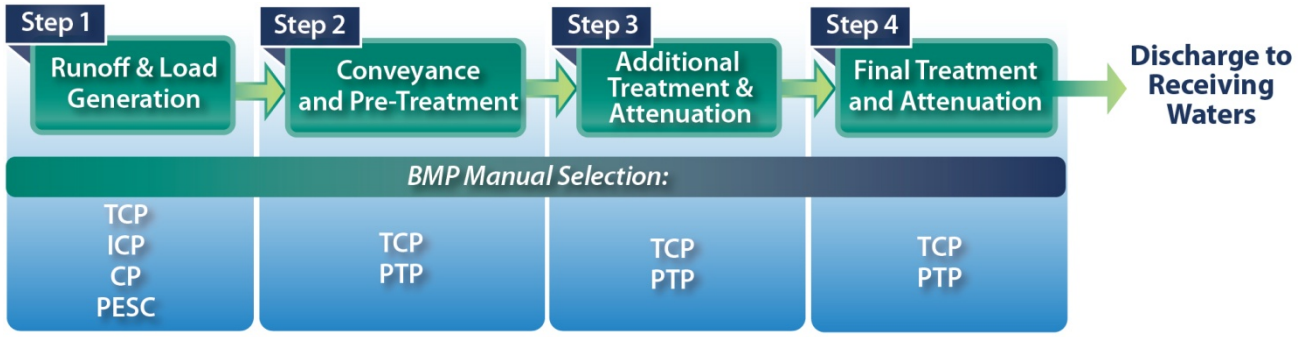


Figure 2 – BMP Selection Process

Temporary BMPs for Construction Activities

Temporary BMPs include many different "good housekeeping" methods as well as short term E&SC activities. The steps involved in utilizing temporary BMPs include design by a Professional Engineer, review and approval by the City of Franklin, implementation, maintenance and inspection. The construction site operator and licensed professional engineer should be responsible for the design and implementation of these BMPs. The contractor bears the responsibility for constructing, maintaining, implementing, and seeking help when it is apparent that the BMPs are not meeting their objectives.

2.2.1 Construction Management Practices

Contractor activities can result in stormwater runoff pollution if not properly managed. The appropriate BMPs shall be utilized to minimize the potential for stormwater pollution. It is recognized that all BMPs are not effective on every construction site. It is important that all BMPs are considered, and that those which are effective for the project at hand should be selected. Considerations for selecting BMPs for contractor activities include the following:

1. **Consider precipitation events**. BMPs may be different on rainy days vs. dry days, winter vs. summer, etc. For instance, a material storage area may be covered with a tarp during the rainy season, but not in the summer. However, plans should be made for some amount of rain, even if it is not expected to generate a flooding event.
2. **Consider the amount of material used**. Less intensive BMP implementation may be necessary if a minimal amount of pollutant containing material is used. Remember that different materials pollute in different amounts.
3. **Consider the volume of water used**. The larger the volume of water used and wastewater generated, the more likely that pollutants transported by this water will reach the stormwater system or be transported off-site.
4. **Consider the site conditions**. BMPs selected will differ depending on whether the activity is conducted on a slope or flat ground, near a stormwater structure or watercourse, etc. Anticipating problems and conducting activities away from certain sensitive areas will reduce the cost and inconvenience of performing BMPs.
5. **Consider accidents**. Pre-establishing a BMP for each conceivable pollutant discharge may be very costly and significantly disrupt construction. As a rule of thumb, establish controls for common (daily or weekly) activities and be prepared to respond quickly to accidents.
6. **Define the difference**. Not everything can or will be deemed an accident and may be classified as negligent disregard of proper practices.

Keep in mind that the BMPs for contractor activities are suggested practices that may or may not apply in every case. Construction personnel should be instructed to develop additional or alternative BMPs that are more cost-effective for a particular project. The best BMP is a construction work force aware of the pollution potential of their activities and committed to a clean worksite. BMP Fact Sheets for Construction Management Practices (CPs) are provided in Section 2 of this manual.

2.2.2 Construction Site Runoff Management Practices

BMPs for erosion and sediment control are selected to meet the BMP objectives based on specific site conditions, construction activities, and cost-effectiveness. Different BMPs may be needed at different times during construction since construction activities are constantly changing the site conditions.

E&SC must begin with the initial prevention of erosion. This can be accomplished through soil protection techniques that will prevent the runoff of soil particles. Erosion and sedimentation will most likely occur to some degree due to active construction areas, and BMP s must be selected to address these issues once they have occurred. Sediment Control BMPs allow sedimentation to be removed from flows before these flows exit the construction site. Consequently, the best protection on active construction sites is generally obtained through simultaneous application of both E&SC BMPs. This combination is effective because it

prevents most erosion before it begins and has the ability to capture sediments that become suspended before the transporting flows leave the construction site.

The following general items are provided to aid in preparing the project plans and choosing appropriate E&SC BMPs:

Minimize Disturbed Areas - Project layout and schedule should be compared with on-site management measures that can limit the exposure of the project site to erosion and sedimentation. The City of Franklin Municipal Code sets standards that require responsible construction practices. The following BMPs should be considered in order to reach the desired goals:

1. Do not disturb any portion of the site unless an improvement is to be constructed there immediately.
2. Staging and timing of construction, grading, clearing, etc. can minimize the size of exposed areas and the length of time the areas are exposed and subject to erosion. For example, only areas that are actively involved in cut and fill operations or are otherwise being graded should be exposed.
3. Retain existing vegetation and ground cover where feasible, especially along watercourses and along the downstream perimeter of the site.
4. Construction should be completed as quickly as possible.
5. Landscaping or other stabilization techniques should be installed immediately after the land has been graded to its final contour.
6. Denuded areas should be kept to a minimum during the wet months of December through May.

Stabilize Disturbed Areas – Stabilization is very important because it protects the soil from being eroded away. Stabilization techniques may include vegetative, chemical, or physical soil coverings. It is important to keep in mind that any soil which is exposed is subject to erosion due to a rainfall event, runoff flowing over the soil, wind blowing across that soil, and vehicles driving on the soil. Consequently, it is important that all soil is covered, other than that which is undergoing active construction. Locations on a construction site that are more susceptible to erosion are:

1. Slopes
2. Highly erosive soils
3. Construction entrances
4. Water resource channels
5. Soil stockpiles

Site Perimeter – BMPs for regulating flow in and out of the site perimeter should be a priority. The following ideas should be considered:

1. Disturbed areas or slopes that drain toward adjacent properties, storm drain inlets or receiving waters, should be protected with temporary linear barriers (continuous berms, silt fences, sand bags, etc.) to reduce or prevent sediment discharge while construction in the area is active. In addition, the contractor should be prepared to stabilize those soils with EP measures prior to the onset of rain.

2. When grading has been completed, the areas should be protected with EP controls such as mulching, seeding, planting, or emulsifiers. The combination of EP measures and SC measures should remain in place until the area is permanently stabilized.
3. Significant offsite flows (especially concentrated flows) that drain onto disturbed areas or slopes should be controlled through use of continuous berms, earth dikes, drainage swales, and lined ditches that will allow for controlled passage or containment of flows.
4. Concentrated flows that are discharged off of the site should be controlled through outlet protection, velocity dissipation devices, and level spreaders in order to prevent erosion of downstream areas.
5. Perimeter controls should be placed everywhere runoff enters or leaves the site. They are usually installed just before clearing, grubbing, and rough grading begin. Additional controls within the interior of the construction site should supplement perimeter controls once rough grading is complete.

Internal Swales and Ditches – Until permanent facilities have been constructed, flows are directed toward internal swales, curbs, and ditches. Design and implementation criteria should include the following:

1. Temporary stormwater facilities are susceptible to erosion from concentrated flows, and should be stabilized through temporary check dams, geotextile mats, and under extreme erosive conditions by lining with concrete.
2. Long or steep slopes should be terraced at regular intervals in order to slow the runoff, and to allow for small amounts of sediment to settle out.
3. Slope benches may be constructed with either ditches along them or back-sloped at a gentle angle toward the hill. These benches and ditches intercept runoff before it can reach an erosive velocity and divert it to a stable outlet.
4. A rough surface such as tall grass can be installed to reduce overland flow velocities.

Internal Erosion - After all erosion and sediment control BMPs have been utilized, excessive sediment should be removed from stormwater both within and along the perimeter of the project site. To prevent erosion temporary barriers or traps should slow the velocity of sediment-laden water. This flow should then enter a pond where soil particles may settle. Appropriate strategies for implementing sedimentation controls include:

- Sediment-laden water should be directed to temporary sediment traps.
- Locate sediment basins and traps at low points below disturbed areas.
- Existing and proposed storm drainage structures should be protected from sediment clogging by implementation of inlet protection for area drains and curb inlets.
- Temporary sediment traps or ponds should be constructed at stormwater outfalls for the site.
- Stormwater detention ponds should be excavated early in the project so that they can serve as sedimentation ponds during construction. Remove accumulated sediment and landscape the ponds when the upstream drainage area is stabilized.
- Temporary sediment barriers such as:

- Silt Fence
- Baffles
- Filter Ring
- Filter Berm
- Tubes and Wattles

Stormwater Inlets and Outfalls – All stormwater inlets, including drop inlets, and pipe inlets, should be protected from sediment intrusion if the area draining to the inlet has been disturbed. This protection may include sand bags, sediment traps, or other similar devices. In addition internal outfalls must be protected to reduce scour from high velocity flows leaving pipes or other drainage facilities.

BMPs for Temporary Construction Site Runoff Management Practices (TCPs) are covered in more detail in Section 3 of this manual.

Permanent Erosion Prevention and Sediment Control BMPs

Permanent BMPs are the final improvements to the configuration of the project. They are designed for long-term management of stormwater pollution after construction activities are complete. Example Permanent BMPs include permanent vegetation, buffer zones, bioengineered stream bank stabilization and channel linings. There is no single BMP that will address all long-term stormwater quality problems. A multi-level strategy is required that incorporates source controls, a series of on-site treatment controls, and community-wide treatment controls. This concept was presented earlier in Figure 2, BMP Selection Process. Permanent BMP selection should be considered in the early planning stages of development.

The BMP Fact Sheets for Permanent Erosion Prevention and Sediment Control (PESC) are provided in Section 4 of this manual.

Permanent Stormwater Quality Treatment Controls

Permanent Stormwater Quality Treatment Controls may include Green Infrastructure Practices (GIPs) such as bioretention, swales, detention ponds, and a variety of other features as well as 80% TSS Treatment Practices such as constructed wetlands, sand filters, and filter strips. Licensed professional engineers are responsible for selection of these management practices. These practices should be included in the early planning stages of development. It is important to consider which treatment controls are most efficient and appropriate for the site. In addition, the long-term maintenance responsibilities should be identified in the plans and specifications to prevent future disputes. Typically, this responsibility is left to either the public or private owner of the property. The contractor and owner are responsible for properly constructing and maintaining the permanent controls.

Permanent Stormwater Quality Treatment Controls are implemented most effectively when they are tied in with the actual project design. They are typically selected during the planning phase, in conjunction with the approval of the tentative plan designed during the design phase of a project. When stormwater controls are considered as part of the design, they are conceptually planned and consequently, more effective. The following should be considered in the design process.

1. Is a detention/retention facility required for flood control? Often, facilities are required to maintain peak runoff at predevelopment levels to reduce downstream conveyance system

damage and other costs associated with flooding. Most permanent BMPs can be incorporated into flood control detention/retention facilities with modest design refinements and limited increase in land area and cost.

2. Planned open spaces that have slopes less than 5% may be merged with stormwater quality/ quantity facilities. Such integrated, multi-use areas may achieve several objectives at a modest cost.

3. Infiltration BMPs may serve as groundwater recharge facilities, although soil conditions are critical to their success. Detention/retention areas may be created in landscaped areas of the project, and vegetated swales/filters may be used as roadside/median or parking lot median vegetated areas.

The BMP Fact Sheets for Permanent Stormwater Treatment Controls (PTPs) including GIPs and 80% TSS Treatment Practices are provided in Section 5 of this manual.

2.2.3 Effectiveness of Green Infrastructure Practices

GIPs are intended to mimic the natural hydrologic condition and allow stormwater to infiltrate into the ground, evapotranspire into the air, or be captured for reuse. Typical GIPs include: sheet flow, infiltration practices, permeable pavement, bioretention, reforestation, tree box filters, green roofs, and assorted other practices.

These GIPs are designed to meet multiple stormwater management objectives, including reductions in runoff volume, peak flow rate reductions, and water quality protection. Multiple small, localized controls may be combined into a treatment train to provide comprehensive stormwater management. The GIPs listed in this section have been designed to be integrated into many common urban land uses on both public and private property, and may be constructed individually, or as part of larger construction projects. Decentralized management strategies are encouraged to be tailored to individual sites; which can eliminate the need for large-scale, capital-intensive centralized controls; and may improve the water quality in Franklin's water resources.

This Manual includes nine of the most common GIPs, shown in summary Table 1 and Table 2. These tables are included to facilitate selection of the most appropriate practices for a given situation. Fact sheets are included in Section 5 for each practice and provide a brief introduction to the practice, details on performance, suitability, limitations, and maintenance requirements. In addition, each practice is assigned a percentage of volume control based on the particular GIP's ability to control volume from smaller storms and from the first flush of larger storms. Not only does reducing runoff volume decrease the amount of

stormwater discharged to sewers, channels and streams, but it is also the most effective stormwater pollution control available.

Table 1 – Effectiveness of BMPs in Meeting Stormwater Management Objectives			
Practices	**Volume**	**Peak Discharge**	**Water Quality**
Bioretention	●	●	●
Urban Bioretention	◉	◉	●
Permeable Pavement	●	●	◉
Infiltration Trench	●	●	●
Water Quality Swales (Dry)	◉	◉	●
Extended Detention	○	●	○
Downspout Disconnection	◉	◉	◉
Grass Channels	○	○	○
Sheet Flow	●	●	◉
Reforestation	●	●	●
Rain Tanks/Cisterns*	◉	○	○
Green Roofs	◉	●	●

* A single cistern typically provides greater volume reduction than a single rain tank

● High effectiveness ◉ Medium effectiveness ○ Low effectiveness

Rankings are qualitative. “High effectiveness” means that one of the GIP’s primary functions is to meet the objective. “Medium effectiveness” means that a GIP can partially meet the objective but should be used in conjunction with other BMPs. “Low effectiveness” means that the GIP’s contribution to the objective is a byproduct of its other functions, and another decentralized control should be used if that objective is important.

Table 2 – Green Stormwater Infrastructure Land Use and Land Area Selection Matrix								
Practices	Criteria							
	Land Use							Land Area Required
	Schools	Com.	Indust.	SF Res.	MF Res.	Parks/Open Space	Roads/ Roadside	
Bioretention	●	●		●	●	●	●	◉
Urban Bioretention	◉	●			●	●	●	○
Permeable Pavement	●	●	◉	●	●	●	●	○
Infiltration Trench	●	●		●	●	●	◉	○
Water Quality Swales (Dry)	●	●			●		●	◉
Extended Detention	●	●	●		●		●	○
Downspout Disconnection	●	◉		●	●	●		○
Grass Channels	●	●		●	●	◉	●	◉
Sheet Flow	●	●		●	●	◉	●	◉
Reforestation	◉		◉	◉	◉	●	●	○/●
Rain Tanks/Cisterns	●	◉	◉	●	●			○
Green Roofs	●	●	●		●			○

● - Well suited for land use applications or high relative dedicated land area required.
◉ - Average suitability for land use applications or moderate relative dedicated land area required.
○ - Low relative dedicated land area required.
Blank – Not applicable for land use.

2.3 Integrated Site Design

The City of Franklin has established a three-part Integrated Site Design (ISD) process in the consideration of stormwater management goals. The ISD process fits well into the general process of land development and serves to assist the designer in making maximum use of the natural features of the site to treat and handle stormwater runoff in a way that integrates such practices into the site layout. Best Management Practice layout planning is accomplished through the ISD process and includes impact reducing site design, integrated stormwater sizing criteria and operations and maintenance of permanent stormwater practices.

Impact-Reducing Site Planning and Design Principles

The first step in the ISD process is to utilize impact-reducing site design principles for stormwater management. Impact-reducing site design includes a number of site design techniques such as preserving natural features and resources, effectively laying out the site elements to reduce impact to the watershed, reducing the amount of impervious surfaces, and utilizing natural features on the site for stormwater management. The goal is to minimize impacts of development by reducing the amount of runoff and pollutants that are generated from a development or redevelopment site, and provide for some nonstructural on-site treatment and control of runoff. Impact-reducing site design concepts can be viewed as both water quantity and water quality management tools that can reduce the size and cost of required structural stormwater controls — sometimes eliminating the need for them entirely — while maintaining or even increasing the value of the property. This site design approach can result in a more natural and cost-effective stormwater management system that better mimics the natural hydrologic conditions of the site, has a lower maintenance burden and increases sustainability.

Step 1: Identify and Delineate Natural Features and Resources

The first step in the impact-reducing site design process is to identify and delineate the natural features and resources that can be used in the protection of water resources by reducing stormwater runoff, providing runoff storage, reducing flooding, preventing soil erosion, promoting infiltration, and removing stormwater pollutants. The design engineer should collect and review information on the existing site conditions and delineate existing site features such as:

- Areas of undisturbed vegetation
- Floodplains and riparian areas
- Ridgetops and steep slopes
- Natural drainage pathways
- Water resource channels and streams
- Aquifers and recharge areas
- Wetlands
- Soil types
- Other natural features or critical areas
- Other features that should be identified in this step are adjacent areas, existing developed areas, and existing stormwater facilities and infrastructure.

Step 2: Conserve Natural Features and Resources

The conservation of natural features such as floodplains, soils, and vegetation helps to retain predevelopment hydrology functions, thus reducing runoff volumes. Impacts to natural features should be minimized by reducing the extent of construction and development practices that adversely impact predevelopment hydrology functions. This includes:

- Building upon the least porous soils or limiting construction activities to previously disturbed soils
- Avoiding mass clearing and grading, and limiting the clearing and grading of land to the minimum needed to construct the development and associated infrastructure
- Avoiding disturbance of vegetation and soil on slopes and near surface waters
- Leaving undisturbed riparian buffers along both sides of the water resource, as defined in the City of Franklin Municipal Code
- Preserving sensitive environmental areas, historically undisturbed vegetation, and native trees
- Conforming to watershed, conservation, and open space plans
- Designing development to fit the site terrain, and building roadways parallel to contour lines wherever possible
- Clustering development to preserve porous soils, natural streams, natural channels and natural slopes
- Avoid floodplains

Step 3: Manage Stormwater Close to the Source

Redirecting runoff back into the ground, close to the point of origin, provides both environmental and economic benefits. Traditional stormwater systems, which collect and convey stormwater, generally increase flows and are likely to suffer failures over time. Techniques include:

- Use GIPs to infiltrate stormwater into the ground instead of concentrating the flow and routing it offsite
- Disconnect impervious surfaces wherever feasible

Step 4: Design to Reduce Runoff Impacts

After conservation areas have been delineated, there are additional opportunities in the preliminary stages of a site design for avoiding downstream stormwater impacts from the development. These primarily deal with the location and configuration of lots or structures on the site and include the following recommendations and options:

- Fit the design to the terrain
- Reduce the limits of clearing and grading (i.e., limit clearing and grading areas to what is absolutely necessary)
- Locate development in less sensitive areas (e.g., outside of wetlands)

- Utilize open space
- Use nontraditional lot designs for residential areas (think outside the box)
- Consider creative development design
- Preserve riparian buffers and undisturbed areas
- Use natural drainage paths instead of storm sewer infrastructure
- Use vegetated swales instead of curb and gutter
- Drain runoff to pervious areas

Step 5: Reduce and Disconnect Impervious Cover

Reducing and disconnecting impervious surfaces increases the rainfall that infiltrates into the ground. Impervious areas should be reduced by maximizing landscaping and using pervious pavements. In addition, the amount of impervious areas hydraulically connected to impervious conveyances (e.g., driveways, walkways, culverts, streets, or storm drains) should be reduced as much as possible. Examples include:

- Installing green roofs
- Directing roof downspouts to vegetated areas, bioretention,, or planter boxes, and routing runoff into vegetated swales instead of gutters
- Using porous pavements where permitted
- Installing shared driveways that connect two or more homes or installing residential driveways with center vegetated strips
- Allowing for shared parking in commercial areas
- Encouraging building developers to increase their number of floors instead of their building's footprint

Step 6: Minimize Soil Compaction

Soil compaction disturbs native soil structure, reduces infiltration rates, and limits root growth and plant survivability. When protected, local soils can have a significant infiltration capacity, and can help meet design requirements. While soil compaction is necessary to provide structurally sound foundations, areas away from foundations are often excessively compacted by vehicle and foot traffic during construction. Minimizing soil compaction can be achieved by:

- Reducing disturbance through design and construction practices
- Limiting areas of access for heavy equipment
- Avoiding extensive and unnecessary clearing and stockpiling of topsoil
- Maintaining existing topsoil and/or using quality topsoil during construction

Integrated Stormwater Sizing Criteria

The second step in the ISD process is to utilize an integrated sizing approach for meeting the City's stormwater runoff **quantity** and **quality** management requirements. These criteria allow the site engineer

to calculate the stormwater control volumes required for water quality and flood protection. The purpose is to provide a framework for designing (sizing) a stormwater management system to:

- Reduce the volume of stormwater runoff and remove runoff pollutants to improve water quality;
- Reduce downstream overbank flooding; and
- Safely pass or reduce the runoff from extreme storm events.

The Integrated Stormwater Sizing Criteria is an integrated set of criteria or design standards that allow the site engineer to size and design structural stormwater controls to address the above objectives. The criteria are summarized in Table 3.

Table 3 - Summary of Sizing Criteria for Stormwater Control and Mitigation

Sizing Criteria		Description
Water Quantity	**Water Quality**	Infiltrate, evapotranspire, harvest and/or use, at a minimum, the first inch of every rainfall event preceded by 72 hours of no measurable precipitation. For projects that cannot meet 100% of the runoff reduction requirement, the remainder of the stipulated amount of rainfall must be treated prior to discharge with a technology expected to remove 80% total suspended solids (TSS).
	Overbank Flood Protection	Provide peak discharge control of the 2, 10, 25, and 50-year storm event on the stormwater management system, adjacent property, and downstream facilities and property to reduce overbank flooding through detention.
	Extreme Flood Protection	Evaluate the effects of the 100-year storm on the stormwater management system, adjacent property, and downstream facilities and property. Manage the impacts of the extreme storm event through detention controls and/or floodplain management.

Each of the integrated stormwater sizing criteria are intended to be used with one another to address the overall stormwater impacts from a development site. When used as a comprehensive set, the integrated criteria control the entire range of hydrologic events, from the smallest runoff-producing rainfalls to the 100-year storm. Figure 3 graphically illustrates the relative volume requirements of each of the integrated stormwater sizing criteria and demonstrates that the criteria are generally "nested" within one another, (i.e., the extreme flood protection volume requirement also contains the overbank flood protection volume and the water quality treatment volume). This nesting provides efficiency when constructing and maintaining stormwater controls.

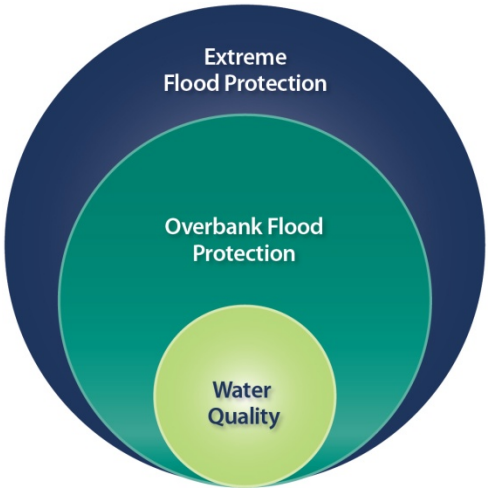


Figure 3 – Representation of the Integrated Stormwater Sizing Criteria

The integrated stormwater sizing criteria is described in more detail below.

2.3.1 Water Quality

Hydrologic studies show that small-sized, frequently occurring storms account for the majority of rainfall events that generate stormwater runoff. Consequently, the runoff from these storms also accounts for a large portion of the annual pollutant loadings. Therefore, by treating these frequently occurring smaller rainfall events and a portion of the stormwater runoff from larger events, it is possible to effectively mitigate the water quality impacts from a developed area whether located in the headwater reaches of the watershed or close in proximity to a 4th order stream.

The Runoff Reduction Method (RRM), presented in Chapter 3, can achieve both volume control and pollutant removal stormwater management goals. For projects that cannot meet 100% of the runoff reduction requirement, the remainder of the stipulated amount of rainfall must be treated prior to discharge with a technology expected to remove 80% TSS in order to comply with the City's NPDES Phase II MS4 Permit. This combined approach allows the designer to apply RRM design principles along with 80% TSS design principles to meet the compliance standard.

Chapter 3.1 of this manual provides technical details regarding RRM. Chapter 3.2 provides technical details regarding the RRM and 80% TSS fall back combined methodology.

The City of Franklin reserves the right to require other treatment goals for other pollutants of concern based on other regulatory requirements or needs (e.g. Total Maximum Daily Load studies).

2.3.2 Overbank Flood Protection (Qp)

An increase in impervious areas by development increases the potential for downstream flooding. The purpose of overbank flood protection is to prevent an increase in the frequency and magnitude of damaging out-of-bank flooding (i.e. flow events that exceed the capacity of the channel and enter the floodplain). It is intended to protect downstream properties from flooding at middle-frequency storm events. The Overbank Flood Protection criterion specifies that the post-development 2, 10, 25, and 50-year, 24-hour

storm peak discharge rate (denoted Qp) not exceed the pre- development (or undisturbed natural conditions) discharge rate.

2.3.3 Extreme Flood Protection (Qf)

The intent of the extreme flood protection is to prevent flood damage from infrequent but large storm events, maintain the boundaries of the mapped 100-year floodplain, and protect the physical integrity of the structural stormwater controls as well as downstream stormwater and flood control facilities. The Extreme Flood Protection criterion specifies that all stormwater management facilities be designed to control runoff for the 100-year, 24 hour storm (denoted Qf) so that the rate at which flow is released over the entire runoff discharge period is equal to or less than predevelopment flows.

Operations and Maintenance

The third and final step in the ISD process is to provide for operation and maintenance (O&M) oversight of the water quality and quantity BMPs. Without proper care and maintenance, the BMPs ability to perform its design function is reduced and it is no longer in compliance with City regulations.

A Stormwater Management Facilities O&M Agreement is required to be submitted with all Stormwater Permit Applications. If final configuration of the stormwater system changes from the design, the O&M Agreement must be updated to reflect changes. As part of the O&M Agreement, a Long Term BMP Maintenance Plan must be developed by the design professional engineer (Found in Section 5). This plan includes a description of the stormwater system, the required inspections, the inspection schedule, and how the inspections should be documented. A report must be submitted to the City of Franklin by July 1 of each year that includes documentation of the inspection and maintenance activities performed.

Additional O&M guidance for Green Infrastructure controls and TSS Practices can be found within each design specification located in Section 5.

3 Post Construction Water Quality

3.1 The Runoff Reduction Method

Introduction

3.1.1 Background

The Runoff Reduction Method (RRM) will serve as the basis for Franklin's approach to Green Infrastructure (GI) requirements in the NPDES Phase II MS4 Permit. The basic RRM derivation can be found in original References 11 and 12. The RRM has been slightly modified and localized for the middle Tennessee region.

In the past, Franklin's pollution reduction approach focused mainly on engineered controls to reduce stormwater pollution as runoff flowed through structural controls, and required that they meet an 80% or more removal efficiency of total suspended solids. Open space land use was of only minor importance. Under the RRM, every land surface will now have an assigned rating in terms of volume of rainfall capture. For example, if open space can infiltrate a significant rainfall event, and it can be credited with 100% TSS removal for all the volume it infiltrates, then the open space itself becomes an effective control. Even impervious surfaces capture a small amount of water and therefore do not generate 100% runoff.

Volume removal is the focus of this approach; and volume reduction equals pollution reduction. Thus, understanding and calculating every aspect of a site's land condition in relation to volume removal is important.

3.1.2 Objectives

The basis for the RRM is a rainfall volume capture goal. The City of Franklin's site design standards require, in combination or alone, management measures that are designed, installed and maintained to infiltrate, evapotranspire, harvest and/or use, on average, the first inch of every rainfall event preceded by 72 hours of no measurable precipitation. The RRM was designed to fulfill several complimentary objectives:

- Meet the one-inch capture requirement under the NPDES MS4 Permit;
- Reflect local hydrologic and land conditions;
- Encourage and incentivize the use of natural solutions; and
- Provide an approach that is simple and effective for a range of development projects

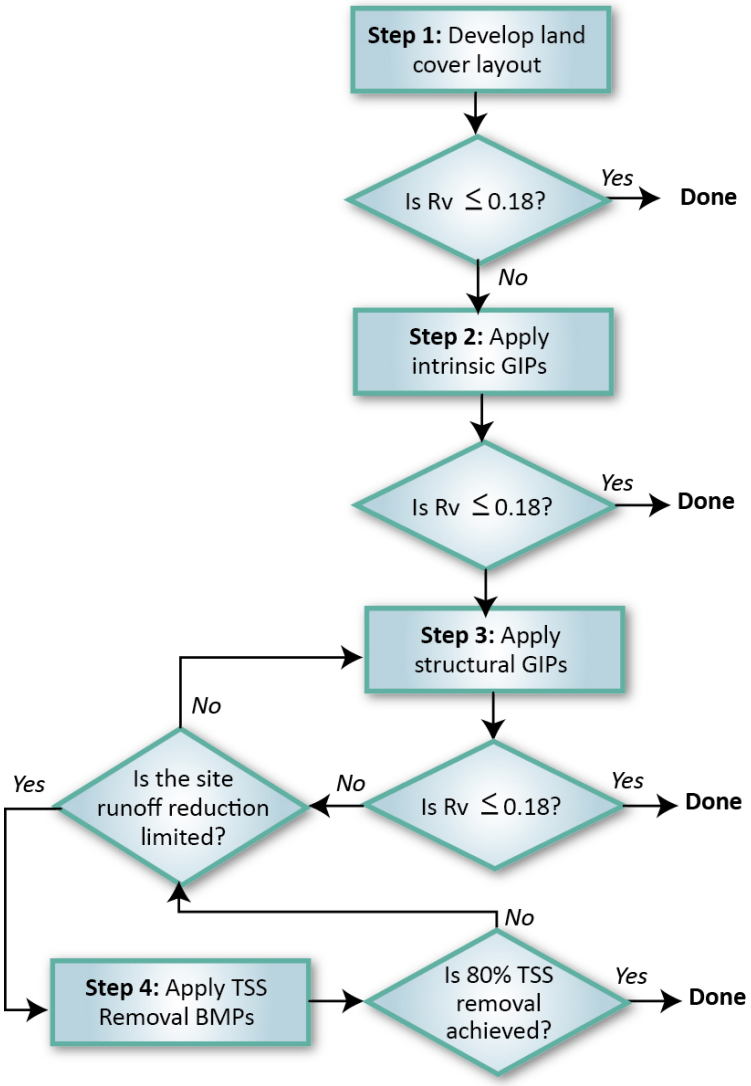
It was found that these objectives could largely be met through the use of a single overarching design standard, backed by specific volume-capture standards for structural controls and rainfall intensity scaled runoff coefficients for other land uses. To be eligible for approval of a site design under this approach the designer must lay out the site such that the total rainfall for a one-inch event of moderate intensity is captured and treated on site through a combination of infiltration, evapotranspiration, harvest and/or use. This objective is accomplished through site layout and GIP design.

The first step in determining if the standard is met is to determine the volumetric runoff coefficient, Rv, which is the percentage of fallen precipitation that runs off of a specific land use area (See Equation 1). Rv within this method reflects a site's post-development runoff volume for storms in the one-inch or larger

range. Based on national studies and standards, and supported by local rainfall-runoff analysis for middle Tennessee soils, it was found that an Rv value of 0.18 generally indicates the capture of the first one-inch of rainfall. Storms larger than one inch may cause runoff.

Each land use is assigned an Rv value. Once Rv values have been developed, they must be weighted for the respective areas. If the weighted Rv for the whole site is 0.18 or less, then the standard has been met. If the Rv standard has not been met, GIPs consisting of intrinsic designs and structural controls devised to capture the remaining required volume are added to the design. These effectively modify the Rv value for contributing drainage areas to that intrinsic design or control. These are shown in Tables 4 and 5.

In summary, in meeting this standard the designer will have carefully considered the effective use of: (1) land cover that reduces runoff; (2) more intrinsic site design GIPs that further reduce runoff; and (3) structural GIPs that capture the remaining volume required to meet the compliance standard. In each step the Rv values and supporting design specifications have been carefully crafted to effectively meet compliance standards while retaining focus on natural approaches. In every case values have been localized through the balanced use of the most recent data sources and continuous simulation modeling of local conditions.



3.1.3 Conceptual Steps in the Runoff Reduction Method

The RRM follows the steps shown below:

Step 1: Reduce Runoff Through Land Use and Ground Cover Decisions

This step focuses on the "background" land cover and how much rainfall it removes from runoff. Design activities in Step 1 focus on impervious area minimization, reduced soil disturbance, forest preservation, etc. The goal is to minimize impervious cover and mass site grading and to maximize the retention of forest and vegetative cover, natural areas and undisturbed soils, especially those most conducive to landscape-scale infiltration.

Calculations for the RRM Step 1 include the computation of volumetric runoff coefficients (Rv) for land use and Hydrologic Soil Group (HSG) combinations (including impervious cover). Site cover runoff coefficients are shown in Table 4.

Step 2: Apply Environmental Site Design Practices (Non-Structural GIPs)

If the target volume capture (Rv ≤ 0.18) has not been attained in Step 1 then Step 2 is required. This step focuses on implementing the more intrinsic GIPs during the early phases of site layout. In this step the designer enhances the ability of the background land cover to reduce runoff volume through the planned and engineered use of such practices as sheet flow, and planned reforestation. Each of these practices is assigned an ability to reduce one-inch of rainfall in a storm of moderate intensity; and this assignment is captured in the Runoff Removal Credit or the RR Credit. RR Credit values for non-structural GIPs are shown in Table 5.

Step 3: Apply Structural GIPs

If the target one-inch capture volume (Rv ≤ 0.18) has not been attained, Step 3 is required. In this step, the designer experiments with combinations of more structural GIPs on the site. In each case, the designer estimates the area to be treated by each GIP to incrementally meet the overall runoff reduction goal. Such engineered practices as infiltration trenches, bioretention, green roofs, permeable pavement, etc. are envisioned. Design and sizing standards have been created for each of these GIPs to insure their ability to meet the one-inch volume capture still required after Steps 1 and 2 have been implemented. RR Credit values for structural GIPs are also shown in Table 5.

The guidance for the effectiveness of the various GIPs is expressed in terms of percent volume reduction (Runoff Reduction Credit). At the end of Step 3, the designer must have achieved the required one-inch volume capture – accomplished by attaining an area weighted Rv value of 0.18 or less.

However, if the Runoff Reduction Performance Standard has not been achieved after Step 3 and the development is determined to be runoff reduction limited (i.e., runoff reduction practices cannot be implemented at the site sufficiently to meet the Runoff Reduction Performance Standard), then the site designer must request approval to use TSS Removal Best Management Practices (BMPs) and, if approved, proceeds to Step 4.

Step 4: Apply TSS Removal BMPs

The application of TSS Removal BMPs will occur only if the Runoff Reduction Performance Standard has not been achieved in Steps 1 through 3, and the site is approved for TSS Removal BMPs because it is runoff reduction limited. In this step, the designer will capture the remainder of the required 1-inch rainfall that was not captured in the Runoff Reduction Method design (in steps 1 through 3), and will treat this volume to the Pollutant Removal Performance Standard of 80% TSS Removal. TSS Removal BMPs such as stormwater wetlands, sand filters, and wet ponds can be used for this purpose.

Technical Details

3.1.4 Step 1: Land use Rv Values

The volumetric runoff coefficient (Rv) is the ratio of the runoff divided by the target rainfall. The Rv values refer to the ratio of rainfall that falls on and is discharged from each drainage area. If 45% of the rainfall for storms in the one-inch range and larger is discharged from the site, the Rv value equals 0.45. Unlike a Rational Method C Factor, for example, Rv is not a constant individual storm-based value, but is rainfall intensity and total depth dependent. Rv values could be developed for individual storms, seasons, or even on an annual basis. Table 4 shows the Rv values that are applicable for the City of Franklin in order to estimate runoff from larger storms of moderate intensity meeting the one-inch and greater standard.

Table 4 - Site Cover Runoff Coefficients

Soil Condition	Volumetric Runoff Coefficient (R_V)			
IMPERVIOUS COVER	0.95			
HYDROLOGIC SOIL GROUP	**A**	**B**	**C**	**D**
FOREST COVER	0.02	0.03	0.04	0.05
TURF	0.15	0.18	0.20	0.23

These values serve as the basis for Step 1 in application of the RRM. The development of an area-weighted estimate of the total site Rv value using site land uses is shown below in Equation 1. Example 1 on the following page demonstrates Step 1 using Equation 1

$$\text{Weighted Rv} = \frac{[(\text{Rv}_1 \times \text{A}_1) + (\text{Rv}_2 \times \text{A}_2) + \cdots]}{(\text{A}_1 + \text{A}_2 + \cdots)} \qquad \textbf{Equation 1}$$

EXAMPLE 1 STEP 1

The first step is to layout the project site and divide it into sub-areas of a specific land use type and Rv. As shown in Figure 4 below, if we have a 10 acre site and 50% of the site was impervious, 20% forest, and 30% turf grass all over HSG B Soils the Rv value would be:

$$\text{Weighted Rv} = \frac{[(\text{Rv}_1 \times \text{A}_1) + (\text{Rv}_2 \times \text{A}_2) + (\text{Rv}_3 \times \text{A}_3)]}{(\text{A}_1 + \text{A}_2 + \text{A}_3)}$$

$$\text{Weighted Rv} = \frac{[(0.95 \times 5.0\text{ac}) + (0.03 \times 2.0\text{ac}) + (0.18 \times 3.0\text{ac})]}{(5.0\text{ac} + 2.0\text{ac} + 3.0\text{ac})}$$

$$\text{Weighted Rv} = 0.54$$

That is, 54% of the rainfall for storms in the range of one-inch and greater runs off. This step does not consider the flow path of the runoff but simply the land use. The requirement is the capture of the first inch of rainfall and an Rv of 0.18 or less. Additional GIPs must be planned and implemented to meet the required Rv for the site.

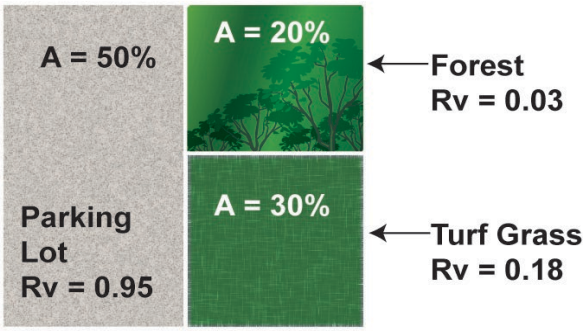


Figure 4 – Site Example with Land Uses

3.1.5 Redevelopment Rv Reduction

Reduction of a sites overall water quality treatment value (Rv value) may be granted by the City Engineer for qualifying non-residential redevelopment sites. Existing outparcels or mixed use developments that contain both residential and commercial uses may qualify but shall be considered on a case by case basis by the City Engineer. Redevelopment Rv reductions are aimed at encouraging older (pre-green infrastructure and TSS requirements) predominately impervious developments in which no existing water quality practices are in place to promote healthier watersheds through infiltration-based water quality practices.

Consideration of parcel eligibility for Redevelopment Rv reduction shall be based on total existing impervious area included in the currently approved development plan. If the parcel in question was developed before the implementation of development plan recordings, then the bases for impervious area will be based on the limits of the current plat of record for that development. This applies to the land located

within the site's property lines. Detailed criteria of eligibility for incentives shall be in accordance with that outlined in the City's current BMP manual and may be revised at any time by the City Engineer. The target Rv value for sites that qualify are stated below. Incremental percentage reductions between target Rv values will not be given.

- Tier 1: 90%-100% Existing Impervious = Target Rv value shall equal .60 or more
- Tier 2: 80%-89.99% Existing Impervious = Target Rv value shall equal .65 or more
- Tier 3: 70%-79.99% Existing Impervious = Target Rv value shall equal .70 or more
- Tier 4: 60%-69.99% Existing Impervious = Target Rv value shall equal .75 or more

3.1.6 Steps 2 and 3: Green Infrastructure Practice Rv Values

Steps 2 and 3 of the RRM involve the planning and design of Green Infrastructure Practices (both intrinsic Step 2 and structural Step 3) to reduce runoff from sub-areas in Step 1. Each sub-area's Rv may be reduced by allowing runoff to flow into downstream GIPs. After GIPs are implemented the total site Rv is recalculated using the GIP modified Rv for each sub-area. In order to satisfy the City's requirement the site Rv must be 0.18 or less. Table 5 lists acceptable GIPs and the assigned Runoff Reduction Credits (RR Credit) for each. These RR Credit values correspond with the values listed in each GIP's specification. Several GIP's in Table 5 have two levels of design options, the two levels refer to specific design requirements contained in the specification sheets within Section 5 of this manual.

Table 5 - Green Infrastructure Practices Runoff Reduction Credit Percentages

Green Infrastructure Practice	% Rainfall Volume Removed/Captured – RR Credit							
	Level 1**				Level 2**			
1. Bioretention	60				80			
2. Urban Bioretention	60				N/A			
3. Permeable Pavement	45				75			
4. Infiltration Trench	50				90			
5. Water Quality Swale	40				60			
6. Extended Detention	15				N/A			
7. Sheet Flow *	50				75			
8. Reforestation (A, B, C, D soils)	96	94	92	90	98	97	96	95
9. Green Roof	80				90			

*See GIP for additional RR Credits.

**See GIP for additional information of the distinction between Level 1 and Level 2 design.

Note that the first six GIPs themselves occupy site land area. Because of their ability to absorb the rain that falls on them they are assigned the corresponding Forest Cover Rv values by soil type from Table 6.

Table 6 - Green Infrastructure Practice Cover Coefficients				
Green Infrastructure Practice	Forest Cover Rv Values for GIPs by Hydrologic Soil Group			
	A	B	C	D
Bioretention Urban Bioretention Permeable Pavement Infiltration Trench Water Quality Swale Extended Detention	0.02	0.03	0.04	0.05

To calculate the Modified Rv value for a sub-area flowing through a GIP, use Equation 2 shown below.

$$\text{Modified Sub-area Rv} = (\text{Sub-area Rv})(1 - \text{RR Credit}) \qquad \textbf{Equation 2}$$

The Modified Sub-area Rv equals the Sub-area Rv as treated by a GIP. Example 1 is continued below and demonstrates Steps 2 and 3 using Equation 2 above.

EXAMPLE 1 - STEP 2 & 3

In Step 2 and 3, the designer uses intrinsic and structural GIPs to reduce the weighted Rv. Continuing with Example 1 Step 1 and using Figure 4, the impervious area has an Rv value of 0.95, half of the parking area can be discharged through one intrinsic GIP, sheet flow level 2 over turf (Table 5: 75% RR Credit for HSG B soil). The other half of the parking area can be discharged through one structural GIP, bioretention with level 2 design (Table 5: 80% RR Credit). The following modified Rv would result using Equation 2: (Note that the forest and turf do not drain to the bioretention area)

$$\text{Sheet Flow (Level 2) Modified Sub-area Rv} = 0.95 * (1-0.75) = 0.24$$

$$\text{Bioretention Modified Sub-area Rv} = 0.95 * (1-0.80) = 0.19$$

Thus, the intrinsic GIP, sheet flow level 2 via a level spreader reduces half the impervious area's Rv from 0.95 to **0.24** and the bioretention facility meeting the level 2 design criteria would cause the remainder of the impervious area's Rv to be reduced from 0.95 to **0.19**. Additionally, the bioretention area occupies land area and can be given a Forest Cover on HSG B soil Rv.

Recalculating the weighted Rv using Equation 1 results in the following:

$$\text{Weighted Rv} = \frac{[(\mathbf{0.24} \times 2.5\text{ac}) + (\mathbf{0.19} \times 2.5\text{ac}) + (\mathbf{0.03} \times 0.14ac) + (0.03 \times 2.0\text{ac}) + (0.18 \times 2.86\text{ac})]}{(10\text{ac})}$$

$$\text{Weighted Rv} = 0.17$$

Using sheet flow via a level spreader over HSG B soil and a bioretention area meeting the Level 2 design criteria runoff from the impervious area is treated and the weighted Rv is reduced to just below the requirement of 0.18.

3.1.7 Rv Calculations for GIPs in Series

The calculation of volume removal rate for controls in series can be complex and specific GIP dependent. The upstream control has the benefit of initially handling runoff from the many small storms while the second GIP in series must handle the overflow from the first – a set of fewer and larger storms. Therefore, the ability to capture instantaneous volumes and store them for later removal is key for the downstream controls. Only the first six controls in Table 5 can be used as the downstream GIP in series: bioretention, urban bioretention, permeable pavement, infiltration trench, water quality swale, and extended detention.

The following equation shall be used for calculation of the Modified Subarea Rv for GIPs in series:

$$\text{Modified Sub-area Rv}_{\text{SERIES}} = \text{Sub-area Rv}(1 - RR_1\text{ Credit})(1 - RR_2\text{ Credit}) \quad \textbf{Equation 3}$$

Where Subarea Rv is the area weighted Rv of the land cover flowing into the first GIP in the series (e.g. Subarea Rv = 0.95 for 100% impervious area, *or* if 50% of the area was impervious and 50% of the area was turf on HSG B soil then the Sub-area Rv is 0.57). RR_1 Credit is the percent volume reduction credit for the first GIP in the series from Table 5 and RR_2 Credit is the percent volume reduction credit for the second

GIP in the series from Table 5. Credit will be granted for no more than two structural controls used in series.

EXAMPLE 2 - GIPs in Series

This example demonstrates how to treat an impervious area by two structural GIPs in series. A 5.0 acre site is 80% impervious (4 ac), 0.75 acre is turf grass, and 0.25 ac is forested. The underlying soils are all HSG C. The impervious area is discharged to two water quality swales level 2 (Table 5: 60% RR Credit) into two bioretention areas level 1 (Table 5: 60% RR Credit). Calculate the Rv for each of the three sub areas of the site – only the impervious area is demonstrating GIPs in series:

(1) Impervious area is discharged through water quality swales and bioretention areas
Modified Sub-area Rv_{SERIES} = 0.95*(1-0.60)(1-0.60) = 0.15

(2) Turf grass HSG C Rv = 0.20

(3) Forest in C Soil Rv = 0.04

Weighted Rv for criteria attainment using Equation 1 is:

$$\text{Weighted Rv} = \frac{[(\mathbf{0.15} \times 4 \text{ ac}) + (\mathbf{0.20} \times 0.75 \text{ ac}) + (\mathbf{0.04} \times 0.25\ ac)]}{(5 \text{ ac})}$$

$$\text{Weighted Rv} = 0.15$$

This equation says that 95% of the rainfall runs off the impervious area and enters the water quality swales of which 60% of is held in the designed swale. The remainder of the prescribed volume would enter the bioretention facility (the largest storms) and 60% of which is captured designed as a level 1 facility allowing approximately 15% to runoff the site in the design situation on an average annual basis.

EXAMPLE 3 - GIPs in Series

A 2.0 acre site is 75% impervious (2 ac), and 0.5 acre is turf grass. The underlying soils are all HSG B. The impervious area consists of a parking lot and building. The building is 0.5 acres and is discharged to a Level 2 Bioretention (Table 5: 80% RR Credit). The parking lot is 1.0 acre and contains 0.5 acre of level 1 pervious pavers (Table 5: 45% RR Credit), the remainder of the runoff not credited by the pavers is captured by a level 2 bioretention (Table 5: 80% RR Credit). Calculate the Rv for each of the two sub areas of the site – only the impervious area from the parking lot is demonstrating GIPs in series:

(1) Parking lot impervious area is discharged and captured by pervious pavers and then by level 2 bioretention

$$\text{Modified Sub-area } Rv_{SERIES} = 0.95*(1-0.45)(1-0.80) = 0.11$$

(2) Building is discharged to a Level 2 Bioretention

$$\text{Modified Sub-area } Rv = 0.95*(1-0.80) = 0.19$$

(3) Turf grass HSG B Rv = 0.18

Weighted Rv for criteria attainment using Equation 1 is:

$$\text{Weighted Rv} = \frac{[(\mathbf{0.11} \times 1 \text{ ac}) + (\mathbf{0.19} \times 0.5 \text{ ac}) + (\mathbf{0.18} \times 0.5\ ac)]}{(2 \text{ ac})}$$

$$\text{Weighted Rv} = 0.15$$

This equation says that 95% of the rainfall runs off the parking lot impervious area enters the pervious pavers and bioretention of which 45% is held in the pavers and 80% of the remainder is held in the bioretention practice. The runoff from the building impervious is captured by the bioretention and when the turf grass (HSG B) is taken into account on an average annual basis 15% runs off the site. Thus, this site meets the Rv target of 0.18 Rv or 18% runoff on an average annual basis.

3.1.8 Sizing of Media-Based GIPs

The following guidance is provided for sizing media based GIPs types of facilities. Details for each type of GIP are provided within Section 5 of this manual. All media-based GIPs shall be sized to provide storage volume for the complete runoff from one inch of rain over the contributing drainage area (CDA). Thus all media storage GIPs shall be sized using the following equations:

$$\text{Tv} = \text{Mult.}\left[\text{P(CDA)(Rv)}\left(\frac{43{,}560 \text{ ft}^2}{1 \text{ ac}}\right)\left(\frac{1 \text{ ft}}{12 \text{ in}}\right)\right] = \text{n(D)(SA)} \qquad \textbf{Equation 4}$$

where:

Tv = GIP treatment volume in cubic feet
Mult. = the multiplier for the GIP from Table 7, if applicable

CDA	=	the contributing drainage area in acres to the GIP.
P	=	1 inch
Rv	=	runoff coefficient for the CDA, if an upstream GIP is used the Rv would be the reduced Modified Sub-area Rv
SA	=	surface area in square feet of the GIP
D	=	media depth of GIP in feet
n	=	Porosity
(D)(n)	=	D_E if more than one media type is required (Equation 5 below)

Note that the Rv value above is for the total area draining to the control. The Treatment Volume (Tv) must be calculated for the volume of runoff from one inch of rainfall that will be discharged to the GIP from the contributing drainage area. Therefore, when using Equation 4 to calculate Tv for a solitary GIP, RR Credits cannot be applied in the calculation of the weighted Rv. When using the equation to calculate Tv for GIPs in series, the weighted Rv can include consideration of the GIP credit that is provided by the upstream GIP when calculating the Tv for the downstream GIP. The resulting Tv is then applicable to the treatment volume that will be required for the downstream GIP. (This methodology is incorporated into the tool)

Table 7 - Multipliers for GIPs for use in Equation 4

Green Infrastructure Practice	Multiplier	
	Level 1	Level 2
1. Bioretention	1	1.25
2. Urban Bioretention	1	n/a
3. Permeable Pavement	1	1.1
4. Infiltration Trench	1	1.1
5. Water Quality Swale	1	1.1
6. Extended Detention	1.25	n/a

Table 8 provides basic volume-based specifications for the standard recommended soil-based media and gravel. Soil-based media is used for GIPs: bioretention, water quality swales and urban bioretention. Gravel is used for design alternatives for the above listed GIPs, as well as, the storage layers for permeable pavement and infiltration trenches.

Average porosity of non-compacted soil and gravel is assumed to be 0.40. Field capacity of the soil is the amount of moisture typically held in the soil/gravel after any excess water from rain events has drained and varies greatly between soil-based media and gravel.

Table 8 - Media Volume-Based Specifications

Parameter	Value	
	Porosity	Field Capacity
Soil-Based Media[1]	0.25	0.25
Gravel[2]	0.40	0.04
Ponding	1.0	NA

1. Soil-Based Media GIPs - bioretention, water quality swales and tree planter boxes
2. Gravel GIPs – design alternatives for GIPs in 1, storage layers for permeable pavement and infiltration trenches

To find the equivalent storage depth for media-based GIPs with multiple layers of media, the equivalent storage depth must be calculated using the following equation:

$$\text{Equivalent Storage Depth} = D_E = n_1(D_1) + n_2(D_2) + \cdots \qquad \textbf{Equation 5}$$

Where, n1 and D1 are for the first layer, etc.

EXAMPLE 4 – Treatment Volume Calculation

Using Example 1, the bioretention level 2 treatment volume will need to be calculated to design the practice. The area draining to the bioretention area is completely impervious (2.5 acres) therefore the Rv is 0.95 (note: if the contributing drainage area to the bioretention area was comprised of 50% impervious area and 50% turf HSG B the Rv used in the treatment volume calculation below would be 0.57). The Rv of the contributing drainage area in this example is 0.95.

$$Rv = 0.95$$

The bioretention structure is level 2 and thus will have 1.25 multiplier (Table 7) for the treatment volume, a media depth of 36 inches and a maximum of 6 inches of ponding. The Equivalent Depth = (3 ft)(0.4) + (0.5 ft)(1.0) = 1.7 ft. Then by application of Equations 4 and 5, solving for SA:

$$Tv = 1.25 \times 1\text{in} \times 2.5\text{ac} \times 0.95\left(\frac{43{,}560\ \text{ft}^2}{1\ \text{ac}}\right)\left(\frac{1\ \text{ft}}{12\ \text{in}}\right)$$

$$Tv = 10{,}777\ \text{ft}^3$$

$$Tv = n(D_E)(SA)$$
$$10{,}777\ \text{ft}^3 = 1.7\ \text{ft}\ (SA)$$
$$SA = 6{,}339\ \text{ft}^2$$

The design treatment volume that the bioretention area must capture is 10,777 ft^3, the required surface area if the bioretention cell was designed with 36 inches of media and 6 inches of ponding is 6,339 ft^2. The surface area required would significantly decrease if the designer chose to increase the media depth.

3.1.9 Calculation of Curve Numbers with Volume Removed

The removal of volume by GIPs changes the runoff depth entering downstream stormwater quantity structures. An approximate approach to accounting for this in reducing the size of peak flow detention facilities is to calculate an "effective SCS curve number" (CNadj) which is less than the actual curve number (CN). CNadj can then be used in hydrologic calculations and in routing. The method can also be used for other hydrologic methods in which a reduction in runoff volume is possible.

Equation 6 provides a way to calculate a total runoff if the rainfall and curve number are known.

$$Q = \frac{(P - 0.2 \times S)^2}{(P + 0.8 \times S)} \quad \text{and} \quad S = \frac{1000}{CN} - 10 \qquad \textbf{Equation 6}$$

Equation 6 is the standard SCS rainfall-runoff equation where P is the inches of rainfall for the 24-hour design storm (Table 9), and Q is the total runoff in depth for that storm in inches.

Table 9 - Franklin 24-Hour Rainfall Depths	
Return Period (Years)	**Rainfall Depth (Inches)**
2	3.68
5	4.48
10	5.12
25	6.02
50	6.75
100	7.51

The adjusted total runoff in depth entering the flood control facility downstream of a GIP is calculated by taking the difference in the original total runoff in depth and the depth captured by the GIP (Tv from Equation 4) expressed in watershed inches using Equation 7 where CDA is the drainage area in acres for the subarea in question.

$$Q_{adj} = Q - \frac{12 * Tv}{43{,}560 * CDA} \qquad \textbf{Equation 7}$$

Equation 8 provides a method to calculate the modified curve number once the Qadj is found.

$$CN_{adj} = \frac{1000}{10+5P+10Q_{adj}-10\left(Q_{adj}^{\,2}+1.25Q_{adj}P\right)^{1/2}} \qquad \textbf{Equation 8}$$

The steps in calculating an adjusted Curve Number (CNadj) are:

Step 1. Calculate Total Runoff for Storm (Q)

Choose the design return period, and using that rainfall as P, calculate an initial Q using Equation 6 and the calculated site curve number.

Step 2. Calculate GIP Capture Volume (Tv)

Compute the captured volume in the GIP control using Equation 4 or proven cistern volume assuming a 72 hour inter-event dry period since the last cistern filling event.

Step 3. Calculate Adjusted Total Runoff (Qadj)

As shown in Equation 7, subtract Tv expressed in watershed inches from Q computed in Step 1.

Step 4. Calculate Adjusted Curve Number (CNadj)

Using Qadj and the P corresponding to the return period in question (the P from step 1), calculate the adjusted
CN using Equation 8.

Step 5. Use CNadj in routing calculations for the specific return period in question.

3.2 The Runoff Reduction Method and 80% TSS Combined Methodology

Introduction

The combined methodology has been developed to address the requirement in Tennessee's NPDES Phase II MS4 Permit that states "For projects that cannot meet 100% of the runoff reduction requirement…, the remainder of the stipulated amount of rainfall must be treated prior to discharge with a technology reasonably expected to remove 80% total suspended solids (TSS)." If Runoff Reduction techniques are not acceptable for use on the site as a whole or on portions of a contributing drainage area, the permit requires the remaining rainfall to be treated by practices that remove 80% TSS. This approach allows the designer to apply TSS Reduction Method (TRM) treatment applications to supplement the RRM in order to meet overall compliance on a site. As a note, the site volumetric runoff coefficient, Rv, is calculated using the RRM methodology in Chapter 3.1. The method presented herein is an attempt to bridge the volume requirement (1in.) and the pollutant removal requirement of 80% TSS Reduction.

3.2.1 Site Limiting Conditions

Runoff Reduction Methodology (RRM) is the preferred pathway in complying with the City's water quality criteria. Therefore an attempt to utilize green infrastructure practices, promoting infiltration, capture and reuse of the first inch of rainfall preceded by 72 hours of no measureable rainfall is required. If a site can be designed using RRM GIPs, the designer is to follow the prescribed methodology in Chapter 3.1 of this manual. However, if "site limiting" conditions exist where infiltration practices would negatively affect the landscape and water resources in the area, the TRM methodology may be used to meet the City's water quality criteria upon the City's approval.

Potential site limiting conditions are listed below:

- Where the potential for introducing pollutants into groundwater exists, unless pretreatment is provided;
- Where pre-existing soil contamination is present in areas subject to come in contact with infiltrated runoff;
- Where sinkholes or other karst features are present on the site;
- Where the site has a historic or archaeological significance that cannot be disturbed as determined by the State Historic Preservation Office;
- Where utility conflicts preclude the use of Green Infrastructure Practices;
- Where steep slopes are present and slope failure may occur (stamped geotechnical report must be presented to City Engineer); and
- Other site limitations as determined by the City Engineer.

Cost of implementing green infrastructure/runoff reduction measures shall not be considered a limitation.

3.2.2 TSS Reduction Method

When the use of TSS Removal BMPs is approved by the City, the Runoff Reduction Requirement can be set aside at the value obtained by the site designer using the Runoff Reduction Method to the extent possible. Runoff Reduction should not be dismissed altogether, as the volume captured using the Runoff Reduction Method will be accounted for in calculations for TSS Removal. The remaining volume must then be managed to achieve the Pollutant Removal Performance Standard of 80% TSS Removal. TSS Removal BMPs such as dry ponds, sand filters, and wet ponds can be used for this purpose.

This section provides the policies, tables and equations that will be used to calculate compliance with the Pollutant Removal Performance Standard. Design specifications for TSS Removal BMPs are provided in Section 5.

The TSS Removal BMPs that are deemed acceptable for use to attain the Pollutant Removal Standard are listed in Table 10. The table presents the TSS removal percentage (%) assigned to each BMP, which will be used to calculate the weighted TSS Removal % (weighted TSS) for the capture volume for comparison with the Pollutant Removal Performance Standard. If the weighted TSS ≥ 80%, then the Performance Standard is achieved.

The TSS Removal % values shown in Table 10 are conservative median pollutant reduction percentages for design purposes that have been derived from existing sampling data, modeling and professional judgment. A BMP design may be capable of exceeding these performances; however, the values in the table are median values that can be achieved over time when the structural BMP is sized, designed, constructed and maintained in accordance with required specifications in this manual. The actual % TSS removal value for a BMP in any single storm event may be higher or lower, depending upon a number of factors, including the inflow pollutant concentration, type of storm event, and maintenance condition of the BMP.

Table 10 - Approved TSS PTP Applications

Structural Control	TSS Removal Credit (%)
General Application BMPs	
Stormwater Wet Pond	80
Constructed Wetland	80
Surface Sand Filter	80
Water Quality Swale	80
Limited Application BMPs	
Organic Filter	80
Underground Sand Filter	80
Perimeter Sand Filter	80
Dry Pond	60
Filter Strip	50
Grass Channel	50
Gravity (Oil-Grit) Separator	40

Technical Details

3.2.3 Calculation of % TSS Removal for TSS Removal BMPs in Series

The case of two or more TSS Removal BMPs in series, where stormwater treated in one BMP and discharged into another BMP for further treatment, is called a treatment train. How and why BMPs might be used in series is discussed in Chapter 2 of this Manual. This section presents the calculation of the total % TSS removal for BMPs in series.

Equation 9 shall be used to calculate the total % TSS removal for a treatment train comprised of two or more TSS Removal BMPs.

$$TSS_{train} = TSS_{up} + TSS_{down} - \frac{(TSS_{up} \, x \, TSS_{down})}{100} \qquad \textbf{Equation 9}$$

Where:

TSS_{train} = TSS Removal % for treatment train (%)
TSS_{up} = TSS Removal % for the upstream BMP, from Table 10 (%)
TSS_{down} = TSS Removal % for the downstream BMP, from Table 10 (%)

Several situations are possible:

A. For development sites where the treatment train provides the only stormwater treatment on the site, it is required that $TSS_{train} \geq 80\%$ to meet the Pollutant Removal Standard.

B. For development sites that have other TSS Removal BMPs for stormwater treatment that are not included in the treatment train, TSS_{train} must be included in Equation 9 in the calculation of the overall % TSS removal for the site.

C. Equation 9 is not used when the TSS Removal BMP is placed in series with an upstream GIP. While the upstream GIP is considered to provide 100% TSS removal to its storage volume, it's pollutant removal ability is not considered because the Pollutant Removal Performance Standard is applied only to the remainder of the NPDES-MS4 permit stipulated volume (i.e., the volume required to treat the entire 1 inch of rainfall) that is not managed by the GIP. Thus, the storage volume of the GIP is not a part of this remaining volume and so the GIP is not included in the calculation of % TSS removal.

3.2.4 Calculation of % TSS Removal for Flow-through Situations

BMPs within a treatment train may sometimes be separated by a contributing drainage area. In this case, Equation 10 is used, since some of the flow entering the downstream BMP has not been treated by the upstream BMP.

$$\mathbf{TSS_{train}} = \frac{\mathbf{TSS_{up}A_{up}} + \mathbf{TSS_{down}CDA_{down}} + \frac{\mathbf{TSS_{down}CDA_{up}\left(100 - TSS_{up}\right)}}{\mathbf{100}}}{\mathbf{CDA_{up} + CDA_{down}}} \qquad \textbf{Equation 10}$$

Where:

TSS_{train} = TSS Removal % for treatment train (%)
TSS_{up} = TSS Removal % for the upstream BMP, from Table 9 (%)
TSS_{down} = TSS Removal % for the downstream BMP, from Table 9 (%)
CDA_{up} = Contributing drainage area for the upstream BMP (acres)
CDA_{down} = Contributing drainage area for the downstream BMP (acres)

Several situations are possible:

A. For development sites where the treatment train provides the only stormwater treatment on the site, it is required that $TSS_{train} \geq 80\%$ to meet the Pollutant Removal Standard.

B. For development sites that have other TSS Removal BMPs for stormwater treatment that are not included in the treatment train, TSS_{train} must be included in Equation 10 in the calculation of the overall % TSS removal for the site.

C. Equation 10 is not used when the TSS Removal BMP is placed in series with an upstream GIP because the storage volume of the GIP is not a part of the remaining capture volume that must be treated by the TSS Removal BMP.

3.2.5 Determining the TSS Treatment Volume

There are two basic scenarios for the application of TSS Removal BMPs on a development site, depending on the extent to which the Runoff Reduction Method will be applied at the development and whether the site designer wishes to use a GIP and a TSS Removal BMP in series. If the latter, several different GIP-TSS BMP series combinations can occur depending upon whether one or both of the requirements of the two-pronged Runoff Reduction Performance Standard are met (i.e., weighted Rv ≤ 0.18 and GIPs can capture the entire Tv_{GIP}). The various circumstances that could occur when using TSS Removal BMPs are as follows:

1. **A TSS Removal BMP is used alone on a runoff reduction limited site where no GIPs or Runoff Reduction can be used or achieved -** To calculate the treatment volume needed for the site, the designer will use the following equation:

$$\mathbf{Tv_{TSS} = P \times Rv \times A \times \frac{43560 \frac{ft^2}{ac}}{12 \frac{in}{ft}}} \qquad \textbf{Equation 11}$$

2. **A TSS Removal BMP is used in series with an upstream GIP –** Equations 12, 13 and 14 will be used to calculate the TSS Treatment Volume Tv_{TSS} when a TSS Removal BMP is used in combination with an upstream GIP.

$$\mathbf{Tv_{TSS} = A + B} \qquad \textbf{Equation 12}$$

Where:
Tv_{TSS} = the volume of runoff that must be treated by TSS Removal BMPs to comply with the Pollutant Removal Performance Standard
A = the TSS treatment volume if $Tv_{actual} < Tv_{GIP}$, where:
Tv_{actual} = the actual storage volume of the proposed upstream GIP(s)

Tv_{GIP} = the *entire capture volume from the 1-inch rainfall event*, from Equation 4, presented previously in this Chapter 3.1

If $Tv_{GIP} = Tv_{actual}$, then A = 0. See Equation 13 to calculate A.

B = the TSS treatment volume if the weighted Rv > 0.18 after application of the Runoff Reduction Method. If weighted Rv ≤ 0.18, then B = 0. See Equation 14 to calculate B.

$$\mathbf{A} = \frac{\mathbf{Mult.}\left(\mathbf{P} \times \mathbf{Rv} \times \mathbf{A} \times \frac{\mathbf{43560}\frac{\boldsymbol{ft^2}}{\boldsymbol{ac}}}{\mathbf{12}\frac{\boldsymbol{in}}{\boldsymbol{ft}}}\right) - \mathbf{Tv_{actual}}}{\mathbf{Mult.}} \qquad \textbf{Equation 13}$$

$$\mathbf{B} = \mathbf{P} \times \mathbf{Rv}(\mathbf{1} - \mathbf{RRCredit}) \times \mathbf{A} \times \frac{\mathbf{43560}\frac{\boldsymbol{ft^2}}{\boldsymbol{ac}}}{\mathbf{12}\frac{\boldsymbol{in}}{\boldsymbol{ft}}} \qquad \textbf{Equation 14}$$

Where:

Mult. = the Multiplier for the GIP included in the GIP design specifications in Section 5.

P = the rainfall depth, 1 inch

Rv = the weighted Rv of the contributing drainage area to the GIP. (e.g., if the entire contributing drainage area to the GIP is impervious, then Rv = 0.95.) Use tables and equations in Chapter 3.1 of this Section to assist in the calculation of Rv.

A = the contributing drainage area to the GIP or BMP (acres)

Tv_{actual} = the treatment volume that can be captured by the upstream GIP(s)

RRCredit the runoff reduction credit for the GIP that is located upstream of the TSS Removal BMP, Table 5.

Equations 12, 13 and 14 can be combined to form Equation 15.

$$\mathbf{Tv_{TSS}} = \left[\frac{\mathbf{Mult.}\left(\mathbf{P} \times \mathbf{Rv} \times \mathbf{A} \times \frac{\mathbf{43560}}{\mathbf{12}}\right) - \mathbf{Tv_{actual}}}{\mathbf{Mult.}}\right] + \left(\mathbf{P} \times \mathbf{Rv}(\mathbf{1} - \mathbf{RRCredit}) \times \mathbf{A} \times \frac{\mathbf{43560}}{\mathbf{12}}\right) \qquad \textbf{Equation 15}$$

There are several possible combinations for GIPs and BMPs working in series. Table 11 lists the combinations and the form of Equation 12 that is used.

Table 11 - Possible GIP-TSS Series Combinations			
Scenario	**Complies with Runoff Reduction Performance Standard?**		**Form of Equation 12 that is used to calculate Tv_{TSS}**
	Rv ≤ 0.18	**GIPs capture entire Tv_{GIP}**	
GIP-TSS Combination 1	No	Yes	$\boldsymbol{Tv_{TSS} = B}$
GIP-TSS Combination 2	Yes	No	$\boldsymbol{Tv_{TSS} = A}$
GIP-TSS Combination 3	No	No	$\boldsymbol{Tv_{TSS} = A + B}$

The following examples show how Equations 12 through 15 are applied to developments to determine the TSS treatment volume.

EXAMPLE 5 GIP-TSS Combination 1

A site designer performing water quality calculations for a 3 acre commercial parking lot development that is runoff reduction limited. A Level 1 infiltration trench on C soil (Table 5: RR Credit = 50%) manages the Tv_{GIP} for the rainfall that falls on the 2.5 acre parking lot but does not lower the weighted Rv for the site sufficiently to achieve Rv ≤ 0.18. The use of other GIPs is not feasible so the designer plans to place a wet pond downstream of the infiltration trench to further handle the runoff. The area of the infiltration trench is 0.2 acres and it has an Rv = 0.04 (Forest on C soil). For the purpose of water quality calculations, the area of the wet pond (0.3 acres) is not included. (Note, this area is typically included for channel protection and peak flow calculations.) Determine the treatment volume for the wet pond.

The Rv for the contributing drainage area to the GIP is determined using Equation 1:

$$\text{Weighted Rv} = \frac{(0.95 \times 2.5 \text{ ac}) + (0.04 \times 0.2 \text{ ac})}{(2.7 \text{ ac})} = 0.88$$

The treatment volume of the wet pond is calculated using Equation 14 (or Equation 15), where A = 0 because the parking lot has sufficient storage volume to manage Tv_{GIP}. So, Equation 15 becomes:

$$Tv_{TSS} = P \times Rv(1 - RRCredit) \times A \times \frac{43560}{12} = 1 \times 0.88(1 - 0.50) \times 2.7ac \times \frac{43560}{12}$$

$$Tv_{TSS} = 4{,}312 \text{ ft}^3$$

Note that the % TSS Removal for the wet pond = 80%, so a properly sized pond will be sufficient to meet the Pollutant Removal Performance Standard of 80% TSS Removal.

EXAMPLE 6 GIP-TSS Combination 2

A site designer performing water quality calculations for a 5 acre development that is runoff reduction limited. The site's weighted Rv is less than 0.18 due to the use of a Level 2 bioretention GIP, but it does not have sufficient storage volume available to capture the entire volume from the 1 inch rainfall. The land cover at the development is as follows: 4 acres of impervious surface (Rv = 0.95) and 1 acre of forest on C soil (Rv = 0.04). The entire development discharges to Level 2 bioretention GIPs which will capture no more than 8,500 ft^3 of runoff. Overflow from the GIPs discharge to a wet pond. Determine the treatment volume for the wet pond.

The weighted Rv for the development without consideration of the GIPs or the TSS Removal BMP is determined using Equation 1.

$$\text{Weighted Rv} = \frac{(0.95 \times 4\text{ ac}) + (0.04 \times 1\text{ ac})}{(5\text{ ac})} = 0.77$$

The Weighted Rv for the site after Level 2 bioretention GIPs are applied is as follows:

$$\text{Weighted Rv} = \frac{(0.95 \times (1 - 0.80) \times 4\text{ ac}) + (0.04 \times 1.0\text{ ac})}{(5\text{ ac})} = 0.16$$

The required treatment volume for the development is calculated using Equation 13 (or Equation 15), where B = 0 because Rv was less than 0.18. So, Equation 15 becomes:

$$\text{Tv}_{\text{TSS}} = \left[\frac{\text{Mult.}\left(\text{P} \times \text{Rv} \times \text{A} \times \frac{43{,}560}{12}\right) - \text{Tv}_{\text{actual}}}{\text{Mult.}}\right]$$

$$\text{Tv}_{\text{TSS}} = \left[\frac{1.25\left(1 \times 0.77 \times 5\text{ac} \times \left(\frac{43560}{12}\right)\right) - 8{,}500\text{ ft3}}{1.25}\right]$$

$$\text{Tv}_{\text{TSS}} = \frac{17{,}469\text{ft}^3 - 8{,}500\text{ft}^3}{1.25} = 7{,}176\text{ ft}^3$$

Note that the % TSS Removal for the wet pond = 80%, so a properly sized pond will be sufficient to meet the Pollutant Removal Performance Standard of 80% TSS Removal.

EXAMPLE 7 GIP-TSS Combination 3

A site designer performing water quality calculations for a 4.5 acre development that is runoff reduction limited. The site's weighted Rv is 0.30 due to the use of a Level 2 water quality swale GIP to treat the 2.5 acre impervious area. The site does not have sufficient storage volume available to capture the entire volume from the 1 inch rainfall in the GIP and an Rv of 0.18 has not been met. The land cover at the development is as follows: 2.5 acres of impervious surface (Rv = 0.95) and 2.0 acres of meadow/turf on C soil (Rv = 0.20). The entire development discharges to the Level 2 water quality swale GIP which can capture no more than 5,500 ft^3. Overflow from the GIP discharges to a wet pond. Determine the treatment volume for the wet pond.

The weighted Rv for the development without consideration of the GIP or the TSS Removal BMP is determined using Equation 1.

$$\text{Weighted Rv} = \frac{(0.95 \times 2.5\ \text{ac}) + (0.20 \times 2.0\ \text{ac})}{(4.5\ \text{ac})} = 0.61$$

The Weighted Rv for the site after a Level 2 water quality swale GIP is applied is as follows:

$$\text{Weighted Rv} = \frac{(0.95 \times (1 - 0.60) \times 2.5\ \text{ac}) + (0.20 \times 2.0\ \text{ac})}{(4.5\ \text{ac})} = 0.30$$

The required treatment volume for the development is calculated using Equation 15:

$$\text{Tv}_{\text{TSS}} = \left[\frac{\text{Mult.}\left(\text{P} \times \text{Rv} \times \text{A} \times \frac{43{,}560}{12}\right) - \text{Tv}_{\text{actual}}}{\text{Mult.}}\right] + \left(\text{P} \times \text{Rv}(1 - \text{RRCredit}) \times \text{A} \times \frac{43560}{12}\right)$$

$$\text{Tv}_{\text{TSS}} = \left[\frac{1.1\left(1 \times 0.61 \times 4.5\ \text{ac} \times \left(\frac{43{,}560}{12}\right)\right) - 5{,}500\ \text{ft}^3}{1.1}\right] + \left(1 \times 0.61(1 - 0.60) \times 4.5\ \text{ac} \times \frac{43560}{12}\right)$$

$$\text{Tv}_{\text{TSS}} = \frac{10{,}961\text{ft}^3 - 5{,}500\text{ft}^3}{1.1} + 3{,}986\ \text{ft}^3 = 8{,}951\text{ft}^3$$

Note that the % TSS Removal for the wet pond = 80%, so a properly sized pond will be sufficient to meet the Pollutant Removal Performance Standard of 80% TSS Removal.

4 References

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2. *Caltrans Storm Water Quality Handbooks*, Camp Dresser & McKee et.al. for the California Department of Transportation, 1997.
3. Chow, Ven Te. *Open Channel Hydraulics*, McGraw-Hill, Inc., 1959.
4. *Landcare Field Guide – An Introduction to Land Degradation*, Cullen Gunn.
5. Roesner, L.A., Aldrich, J., Hartigan, J.P., et.al., *Urban Runoff Quality Management – WEF Manual of Practice No. 23 / ASCE Manual and Report on Engineering Practice No. 87*, 1998.
6. *Sevenmile Creek Basin Pilot Stormwater Quality Master Plan*, Camp Dresser & McKee et.al. for the Metropolitan Nashville and Davidson County Department of Public Works, February, 2000.
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10. *Metropolitan Nashville – Davidson County Stormwater Management Manual, Volume 5 – Low Impact Development,* Metropolitan Government of Nashville and Davidson County, Metro Water Services, June 2012.
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13. *Precipitation-Frequency Atlas of the United States.* NOAA Atlas 14, Volume 2, Version 3.0, G. M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley, NOAA, National Weather Service, Silver Spring, Maryland, 2006.

Section 5
Permanent Stormwater Treatment Controls (PSTCs)

Section 5 – Permanent Stormwater Treatment Controls (PSTC)

5.1 Introduction

This section presents the BMP fact sheets for Permanent Stormwater Treatment Controls (PSTC). PSTCs are intended to treat stormwater runoff in the long-term. Unlike many of the other BMP types, these can be designed to achieve both stormwater quantity and quality management objectives. The Long Term Maintenance Plan (LTMP) and Agreement is also included as a part of this section on the following page. PSTCs can also be classified as stormwater control measures (SCMs).

5.2 Management Practice Fact Sheets

This section contains the following BMP fact sheets.

Green Infrastructure Permanent Treatment Practice Fact Sheets			
Fact Sheet ID	**Description**	**Fact Sheet ID**	**Description**
GIP – 01	Bioretention	**GIP – 08**	Reforestation
GIP – 02	Urban Bioretention	**GIP – 09**	Green Roof
GIP – 03	Permeable Pavement	**Appendix A**	Pretreatment Details
GIP – 04	Infiltration Trenches	**Appendix B**	Infiltration Testing Procedures
GIP – 05	Water Quality Swale	**Appendix C**	Recommended Plants for Biofiltration Practices
GIP – 06	Extended Detention Pond	**Appendix D**	As-Built Requirements
GIP – 07	Sheet Flow		

TSS Permanent Treatment Practice Fact Sheets			
Fact Sheet ID	**Description**	**Fact Sheet ID**	**Description**
TSS – 01	Stormwater Wet Ponds	**TSS – 07**	Grass Channels
TSS – 02	Constructed Wetlands	**TSS – 08**	Underground Sand Filters
TSS – 03	Surface Sand Filters	**TSS – 09**	Perimeter Sand Filters
TSS – 04	Water Quality Swales	**TSS – 10**	Organic Filters
TSS – 05	Dry Ponds	**TSS – 11**	Gravity (Oil-Grit) Separators
TSS – 06	Filter Strips		

Each fact sheet has a quick reference guide indicating what pollutant constituents the BMP is targeting and implementation requirements. The BMPs presented in this section are intended to serve as permanent treatment measures. Additional details are provided in sections covering Temporary Construction Site Runoff Management Practices (TCPs) for practices that are intended to function on a short-term basis (lasting only as long as construction activities) and Permanent Erosion Prevention and Sediment Control (PESC) for practices that are intended to function on a long-term basis.

The City of Franklin approves of the use of underground detention, including concrete vaults, and HDPE corrugated pipe and arched pipe systems, which may be designed to meet detention requirements. Corrugated metal pipe is not an approved material for use in underground detention or other permanent installation in The City of Franklin.

Bioretention

Description: Bioretention cells are vegetated, shallow depressions that treat stormwater runoff. Captured runoff is treated by filtration through an engineered soil medium and is then either infiltrated into the subsoil or exfiltrated through an underdrain.

Variations:
Constructed without an underdrain in soils with measured infiltration rates greater than 0.5 inch per hour, and with an underdrain in less-permeable soils.

Advantages/Benefits:
- Reduced runoff volume
- Reduced peak discharge rate
- Reduced Total Suspended Solids (TSS)
- Reduced pollutant loading
- Reduced runoff temperature
- Groundwater recharge (if soils are sufficiently permeable)
- Habitat creation
- Enhanced site aesthetics
- Reduced heat island effect

Disadvantages/Limitations:
- Problems with installation can lead to failure
- Minimum 2-foot separation from groundwater and bedrock is required
- Suitable for pollution hotspots only with underdrain and liner

Design Considerations:
- Maximum contributing impervious drainage area of 5 acres
- Slope of drainage area = 1 – 5% or terraced to slow flow

Roadway Applications
- Use within public ROW may be permitted subject to additional restrictions and City approval. See GIP-02 for more information

Selection Criteria:

Level 1 – 60% Runoff Reduction Credit

Level 2 – 80% Runoff Reduction Credit

Land Use Considerations:

[x] **Residential**

[x] **Commercial**

[x] **Industrial (with City approval)**

Maintenance:
- Regular maintenance of landscaping to maintain healthy vegetative cover
- Irrigation when necessary during first growing season
- Periodic trash removal

Maintenance Burden

[M]

L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

Individual bioretention cells can serve impervious drainage areas of 5 acres or less, though multiple distinct cells may be designed parallel to each other to accommodate larger areas once approved by City staff. Surface runoff is directed into a shallow landscaped depression that incorporates many of the pollutant removal mechanisms that operate in forested ecosystems. The primary component of a bioretention practice is the filter bed, which has a mixture of sand, soil and organic material as the filtering media, typically with a surface mulch layer. During storms, runoff temporarily ponds up to 12 inches above the mulch layer and then rapidly filters through the bed. If the subsoil infiltration rate is 0.5 inches per hour or less, the filtered runoff is collected in an underdrain and returned to the storm drain system. The underdrain consists of a perforated pipe in a gravel layer installed along the bottom of the filter bed. Underdrains can also be installed beneath a portion of the filter bed, above a stone "sump" layer, or eliminated altogether, thereby increasing stormwater infiltration.

Bioretention can also be designed to infiltrate runoff into native soils. This can be done if the soil infiltration rate is greater than 0.5 inches per hour, the groundwater table and bedrock is low, and the risk of groundwater contamination is low.

SECTION 2: PERFORMANCE

The overall runoff reduction capabilities of bioretention in terms of the Runoff Reduction Method are summarized in **Table 1.1**. Bioretention creates a good environment for runoff reduction, filtration, biological uptake, and microbial activity, and provides high pollutant removal. Bioretention can become an attractive landscaping feature with high amenity value and community acceptance.

Table 1.1. Runoff Volume Reduction Provided by Bioretention Basins

Stormwater Function	Level 1 Design	Level 2 Design
Runoff Volume Reduction (RR)	60%	80%

Sources: CSN (2008) and CWP (2007)

SECTION 3: DESIGN TABLE

Table 1.2. Bioretention Design Criteria	
Level 1 Design (RR: 60)	**Level 2 Design (RR: 80)**
Sizing (Section 6.1)	**Sizing** (Section 6.1)
Surface Area (sq. ft.) = Tv / Equivalent Storage Depth[1]	**Surface Area (sq. ft.)** = (1.25*Tv) / Equivalent Storage Depth[1]
Minimum Surface Area: 3% of total drainage area	
Maximum Contributing Impervious Drainage Area = 5 acres	
Maximum Ponding Depth = 12 inches	
Filter Media Depth Minimum = 24 inches; **Maximum** = 6 feet	**Filter Media Depth Minimum** = 36 inches; **Maximum** = 6 feet
Media & Surface Cover (Section 6.6) = mixed on-site or supplied by vendor; the final composition shall be: 85% to 88% sand; 8% to 12% soil fines; and 3% to 5% organic matter	
Sub-soil Testing (Section 6.2): Testing is required. Min. infiltration rate > 0.5 inch/hour in order to remove the underdrain requirement.	**Sub-soil Testing** (Section 6.2): Testing is required. Min. infiltration rate > 0.5 inch/hour in order to remove the underdrain requirement.
Underdrain (Section 6.7) = PVC or Corrugated HDPE with clean-outs ***OR***, none, underdrain may be eliminated if soil infiltration requirements are met (**Section 6.2**)	**Underdrain & Underground Storage Layer** (Section 6.7) = PVC or Corrugated HDPE with clean-outs, and a minimum 12-inch stone sump below the invert; ***OR***, none, underdrain may be eliminated if soil infiltration requirements are met (**Section 6.2**)
Inflow: sheet flow or concentrated flow	
Geometry (Section 6.3): length of shortest flow path/overall length = 0.3; ***OR***, other design methods used to prevent short- circuiting	**Geometry** (Section 6.3): length of shortest flow path/overall length = 0.8; ***OR***, other design methods used to prevent short-circuiting
Pretreatment (Section 6.4): a pretreatment cell/forebay and enhanced check dam or any approved measure for sheet flow conditions.	**Pretreatment** (Section 6.4): a pretreatment cell/forebay and enhanced check dam or any approved measure for sheet flow conditions.
Conveyance & Overflow (Section 6.5)	**Conveyance & Overflow** (Section 6.5)
Planting Plan (Section 6.8): a planting template to include perennials, grasses, sedges or shrubs to achieve a surface area coverage[2] of at least 75% within 2 years by using the recommended spacing in **Appendix C.**	**Planting Plan** (Section 6.8): a planting template to include perennials, grasses, sedges, or shrubs to achieve a surface area coverage[2] of at least 75% within 2 years by using the recommended spacing in **Appendix C**. **MUST** also include trees planted at 1 tree/400 s.f.
Building Setbacks [3] (Section 5):	
Long Term Maintenance Requirements (Section 10)	

[1]Storage depth is the sum of the porosity (n) of the soil media and gravel layers multiplied by their respective depths, plus the surface ponding depth. Refer to **Section 6.1**.

[2]Surface area coverage in reference to planting is the percentage of vegetative cover in a planting area.

[3]These are recommendations for simple building foundations. If an in-ground basement or other special conditions exist, the design shall be reviewed by a licensed engineer. Also, a special footing or drainage design may be used to justify a reduction of the setbacks noted above.

SECTION 4: TYPICAL DETAILS

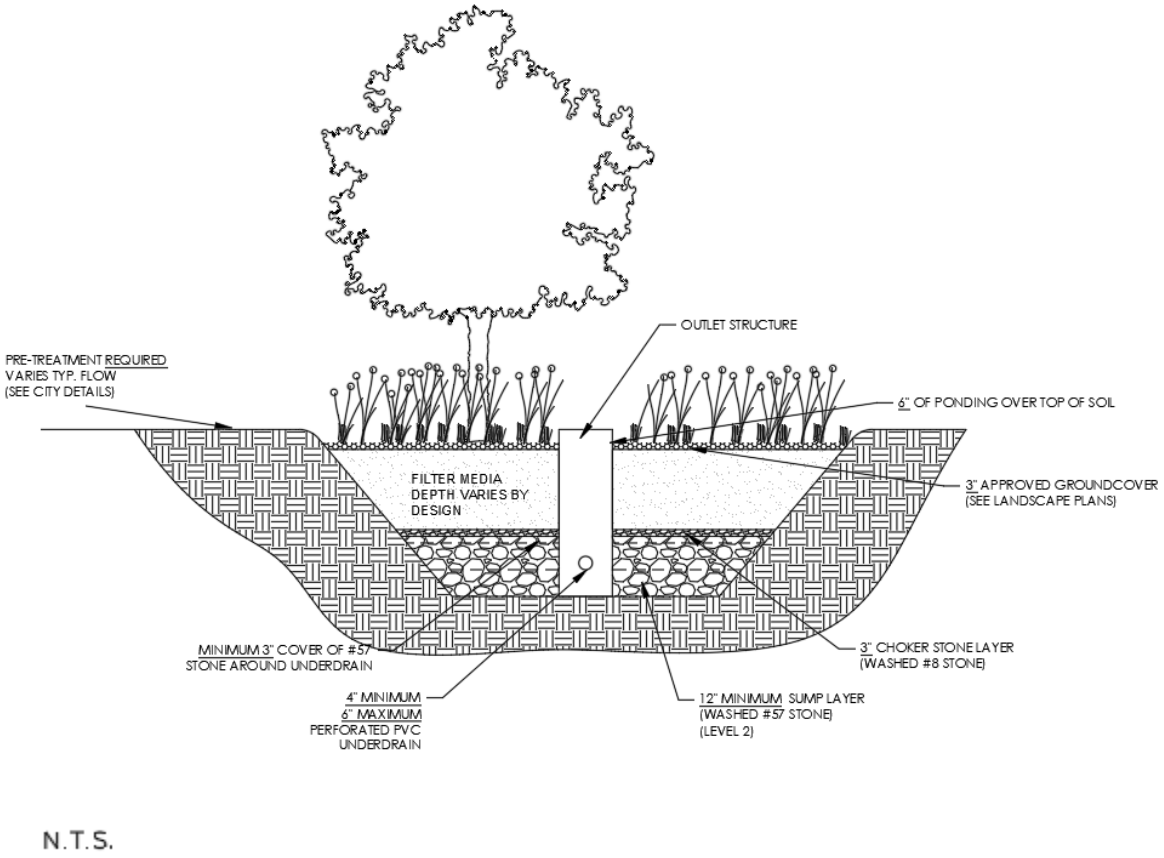


Figure 1.2. Typical Detail of Bioretention

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

5.1 PHYSICAL FEASIBILITY

Bioretention can be applied in most soils or topography since runoff simply percolates through an engineered soil bed and can be returned to the stormwater system if the infiltration rate of the underlying soils is low. Key constraints with bioretention include the following:

Accessibility. Bioretention facilities require periodic maintenance and shall be accessible to various types of equipment. A path of travel for equipment no less than 12 feet in width shall be provided for the bioretention facility. Each bioretention onsite shall have one point of vehicle access.

Applications. Bioretention areas have been used at commercial, institutional, and residential sites in spaces that are traditionally pervious and landscaped. It should be noted that special care must be taken to provide adequate space for pretreatment for bioretention cells in high traffic areas. Typical locations for bioretention areas could include parking lot islands and edges, courtyards, and unused pervious areas onsite.

Available Space. Planners and designers can assess the feasibility of using bioretention based on a simple relationship between the contributing drainage area and the corresponding required surface area. The bioretention surface area shall be a minimum 3% of the contributing drainage area. The minimum length and width dimensions of the bioretention area shall both be 10 feet.

Contributing Drainage Area (CDA). Bioretention works best with smaller contributing drainage areas, where it is easier to achieve flow distribution over the filter bed without experiencing erosive velocities and excessive ponding times. Typical drainage area size can range from 0.1 acres to a maximum of 5 acres of impervious cover, with no more than 2.5 acres impervious drainage area per inlet to the bioretention forebay, due to limitations on the ability of bioretention to effectively manage large volumes and peak rates of runoff. However, if hydraulic considerations are adequately addressed to manage the potentially high peak inflow of drainage areas larger than 5 acres total contributing impervious area, (such as off-line or low-flow diversions, splitter structures, etc.), there may be case-by-case instances where the City may allow these recommended maximums to be exceeded. In such cases, the bioretention facility should be located centrally within the drainage area so as to capture the Treatment Volume (T_v) equally from the entire contributing area, and not fill the entire volume from the immediately adjacent area, thereby bypassing the runoff from the more remote portions of the site. In all cases, reduction of inflow velocities and means of even distribution across the bioretention surface shall be demonstrated in the design of the bioretention.

Curb cuts. If curb cuts are to be used in the design of the bioretention area, the designer shall provide calculations showing the curb cut can safely pass the 10 year storm event.

Floodplains. Bioretention areas should be constructed outside the limits of the 100-year floodplain. While not prohibited from use in floodplain areas, designers should be aware of the resulting increased maintenance burden for the property owner.

Irrigation or Baseflow. The planned bioretention area shall not receive baseflow, chlorinated wash-water or other such flows that are not stormwater runoff, except for irrigation as necessary for the survival of plantings within the bioretention area. If irrigation is to be placed within the bioretention area footprint, an irrigation plan shall be submitted to the City for review and approval. A soil moisture sensor shall be included in all irrigation plans submitted.

Setbacks. It is not recommended to place bioretention areas immediately adjacent to structures. to avoid the risk of seepage, a licensed PE should be consulted to determine the appropriate setbacks necessary to prevent bioretention infiltration from compromising structural foundations or pavement. At a minimum, bioretention basins should be located a horizontal distance of 100 feet from any water supply well and 50 feet from septic systems. Horizontal separation of at least 5 feet or the overall depth of the bioretention, whichever is greater, is required between the amended soils of the bioretention and any adjacent hardscape (i.e. parking lots or sidewalks). Please see **GIP-02** for additional information on ROW applications and where setbacks from structures, roadways, sidewalks and other hardscape cannot be met.

Subsurface Constraints. Vertical constraints such as retaining walls, structures, or other impermeable barriers are limited to a maximum of 50% of the Level 2 bioretention perimeter. Level 1 bioretention areas can have vertical constraints around the entire perimeter but shall meet all requirements for a Level 1 bioretention area. If requirements cannot be met, see the **GIP-02**. Bioretention shall always have 2 feet of separation from the water table to ensure that groundwater does not intersect the filter bed. Mixing can lead to possible groundwater contamination or failure of the bioretention facility. If bedrock is encountered during testing or construction of the bioretention area, the bottom sump elevation of the BMP design shall be above the lowest bedrock/refusal elevation encountered in subsurface testing.

Utilities. Designers should ensure that future tree canopy growth in the bioretention area will not interfere with existing overhead utility lines. Interference with underground utilities and any associated utility easements shall also be avoided, particularly water and sewer lines. No below-grade utilities are allowed within the footprint of bioretention areas, including pretreatment. No overhead utilities are allowed over bioretention areas incorporating tree plantings.

SECTION 6: DESIGN CRITERIA

6.1 SIZING OF BIORETENTION PRACTICES

6.1.1 Stormwater Quality

Sizing of the surface area (SA) for bioretention practices is based on the computed Treatment Volume (T_v) required for the contributing drainage area and the storage provided in the facility. The required surface area (in square feet) is computed as the Treatment Volume (in cubic feet) divided by the equivalent storage depth (in feet). The equivalent storage depth is computed as the depth of gravel, media, and surface ponding (in feet) multiplied by the accepted porosity.

The accepted porosities (n) are (see **Table 1.3** below):

Table 1.3. Bioretention Accepted Porosities	
Material	**Porosity Value (n)**
Gravel (#57 Stone) Underdrain and Sump Layer	0.40
Choker (#8 Stone) Layer	0.40
Bioretention Soil Media	0.25
Surface Cover	0.00
Surface Storage	1.00

The mulch and choker stone layer shall not be used in calculations for the equivalent depth due to the variability of material and porosity values.

The equivalent storage depth for a typical Level 1 design with 2 ft of media and a 6-inch surface ponding depth is therefore computed as:

Equation 1.1. Bioretention Level 1 Design Storage Depth

$$\text{Equivalent Storage Depth} = D_E = n_1(D_1) + n_2(D_2) + \cdots$$

$$D_E = (2\ ft. \times 0.25) + (0.5 \times 1.0) = 1.30\ ft.$$

Where n_1 and D_1 are for the first layer, etc.

The equivalent storage depth for a typical Level 2 design with a 1 foot gravel sump layer, 3 feet of media, and a 6-inch surface ponding depth is computed as:

Equation 1.2. Bioretention Level 2 Design Storage Depth

$$D_E = (1\ ft. \times 0.25) + (3\ ft. \times 0.40) + (0.5 \times 1.0) = 2.10\ ft.$$

While this method is simplistic, simulation modeling has proven that it yields a total storage volume somewhat equivalent to 80% total average rainfall volume removal for infiltration rates from 0.5 in/hr. through 1.2 in/hr.

Therefore, the Level 1 Bioretention Surface Area (SA) is computed as:

Equation 1.3. Bioretention Level 1 Design Surface Area

$$SA\ (sq.\ ft.) = (T_v) / D_E$$

And the Level 2 Bioretention Surface Area is computed as:

Equation 1.4. Bioretention Level 2 Design Surface Area

$$SA\ (sq.\ ft.) = (1.25 * Tv) / D_E$$

Where:

SA = Minimum surface area of bioretention filter (sq. ft.)
D_E = Equivalent Storage Depth (ft.)
T_v = Treatment Volume (cu. ft.) = [(1.0 in.)(R_v)(A)*3630]

Where: A = Area in acres
(NOTE: R_v = the composite runoff coefficient from the RR Method. A table of R_V values and the equation for calculating a composite Rv is located in Section 1 Chapter 3 of this manual)

Equations 1.1 through 1.4 should be modified if the storage depths of the soil media (max. 6 feet), gravel layer, or ponding depth (max. 12 inches) vary in the actual design or with the addition of any surface or subsurface storage components (e.g., additional area of surface ponding, subsurface storage chambers, etc.).

6.1.2 Stormwater Quantity

It is recommended that rain events larger than the 1 inch storm bypass bioretention areas to prevent additional maintenance burden. If designed with sufficient volume and appropriate outlet structures, designers can utilize the bioretention area as both water quality and peak flow attenuation.

Surface Storage. The ponding maximum ponding depth for any bioretention area is 12 inches from the top of soil elevation. 6 inches of ponding is recommended for plant survivability.

Subsurface Storage. Additional volume can be provided for peak flow attenuation by increasing the depth of the media or stone. Additional subsurface storage will not be allowed without sufficient infiltration rates. The maximum excavation depth from final grade for bioretention areas is 10 feet.

Adjusted CN. The removal of runoff volume by bioretention changes the runoff depth entering downstream flood control facilities. An approximate approach to accounting for this in reducing the size of peak flow detention facilities is to calculate an "effective SCS curve number" (CN_{adj}), which is less than the actual curve number (CN). CN_{adj} can then be used in hydrologic calculations and in routing. The method can also be used for other hydrologic methods in which a reduction in runoff volume is possible. Adjusted curve numbers shall not be used where underdrains discharge any portion of the treatment volume to the downstream facilities.

Hydraulic Modeling Requirements. Due to the variability of infiltration rates over time, specific rates of infiltration shall not to be utilized in hydraulic modeling for bioretention facilities. Note that for design calculations and sizing of detention facilities to be accurate, infiltration must be confirmed by on-site infiltration testing. Where underdrains are utilized, they shall be included in hydraulic modeling, with only the "sump" portion below the underdrain being completely removed from the downstream runoff volume. The bioretention area shall be modeled using an equivalent volume based on the equivalent depth calculation. The underdrain shall be modeled as an equivalent orifice.

6.1.3 Pretreatment Forebay Sizing

The volume of the pretreatment forebay required for concentrated flow entering a bioretention area based on, but exclusive of the total treatment volume (Tv) required (see **Section 6.4**). Riprap used for energy dissipation within the forebay shall be sized per TDOT specifications. The sizing of the pretreatment forebay is computed as:

Equation 1.5. Pretreatment Forebay Treatment Volume Sizing

$$Tv_{Forebay} = Tv * 0.15\ (Level\ 1\ Bioretention)$$

$Tv_{Forebay}$ = *(1.25*Tv) * 0.25 (Level 2 Bioretention)*

Where:

Tv = Total required Treatment Volume (cu. ft.)
$Tv_{Forebay}$ = Treatment Volume required for the forebay (see Section 6.4) (cu. ft.)

6.1.4 Sizing of Velocity Dissipation for an Underdrain

Velocity dissipation for underdrains that daylight rather than tying into the storm drain system is required to prevent scouring. The discharge rate for the 1-inch storm should be determined by using the contributing drainage basin to the specific bioretention area. Below is the method for determining the velocity of flow (fps) from an underdrain within a bioretention area (**Figure 1.2**). Riprap used as energy dissipation shall be sized per TDOT specifications.

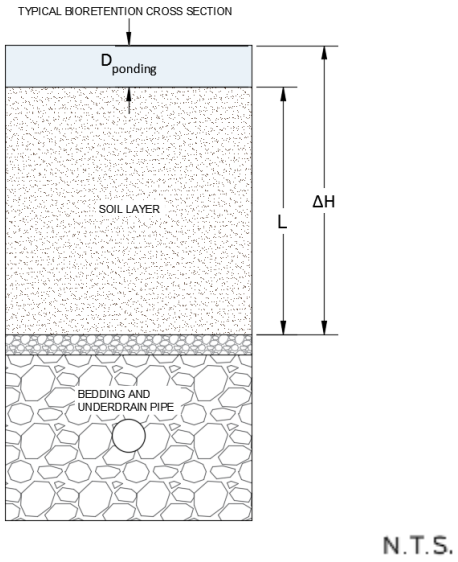


Figure 1.2: Cross Section of Bioretention for Underdrain Sizing

Equation 1.6. Determine Cross Section Flow

$$A = V_{ud} / D_{ponding}$$

Where:

A = flow cross sectional area (sq. ft.)
V_{ud} = Runoff Volume (cu. ft.)
$D_{ponding}$ = Depth of ponded water (ft.)

Equation 1.7. Determine the Infiltration Rate through the Soil

$$q = (K^* \Delta H)/L$$

Where:

q = flow per cross sectional unit (in./hr.)
K = hydraulic conductivity of the amended soil (in./hr.) (typically 1 in./hr.)
ΔH = change in hydraulic head from the ponding depth to the bedding layer (ft.)
L = thickness of the soil layer (ft.)

Equation 1.8. Determine the total flow through the Underdrain

$$Q = q * A$$

Where:

Q = total flow through the underdrain (cu. ft./s)
q = flow per cross sectional unit (in./hr.)
A = flow cross sectional area (sq. ft.)

Equation 1.9. Determine the velocity through the Underdrain

$$V = Q/A_{ud}$$

Where:

V = velocity of water leaving underdrain (ft./s)
Q = total flow through the underdrain (cu. ft./s)
A_{ud} = cross sectional area of the underdrain (sq. ft.)

6.2 SOIL INFILTRATION RATE TESTING

In order to determine if an underdrain will be needed, and to accurately assess the expected reduction in runoff volume for sizing of detention facilities, one must measure the infiltration rate of subsoils at the bottom sump elevation of the bioretention area. The infiltration rate of subsoils must exceed 0.5 inch per hour in order to remove the underdrain requirement for bioretention basins. On-site soil infiltration rate testing procedures are outlined in **Appendix B**. The number of soil tests varies base on the size of the bioretention area:

- < 1,000 ft² = 2 tests
- 1,000 – 10,000 ft² = 4 tests
- >10,000 ft² = 4 tests + 1 test for every additional 5,000 ft²

If bedrock is encountered during subsurface testing for the construction of the bioretention area, the bottom sump elevation of the BMP design shall be above the lowest bedrock/refusal elevation encountered in subsurface testing. If, during construction, infiltration rates are suspected to have decreased due to machinery, material storage, or other causes of compaction of the underlying soils, additional infiltration testing may be required to verify pre-construction infiltration rates have not been reduced.

6.3 BMP GEOMETRY

The side slopes of the bioretention area shall be no steeper than 3H:1V for maintenance considerations. Flatter slopes are encouraged to enhance pretreatment where adequate space is available.

Bioretention basins shall be designed with internal flow path geometry such that the treatment mechanisms provided by the bioretention are not bypassed or short-circuited. Examples of short-circuiting include inlets or curb cuts that are very close to outlet structures, or incoming flow that is diverted immediately to the underdrain through stone layers. For these bioretention areas to have an acceptable internal geometry, the "travel time" from each inlet to the outlet should be maximized, and incoming flow must be distributed as evenly as possible across the filter surface area. The designer shall ensure that incoming flow is spread as evenly as possible across the filter surface to maximize the treatment potential.

One important characteristic is the length of the shortest flow path compared to the overall length, as shown in **Figure 1.3** below. In this figure, the ratio of the shortest flow path to the overall length is represented as:

Equation 1.10. Ratio of Shortest Flow Path to Overall Length

$$SFP / L$$

Where:

SFP = length of the shortest flow path

L = length from the most distant inlet to the outlet for multiple inlet bioretention areas or length from the most distant edge of soil media to the outlet structure for single inlet bioretention areas

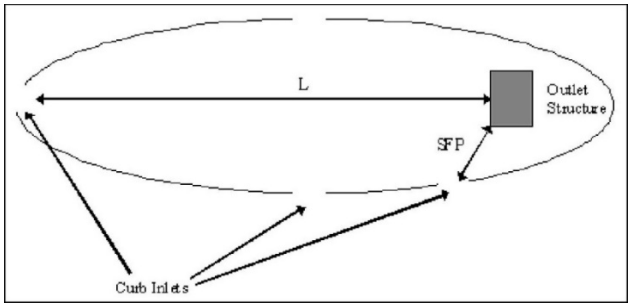


Figure 1.3. Diagram showing shortest flow path as part of BMP geometry (source: VADCR, 2010)

For Level 1 designs, the SFP/L ratio must be 0.3 or greater; the ratio must be 0.8 or greater for Level 2 designs. In some cases, due to site geometry, some inlets may not be able to meet these ratios. However, the drainage area served by such inlets shall constitute no more than 20% of the contributing drainage area. Alternately, the designer may incorporate other design features that prevent short-circuiting, including features that help spread and distribute runoff as evenly as possible across the filter surface.

6.4 PRETREATMENT

Pretreatment of runoff entering bioretention areas is necessary to trap coarse sediment particles before they reach and prematurely clog the filter bed. Pretreatment measures shall be designed to evenly spread runoff across the entire width of the bioretention area. Flow from the pretreatment area to the bioretention filter bed shall not exceed 2 feet per second. Several pretreatment measures are feasible, depending on the scale of the bioretention practice and whether it receives sheet flow or concentrated flows. See **Table 1.4** for pretreatment requirements based on the type of flow. Pretreatment measures shown below are examples and a combination of the other forms of pretreatment can be utilized. See **Appendix A** for more details.

Table 1.4 Required Pretreatment Elements for Bioretention Areas

Flow Type	Level 1 Options	Level 2 Options
Concentrated/Point Flow	• Forebay ○ 15% pretreatment volume (exclusive of total treatment volume) ○ Enhanced check dam (TDOT EC-STR-6A) ○ Slightly sloped bottom without stone • Proprietary structure (City approval)	• Forebay ○ 25% pretreatment volume (exclusive of total treatment volume) ○ Enhanced check dam (TDOT EC-STR-6A) ○ Slightly sloped bottom without stone • Proprietary structure (City approval)
Sheet Flow	Gravel diaphragm to grass filter strip	
Upstream GIP	Outlet and scour protection required at upstream GIP outfall	

6.5 CONVEYANCE AND OVERFLOW

On-line Bioretention: An overflow structure shall always be incorporated into on-line designs to safely convey

larger storms through the bioretention area. The following criteria apply to overflow structures:

- The overflow associated with the 100-year design storms shall be controlled so that velocities are non-erosive at the outlet point (i.e., to prevent downstream erosion).
- A common overflow system within bioretention practices consists of an outlet structure, which is scaled for the application, where the top of the structure is placed at the maximum water surface elevation of the bioretention area (typically 6 inches, maximum 12 inches, above the surface of the filter bed).
- The filter bed surface shall be flat so that the bioretention area fills up evenly.

Off-line Bioretention: Off-line designs are preferred. One common approach is to create an alternate flow path at the inflow point into the structure such that when the maximum ponding depth is reached, the incoming flow is diverted past the facility. In this case, the higher flows do not pass over the filter bed and through the facility, and additional flow is able to enter as the ponding water filtrates through the soil media.

Another option is to utilize a low-flow diversion or flow splitter at the inlet to allow only the Treatment Volume to enter the facility. This may be achieved with a weir or curb opening sized for the target flow, in combination with a bypass channel. Using a weir or curb opening helps minimize clogging and reduces the frequency of required maintenance. Due to the tight tolerances required for flow splitter structures, reliance on pipe invert elevations is not an approved method of splitting stormwater flows. Flow splitting structures shall incorporate an adjustable internal weir that can be adjusted in the field to account for as-built elevations which may differ slightly from the design plans.

6.6 FILTER MEDIA

The filter media and surface cover are the two most important elements of a bioretention facility in terms of long-term performance. The following are key factors to consider in determining an acceptable soil media mixture.

General Filter Media Composition. The recommended bioretention soil mixture is generally classified as a loamy sand on the USDA Texture Triangle, with the following composition by volume: **85% to 88% sand; 8% to 12% soil fines; and 3% to 5% organic matter**. Sand shall consist of silica-based aggregate and shall meet the sieve sizes shown in **Table 1.6**. No substitutions for alternative materials such as "engineered sand" or recycled materials will be accepted.

Table 1.6. Sand sieve size requirements

Sieve	Size	% Passing
3/8 in	9.50 mm	100
No. 4	4.75 mm	95 to 100
No. 8	2.36 mm	80 to 100
No. 16	1.18 mm	45 to 85
No. 30	0.60 mm	15 to 60
No. 50	0.30 mm	3 to 15
No. 100	0.15 mm	0 to 4
Effective Particle Size (D10) > 0.30 mm Uniformity Coefficient (D60/D10) < 0.40		

It may be advisable to start with an open-graded coarse silica sand material and proportionately mix in topsoil that will likely contain anywhere from 8% to 12% soil fines (sandy loam, loamy sand) to achieve the desired ratio of sand and fines. An additional 3% to 5% organic matter can then be added. (The exact composition of organic matter and topsoil material will vary, making particle size distribution and recipe for the total soil media mixture difficult to define in advance of evaluating the available material.)

Infiltration Rate. The bioretention soil media should have a minimum infiltration rate of 1 inch per hour (a proper soil mix will have an initial infiltration rate that is significantly higher). Verification of the infiltration rates of installed amended soils can be performed per ASTM D3385-18.

Depth. The standard minimum filter bed depth ranges from 24 and 36 inches for Level 1 and Level 2 designs, respectively. If trees are included in the bioretention planting plan, tree planting holes in the filter bed shall be deeper to provide enough soil volume for the root structure of mature trees. Use perennials or shrubs instead of trees to landscape shallower filter beds.

Mulch. A 3-inch layer of mulch on the surface of the filter bed enhances plant survival, suppresses weed growth, and helps pretreats runoff before it reaches the filter media. Shredded, aged hardwood, especially cypress, makes a very good surface cover, as it retains a significant amount of nitrogen and typically will not float away. Shredded hardwood mulch will require replacement as a part of regular maintenance.

6.7 UNDERDRAIN AND UNDERGROUND STORAGE LAYER

Level 1 designs require a 4 to 6 inch diameter PVC or HDPE underdrain surrounded by a 3 inch jacket of 1 inch (#57) stone unless the infiltration rate of the surrounding soils is greater than 0.5 inches per hour. Some Level 2 designs will not use an underdrain (where soil infiltration rates meet minimum standards; see **Section 6.2** and **Table 1.2**). For Level 2 designs with an underdrain, an underground storage layer, or "sump", of a minimum of 12 inches of #57 stone shall be incorporated below the invert of the underdrain. The underground storage layer must not extend beyond the footprint of the overlying filter media.

The maximum size of pipe that can be located within the bioretention footprint is 6 inches. Larger stormwater trunk lines shall be outside of the footprint of the bioretention or may be within the berm if there is sufficient setback from the filter media footprint to prevent undermining of the trunk line. Storm lines that convey flow away from the bioretention area (from the outlet structure through the berm, for instance) may exceed the maximum diameter of 6 inches. The depth of the storage layer will depend on the target treatment and storage volumes needed to meet water quality criteria. The storage layer shall consist of clean, washed #57 stone or an approved infiltration module.

If the underdrain is to daylight instead of tying into a storm structure, scour protection shall be provided based of the velocity, in feet per second, exiting the underdrain during the 10 year storm event (see **Section 6.1.4**).

All bioretention basins shall include observation wells. The observation wells should be tied into any T's or Y's in the underdrain system, and should extend upwards to be above the surface, with a vented cap. In addition, cleanout pipes shall be provided.

6.8 BIORETENTION PLANTING PLANS

A landscaping plan must be provided for each bioretention area. Minimum plan elements shall include the proposed bioretention template to be used, delineation of planting areas, the planting plan, including the size, the list of planting stock, sources of plant species, and the planting sequence, including post-nursery care and initial maintenance requirements. The planting area is defined as the area disturbed by construction events. The planting plan must address 100% of the planting area. It is highly recommended that the planting plan be prepared by a qualified landscape architect, in order to tailor the planting plan to the site-specific conditions.

Native plant species are preferred over non-native species, but some ornamental species may be used for landscaping effect if they are not aggressive or invasive. **Appendix C** lists native plant species suitable for use in bioretention.

The choice of which planting template to use depends on the scale of bioretention, the context of the site in the urban environment, the filter depth, the desired landscape amenities, and the future owner's capability to maintain the landscape. In general, the vegetative goal is to achieve a surface area coverage of at least 75% in the first two years. For a bioretention area to qualify for Level 2 Design, a minimum of one tree must be planted for every 400 square feet. All bioretention areas shall include at least 5% of native milkweed vegetation within the planting plan.

6.9 BIORETENTION MATERIAL SPECIFICATIONS

Table 1.5. Bioretention Material Specifications		
Material	**Specification**	**Notes**
Surface Layer	• Shredded hardwood mulch • River stone • Native grasses	Lay a 3-inch layer on the surface of the filter bed to suppress weed growth and prevent erosion
Filter Media Composition	Filter Media to contain a mix of topsoil, sand and organic matter to achieve the following final composition (by volume): • 85% to 88% sand; • 8% to 12% soil fines; and • 3% to 5% organic matter	The volume of filter media placed shall be based on 110% of the plan volume, to account for settling or compaction.
Choker Layer	Use a 3-inch layer of #8 or #89 stone above the stone layer.	Meet TDOT Construction Specifications.
Underdrain Layer	12-inch layer of 1-inch stone (#57 stone) shall be washed and clean and free of all fines.	Underdrain shall have a minimum of 3 inches of stone above the top of pipe.
Underdrains	Use a 4 or 6-inch corrugated HDPE or PVC pipe with 3/8-inch perforations at 6 inches on center; position each underdrain on a minimum 0.5% slope located no more than 20 feet from the next pipe.	Lay the perforated pipe under the length of the bioretention cell and install non-perforated pipe as needed to connect with the storm drain system. Install T's and Y's as needed, depending on the underdrain configuration.
Cleanouts, and Observation Wells	6 inch SDR 35 PVC pipe with vented cap or anchor plate	Cleanouts are required at the upper end of the underdrain. The number of observation wells equals the number of test pits required for infiltration testing (Appendix B)
Storage Layer	#57 clean washed stone	Meet TDOT Construction Specifications.
Plant Materials	**Shrubs**: Minimum 3 gal or 18-24" at 4' o.c. (or 1plant/15 s.f.). **Grasses, sedges, perennials**: Size and max. spacing as called for in Tables 1.4, 1.5 and 1.6 herein. **Trees**: Minimum size 2" caliper, maximum spacing for Level 2 design of 1 tree/400 s.f. (NOTE: the 2" cal, minimum allows it to be counted toward landscape ordinance requirements)	Establish plant materials as specified in the landscaping plan and the recommended plant list.

SECTION 7: SPECIAL CASE DESIGN ADAPTATIONS

7.1 SHALLOW BEDROCK AND GROUNDWATER CONNECTIVITY

Many parts of Franklin have shallow bedrock and groundwater, which can constrain the application of deeper bioretention areas (particularly Level 2 designs). If bedrock or groundwater is encountered during subsurface testing for the construction of the bioretention area, the bottom sump elevation of the bioretention design shall be above the lowest bedrock/refusal or groundwater elevation encountered in subsurface testing. Bedrock removal should be limited to unexpected outcroppings and rises not encountered in subsurface testing.

Note that this is not a desirable design and should be utilized only when all other possibilities have been exhausted.

In cases where the reduced curve number method is to be utilized in stormwater quality calculations, no bedrock shall be located within 2 feet of the bottom grade of the bioretention area.

7.2 KARST

Karst regions are found in much of Middle Tennessee. Infiltrative practices, such as bioretention areas, shall not be used in any areas with high risk of sinkhole formations or in areas of known sinkholes. Increasing stormwater runoff to sinkholes is prohibited.

7.3 SITE SPECIFIC LIMITATIONS

Some sites may have areas identified as site specific limitations to infiltration of stormwater runoff. Site specific limitations shall be determined by the City engineer and approved through the Stormwater variance process. Sites with brownfield permits are an example of site specific limitations. Site specific limitations cannot be self-imposed or be caused by requirements within the City Ordinance. It should be noted that the site specific limitation may only occupy a portion of the entire proposed use, and that some "clean" areas (such as rooftops) can be diverted away to another infiltration or runoff reduction practice. Development proposals should be carefully reviewed to determine if any future operation, on all or part of the site, will be designated as a potential site specific limitation. Based on this designation, infiltration may be restricted or prohibited.

SECTION 8: CONSTRUCTION

8.1 CONSTRUCTION SEQUENCE

Construction Stage Erosion and Sediment Controls. Bioretention areas should be fully protected by silt fence or construction fencing, particularly if they will rely on infiltration (i.e., have no underdrains.) Ideally, bioretention should remain outside the limit of disturbance during construction to prevent soil compaction by heavy equipment. Bioretention basin locations may be used as small sediment traps or basins during construction. However, these must be accompanied by notes and graphic details on the erosion prevention and sediment control (EPSC) plan specifying that (1) the maximum excavation depth at the construction stage must be at least 1 foot above the post-construction installation, and (2) the facility must contain an underdrain. The plan must also show the proper procedures for converting the temporary sediment control practice to a permanent bioretention facility, including dewatering, cleanout and stabilization.

8.2 BIORETENTION INSTALLATION

The following is a typical construction sequence to properly install a bioretention basin. These steps may be modified to reflect different bioretention applications or expected site conditions:

Step 1. Construction of the bioretention area should begin after the entire contributing drainage area has been stabilized with vegetation). **THIS IS THE MOST IMPORTANT FACTOR DETERMINING THE SUCCESS OR FAILURE OF THE BIORETENTION AREA. BIORETENTION AREAS WILL**

FAIL IF SEDIMENT IS ALLOWED TO FLOW INTO THEM. It may be necessary to block certain curb cuts or other inlets while the bioretention area is being constructed. The proposed site should be checked for existing utilities prior to any excavation.

Step 2. The designer and the installer should have a preconstruction meeting, checking the boundaries of the contributing drainage area and the actual inlet elevations to ensure they conform to original design. Since other contractors may be responsible for constructing portions of the site, it is quite common to find subtle differences in site grading, drainage and paving elevations that can produce hydraulically important differences for the proposed bioretention area. The designer should clearly communicate, in writing, any project changes determined during the preconstruction meeting to the installer and the plan review/inspection authority.

Step 3. Temporary EPSC controls are needed during construction of the bioretention area to divert stormwater away from the bioretention area until it is completed. Special protection measures such as erosion control fabrics may be needed to protect vulnerable side slopes from erosion during the construction process.

Step 4. Any pretreatment cells should be excavated first and then sealed to trap sediments.

Step 5. Excavators or backhoes should work from the sides to excavate the bioretention area to its appropriate design depth and dimensions. Excavating equipment should have scoops with adequate reach so they do not have to sit inside the footprint of the bioretention area. Contractors should use a cell construction approach in larger bioretention basins, whereby the basin is split into 500 to 1,000 sq. ft. temporary cells with a 10-15 foot earth bridge in between, so that cells can be excavated from the side.

Step 6. Scarify the bottom soils to a depth of 6 to 12 inches to promote greater infiltration.

Step 7. If a stone storage layer will be used, place the appropriate depth of #57 stone on the bottom, install the perforated underdrain pipe, pack #57 stone to 3 inches above the underdrain pipe, and add approximately 3 inches of choker stone, #8, as a filter between the underdrain layer and the soil media layer. If a stone storage layer is not used, the pipe may be placed within the underdrain layer.

Step 8. Deliver or prepare the soil media and store it on an adjacent impervious area or plastic sheeting. Apply the media in 12-inch lifts until the desired top elevation of the bioretention area is achieved. Install 110% of the required soil volume to compensate for future settlement.

Step 9. Prepare planting holes for any trees and shrubs, install the vegetation, and water them during weeks of no rain for the first two months. Install any temporary irrigation.

Step 10. Place the surface cover in both cells (mulch, river stone or turf), depending on the design.

Step 12. Conduct the final construction inspection (see **Section 9**).

8.3 CONSTRUCTION INSPECTION

Use detailed inspection checklists that require sign-offs by qualified individuals at critical stages of construction to ensure that the contractor's interpretation of the plan is consistent with the designer's intent.

SECTION 9: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 10: OPERATION AND MAINTENANCE

10.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

10.2 FIRST YEAR MAINTENANCE OPERATIONS

Successful establishment of bioretention areas requires that the following tasks be undertaken in the first year following installation:

Initial inspections. For the first 6 months following construction, the site should be inspected at least twice after storm events that exceed 0.5 inch of rainfall.

Spot Reseeding. Inspectors should look for bare or eroding areas in the contributing drainage area or around the bioretention area, and make sure they are immediately stabilized with grass cover.

Fertilization. One-time, spot fertilization may be needed for initial plantings.

Watering. Depending on rainfall, watering may be necessary once a week during the first 2 months, and then as needed during first growing season (April-October).

Remove and replace dead plants. Since up to 10% of the plant stock may die off in the first year, construction contracts should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction. The typical thresholds below which replacement is required are 85% survival of plant material and 100% survival of trees.

10.3 MAINTENANCE INSPECTIONS

It is highly recommended that a spring maintenance inspection and cleanup be conducted at each bioretention area. The following is a list of some of the key maintenance problems to look for:

- Check to see if 75% to 90% cover (mulch plus vegetative cover) has been achieved in the bed, and measure the depth of the remaining mulch. If the mulch layer is less than 3 inches, additional mulch is required.
- Check for sediment buildup at inflow points, curb cuts, gravel diaphragms or pavement edges that prevents flow from reaching the filter bed, and check for other signs of bypassing. Remove accumulated sediment.
- Check for any winter- or salt-killed vegetation and replace with hardier species from the approved plant list.
- Note presence of accumulated sand, sediment and trash in the pretreatment cell or filter beds and remove it.
- Inspect bioretention side slopes and grass filter strips for evidence of any rill or gully erosion, and repair and stabilize any erosion issues found.
- Check the bioretention bed for evidence of mulch flotation, excessive ponding, dead plants or concentrated flows, and take appropriate remedial action.
- Look for any bare soil or sediment sources in the contributing drainage area and stabilize them immediately.
- Check for clogged or slow-draining soil media, often caused by a crust formed on the top layer or inappropriate soil media composition. Remediate as necessary to restore proper filtration characteristics.

10.4 ROUTINE AND NON-ROUTINE MAINTENANCE TASKS

Maintenance of bioretention areas should be integrated into routine landscape maintenance tasks. If landscaping contractors will be expected to perform maintenance, their contracts should contain specifics on unique bioretention landscaping needs, such as maintaining elevation differences needed for ponding, proper mulching, sediment and trash removal, and limited use of fertilizers and pesticides. A customized maintenance schedule must be prepared for each bioretention facility, since the maintenance tasks will differ depending on the scale of bioretention, the landscaping template chosen, and the type of surface cover. A generalized summary of common maintenance tasks and their frequency is provided in **Table 1.10**.

The most common non-routine maintenance problem involves the presence of standing water for extended periods. If water remains on the surface for more than 24 hours after a storm, adjustments to the grading or underdrain repairs may be needed. The surface of the filter bed should also be checked for accumulated sediment or a fine crust that builds up after the first several storm events. There are several methods that can be used to rehabilitate the filter bed (try the easiest things first, as listed below):

- Open the underdrain observation well or cleanout and pour in water to verify that the underdrains are functioning and not clogged or otherwise in need of repair. The purpose of this check is to see if there is standing water all the way down through the soil. If there is standing water on top, but not in the underdrain, then there is a clogged soil layer. If the underdrain and stand pipe indicates standing water, then the underdrain must be clogged and will need to be snaked.
- Remove accumulated sediment and till 2 to 3 inches of sand into the upper 8 to 12 inches of soil.
- Install sand wicks from 3 inches below the surface to the underdrain layer. This reduces the average concentration of fines in the media bed and promotes quicker drawdown times. Sand wicks can be installed by excavating or augering (using a tree auger or similar tool) down to the gravel storage zone to create vertical columns which are then filled with a clean open-graded coarse sand material (ASTM C-33 concrete sand or similar approved sand mix for bioretention media). A sufficient number of wick drains of sufficient dimension should be installed to meet the design dewatering time for the facility.
- Remove and replace some or all of the soil media.

Table 1.10. Suggested Annual Maintenance Activities for Bioretention

Maintenance Tasks	Frequency
Mowing of grass filter strips and bioretention turf cover	At least 4 times a year
Spot weeding, erosion repair, trash removal, and mulch raking	Twice during growing season
Add reinforcement planting to maintain desired vegetation density	As needed
Remove invasive plants using recommended control methods	As needed
Stabilize the contributing drainage area to prevent erosion	As needed
Spring inspection and cleanup	Annually
Supplement mulch to maintain a 3 inch layer	Annually
Prune trees and shrubs	Annually
Remove sediment in pretreatment cells and inflow points	Once every 2 to 3 years
Replace the mulch layer	Every 3 years

SECTION 11: COMMUNITY & ENVIRONMENTAL CONCERNS

11.1 ENVIRONMENTAL AND COMMUNITY ISSUES

The following is a list of several other community and environmental concerns that may also arise when infiltration practices are proposed:

Nuisance Conditions. Poorly designed infiltration practices can create potential nuisance problems such as

basement flooding, poor yard drainage and standing water. In most cases, these problems can be minimized through proper adherence to the setback, soil testing and pretreatment requirements outlined in this specification.

Mosquito Risk. Infiltration practices have some potential to create conditions favorable to mosquito breeding, if they clog and have standing water for extended periods. Proper installation and maintenance of the bioretention area will prevent these conditions from occurring.

Groundwater Injection Permits. Groundwater injection permits are required if the infiltration practice is deeper than the longest surface area dimension of the practice (EPA, 2008). Designers should investigate whether a proposed infiltration practice is subject to Tennessee groundwater injection well permit requirements

Urban Bioretention

Description: Urban Bioretention is similar to traditional bioretention practices, except that the bioretention is fit into concrete-sided containers within urban landscapes, such as planter boxes or tree planters. Captured runoff is treated by filtration through an engineered soil medium and is then either infiltrated into the subsoil or exfiltrated through an underdrain.

Variations:

- Stormwater planters – in landscaping areas between buildings and roadways or sidewalks
- Green Street swales and planters – on street edge of sidewalk where street landscaping is normally installed
- Proprietary planting cells

Advantages/Benefits:

- Reduced runoff volume
- Reduced peak discharge rate
- Reduced TSS
- Reduced pollutant loading
- Reduced runoff temperature
- Groundwater recharge (if soils are sufficiently permeable)
- Habitat creation
- Enhanced site aesthetics
- Reduced heat island effect

Disadvantages/Limitations:

- Separation from groundwater is required
- Not suitable for pollution hotspots

Design considerations:

- Maximum contributing drainage area of 2,500 square feet. For drainage areas > 2,500 square feet see GIP-01.
- Underdrain required
- Design to drain within 24 hours
- Maximum running slope of 3%
- Must not create a fall or tripping hazard. Consider edge protection or Knee walls when adjacent to pedestrian routes.

Roadway Applications

- City approval is required for use within public ROW
- Stormwater can be conveyed by sheet flow or curb cuts
- Design as a series of cells running parallel to roadway
- Impermeable liner must be installed roadside to protect roadway base

Selection Criteria:

LEVEL 1 – 60% Runoff Reduction Credit

Land Use Considerations:

[x] **Residential**

[x] **Commercial**

[x] **Industrial (with CITY Approval)**

Maintenance:

- Regular maintenance of landscaping to maintain healthy vegetative cover
- Irrigation when necessary during first growing season
- Periodic trash removal

Maintenance Burden

[M]

L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

Urban bioretention practices are similar in function to regular bioretention practices except they are adapted to fit into "containers" within urban landscapes. Typically, urban bioretention is installed within an urban streetscape, urban landscaping beds, tree planters, and plazas. Urban bioretention is not intended for large commercial areas, nor should it be used to treat small sub-areas of a large drainage area such as a parking lot. Rather, urban bioretention is intended to be incorporated into small fragmented drainage areas such as shopping or pedestrian plazas within a larger urban development. Urban Bioretention within the Right of Way (ROW) required City approval and shall only be used to treat water that falls in the ROW.

Urban bioretention features hard edges, often with vertical concrete sides, as contrasted with the gentler earthen slopes of regular bioretention. If these practices are outside of the ROW, they may be open-bottomed, to allow some infiltration of runoff into the sub-grade but shall always include an underdrain.

Stormwater planters take advantage of limited space available for stormwater treatment by placing a soil filter in a container located above ground or at grade in landscaping areas between buildings and roadways with an impermeable liner protection (**Figure 2.1**). The small footprint of foundation planters is typically contained in a precast or cast-in-place concrete vault. Other materials may include molded polypropylene cells and precast modular block systems. Stormwater planters must be outside the ROW if they are treating roof water or runoff from areas outside of the ROW.

Figure 2.1. Stormwater Planters (source: City of Portland, OR)

Green Street swales and planters are installed in the sidewalk zone near the street where urban street trees are normally installed. The soil volume for the tree pit is increased and used as a stormwater storage area (**Figure 2.2**). The surface of the enlarged planting area may be mulch, grates or pervious pavement (if outside the ROW). Large and shared rooting space and a reliable water supply increase the growth and survival rates in this otherwise harsh planting environment.

Figure 2.2. Green Street Planters on Deaderick St., Nashville, TN

SECTION 2: PERFORMANCE

The runoff reduction function of an urban bioretention area is described in **Table 2.1**.

Table 2.1. Runoff Volume Reduction Provided by Urban Bioretention Areas		
Stormwater Function	**Level 1 Design**	**Level 2 Design**
Runoff Volume Reduction (RR)	60%	Level 1 Design Only

Sources: CSN (2008) and CWP (2007)

SECTION 3: DESIGN TABLE

Design criteria for urban bioretention are detailed in **Table 2.2**, below.

Table 2.2. Urban Bioretention Design Criteria
Level 1 Design Only (RR: 60)
Sizing (Refer to **Section 6.1**): Surface Area (sq. ft.) = Tv/Equivalent Storage Depth[1]
Maximum Drainage Area: 2,500 sq. ft.
Maximum Ponding Depth: 6 inches
Filter Media Depth: minimum = 30 inches; recommended maximum = 48 inches
Underdrain = 4 or 6 inch PVC or HDPE with clean-outs (Refer to **Section 6.9**)
Gravel layer depth: minimum = 10 inches
Media and Surface Cover: (Refer to **Section 6.5**)
Sub-soil testing: (Refer to **GIP-01**, **Section 6.2**)
Inflow: sheet flow, curb cuts, trench drains, and roof drains, etc.
Building Setbacks: (Refer to **Section 5**)
Long Term Maintenance Plan: (Refer to **Section 9**)

[1] Storage depth is the sum of the porosity (n_r) of the soil media and gravel layers multiplied by their respective depths, plus the surface ponding depth. Refer to **Section 6.1**.

SECTION 4: TYPICAL DETAILS

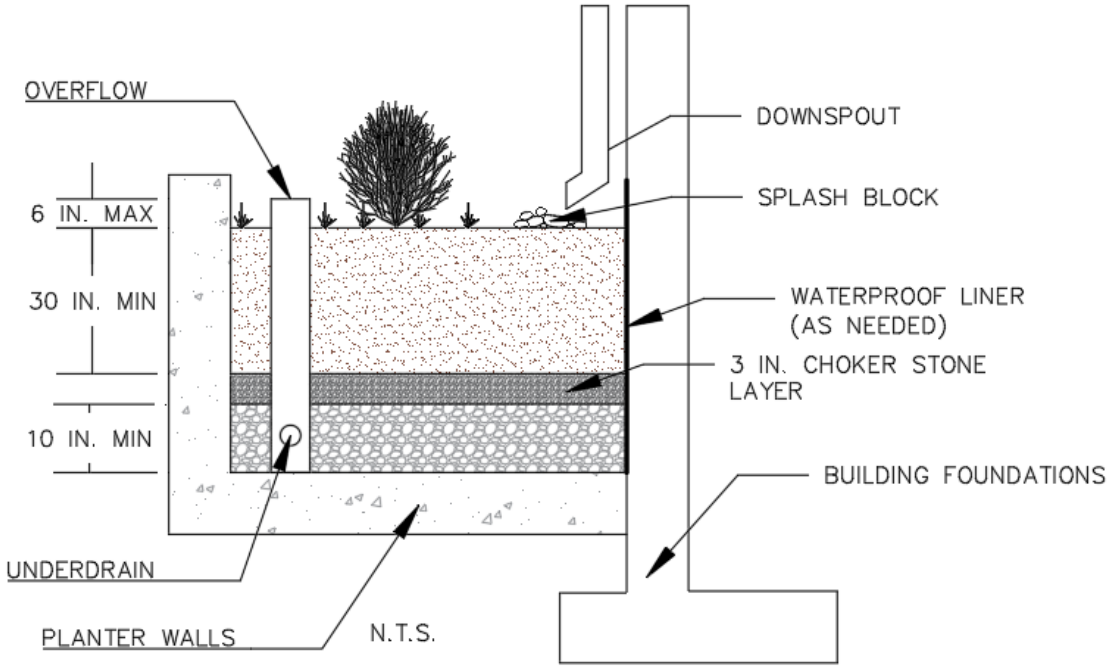


Figure 2.3. Stormwater Planter Cross-Section

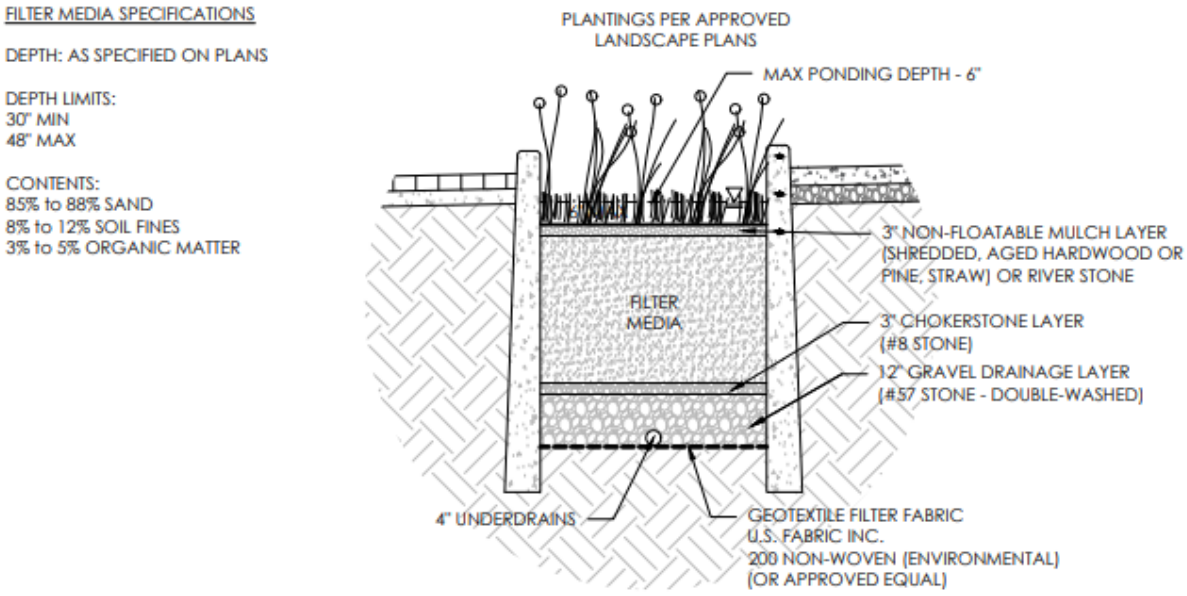


Figure 2.4. Typical Urban Bioretention Detail

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

In general, urban bioretention has the same constraints as regular bioretention, along with a few additional constraints as noted below:

Adequate Drainage. Urban bioretention practice elevations must allow the untreated stormwater runoff to be discharged at the surface of the filter bed and ultimately connect to the local storm drain system.

Available Hydraulic Head. In general, 3 feet of elevation difference is needed between the downstream storm drain invert and the inflow point of the urban bioretention practice. This is generally not a constraint, due to the standard depth of most storm drains systems.

Contributing Drainage Area. Urban bioretention is limited to 2,500 sq. ft. of impervious drainage area. However, this is considered a general rule; larger drainage areas may be allowed with sufficient flow controls and other mechanisms to ensure proper function, safety, and community acceptance. The drainage areas in these urban settings are typically considered to be 100% impervious. While multiple planters or swales can be installed to maximize the treatment area in ultra-urban watersheds, urban bioretention is not intended to be used as treatment for large impervious areas (such as parking lots).

Curb cuts. If curb cuts are to be used in the design of the bioretention area, the designer shall provide calculation showing the curb cut can safely pass the 10 year storm event.

Minimizing External Impacts. Because urban bioretention practices are installed in urban settings, individual units may be subject to higher public visibility, greater trash loads, pedestrian use traffic, vandalism, and even vehicular loads. These practices should be designed in ways that prevent, or at least minimize, such impacts. Designers should clearly recognize the need to perform frequent landscaping maintenance to remove trash, check for clogging, and maintain vigorous vegetation. The urban landscape context may feature naturalized landscaping or a more formal design. When urban bioretention is used in sidewalk areas of high foot traffic, designers shall not impede pedestrian movement or create a safety hazard and maintain the American with Disabilities Act (ADA) required path of travel. Designers may also install low fences (such as a low garden fence), grates or other measures to prevent damage from pedestrian short-cutting across the practices.

Setbacks. If an impermeable liner and an underdrain are used, no setback is required from the building. Otherwise, the urban bioretention practice shall be at least 10 feet down gradient from the building. Building designers shall always be made aware of stormwater BMPs in close proximity to buildings so that appropriate precautions are taken for basement, footing and foundation designs.

Utilities. Urban bioretention practices frequently compete for space with a variety of utilities. Since they are often located parallel to the ROW, care should be taken to provide utility-specific horizontal and vertical setbacks. No below-grade utilities are allowed within the footprint of the urban bioretention areas. No overhead utilities are allowed over urban bioretention areas incorporating tree plantings.

SECTION 6: DESIGN CRITERIA

Urban bioretention practices are similar in function to regular bioretention practices except they are adapted to fit into "containers" within urban landscapes. Therefore, special sizing accommodations are made to allow these practices to fit in very constrained areas where other surface practices may not be feasible.

6.1 SIZING OF URBAN BIORETENTION

The required surface area of the urban bioretention filter is calculated by dividing the Treatment Volume by the Equivalent Storage Depth (**Equation 2.2** below), in the same manner as it is calculated for traditional bioretention. The equivalent storage depth is computed as the depth of media, gravel, or surface ponding (in feet) multiplied by the accepted void ratio.

The accepted porosities (n) are:

Table 2.3. Urban Bioretention Accepted Porosities	
Material	**Porosity Value (n)**
Gravel (#57) Stone	0.40
Soil Media	0.25
Surface Storage	1.00

Equation 2.1. Urban Bioretention Equivalent Storage Depth

$$\text{Equivalent Storage Depth} = D_E = n_1(D_1) + n_2(D_2) + \cdots$$

The equivalent storage depth for an urban bioretention facility with a 30-inch media depth, 12-inch gravel layer, and a 6-inch surface ponding depth is therefore computed as:

$$D_E = (2.5 \text{ ft.} \times 0.25) + (1 \text{ ft.} \times 0.40) + (0.5 \text{ ft.} \times 1.0) = 1.9 \text{ ft.}$$

Where n_1 and D_1 are for the first layer, etc.

Surface Area (SA) is computed as:

Equation 2.2. Urban Bioretention Sizing

$$SA \text{ (sq. ft.)} = T_v \text{ (cu. ft.)} / D_E$$

Where:

SA = the surface area of the urban bioretention facility (in sq. ft.)
D_E = Equivalent Storage Depth (ft.)
T_v = the required Treatment Volume (in cu. ft.)

Equation 2.3. Treatment Volume

$$Tv = [(1.0 \text{ in.})(R_v)(A)/12]$$

Where:

Tv = the required Treatment Volume (in cu. ft.)
A = the contributing drainage area (in sq. ft.)
R_v = Runoff Coefficient found in Section 1 Chapter 3 of this Manual

Equations 2.1 and 2.2 should be modified if the storage depths of the soil media, gravel layer, or ponded water vary in the actual design.

6.2 GENERAL DESIGN CRITERIA FOR URBAN BIORETENTION

Design of urban bioretention should follow the general guidance presented in this Bioretention design

specification. The actual geometric design of urban bioretention is usually dictated by other landscape elements such as buildings, sidewalk widths, utility corridors, retaining walls, etc. Designers can divert fractions of the runoff volume from small impervious surfaces into urban bioretention that is integrated with the overall landscape design. Inlets and outlets shall be located as far apart as possible. The ground surface of the urban bioretention cell shall be flat. The soil media depth shall be a minimum of 30 inches. If large trees and shrubs are to be installed, soil media depths should accommodate. Urban bioretention located adjacent to walkways must incorporate ADA-compliant edge protection and shall not present a fall or tripping hazard. All urban bioretention practices shall be designed to fully drain within 24 hours

6.3 PRETREATMENT

Velocity dissipation shall be provided at any inlet into the urban bioretention area. The inlet(s) to urban bioretention should be stabilized using coarse aggregate stone, splash block, river stone or other acceptable energy dissipation measures. The following forms of inlet stabilization are recommended:

- Stone energy dissipaters.
- Sheet flow over a depressed curb with a 3-inch drop.
- Curb cuts allowing runoff into the bioretention area.
- Covered drains that convey flows under sidewalks from the curb or from downspouts (if the bioretention area is outside of the ROW).
- Grates or trench drains that capture runoff from the sidewalk or plaza area.

Pretreatment is not required with urban bioretentions, but it is highly recommended to improve functionality. Options overlap with those of regular bioretention practices. However, the materials used may be chosen based on their aesthetic qualities in addition to their functional properties. For example, river rock may be used in lieu of rip rap. Other pretreatment options may include one of the following:

- A trash rack between the pretreatment cell and the main filter bed. This will allow trash to be collected from one location.
- A trash rack across curb cuts. While this trash rack may clog occasionally, it keeps trash in the gutter, where it can be picked up by street sweeping equipment.
- A pretreatment area above ground or a manhole or grate directly over the pretreatment area

6.4 CONVEYANCE AND OVERFLOW

Overflows can either be diverted from entering the bioretention cell or dealt with via an overflow inlet. Optional methods include the following:

- Size curb openings to capture only the Treatment Volume and bypass higher flows through the existing gutter.
- Use landscaping type inlets or standpipes with trash guards as overflow devices.
- Use a pretreatment chamber with a weir design that limits flow to the filter bed area.

6.5 FILTER MEDIA

The filter media and surface cover are the two most important elements of a bioretention facility in terms of long-term performance. The following are key factors to consider in determining an acceptable soil media mixture.

General Filter Media Composition. The recommended bioretention soil mixture is generally classified as a loamy sand on the USDA Texture Triangle, with the following composition by volume: **85% to 88% sand; 8% to 12% soil fines; and 3% to 5% organic matter**. Sand shall consist of silica-based aggregate and shall meet the sieve sizes shown in **Table 1.6**. No substitutions for alternative materials such as "engineered sand" or recycled materials will be accepted.

Table 1.6. Sand sieve size requirements		
Sieve	**Size**	**% Passing**
3/8 in	9.50 mm	100
No. 4	4.75 mm	95 to 100
No. 8	2.36 mm	80 to 100
No. 16	1.18 mm	45 to 85
No. 30	0.60 mm	15 to 60
No. 50	0.30 mm	3 to 15
No. 100	0.15 mm	0 to 4
Effective Particle Size (D10) > 0.30 mm Uniformity Coefficient (D60/D10) < 0.40		

It may be advisable to start with an open-graded coarse silica sand material and proportionately mix in topsoil that will likely contain anywhere from 8% to 12% soil fines (sandy loam, loamy sand) to achieve the desired ratio of sand and fines. An additional 3% to 5% organic matter can then be added. (The exact composition of organic matter and topsoil material will vary, making particle size distribution and recipe for the total soil media mixture difficult to define in advance of evaluating the available material.)

Mulch. A 3-inch layer of mulch on the surface of the filter bed enhances plant survival, suppresses weed growth, and helps pretreats runoff before it reaches the filter media. Shredded, aged hardwood, especially cypress, makes a very good surface cover, as it retains a significant amount of nitrogen and typically will not float away. Shredded hardwood mulch will require replacement as a part of regular maintenance.

6.6 SPECIFIC DESIGN ISSUES FOR STORMWATER PLANTERS

Since stormwater planters are often located near building foundations, waterproofing by using a watertight concrete shell or an impermeable liner is required to prevent seepage. The building architect shall be notified if a stormwater planter is to be utilized to ensure any impermeable liner is shown on the corresponding building plans.

6.7 SPECIFIC DESIGN ISSUES FOR GREEN STREETS SWALES AND PLANTERS

- The bottom of the soil layer must be a minimum of 4 inches below the root ball of any plants to be installed.
- Green streets design sometimes cover portions of the stone storage layer with pervious pavers (if outside the ROW). Green streets design can provide additional storage volume within stone storage layers beneath pervious pavers and sidewalks adjacent to urban bioretention cells.
- Installing a tree pit grate over filter bed media is one possible solution to prevent pedestrian traffic and trash accumulation.
- Low, wrought iron fences can help restrict pedestrian traffic across the tree pit bed and serve as a protective barrier if there is a drop-off from the pavement to the urban bioretention cell.
- A removable grate capable of supporting typical H-20 axle loads may be used to allow the tree to grow through it.
- Removable grates in pedestrian areas shall be ADA compliant.
- Each tree needs a minimum of 100 square feet of shared root space.
- Proprietary tree pit devices are acceptable, provided they conform to this specification.

6.8 PLANTING AND LANDSCAPING CONSIDERATIONS

The degree of landscape maintenance that can be provided will determine some of the planting choices for urban bioretention areas. The planting cells can be formal gardens or naturalized landscapes. Landscaping in the ROW should be designed to limit visual obstructions for pedestrian and vehicular traffic. See **Appendix C** for all planting and landscaping requirements, as well as all native plant lists.

In areas where less maintenance will be provided and trash accumulation in shrubbery or herbaceous plants is a concern, consider a "turf and trees" landscaping model. Spaces for herbaceous flowering plants can be included. This may be attractive at a community entrance location.

Native trees or shrubs are preferred for urban bioretention areas, although some ornamental species may be used. As with regular bioretention, selected perennials, shrubs, and trees must be tolerant of drought, and inundation. The landscape designer should also consider that de-icing materials may accumulate in the bioretention areas in winter and could kill vegetation. Additionally, tree species selected shall meet the City of Franklin street tree requirements within the Zoning Ordinance.

6.9 UNDERDRAIN AND UNDERGROUND STORAGE LAYER

The unique components for urban bioretention may include the inlet control device, a concrete box or other containing shell, protective grates, and an underdrain that daylights to another stormwater practice or connects to the storm drain system. The underdrain should consist of perforated pipe greater than or equal to 4 inches in diameter, placed in a layer of washed #57 stone. It shall have a minimum of 3 inches of washed #57 laid above the pipe and have a minimum slope of 0.5%.

All bioretention basins shall include observation wells. The observation wells should be tied into any T's or Y's in the underdrain system, and should extend upwards to be above the surface, with a vented cap. In addition, cleanout pipes shall be provided.

6.10 URBAN BIORETENTION MATERIAL SPECIFICATIONS

Table 2.4. Urban Bioretention Material Specification

Material	Specification	Notes
Surface Layer	• Shredded, aged hardwood mulch • River stone • Native grasses	Lay a 3-inch layer on the surface of the filter bed to suppress weed growth and prevent erosion
Filter Media Composition	Filter Media to contain a mix of topsoil, sand and organic matter to achieve the following final composition (by volume): • 85% to 88% sand; • 8% to 12% soil fines; and • 3% to 5% organic matter	The volume of filter media placed shall be based on 110% of the plan volume, to account for settling or compaction.
Choker Layer	Use a 3-inch layer of #8 or #89 stone above the stone layer.	Meet TDOT Construction Specifications

Reservoir Layer	10 or 12-inch layer of 1-inch stone (#57 stone) should be washed and clean and free of all fines.	3 inches of #57 stone should cover the underdrain with stone above the top of the pipe
Underdrains	Use a 4 or 6-inch corrugated HDPE or PVC pipe with 3/8-inch perforations at 6 inches on center; position each underdrain on a minimum 0.5% slope located no more than 20 feet from the next pipe.	Lay the perforated pipe under the length of the bioretention cell and install non-perforated pipe as needed to connect with the storm drain system. Install T's and Y's as needed, depending on the underdrain configuration.
Cleanouts, and Observation Wells	4 or 6 inch SDR 35 PVC pipe with vented cap or anchor plate	Cleanouts are required at the upper end of the underdrain. The number of observation wells equals the number of test pits required for infiltration testing (Appendix B)
Storage Layer	#57 clean washed stone	Meet TDOT Construction Specifications

SECTION 7: CONSTRUCTION

The construction sequence and inspection requirements for urban bioretention are generally the same as other bioretention practices. Consult the construction sequence and inspection guidance provided in the main bioretention design specification **(GIP-01)**. In cases where urban bioretention is constructed in the road or ROW, the construction sequence may need to be adjusted to account for traffic control, pedestrian access and utility notification.

Urban bioretention areas should only be constructed after the drainage area to the facility is completely stabilized. The specified growth media should be placed and spread by hand with minimal compaction, in order to avoid compaction and maintain the porosity of the media. The media should be placed in 12 inch lifts with no machinery allowed directly on the media during or after construction. The media should be overfilled above the proposed surface elevation, as needed, to allow for natural settling. Lifts may be lightly watered to encourage settling. After the final lift is placed, the media should be raked (to level it), saturated, and allowed to settle prior to installation of plant materials.

SECTION 8: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 9: OPERATION AND MAINTENANCE

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

Routine operation and maintenance are essential to gain public acceptance of highly visible urban bioretention areas. Weeding, pruning, the removal and replacement of dead vegetation and trash removal should be done as

needed to maintain the aesthetics necessary for community acceptance. During drought conditions, it may be necessary to water the plants, as would be necessary for any landscaped area.

To ensure proper performance, installers should check that stormwater infiltrates properly into the soil within 24 hours after a storm. If excessive surface ponding is observed, corrective measures include inspection for soil compaction and underdrain clogging. Consult the maintenance guidance outlined in **Table 2.5 and (GIP-01)**.

Table 2.5. Suggested Annual Maintenance Activities for Urban Bioretention	
Maintenance Tasks	**Frequency**
Spot weeding, erosion repair, trash removal, and mulch raking	Twice during growing season
Add reinforcement planting to maintain desired vegetation density	As needed
Remove invasive plants using recommended control methods	As needed
Stabilize the contributing drainage area to prevent erosion	As needed
Spring inspection and cleanup	Annually
Supplement mulch to maintain a 3 inch layer	Annually
Prune trees and shrubs	Annually
Remove accumulated sediment and fines at inflow points	Once every 2 to 3 years
Replace the mulch layer	Every 3 years

SECTION 10: RIGHT OF WAY DESIGN CONSIDERATIONS

Green Street swales and planters are applicable along roads. Approval by City of Franklin staff is required before the use of application within the ROW. They can be used along curbside in urban areas with stormwater being conveyed by sheet flow or curb cuts. Green Street swales and planters can also be designed as a series of cells running parallel to roadway. A reinforced concrete wall must separate the road subgrade from the bioretention feature. Segmental block walls shall not be used for urban bioretention areas within the ROW.

Permeable Pavement

Description: Permeable pavements allow stormwater runoff to filter through voids in the pavement surface into an underlying stone reservoir, where it is temporarily stored and/or infiltrated. Porous paving systems have several design variants. The four major categories are: 1) pervious concrete; 2) modular block systems; 3) porous asphalt and 4) grass and gravel pavers. All have a similar structure, consisting of a surface pavement layer, an underlying stone aggregate reservoir layer and a filter layer or fabric installed on the bottom. Porous asphalt shall not be used within the City of Franklin.

Variations: permeable interlocking pavers, concrete grid pavers, plastic reinforced grid pavers

Advantages/Benefits:

- Runoff volume reduction
- Can increase aesthetic value
- Provides water quality treatment

Disadvantages/Limitations:

- Cost
- Maintenance
- Limited to low traffic areas with limited structural loading
- Potential issues with handicap access
- Infiltration can be limited by underlying soil property
- Not effective on steep slopes

Applications:

- Best used in low traffic and low load bearing areas
- Parking lots (particularly overflow areas)
- Driveways (commercial)
- Sidewalks (outside the Right of Way)
- Emergency access roads, maintenance roads and trails, etc.

Manufacturer recommendations for installation shall supersede any requirement within the BMP manual

Selection Criteria:

LEVEL 1 – 45% Runoff Reduction Credit

LEVEL 2 – 95% Runoff Reduction Credit

Land Use Considerations:

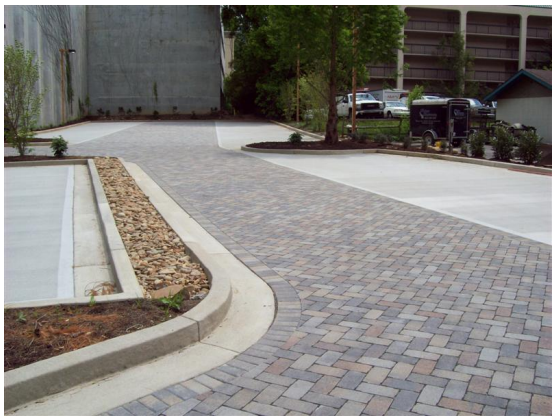
X	**Residential**
X	**Commercial**
X	**Industrial**

Maintenance:

- Turf pavers can require mowing, fertilization, and irrigation. Plowing is possible, but requires use of skids
- Sand, salt, and deicers shall not be applied
- Adjacent areas should be fully stabilized with vegetation to prevent sediment-laden runoff from clogging the surface
- A vacuum-type sweeper or high-pressure hosing (for porous concrete) should be used for cleaning

H	**Maintenance Burden** L = Low M = Moderate H = High

SECTION 1: DESCRIPTION



Permeable pavements are alternative paving surfaces that allow stormwater runoff to filter through voids in the pavement surface into an underlying stone reservoir, where it is temporarily stored and/or infiltrated. Permeable pavements consist of a surface pavement layer, an underlying stone aggregate reservoir layer and a filter layer or fabric installed on the bottom (See **Figure 3.1** below).

The thickness of the reservoir layer is determined by both a structural and hydraulic design analysis. The reservoir layer serves to retain stormwater and supports the design traffic loads for the pavement. In low-infiltration soils, some of the filtered runoff is collected in an underdrain and returned to the storm drain system. If infiltration rates in the native soils permit, permeable pavement can be designed with a sump beneath the underdrain, to enable full infiltration of runoff. A combination of these methods can be used to infiltrate a portion of the filtered runoff.

Permeable pavement is typically designed to treat stormwater that falls on the actual pavement surface area, but it may also be used to accept run-on from small adjacent impervious areas, such as impermeable driving lanes or rooftops. However, careful sediment control is needed for any run-on areas to avoid clogging of the down-gradient permeable pavement. Permeable pavement has been used at commercial, institutional, and residential sites in spaces that are traditionally impervious. Permeable pavement promotes a high degree of runoff volume reduction and nutrient removal, and it can also reduce the effective impervious cover of a development site.

SECTION 2: PERFORMANCE

The overall runoff reduction of permeable pavement is shown in **Table 3.1**.

Table 3.1. Runoff Volume Reduction Provided by Permeable Pavement		
Stormwater Function	**Level 1 Design**	**Level 2 Design**
Runoff Volume Reduction (RR)	45%	95%

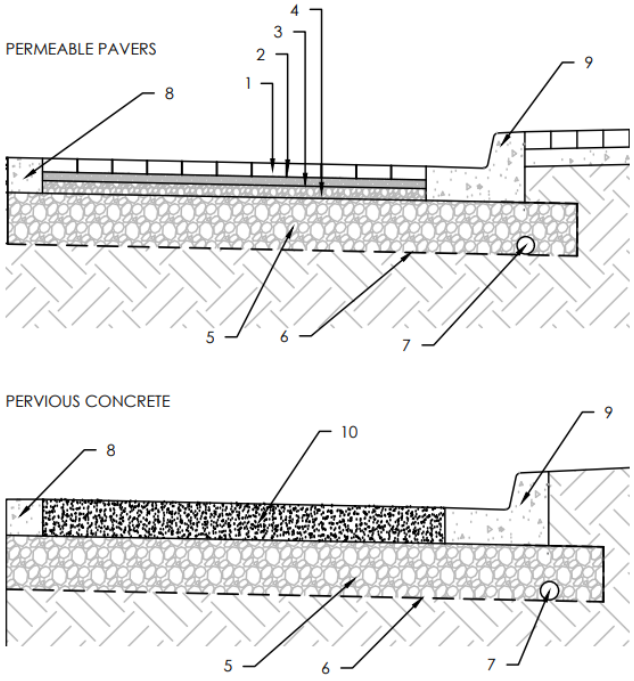
SECTION 3: DESIGN TABLE

The major design goal of permeable pavement is to maximize runoff reduction. To this end, designers may choose to use a baseline permeable pavement design (Level 1) or an enhanced design (Level 2) that maximizes runoff reduction. To qualify for Level 2, the design must meet all design criteria shown in the right hand column of **Table 3.2**.

Table 3.2. Permeable Pavement Design Criteria	
Level 1 Design	**Level 2 Design**
Sizing (Section 6.1): Tv [1]= (1)(Rv)(A) 3630	**Sizing (Section 6.1)**: Tv [1]= (1.1)(Rv)(A) 3630
Sub-soil Testing (Section 6.2): Testing is required. Min. infiltration rate > 0.5 inch/hour in order to remove the underdrain requirement.	**Sub-soil Testing** (Section 6.2): Testing is required. Min. infiltration rate > 0.5 inch/hour in order to remove the underdrain requirement.
Contributing Drainage Area (Section 5): Twice the permeable surface area.	**Contributing Drainage Area (Section 5)**: No additional contributing drainage area allowed.
Underdrain (Section 6.8) = PVC or Corrugated HDPE with clean-outs. Underdrains are required. (**Section 6.2**)	**Underdrain & Underground Storage Layer** (Section 6.7) = PVC or Corrugated HDPE with clean-outs, and a minimum 12-inch stone sump below the invert. Underdrains are required. (**Section 6.2**)
Long Term Maintenance Requirements (Section 11)	

1. A = Area in acres

SECTION 4: TYPICAL DETAILS



1	3 1/8" THICKNESS CONCRETE PAVERS 8,000 PSI STRENGTH
2	1/4" JOINTS NO. 8 STONE
3	2" BEDDING COURSE NO. 8 AGGREGATE
4	3" OPEN-GRADED BASE NO. 57 STONE
5	12" STONE SUBBASE NO. 2 STONE
6	GEOTEXTILE FILTER FABRIC U.S. FABRIC INC. 200 NON-WOVEN (ENVIRONMENTAL) (OR APPROVED EQUAL)
7	4" OR 6" P.V.C. UNDERDRAIN
8	RIBBON CURB (SEE C.O.F. STANDARD CURB DETAIL)
9	STANDARD C.O.F. CURB AS SPECIFIED ON PLANS
10	PERVIOUS CONCRETE PER ACI STANDARD

Figure 3.1. Typical Detail of Concrete Pavers and Permeable Concrete

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

Since permeable pavement has a very high runoff reduction capability, it should always be considered as an alternative to conventional pavement. Permeable pavement is subject to the same feasibility constraints as most infiltration practices, as described below.

Contributing Drainage Area. Any external drainage area contributing runoff to permeable pavement should not exceed twice the surface area of the Level 1 permeable pavement and shall be as close to 100% impervious as possible. Level 2 designs shall only treat the rainfall that falls on its surface. Careful sediment source control and/or a pre-treatment strip or sump (e.g., stone or gravel) should be used to control sediment run-on to the permeable pavement section if there is any permeable run-on upgradient. It is recommended to not place permeable pavement under tree cover or near overhanging landscaping.

Available Space. A prime advantage of permeable pavement is that it does not require its surface area to be set aside solely for stormwater management and can still be utilized for vehicular or pedestrian. This can be important for tight sites and areas with high land costs where usable surface area is at a premium.

Pavement Subgrade Slope. The subgrade slope of a permeable pavement installation shall be as flat as possible (i.e., 0% longitudinal slope) to enable even distribution and infiltration of stormwater. However, a maximum longitudinal slope of 1% is permissible if an underdrain is employed. Lateral slopes should be 0%. The subgrade of the permeable pavement shall be an even slope both longitudinally and laterally to establish a level reservoir layer. Designers should consider using a terraced subgrade design for permeable pavement in sloped areas, especially

when the local slope is several percent or greater. An overflow for larger design storms shall be provided. The surface slope shall be a maximum of 10% but is recommended to be less than 1%.

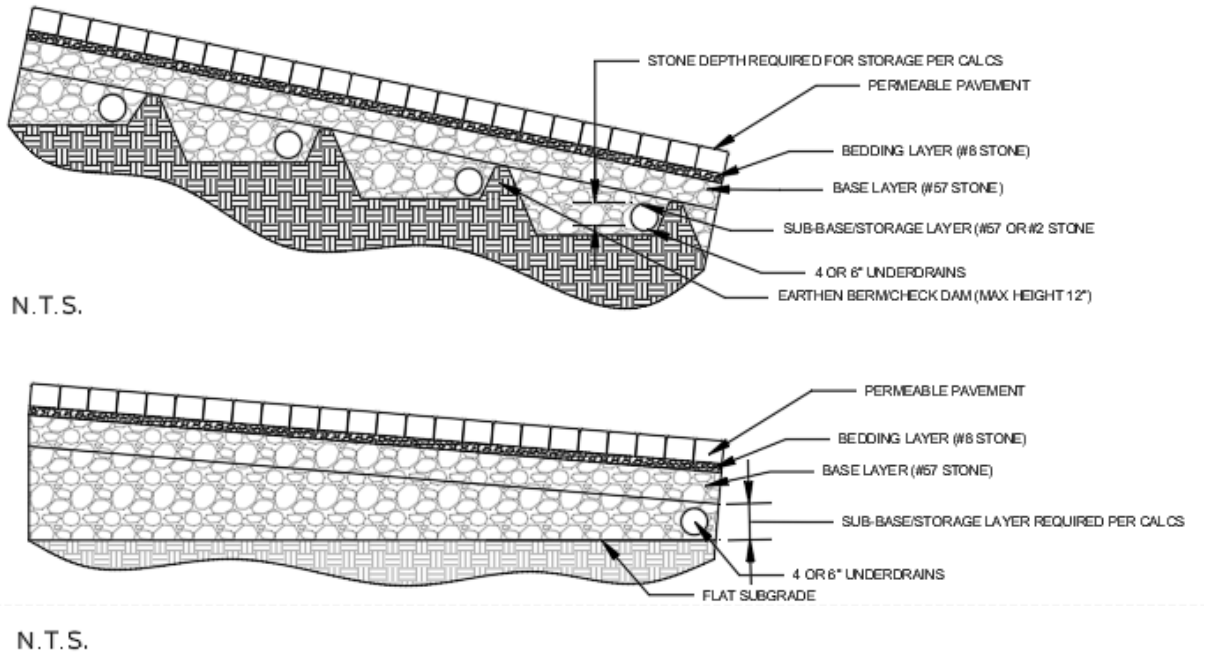


Figure 3.2. Typical Detail of Terraced and Flat Subgrade

Minimum Hydraulic Head. The elevation difference needed for permeable pavement to function properly is generally nominal, although 2 to 4 feet of head may be needed to drive flows through underdrains. Flat terrain may affect proper drainage permeable pavement designs, so underdrains shall have a minimum 0.5% slope.

Subsurface Constraints. A high groundwater table may cause runoff to pond at the bottom of the permeable pavement system. Therefore, a minimum vertical distance of 2 feet must be provided between the bottom of the subgrade of the permeable pavement and the seasonal high water table. The bottom subgrade of the permeable pavement system shall be above the bedrock/refusal depth provided with the geotechnical report.

Utilities. No utilities shall be located under the permeable pavement. All wet utilities shall be hydraulically disconnected to prevent a direct connection to the MS4.

Setbacks. Permeable pavement shall not be hydraulically connected to structure foundations, in order to avoid harmful seepage. It is not recommended to place permeable pavement immediately adjacent to structures. To avoid the risk of seepage, a licensed PE should be consulted to determine the appropriate setbacks necessary to prevent pavement infiltration from compromising structural foundations or pavement. At a minimum, small- and large-scale pavement applications shall be located a minimum horizontal distance of 100 feet from any water supply well, 50 feet from septic systems, and at least 5 feet down-gradient from dry or wet utility lines.

High Loading Situations. Permeable pavement is not intended to treat sites with high sediment, trash, or landscape debris loads, since such loads will cause the practice to clog and fail.

Limitations. Permeable pavement can be used as an alternative to most types of conventional pavement at residential, commercial and institutional developments; however, it is not currently approved for use in the Right of Way (ROW).

SECTION 6: DESIGN CRITERIA

6.1 SIZING OF PERMEABLE PAVEMENT

Structural Design. If permeable pavement will be used in a parking lot or other setting that involves vehicles, the pavement surface must be able to support the maximum anticipated traffic load. The structural design process will vary according to the type of pavement selected, and the manufacturer's specific recommendations shall be consulted. The thickness of the permeable pavement and reservoir layer must be sized to support structural loads and to temporarily store the design storm volume (e.g., the water quality, channel protection, and/or flood control volumes). On most new development and redevelopment sites, the structural support requirements will dictate the depth of the underlying stone reservoir.

The structural design of permeable pavements involves consideration of four main site elements:

- Total traffic;
- In-situ soil strength;
- Environmental elements; and
- Bedding and Reservoir layer design.

The resulting structural requirements may include, but are not limited to, the thickness of the pavement, filter, and reservoir layer. Designers should note that if the underlying soils have a low California Bearing Ratio (CBR) (less than 4%), they may need to be compacted to at least 95% of the Standard Proctor Density, which generally rules out their use for infiltration.

Designers should determine structural design requirements by consulting transportation design guidance sources, such as the following:

- TDOT Roadway Design Guidelines (latest edition);
- AASHTO Guide for Design of Pavement Structures (latest edition); and,
- AASHTO Supplement to the Guide for Design of Pavement Structures (latest edition).

Hydraulic Design. Permeable pavement is typically sized to store the complete water quality Treatment Volume (T_v) or another design storm volume in the reservoir layer. Modeling has shown that this simplified sizing rule approximates an 80% average rainfall volume removal for subsurface soil infiltration rates up to one inch per hour. More conservative values are given because both local and national experience has shown that clogging of the permeable material can be an issue, especially with larger contributing areas carrying significant soil materials onto the permeable surface.

The infiltration rate typically will be less than the flow rate through the pavement, so that some underground reservoir storage will usually be required. Designers should initially assume that there is no outflow through underdrains, using **Equation 3.1** to determine the depth of the reservoir layer, assuming runoff fully infiltrates into the underlying soil:

Equation 3.1. Depth of Reservoir Layer with no Underdrain

$$d_p = \frac{\{(d_c \times R) + P - (i/2 \times t_f)\}}{n}$$

Where:

d_p = The depth of the reservoir layer (ft.)

d_c = The depth of runoff from the contributing drainage area (not including the permeable paving surface)

		for the Treatment Volume (T_v/A_c), or other design storm (ft.)
R	=	A_c/A_p = The ratio of the contributing drainage area (A_c, not including the permeable paving surface) to the permeable pavement surface area (A_p) [NOTE: The maximum value for the Level 1 design is R = 2, (the external drainage area A_c is twice that of the permeable pavement area Ap; and for Level 2 design R = 0 (the drainage area is made up solely of permeable pavement A_p].
P	=	The rainfall depth for the Treatment Volume (Level 1 = 1 in.; Level 2 = 1.1 in.), or other design storm (ft.)
i	=	The field-verified infiltration rate for native soils (ft./day)
t_f	=	The time to fill the reservoir layer (day) – typically 2 hours or 0.083 day
n	=	The porosity for the reservoir layer (0.4)

The maximum allowable depth of the reservoir layer is constrained by the maximum allowable drain time, which is calculated using **Equation 3.2**.

Equation 3.2. Maximum Depth of Reservoir Layer

$$d_{p-max} = \frac{(i/2 \times t_d)}{n}$$

Where:

d_{p-max}	=	The maximum depth of the reservoir layer (ft.)
i	=	The field-verified infiltration rate for native soils (ft./day)
t_d	=	The maximum allowable time to drain the reservoir layer, typically 1 to 2 days
n	=	The porosity for the reservoir layer (0.4)

The following design assumptions apply to **Equations 3.1 and 3.2**:

- The contributing drainage area (A_c) should not contain pervious areas.
- For design purposes, the native soil infiltration rate (i) should be the field-tested soil infiltration rate divided by a factor of safety of 2. The minimum acceptable native soil infiltration rate is 0.5 inches/hr.
- The porosity (n) for No. 57 stone = 0.40
- Max. drain time for the reservoir layer should be not less than 24 or more than 48 hours.

If the depth of the reservoir layer is too great (i.e. d_p exceeds $d_{p\text{-}max}$), or the verified soil infiltration rate is less than 0.5 inches per hour, then the design method typically changes to account for underdrains. The storage volume in the pavements must account for the underlying infiltration rate and outflow through the underdrain. In this case, the design storm should be routed through the pavement to accurately determine the required reservoir depth. Alternatively, the designer may use **Equations 3.3 through 3.5** to approximate the depth of the reservoir layer for designs using underdrains.

Equation 3.3 can be used to approximate the outflow rate from the underdrain. The hydraulic conductivity, *k*, of gravel media is very high (~17,000 ft./day). However, the permeable pavement reservoir layer will drain increasingly slower as the storage volume decreases (i.e. the hydraulic head decreases). To account for this change, a conservative permeability coefficient of 100 ft./day can be used to approximate the average underdrain outflow rate.

Equation 3.3. Outflow through Underdrain

$$q_u = k \times m$$

Where:

q_u	=	Outflow through the underdrain (per outlet pipe, assumed 6-inch diameter)(ft./day)
k	=	Hydraulic conductivity for the reservoir layer (ft./day – assume 100 ft./day)
m	=	Underdrain pipe slope (ft./ft.)

Once the outflow rate through the underdrain has been approximated, **Equation 3.4** is used to determine the depth of the reservoir layer needed to store the design storm.

Equation 3.4. Depth of Reservoir Layer with Outflow through Underdrain

$$d_p = \frac{\{(d_c \times R) + P - (i/2 \times t_f) - (q_u \times t_f)\}}{n}$$

Where:

d_p	=	Depth of the reservoir layer (ft.)
d_c	=	Depth of runoff from the contributing drainage area (not including the permeable pavement surface) for the Treatment Volume (Tv/A_c), or other design storm (ft.)
R	=	A_c/A_p = The ratio of the contributing drainage area (A_i (not including the permeable pavement surface) to the permeable pavement surface area (A_p)
P	=	The rainfall depth for the Treatment Volume (Level 1 = 1 inch; Level 2 = 1.1 inch), or other design storm (ft.)
i	=	The field-verified infiltration rate for the native soils (ft./day)
t_f	=	The time to fill the reservoir layer (day) – typically 2 hours or 0.083 day
n	=	The porosity for the reservoir layer (0.4)
q_u	=	Outflow through Underdrain (ft/day)

The maximum allowable depth of the reservoir layer is constrained by the maximum allowable drain time, which is calculated using **Equation 3.5**.

Equation 3.5. Maximum Depth of Reservoir Layer with Outflow through Underdrain

$$d_{p-max} = \frac{\{(i/2 \times t_d) - (q_u \times t_d)\}}{n}$$

Where:

d_{p-max}	=	The maximum depth of the reservoir layer (ft.)
i	=	The field-verified infiltration rate for the native soils (ft./day)
n	=	The porosity for the reservoir layer (0.4)
t_d	=	The time to drain the reservoir layer (day – typically 1 to 2 days)
q_u	=	Outflow through Underdrain (ft/day)

If the depth of the reservoir layer is still too great (i.e. d_p exceeds $d_{p\text{-}max}$), the number of underdrains can be increased, which will increase the underdrain outflow rate.

Permeable pavement can also be designed to address, in whole or in part, the detention storage needed to comply with channel protection and/or flood control requirements. Permeable pavement shall have an underdrain if being used for detention storage. The designer can model various approaches by factoring in storage within the stone aggregate layer and any outlet structures used as part of the design. Routing calculations can also be used to provide a more accurate solution of the peak discharge and required storage volume.

Once runoff passes through the surface of the permeable pavement system, designers should calculate outflow pathways to handle subsurface flows. Subsurface flows can be regulated using underdrains, the volume of storage in the reservoir layer, and the bed slope of the reservoir layer.

6.2 SOIL INFILTRATION RATE TESTING

All permeable pavement systems shall have an underdrain. On-site soil infiltration rate testing procedures are outlined in **Appendix B**. The same frequency of soil borings must be taken to confirm the underlying soil properties at the depth where infiltration is designed to occur (i.e., to ensure that the depth to water table, depth to bedrock, or karst is defined).

Table 3.3. Required Infiltration Testing per Sq.Ft of pavement			
Impervious Area Treated	250 to 1,000 sq. ft.	1,000 to 10,000 sq. ft.	More than 10,000 sq. ft.
Required Soil Tests	Two per practice	Four per practice	Four + one per every additional 5000 ft^2

6.3 TYPE OF SURFACE PAVEMENT

Pervious concrete, permeable interlocking concrete pavers, concrete grid pavers, and plastic reinforced grid paver surfaces are permitted.

6.4 INTERNAL GEOMETRY AND DRAWDOWNS

- ***Elevated Underdrain.*** To promote greater runoff reduction for permeable pavement located on marginal soils, an elevated underdrain should be installed with a stone jacket that creates a 12 to 18 inch deep storage layer *below* the underdrain invert. The void storage in this layer can help qualify a site to achieve Level 2 design.
- ***Rapid Drawdown.*** When possible, permeable pavement should be designed so that the target runoff reduction volume stays in the reservoir layer for at least 36 hours before being discharged through an underdrain.
- ***Conservative Infiltration Rates.*** Designers should always decrease the measured infiltration rate by a factor of 2 during design, to approximate long term infiltration rates.

6.5 PRETREATMENT

Pretreatment for most permeable pavement applications is not necessary, since the surface acts as pretreatment to the reservoir layer below. For areas where there is a transition from conventional pavements to permeable pavement, a ribbon curb shall be installed between to two pavements to prevent settling and prevent fines from clogging the surface of the permeable pavement.

6.6 CONVEYANCE AND OVERFLOW

Permeable pavement designs should include methods to convey larger storms (e.g., 2-yr, 10-yr) to the storm drain system. The following is a list of methods that can be used to accomplish this:

- Place a perforated pipe horizontally near the top of the reservoir layer to pass excess flows after water has filled the base. The placement and/or design should be such that the incoming runoff is not captured (e.g., placing the perforations on the underside only).
- Increase the thickness of the top of the reservoir layer by as much as 6 inches (i.e., create freeboard). The design computations used to size the reservoir layer often assume that no freeboard is present.
- Create underground detention within the reservoir layer of the permeable pavement system. Reservoir storage may be augmented by plastic or concrete pipes, arch structures, etc. Corrugated metal is not permitted.
- Route excess flows to another detention or conveyance system that is designed for the management of extreme event flows.
- Set the storm drain inlets flush with the elevation of the permeable pavement surface to effectively convey excess stormwater runoff past the system (typically in remote areas). The design should also make allowances for relief of unacceptable ponding depths during larger rainfall events.

6.7 RESERVOIR LAYER

The thickness of the reservoir layer is determined by runoff storage needs, the infiltration rate of in situ soils, structural requirements of the pavement sub-base, depth to water table and bedrock, and frost depth conditions. A professional should be consulted regarding the suitability of the soil subgrade.

- The reservoir below the permeable pavement surface should be composed of clean, washed stone aggregate and sized for both the storm event to be treated and the structural requirements of the expected traffic loading.
- The storage layer may consist of clean washed No. 57 stone, although No. 2 stone is preferred because it provides additional storage and structural stability.

6.8 UNDERDRAINS

The use of underdrains is required for each permeable pavement system due to compaction needed for the Proctor Density Test. Each underdrain shall be installed at a minimum 0.5% slope located 20 feet or less from the next pipe (or equivalent corrugated HDPE may be used for smaller load-bearing applications). Perforated pipe installed for the full length of the permeable pavement cell, and non-perforated pipe, as needed, is used to connect with the storm drain system. T's and Y's shall be installed as needed, depending on the underdrain configuration. Extend cleanout pipes to the surface with vented caps or traffic rated lids at the Ts and Ys. Underdrains can also be used to manage extreme storm events to keep detained stormwater from backing up into the permeable pavement.

- An underdrain(s) shall have at least a 3 inch stone jacket around the underdrain.
- An underdrain(s) can also be installed and capped at a downstream structure as an option for future use if maintenance observations indicate a reduction in the soil permeability.

6.9 MAINTENANCE REDUCTION FEATURES

Maintenance is a crucial element to ensure the long-term performance of permeable pavement. The most frequently cited maintenance problem is surface clogging caused by organic matter and sediment, which can be reduced by the following measures:

- *Protecting the Bottom of the Reservoir Layer.* There are two options to protect the bottom of the reservoir layer from intrusion by underlying soils. The first method involves covering the bottom with nonwoven, polypropylene geotextile that is permeable, although some practitioners recommend avoiding the use of filter fabric since it may become a future plane of clogging within the system. Permeable filter fabric is still recommended to protect the excavated sides of the reservoir layer, in order to prevent soil piping. The second method is to form a barrier of choker stone and sand. In this case, underlying native soils should be

separated from the reservoir base/subgrade layer by a thin 2 to 4 inch layer of clean, washed, choker stone (ASTM D 448 No. 8 stone) covered by a layer of 6 to 8 inches of course sand.

- ***Observation Well.*** An observation well, consisting of a well-anchored, perforated 4 to 6 inch (diameter) PVC pipe that extends vertically to the bottom of the reservoir layer, should be installed at the downstream end of all large-scale permeable pavement systems. The observation well should be fitted with a lockable cap or traffic rated lid installed flush with the ground surface (or under the pavers) to facilitate periodic inspection and maintenance. The observation well is used to observe the rate of drawdown within the reservoir layer following a storm event.
- ***Overhead Landscaping.*** Check the area of parking lots required to be in landscaping. Large-scale permeable pavement applications should be carefully planned to integrate this landscaping in a manner that maximizes runoff treatment and minimizes the risk that sediment, mulch, grass clippings, leaves, nuts, and fruits will inadvertently clog the paving surface.

SECTION 7: Material Specifications

Permeable pavement material specifications vary according to the specific pavement product selected. **Table 3.4** describes general material specifications for the component structures installed beneath the permeable pavement. **Table 3.4** provides specifications for general categories of permeable pavements. Designers should consult manufacturer's technical specifications for specific criteria and guidance.

Table 3.4. Material Specifications for Underneath the Pavement Surface

Material	Specification	Notes
Permeable Pavement System	Permeable Interlocking Concrete Pavers[1] Pervious Concrete[2] Reinforced Turf Systems[3] Reinforced Gravel Systems[4]	ASTM C936[1] ASTM C1688/C16188M & ACI 522[2] ASTM D638[3] ASTM D638[4]
Bedding Layer	#8 or #89 clean, washed stone	Meet TDOT Construction Specifications
Reservoir Layer	#57 or #2 clean, washed stone	Meet TDOT Construction Specifications. Depth is based on the pavement structural and hydraulic requirements.
Underdrain	4 to 6 inch diameter perforated HDPE or PVC pipe with 3/8-inch perforations at 6 inches on center;	(AASHTO M 252) Place perforated pipe at base of the reservoir layer at the lower end of the paver cell
Cleanout	6 inch SDR 35 PVC pipe with vented cap	Use traffic rated castings where required. Provide cleanouts at the upper end of the underdrain.
Filter Fabric/Sand Choker Layer	Filter Fabric (125 gpm/sq.ft.)[1] 2 to 4 inch layer of coarse sand[2]	AASHTO M288-06, ASTMD4491 & D4751[1] Meet TDOT Construction Specifications[2]
Impermeable Liner (if needed)	Use a thirty mil (minimum) PVC Geomembrane liner covered by 8 to 12 oz./sq. yd.[2] non-woven geotextile.	

[1] Specifications for Permeable Interlocking Concrete Pavers

[2]Specifcations for Pervious Concrete

[3]Specifications for Reinforced Turf Systems

[4]Specifications for Reinforced Gravel Systems

SECTION 8: SPECIAL CASE DESIGN ADAPTATIONS

The design adaptation described below permits permeable pavement to be used on a wider range of sites.

However, it is important not to force this practice onto marginal sites. Other runoff reduction practices are often preferred alternatives for difficult sites.

8.1 SHALLOW BEDROCK

Many parts of Franklin have shallow bedrock, which can constrain the application of deeper permeable paver systems. If bedrock is encountered during construction of the permeable pavement system, the bottom subgrade of the permeable paver system shall be above the bedrock/refusal depth provided with the geotechnical report.

8.2 KARST

Karst regions are found in much of Middle Tennessee. Infiltrative practices, such as permeable pavement, shall not be used in any areas with high risk of sinkhole formations or in areas of know sinkholes.

8.3 SITE SPECIFIC LIMITATIONS

Some sites may have areas identified as site specific limitations to infiltration of stormwater runoff. Site specific limitations shall be determined by the City engineer and approved through the Stormwater variance process. Sites with brownfield permits are an example of site specific limitations. Site specific limitations cannot be self-imposed or be caused by requirements within the City Ordinance. It should be noted that the site specific limitation may only occupy a portion of the entire proposed use, and that some "clean" areas (such as rooftops) can be diverted away to another infiltration or runoff reduction practice. Development proposals should be carefully reviewed to determine if any future operation, on all or part of the site, will be designated as a potential site specific limitation. Based on this designation, infiltration may be restricted or prohibited.

SECTION 9: CONSTRUCTION

Experience has shown that proper installation is absolutely critical to the effective operation of a permeable pavement system.

9.1 NECESSARY EROSION & SEDIMENT CONTROLS

- All permeable pavement areas should be fully protected from sediment intrusion by silt fence or construction fencing, particularly if they are intended to infiltrate runoff.
- Permeable pavement areas should remain outside the limit of disturbance during construction to prevent soil compaction by heavy equipment. Permeable pavement areas should be clearly marked on all construction documents and grading plans. To prevent soil compaction, heavy vehicular and foot traffic should be kept out of permeable pavement areas during and immediately after construction.
- During construction, care should be taken to avoid tracking sediments onto any permeable pavement surface to avoid clogging.
- Any area of the site intended ultimately to be a permeable pavement area should generally not be used as the site of a temporary sediment basin.
- Where locating a sediment basin on an area intended for permeable pavement is unavoidable, the invert of the sediment basin must be a minimum of 2 feet above the final design elevation of the bottom of the aggregate reservoir course.
- All sediment deposits in the excavated area should be carefully removed prior to installing the subbase, base and surface materials

9.2 PERMEABLE PAVEMENT CONSTRUCTION SEQUENCE

The following is a typical construction sequence to properly install permeable pavement:

Step 1. Construction of the permeable pavement shall only begin after the entire contributing drainage area has been stabilized. The proposed site should be checked for existing utilities prior to any excavation. Do not install the system in rain or snow, and do not install frozen bedding materials.

Step 2. As noted above, temporary EPSC measures are needed during installation to divert stormwater away from the permeable pavement area until it is completed. Special protection measures such as erosion control fabrics may be needed to protect vulnerable side slopes from erosion during the excavation process. The proposed permeable pavement area must be kept free from sediment during the entire construction process. Construction materials that are contaminated by sediments must be removed and replaced with clean materials.

Step 3. Where possible, excavators or backhoes should work from the sides to excavate the reservoir layer to its appropriate design depth and dimensions. For micro-scale and small-scale pavement applications, excavating equipment should have arms with adequate extension so they do not have to work inside the footprint of the permeable pavement area (to avoid compaction). Contractors can utilize a cell construction approach, whereby the proposed permeable pavement area is split into 500 to 1000 sq. ft. temporary cells with a 10 to 15 foot earth bridge in between, so that cells can be excavated from the side. Excavated material should be placed away from the open excavation so as to not jeopardize the stability of the side walls.

Step 4. The native soils along the bottom and sides of the permeable pavement system should be scarified or tilled to a depth of 3 to 4 inches prior to the placement of the filter layer or filter fabric. In large scale paving applications with weak soils, the soil subgrade may need to be compacted to 95% of the Standard Proctor Density to achieve the desired load-bearing capacity. (NOTE: This effectively eliminates the infiltration function of the installation, and it must be addressed during hydrologic design.)

Step 5. If filter fabric is to be installed on the bottom and the sides of the reservoir layer, the strips should overlap down-slope by a minimum of 2 feet, and be secured a minimum of 4 feet beyond the edge of the excavation. Where the filter layer extends beyond the edge of the pavement (to convey runoff to the reservoir layer), install an additional layer of filter fabric 1 foot below the surface to prevent sediments from entering into the reservoir layer. Excess filter fabric should not be trimmed until the site is fully stabilized.

Step 6. Provide a minimum of 2 inches of aggregate above and below the underdrains. The underdrains should slope down towards the outlet at a grade of 0.5% or steeper. The up-gradient end of underdrains in the reservoir layer should be capped. Where an underdrain pipe is connected to a structure, there shall be no perforations within 1 foot of the structure. Ensure that there are no perforations in clean-outs and observation wells within 1 foot of the surface.

Step 7. Moisten and spread 6-inch lifts of the appropriate clean, washed stone aggregate (usually No. 2 or No. 57 stone). Place at least 4 inches of additional aggregate above the underdrain, and then compact it using a vibratory roller in static mode until there is no visible movement of the aggregate. Do not crush the aggregate with the roller.

Step 8. Install the bedding layer. The thickness of the bedding layer is to be based on the block manufacturer's recommendation or that of a qualified professional.

Step 9. Paving materials shall be installed in accordance with manufacturer or industry specifications for the particular type of pavement.

9.3 CONSTRUCTION INSPECTION

Inspections before, during and after construction are needed to ensure that permeable pavement is built in accordance with these specifications. Use detailed inspection checklists that require sign-offs by qualified individuals at critical stages of construction, to ensure that the contractor's interpretation of the plan is consistent with the designer's intent.

Some common pitfalls can be avoided by careful construction supervision that focuses on the following key aspects of permeable pavement installation:

- Store materials in a protected area to keep them free from mud, dirt, and other foreign materials.
- The contributing drainage area should be stabilized prior to directing water to the permeable pavement area.
- Check the aggregate material to confirm that it is clean and washed, meets specifications and is installed to the correct depth.
- Check elevations (e.g., the invert of the underdrain, inverts for the inflow and outflow points, etc.) and the surface slope.
- Make sure the permeable pavement surface is even, runoff evenly spreads across it, and the storage bed drains within 48 hours.
- Inspect the structural integrity of the pavement surface, looking for signs of slumping, cracking, spalling or broken pavers. Replace or repair affected areas.
- Ensure that caps are placed on the upstream (but not the downstream) ends of the underdrains.
- Inspect the pretreatment structures (if applicable) to make sure they are properly installed and working effectively.
- The drawdown rate should be measured at the observation well for three (3) days following a storm event in excess of 0.5 inch in depth. If standing water is still observed in the well after three days, this is a clear sign that clogging is a problem.
- Once the final construction inspection has been completed, log the GPS coordinates for each facility and submit them to the City.

SECTION 10: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix as required components of the as-built differ from measure to measure.

SECTION 11: MAINTENANCE

11.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

11.2 MAINTENANCE TASKS

It is difficult to prescribe the specific types or frequency of maintenance tasks that are needed to maintain the hydrologic function of permeable pavement systems over time. Most installations work reasonably well year after year with little or no maintenance, whereas some have problems right from the start.

One preventative maintenance task involves vacuum sweeping on a frequency consistent with the use and loadings encountered in the parking lot. Vacuum sweeping should be performed once or twice a year. This frequency should be adjusted according to the intensity of use and deposition rate on the permeable pavement surface. More frequent blowing, with a handheld or backpack blower, may also help prevent organic material from impacting the pavement. The contract for sweeping should specify that after vacuum sweeping is completed any joint material shall be replaced in interlocking paver systems.

11.3 MAINTENANCE INSPECTIONS

It is highly recommended that a spring maintenance inspection and cleanup be conducted at each permeable pavement site, particularly at large-scale applications.

Maintenance of permeable pavement is driven by annual inspections that evaluate the condition and performance of the practice. The following are suggested (at minimum) annual maintenance inspection points for permeable pavements:

- The drawdown rate should be measured at the observation well for three (3) days following a storm event in excess of 0.5 inch in depth. If standing water is still observed in the well after three days, this is a clear sign that clogging is a problem.
- Inspect the surface of the permeable pavement for evidence of sediment deposition, organic debris, staining or ponding that may indicate surface clogging. If any signs of clogging are noted, schedule a vacuum sweeper (no brooms or water spray) to remove deposited material. Then, test sections by pouring water from a five gallon bucket to ensure they work.
- Inspect the structural integrity of the pavement surface, looking for signs of surface deterioration, such as slumping, cracking, spalling or broken pavers. Replace or repair affected areas, as necessary.
- Check inlets, pretreatment cells and any flow diversion structures for sediment buildup and structural damage. Note if any sediment needs to be removed.
- Inspect the condition of the observation well and make sure it is still capped.
- Inspect any contributing drainage area for any controllable sources of sediment or erosion.

SECTION 12: COMMUNITY & ENVIRONMENTAL CONCERNS

Compliance with the Americans with Disabilities Act (ADA). Porous concrete and porous asphalt are generally considered to be ADA compliant. Interlocking concrete pavers are ADA compliant, if designers ensure that surface openings between pavers do not exceed 0.5 inch. However, some forms of interlocking pavers may not be suitable for handicapped parking spaces. Interlocking concrete pavers interspersed with other hardscape features (e.g., concrete walkways) *can* be used in creative designs to address ADA issues.

Underground Injection Control Permits. The Safe Drinking Water Act regulates the infiltration of stormwater in certain situations pursuant to the Underground Injection Control (UIC) Program, which is administered either by the EPA or a delegated state groundwater protection agency. In general, the EPA (2008) has determined that permeable pavement installations are not classified as Class V injection wells, since they are always wider than they are deep.

Air and Runoff Temperature. Permeable pavement appears to have some value in reducing summer runoff temperatures, which can be important in watersheds with sensitive cold-water fish populations. The temperature reduction effect is greatest when runoff is infiltrated into the sub-base, but some cooling may also occur in the reservoir layer, when underdrains are used. ICPI (2008) notes that the use of certain reflective colors for interlocking concrete pavers can also help moderate surface parking lot temperatures.

Vehicle Safety. Permeable pavement is generally considered to be a safer surface than conventional pavement. Permeable pavement has less risk of hydroplaning, more rapid ice melt and better traction than conventional pavement.

Infiltration Trenches

Description: Excavated trench filled with stone aggregate used to capture and allow infiltration of stormwater runoff into the surrounding soils from the bottom and sides of the trench. Runoff from each rain event is captured and treated primarily through settling and filtration.

Components:
- Soil infiltration rate of greater than 0.5 in/hr required
- Excavated trench (3 to 8 foot depth) filled with stone media (1.5- to 2.5-inch diameter); pea gravel and sand filter layers
- A sediment forebay and grass channel, or equivalent upstream pretreatment, must be provided
- Observation well to monitor percolation

Advantages/Benefits:
- Provides for groundwater recharge
- Good for small sites with porous soils
- Cost effective
- High community acceptance when integrated into a development

Disadvantages/Limitations:
- Potential for groundwater contamination
- High clogging potential; should not be used on sites with fine-particle soils (clays or silts) in drainage area
- Cannot be used in karst soils
- Geotechnical testing required
- Community perceived concerns with mosquitoes and safety

Design considerations:
- 5 acres maximum drainage area
- Space Required – Varies depending on the depth of the facility
- Minimum Depth to Water Table – 2 feet between the bottom of the infiltration trench and the elevation of the seasonally high water table

Selection Criteria:

Level 1 – 50%

Level 2 – 90%

Land Use Considerations:

X	**Residential**
X	**Commercial**
X	**Industrial (with City approval)**

Maintenance:
- Inspect for clogging
- Remove sediment from forebay
- Replace pea gravel layer as needed
- Maintain side slopes/remove invasive vegetation

H	**Maintenance Burden** L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

Infiltration trenches are excavations typically filled with stone to create an underground reservoir for stormwater runoff (see **Figure 4.1**). The runoff volume gradually exfiltrates through the bottom and sides of the trench into the subsoil over a 2-day period and eventually reaches the water table. By diverting runoff into the soil, an infiltration trench not only treats the water quality volume, but also helps to preserve the natural water balance on a site and can recharge groundwater and preserve base flow. Due to this fact, infiltration systems are limited to areas with highly porous soils where the water table and/or bedrock are located well below the bottom of the trench.

In addition, infiltration trenches must be carefully sited to avoid the potential of groundwater contamination. Infiltration trenches are not intended to trap sediment and must always be designed with a sediment forebay and grass channel, filter strip or other appropriate pretreatment measures to prevent clogging and failure. Due to their high potential for failure, these facilities must only be considered for sites where upstream sediment control can be ensured.

Using the natural filtering properties of soil, infiltration trenches can remove a wide variety of pollutants from stormwater through sorption, precipitation, filtering, and bacterial and chemical degradation. Sediment load and other suspended solids should be removed from runoff by pretreatment measures on-site before they reach the trench surface.

SECTION 2: PERFORMANCE

When used appropriately, infiltration has a very high runoff volume reduction capability, as shown in **Table 4.1.**

Table 4.1. Summary of Runoff Reduction Provided by Infiltration[1]

Stormwater Function	Level 1 Design	Level 2 Design
Runoff Volume Reduction (RR)	50%	90%

SECTION 3: DESIGN TABLE

The major design goal for infiltration is to maximize runoff volume reduction. To this end, designers may choose to go with the baseline design (Level 1) or choose an enhanced design (Level 2) that maximizes runoff reduction. To qualify for Level 2, the infiltration practice must meet all the design criteria shown in the right hand column of **Table 4.2**.

Table 4.2. Level 1 and Level 2 Infiltration Design Guidelines	
Level 1 Design (RR:50)	**Level 2 Design (RR:90)**
Sizing: Tv = (1*Rv*A)/12	Sizing: Tv = (1.1*Rv*A)/12
At least two forms of pre-treatment (see **Table 4.4**)	At least three forms of pre-treatment (see **Table 4.4**)
Soil infiltration rate > 0.5 in/hr & <1 in/hr 1 test hole/50 linear ft, minimum of 2 (see Appendix **B**)	Soil infiltration rates of 1.0 to 4.0 in/hr 1 test hole/50 linear ft, minimum of 2 (see Appendix **B**)
Minimum of 2 feet between the bottom of the infiltration practice and the seasonal high water table or bedrock (**Section 4.1**)	
T_v infiltrates within 48 hours (**Section 4.3**)	
Setbacks – see suggested minimum setbacks **(Section 4.1)**	
All Designs are subject to hotspot runoff restrictions/prohibitions	

SECTION 4: TYPICAL DETAILS

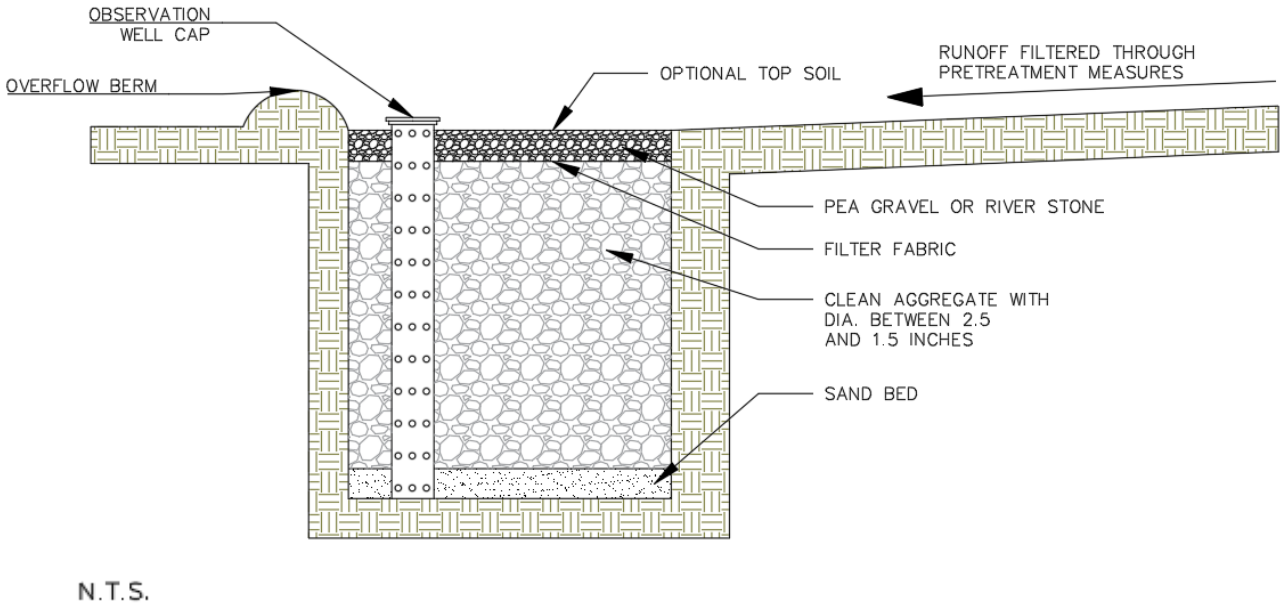


Figure 4.1. Typical Infiltration Trench Section

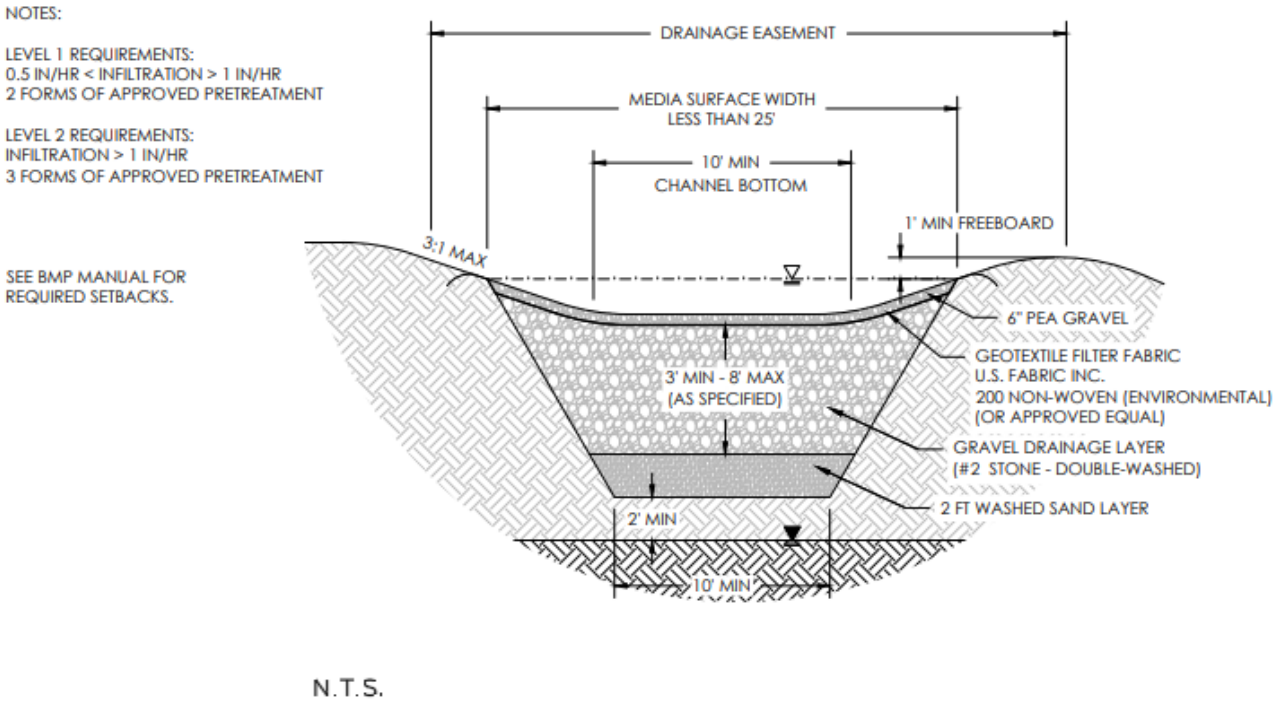


Figure 4.2. Typical Infiltration Trench Detail

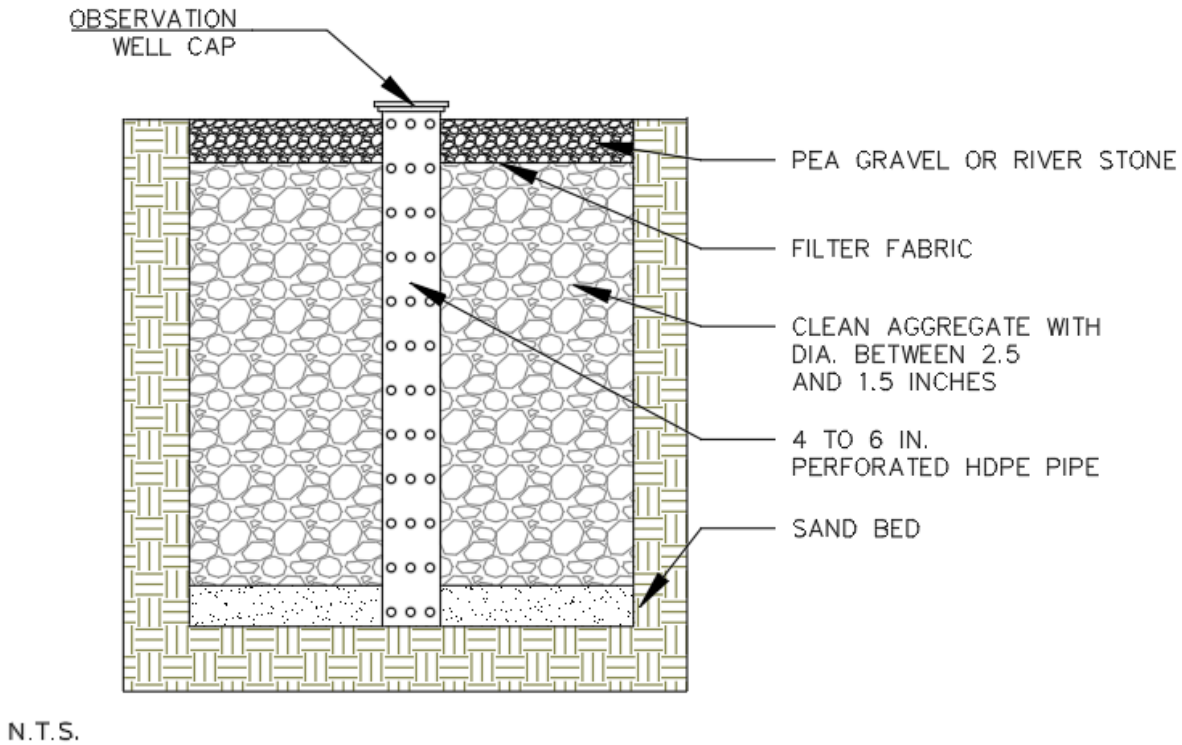


Figure 4.3. Observation Well Typical Section

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATION

Infiltration trenches are generally suited for medium-to-high density residential, commercial and institutional developments where the subsoil is sufficiently permeable to provide a reasonable infiltration rate and the water table is low enough to prevent groundwater contamination. They are applicable primarily for impervious areas where there are not high levels of fine particulates (clay/silt soils) in the runoff and should only be considered for sites where the sediment load is relatively low

Accessibility. Infiltration trenches require periodic maintenance and shall be accessible to various types of equipment. A path of travel for equipment no less than 12 feet in width shall be provided for the infiltration trench. Each infiltration trench shall have one point of vehicle access.

Applications. Infiltration trenches can either be used to capture sheet flow from a drainage area or function as an off-line device. Due to the relatively narrow shape, infiltration trenches can be adapted to many different types of sites and can be utilized in retrofit situations. Unlike some other structural stormwater controls, they can easily fit into the margin, perimeter, or other unused areas of developed sites. To reduce the potential for costly maintenance and/or system reconstruction, it is strongly recommended that the trench be located in an open or lawn area, with the top of the structure as close to the ground surface as possible. Infiltration trenches shall not be located beneath paved surfaces, such as parking lots

Contributing Drainage Area (CDA). Infiltration trenches work best with smaller contributing drainage areas, where it is easier to achieve flow distribution over the filter bed without experiencing erosive velocities and excessive ponding times. Infiltration trenches shall have a total contributing drainage area of 5 acres or less.

Curb Cuts. If curb cuts are to be used in the design of the infiltration trench, the designer shall provide calculation showing the curb cut can safely pass the 10 year storm event.

Floodplains. Infiltration trench should be constructed outside the limits of the 100-year floodplain. While not prohibited from use in floodplain areas, designers should be aware of the resulting increased maintenance burden for the property owner.

Irrigation. The planned infiltration trench should not receive baseflow, irrigation water, chlorinated wash-water or other such flows that are not stormwater runoff, except for irrigation as necessary for the survival of plantings within the infiltration trench. If irrigation is to be placed within the infiltration trench footprint, an irrigation plan shall be submitted to the City for review and approval. A soil moisture sensor shall be included in all irrigation plans submitted.

Setbacks. Suggested minimum setback requirements for infiltration trench facilities:

- From a property line – 10 feet
- From a building foundation – 25 feet
- From a private well – 100 feet
- From a public water supply well – 1,200 feet
- From a septic system tank/leach field – 100 feet
- From surface waters – 100 feet
- From surface drinking water sources – 400 feet (100 feet for a tributary)
- From adjacent hardscapes – 5 feet (minimum) or the depth of the infiltration trench

Subsurface Constraints. There shall be at least 2 feet between the bottom of the infiltration trench and the elevation of the seasonally high water table.

Utilities. Designers should ensure that future tree canopy growth in the infiltration trench will not interfere with existing overhead utility lines. Interference with underground utilities and any associated utility easements shall also be avoided, particularly water and sewer lines. No below-grade utilities are allowed within the footprint of infiltration trench, including pretreatment. No overhead utilities are allowed over the infiltration trenches incorporating tree plantings.

SECTION 6: DESIGN CRITERIA

6.1 SIZING OF INFILTRATION TRENCHES

The major design goal for infiltration is to maximize runoff volume reduction. To this end, designers may choose to go with the baseline design (Level 1) or choose an enhanced design (Level 2) that maximizes runoff reduction. To qualify for Level 2, the infiltration practice must meet all the design criteria shown in the right hand column of **Table 4.2**.

6.1.1 Stormwater Quality

Sizing of the surface area (SA) for the infiltration trench id based on the computed treatment volume (Tv) for the contributing drainage area and the storage provided in the facility. The required surface area (in square feet) is computed as the Treatment Volume (in cubic feet) divided by the equivalent storage depth (in feet). The equivalent storage depth is computed as the depth of gravel, media, and surface ponding (in feet) multiplied by the accepted porosity. See **Table 4.3** below for accepted porosities.

Table 4.3. Infiltration Trench Accepted Porosities

	Minimum Depth Required (inches)	Porosity Value (n)
Reservoir	36-96 inches	0.40

Use the following equation to calculate the required reservoir depth:

Equation 5.1. Required Depth of Reservoir Layer

$$D_{r-req} = \frac{T_{v-req}}{SA * n}$$

Where:

D_{r-req} = The required depth of the reservoir layer (ft); 36 inch minimum
T_{v-req} = The required treatment volume (cu. Ft.)
SA = The surface area of the infiltration trench (sq. ft.); 25- foot maximum width
n = The porosity of the reservoir layer

The maximum allowable depth of the reservoir layer is constrained by the allowable drain time, which is calculate using **Equation 4.2.**

Equation 4.2. Maximum Depth of Reservoir Layer

$$D_{r-max} = \frac{(\frac{i}{2} * t_d)}{n}$$

Where:

D_{r-max} = The maximum depth of the reservoir layer (ft.)
i = The field-verified infiltration rate for native soils (ft./day); slowest infiltration rate shall be used
t_d = The maximum allowable time to drain the reservoir layer; typically, 24 to 48 hours
n = The porosity of the reservoir layer

The required depth of the reservoir layer (D_{r-req}) must not exceed the maximum depth of the reservoir layer (D_{r-max}).

6.1.2 Stormwater Quantity

It is recommended that rain events larger than the 1 inch storm bypass infiltration trench to prevent additional maintenance burden. If designed with sufficient volume and appropriate outlet structures, designers can utilize the infiltration trench as both water quality and peak flow attenuation.

Surface Storage. The ponding depth for any infiltration trench within the any storm event shall be a maximum of 12 inches.

Subsurface Storage. Additional volume can be provided for peak flow attenuation by increasing the depth of the media or stone. Additional subsurface storage will not be allowed without sufficient infiltration rates. The maximum excavation depth is 10 feet.

Adjusted CN. The removal of volume by infiltration trench changes the runoff depth entering downstream flood control facilities. An approximate approach to accounting for this in reducing the size of peak flow detention facilities is to calculate an "effective SCS curve number" (CN_{adj}), which is less than the actual curve number (CN). CN_{adj} can then be used in hydrologic calculations and in routing. The method can also be used for other hydrologic methods in which a reduction in runoff volume is possible.

Hydraulic Modeling Requirements. Due to the variability of infiltration rates over time, specific rates of infiltration shall not to be utilized in hydraulic modeling for detention facilities. Where underdrains are utilized, they shall be included in hydraulic modeling, with only the "sump" portion below the underdrain being completely removed from the downstream runoff volume. Note that for design calculations and sizing of detention facilities to be accurate, infiltration must be confirmed by on-site infiltration testing. The infiltration trench shall be modeled using an equivalent volume based on the equivalent depth calculation. The underdrain shall be modeled as an equivalent orifice.

6.2 SOIL INFILTRATION RATE TESTING

To be suitable for infiltration, underlying soils shall have an infiltration rate of greater than 0.5 inches per hour, as initially determined from NRCS soil textural classification and subsequently confirmed by field geotechnical tests. The minimum geotechnical testing is one test hole per 50 linear feet, with a minimum of two borings per facility (taken within the proposed limits of the facility). Infiltration trenches cannot be used in fill soils. Clay lenses, bedrock or other restrictive layers below the bottom of the trench will reduce infiltration rates unless excavated.

On-site soil infiltration rate testing procedures are outlined in **Appendix B**. The number of soil tests varies base on the size of the infiltration trench:

- < 1,000 ft^2 = 2 tests
- 1,000 – 10,000 ft^2 = 4 tests
- >10,000 ft^2 = 4 tests + 1 test for every additional 5,000 ft^2

The bottom sump elevation of the infiltration trench must be at least two feet above bedrock and the seasonally high groundwater table. If, during construction, infiltration rates are suspected to have decreased due to machinery, material storage, or other causes of compaction of the underlying soils, additional infiltration testing may be required to verify pre-construction infiltration rates have not been reduced.

6.3 BMP GEOMETRY

Infiltration trenches are designed for intermittent flow and must be allowed to drain and allow aeration of the surrounding soil between rainfall events. They must not be used on sites with a continuous flow from groundwater, sump pumps, or other sources. Infiltration trenches shall fully dewater within 48 hours of the preceding rain event. The infiltration trench shall be designed to fully dewater the entire Tv within 24 to 48 hours after a rainfall event. The slowest infiltration rate obtained from tests performed at the site shall be used in the design calculations. Trench depths should be between 3 and 8 feet, to provide for easier maintenance. The width of a trench shall be less than 25 feet. The bottom slope of a trench shall be flat across its length and width to evenly distribute flows, encourage uniform infiltration through the bottom, and reduce the risk of clogging.

Broader, shallow trenches reduce the risk of clogging by spreading the flow over a larger area for infiltration. The surface area required is calculated based on the trench depth, soil infiltration rate, aggregate void space, and fill time (assume a fill time of 2 hours for most designs).

6.4 PRETREATMENT

Pretreatment facilities shall always be used in conjunction with an infiltration trench to prevent clogging and failure. Details and design criteria for pretreatment measures for infiltration trenches can be found in **Appendix A**.

Every infiltration practice must include multiple pretreatment techniques, although the nature of pretreatment practices depends on the scale at which infiltration is applied. The number, volume and type of acceptable pretreatment techniques needed for the two scales of infiltration are provided in **Table 4.4**.

Table 4.4. Required Pretreatment Elements for Infiltration Practices

Pretreatment[1]	**Level of Infiltration Trench**	
	Level 1 Infiltration	**Level 2 Infiltration**
Number and Volume of Pretreatment Techniques Employed	**2** techniques; **15%** minimum pretreatment volume required (exclusive).	**3** techniques; **25%** minimum pretreatment volume required (exclusive); at least **one** separate pre-treatment cell.
Acceptable Pretreatment Techniques	Grass filter strip Grass channel Gravel diaphragm	Sediment trap cell Sand filter cell Grass filter strip Gravel diaphragm

[1] A minimum of 50% of the runoff reduction volume must be pre-treated by a filtering or bioretention practice *prior* to infiltration *if* the site is a restricted stormwater hotspot

For a trench receiving sheet flow from an adjacent drainage area, the pretreatment system shall consist of a vegetated filter strip with a minimum 25-foot length. A vegetated buffer strip around the entire trench is required if the facility is receiving runoff from both directions. If the infiltration rate for the underlying soils is greater than 2 inches per hour, 50% of the Tv should be pretreated by another method prior to reaching the infiltration trench.

For an off-line configuration, or concentrated flow, pretreatment shall consist of a sediment forebay, vault, plunge pool, or similar sedimentation chamber (with energy dissipaters) sized to 25% of the storage volume (Tv). Exit velocities from the pretreatment chamber shall be nonerosive for the 2-year design storm.

6.5 CONVEYANCE AND OVERFLOW

Outlet structures are not required for infiltration trenches. If an outlet structure is utilized, the structure shall be placed outside the footprint of the infiltration trench. Typically for off-line designs, there is no need for an emergency spillway. However, a nonerosive overflow channel shall be provided to safely pass flows that exceed the storage capacity of the trench to a stabilized downstream area or watercourse.

On-line Infiltration Trench. An overflow structure shall always be incorporated into on-line designs to safely convey larger storms through the infiltration trench. The following criteria apply to overflow structures:

- The overflow associated with the 100-year design storms should be controlled so that velocities are non-erosive at the outlet point (i.e., to prevent downstream erosion).
- A common overflow system within infiltration practices consists of an outlet structure, which is scaled for the application, where the top of the structure is placed at the maximum water surface elevation of the infiltration trench (typically 6 inches above the surface of the filter bed).
- A trench shall be designed to fully dewater the entire Tv within 24 to 48 hours after a rainfall event. If used for both quality and quantity design, the infiltration trench shall fully dewater in 48 hours in the 100-year storm event. The slowest infiltration rate obtained from tests performed at the site should be used in the design calculations.

Off-line Infiltration Trench. Off-line designs are preferred. One common approach is to create an alternate flow path at the inflow point into the structure such that when the maximum ponding depth is reached, the incoming flow is diverted past the facility. In this case, the higher flows do not pass over the filter bed and through the facility, and additional flow is able to enter as the ponding water filtrates through the soil media.

Another option is to utilize a low-flow diversion or flow splitter at the inlet to allow only the Treatment Volume to enter the facility. This may be achieved with a weir or curb opening sized for the target flow, in combination with a bypass channel. Using a weir or curb opening helps minimize clogging and reduces the frequency of required maintenance. Using differing pipe elevations is not an approved method to achieve flow splitting.

6.6 OBSERVATION WELL

An observation well must be installed in every infiltration trench and should consist of a perforated PVC or HDPE pipe, 4 to 6 inches in diameter, extending to the bottom of the trench (see **Figure 4.2** for a schematic of an observation well). The observation well will show the rate of dewatering after a storm, as well as provide a means of determining sediment levels at the bottom and when the filter fabric at the top is clogged and maintenance is needed. It should be installed along the centerline of the structure, flush with the ground elevation of the trench. A visible floating marker should be provided to indicate the water level. The top of the well should be capped and locked to discourage vandalism and tampering.

6.7 MATERIAL SPECIFICATION

The stone aggregate used in the trench should be washed, bank-run gravel, 1.5 to 2.5 inches in diameter with a porosity of about 40%. Aggregate contaminated with soil shall not be used. A 6-inch layer of clean, washed sand is placed on the bottom of the trench to encourage drainage and prevent compaction of the native soil while the stone aggregate is added.

A top layer of filter fabric is located 2 to 6 inches from the top of the trench and serves to prevent sediment from passing into the stone aggregate. Since this top layer serves as a sediment barrier, it will need to be replaced more frequently and must be readily separated from the side sections. The top surface of the infiltration trench above the filter fabric is typically covered with pea gravel. The pea gravel layer improves

sediment filtering and maximizes the pollutant removal in the top of the trench. In addition, it can easily be removed and replaced should the device begin to clog. Alternatively, the trench can be covered with permeable topsoil and seeded with grass in a landscaped area. Vegetated filter strips and buffers should fit into and blend with surrounding area. Native grasses are preferable, if compatible. The trench may be covered with permeable topsoil and planted with grass in a landscaped area. If sod is to be used it shall be a sand based or washed sod product.

Table 4.5. Infiltration Trench Material Specifications

Material	Specification	Notes
Surface Layer	River Stone Turf (Seeded not sodded)	Lay a 3 inch layer on the surface of the filter bed to suppress weeds and prevent erosion
Filter Fabric	Use a non-woven geotextile fabric with a flow rate of >110 gal./min./ft^2	Apply to sides and below surface cover. Meet AASHTO M288-06, ASTM D4491 & D4751 standards
Gravel Drainage Layer	#57 or #2 clean washed stone	Meet TDOT Construction Specifications
Choker Layer	6-inch layer of clean, washed sand or # 8 or # 89 stone	Meet TDOT Construction Specifications
Observation Wells	6 inch PVC or HDPE pope with vented cap	Install one per 50 feet of length of the infiltration trench (minimum 1)

SECTION 7: SPECIAL CASE DESIGN APPLICATION

7.1 SHALLOW BEDROCK AND GROUNDWATER CONNECTIVITY

Many parts of Franklin have shallow bedrock, which can constrain the application of deeper infiltration trenches (particularly Level 2 designs). If bedrock is encountered during construction of the infiltration trench, the bottom sump elevation of the infiltration trench design shall be above the lowest bedrock / refusal elevation encountered in subsurface testing.

7.2 KARST

Karst regions are found in much of Middle Tennessee. Infiltrative practices, such as infiltration trenches, shall not be used in any areas with high risk of sinkhole formations or in areas of know sinkholes.

7.3 SITE SPECIFIC LIMITATIONS

Some sites may have areas identified as site specific limitations to infiltration of stormwater runoff. Site specific limitations shall be determined by the City engineer and approved through the Stormwater variance process. Sites with brownfield permits are an example of site specific limitations. Site specific limitations cannot be self-imposed or be caused by requirements within the City Ordinance. It should be noted that the site specific limitation may only occupy a portion of the entire proposed use, and that some "clean" areas (such as rooftops) can be diverted away to another infiltration or runoff reduction practice. Development proposals should be carefully reviewed to determine if any future operation, on all or part of the site, will be designated as a potential site specific limitation. Based on this designation, infiltration may be restricted or prohibited.

SECTION 8: CONSTRUCTION

The trench excavation should be limited to the width and depth specified in the design. Excavated material should be placed away from the open trench so as not to jeopardize the stability of the trench sidewalls. The bottom of the excavated trench shall not be loaded in a way that causes soil compaction and should be scarified prior to placement of sand. The sides of the trench shall be trimmed of all large roots. The sidewalls

shall be uniform with no voids and scarified prior to backfilling. All infiltration trench facilities shall be protected during site construction and should be constructed after upstream areas have been stabilized.

Unless otherwise approved by the City of Franklin Engineering Department the following installation steps shall be required of the person(s) installing the water quality BMPs located on this site. Failure to adhere to the following procedures may require reinstallation, reconstruction, or replacement of part or whole sections of the water quality BMP as well as denial of bond reductions and/or releases. Please contact the City's Engineering Department or your EPSC inspector for guidance if parts of this procedure are not applicable to a BMP that you are installing.

Step 1. Construction of the trench area may only begin after the entire contributing drainage area has been stabilized with vegetation. It may be necessary to block certain curbs or other inlets while the area is being constructed. The proposed site should be checked for existing utilities prior to any excavation.

Step 2. Contractor is to provide method of diverting runoff flow around the construction of the infiltration trench area during periods of rainfall to ensure sediment does not enter aruea. EPSC measures may need to be utilized during the installation. Construction materials that are contaminated by sediments must be removed and replaced with clean materials.

Step 3. Excavate infiltration trench area. Excavators or backhoes should work from the sides to excavate the area to the design depth and dimensions. Excavating equipment should have scoops with adequate reach so they do not sit inside the footprint of the area. If heavy rainfall occurs while the trench is open the soil shall be scarified/raked to ensure the surrounding soils have not been smeared.

Step 4. Scarify subgrade by ripping the bottom soils to a depth of 12" prior to stone placement.

Step 5. CALL CITY OF FRANKLIN INSPECTOR FOR INSPECTION 615-791-3218.

Step 6. Install washed stone layer. Install underdrain pipes and connect to the outlet structure. Install additional stone on the underdrain pipes as per the infiltration trench section detail. Contractor to flag the underdrain locations (3' each side) as the additional sections are being installed. A small loader is to be used for placement of additional sections and is to avoid accessing the areas of the underdrain pipe installation to prevent damage to the perforated pipe.

Step 7. CALL CITY OF FRANKLIN INSPECTOR FOR INSPECTION 615-791-3218.

Step 8. Install permeable geotextile fabric.

Step 9. Backfill with media that is specified.

Step 10. Contractor to flag limits of BMP for survey to locate and show on AS-BUILT plans.

SECTION 9: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D.** Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 10: OPERATION & MAINTENANCE

10.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the BMP operations and maintenance plan.

10.2 MAINTENANCE INSPECTIONS

It is highly recommended that spring maintenance inspections and a cleanup is conducted at the infiltration trench yearly. The following is a list of some key maintenance items to look for:

- Check to see if 75% to 90% cover (stone or vegetative cover) has been achieved in the bed and measure the depth of the remaining stone. If the stone layer is less than 3 inches, additional stone is required.
- Check for sediment buildup at inflow points, curb cuts, gravel diaphragms or pavement edges that prevents flow from reaching the filter bed, and check for other signs of bypassing. Remove accumulated sediment.
- Check for any winter- or salt-killed vegetation and replace.
- Note presence of accumulated sand, sediment and trash in the pretreatment cell or filter beds and remove it.
- Inspect infiltration trench side slopes and grass filter strips for evidence of any rill or gully erosion, and repair and stabilize any erosion issues found.
- Check the infiltration trench for evidence of excessive ponding or concentrated flows and take appropriate remedial action.
- Look for any bare soil or sediment sources in the contributing drainage area and stabilize them immediately.
- Check observation wells following 3 days of dry weather. Failure to percolate within this time period indicates clogging.
- Remove trees and other unwanted vegetation that starts to grow in the vicinity of the trench.
- Excavate trench walls to expose clean soil.

10.3 ROUTINE AND NON-ROUTINE MAINTENANCE TASKS

The most common non-routine maintenance problem involves standing water for longer than 24-48 hours. If water remains on the surface for longer than 24 hours after a preceding rain event, the infiltration trench is no longer functioning as designed. The following are several methods to remediate the ponding water.

- Replace pea gravel/topsoil and top surface filter fabric when clogged.
- Perform total rehabilitation of the trench to maintain design storage capacity.

Water Quality Swale

Description: Vegetated open channels designed to capture and infiltrate stormwater runoff within a dry storage layer beneath the base of the channel.

Components:
- Open trapezoidal or parabolic channel to store entire treatment volume, which is ultimately infiltrated
- Filter bed of permeable, engineered soils
- Underdrain system for impermeable soils
- Check dams every 50 feet, if length exceeds 100 feet

Advantages/Benefits:
- Stormwater treatment combined with conveyance
- Less expensive than curb and gutter
- Reduces runoff velocity
- Promotes infiltration

Disadvantages/Limitations:
- Higher maintenance than curb and gutter
- Cannot be used on steep slopes
- High land requirement
- Requires 3 feet of head

Design considerations:
- Longitudinal slopes ideally less than 2%
- Bottom channel width of 2 to 8 feet
- Underdrain required for subsoil infiltration rates less than 0.5 inches/hour
- Max 2.5 acres of impervious drainage area
- Side slopes of 3:1 or flatter; 4:1 recommended
- Must convey the 10-year storm event with a minimum of 6 inches of freeboard

Selection Criteria:

Level 1 – 40% Runoff Reduction Credit

Level 2 – 60% Runoff Reduction Credit

Land Use Considerations:

[X] **Residential**

[X] **Commercial**

[X] **Industrial** (with CITY approval)

Maintenance:
- Maintain grass height
- Remove sediment from forebay and channel
- Remove accumulated trash and debris
- Re-establish plants as needed

[M] **Maintenance Burden**
L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

Water quality swales are essentially bioretention cells that are shallow, linear channels covered with grasses or other surface material (other than mulch and ornamental plants). The water quality swale is a soil filter system that temporarily stores and then filters the desired Treatment Volume (T_v). Water quality swales rely on a pre-mixed soil media filter below the channel that is similar to that used for bioretention. If soils are extremely permeable, runoff infiltrates into underlying soils. Otherwise, the runoff treated by the soil media flows into an underdrain, which conveys treated runoff back to the conveyance system further downstream. The underdrain system consists of a perforated pipe within a gravel layer on the bottom of the swale, beneath the filter media. Water quality swales may appear as simple dense grass channels with the same shape and turf cover, while others may have more elaborate landscaping. Swales can be planted with medium to tall meadow grasses, decorative herbaceous cover or trees.

SECTION 2: PERFORMANCE

The primary pollutant removal mechanisms operating in swales are settling, filtering infiltration and plant uptake. The overall runoff reduction capabilities of water quality swales are summarized in **Table 5.1**.

Table 5.1. Runoff Volume Reduction Provided by Water Quality Swales

Stormwater Function	Level 1 Design	Level 2 Design
Runoff Volume Reduction (RR)	40%	60%

SECTION 3: DESIGN TABLE

Swales can be oriented to accept runoff from a single discharge point, or to accept runoff as lateral sheet flow along the swale's length.

Table 5.2. Water Quality Swale Design Criteria	
Level 1 Design (RR:40)	**Level 2 Design (RR:60)**
Sizing: See Section 6.1	**Sizing**: See Section 6.1
Surface Area (sq. ft.) = Tv/ Storage depth[1]	**Surface Area** (sq. ft.) = (1.1*Tv) / Storage Depth[1]
Effective swale slope: ≤ 2%	**Effective swale slope**: ≤ 1 %
Media Depth: minimum = 18 inches; recommended maximum = 36 inches	**Media Depth**: minimum = 24 inches; recommended maximum = 36 inches
Infiltration Testing (Section 6.2): one per 50 linear feet, 2 minimum; min. infiltration rate must be > 0.5 inch/hour to remove the underdrain requirement	
Underdrain (Section 6.7): Schedule 40 PVC or HDPE with clean-outs with 3/8 inch perforations on center	
Underground Storage Layer: (Section 6.7): a minimum 12-inch stone sump below the invert; OR none if the soil infiltration requirements are met (see **Section 6.2**)	
Filter Media (Section 6.6): 85% to 88%; 8% to 12% soil fines; 3% to 5% organic matter	
Inflow: sheet or concentrated flow with appropriate pretreatment	
Pretreatment: (Section 6.4): a pretreatment cell, level spreader, grass filter strip, gravel diaphragm, or gravel flow pretreatment structure.	
Planting Plan: medium to tall meadow grasses, decorative herbaceous cover, and trees are encouraged. Avoid sod or seeding overlain with straw.	

[1]The storage depth is the sum of the porosity (n) of the soil media and gravel layers multiplied by their respective depths, plus the surface ponding depth (Refer to Section 6.1)

SECTION 4: TYPICAL DETAILS

Figures 5.2 through 5.4 below provide typical schematics for water quality swales.

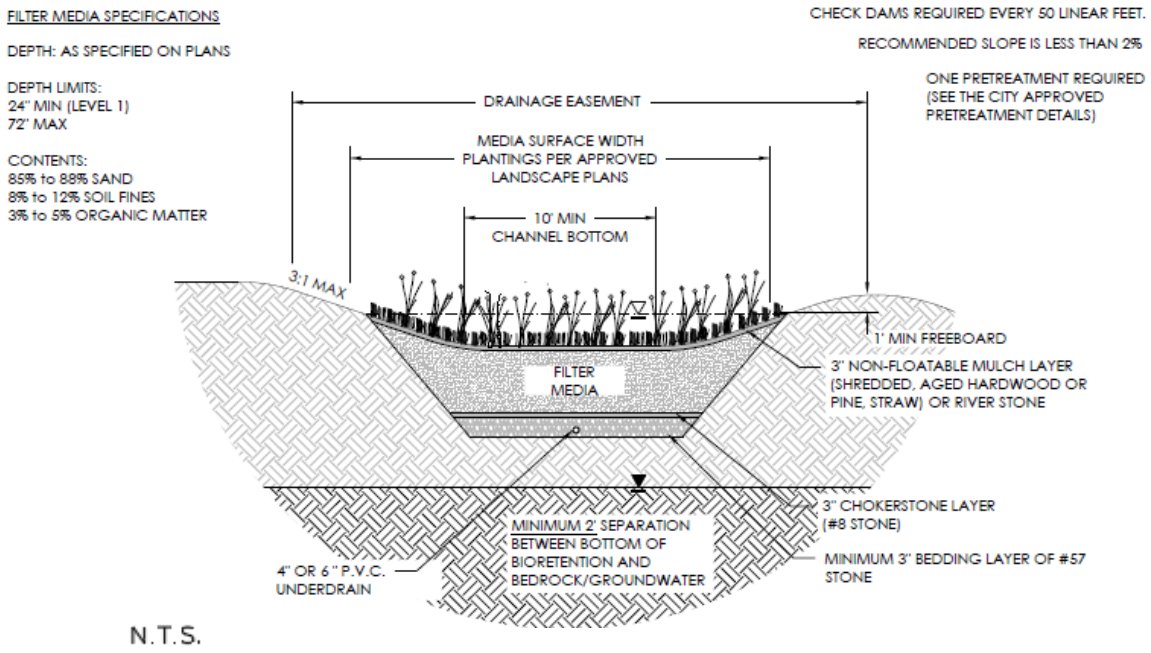


Figure 5.2. Typical Detail for Level 1 Water Quality Swale

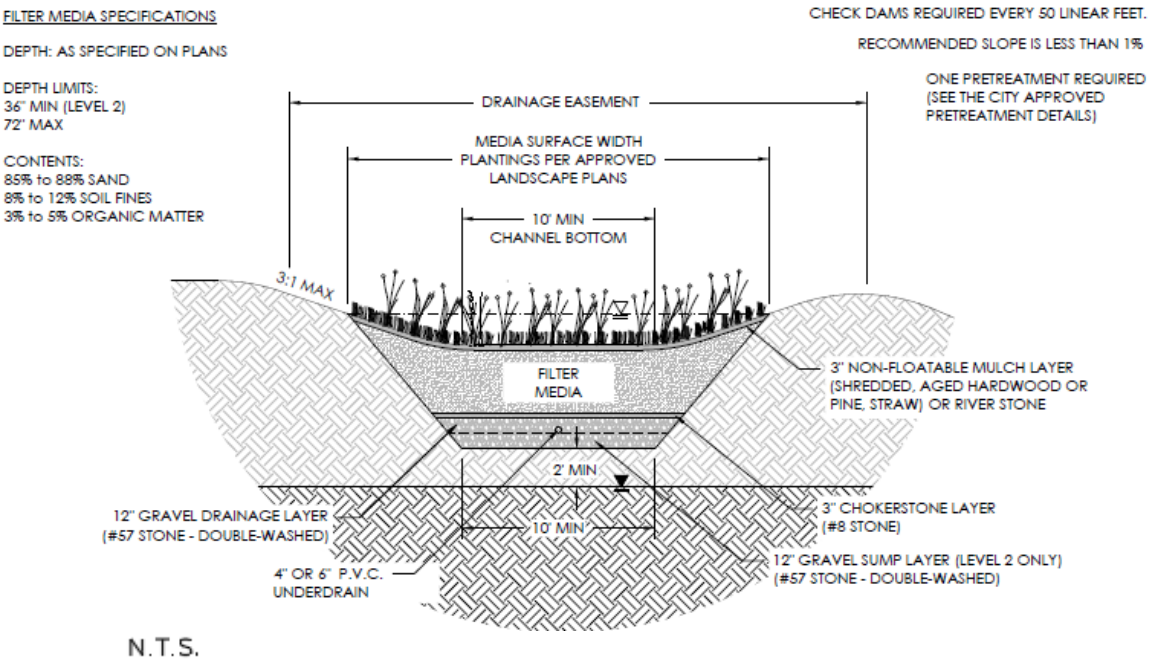


Figure 5.3. Typical Detail for Level 2 Water Quality Swale

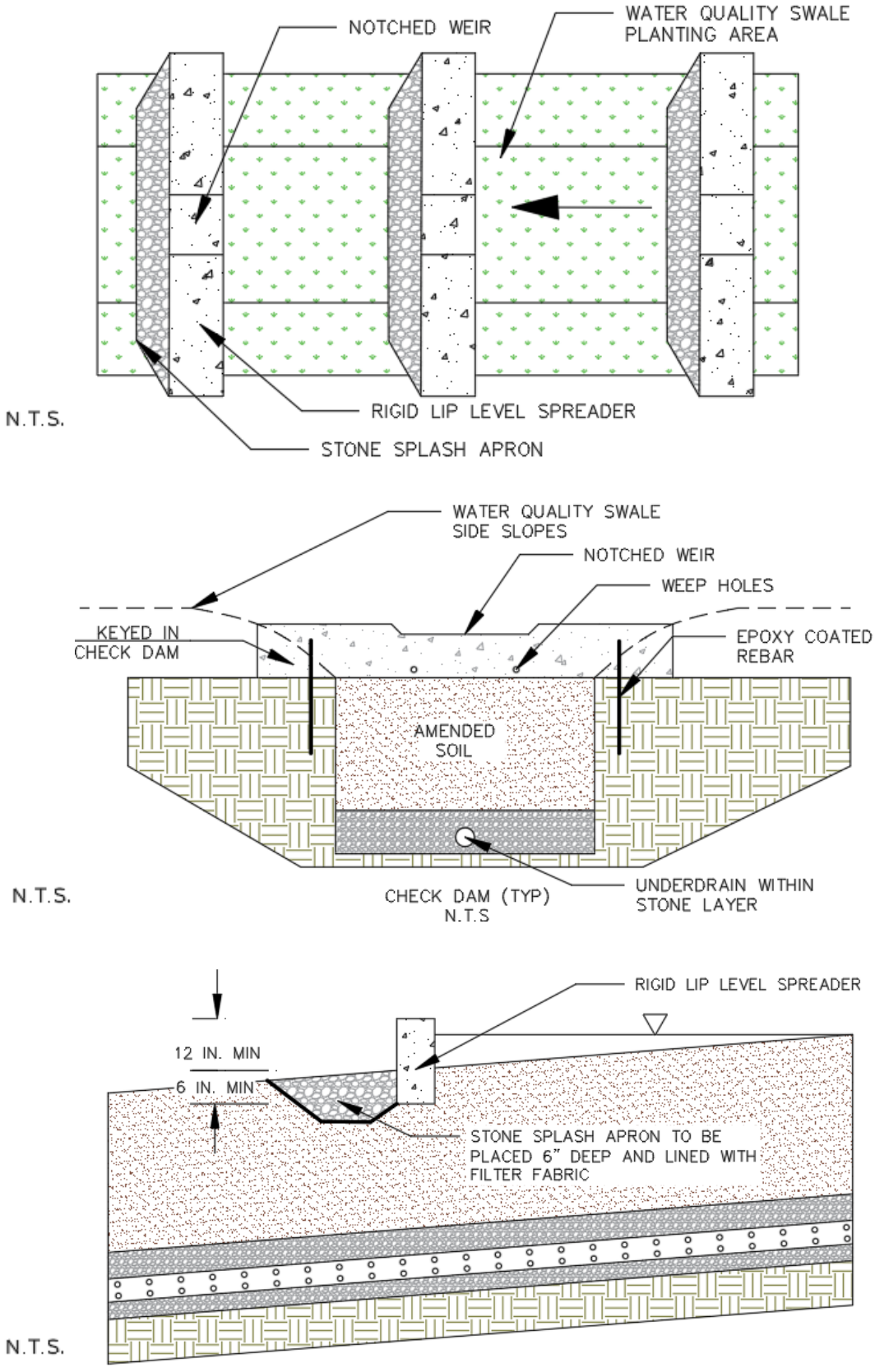


Figure 5.4. Typical Detail for Water Quality Swale Check Dam

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

Water quality swales can be implemented on a variety of development sites where density and topography permit their application. Some key feasibility issues for water quality swales include the following:

Accessibility. Water quality swales require periodic maintenance and shall be accessible to various types of equipment. A path of travel for equipment no less than 12 feet in width shall be provided for the water quality swale. Each water quality swale shall have one point of vehicle access.

Available Hydraulic Head. A minimum amount of hydraulic head is needed to implement water quality swales, measured as the difference in elevation between the inflow point and the downstream storm drain invert. Water quality swales typically require 3 feet of hydraulic head.

Available Space. Water quality swale footprints can fit into relatively narrow corridors between utilities, roads, parking areas, or other site constraints. Water quality swales shall at a minimum be 3% of the size of the contributing drainage area, depending on the amount of impervious cover.

Contributing Drainage Area. The maximum impervious contributing drainage area to a water quality swale should be 2.5 acres. When water quality swales treat larger drainage areas, the velocity of flow through the surface channel often becomes too great to treat runoff or prevent erosion in the channel. Similarly, the longitudinal flow of runoff through the soil, stone, and underdrain may cause hydraulic overloading at the downstream sections of the water quality swale. An alternative is to provide a series of inlets or diversions that convey the treated water to an outlet location.

Depth to Water Table. Designers should ensure that the bottom of the water quality swale is at least 2 feet above the seasonally high groundwater table, to ensure that groundwater does not intersect the filter bed, since this could lead to groundwater contamination or practice failure.

Hydraulic Capacity. Water quality swales that are an on-line practice must be designed with enough capacity to (1) convey runoff from the 100-year design storms at non-erosive velocities, and (2) contain the 10-year flow within the banks of the swale. This means that the swale's surface dimensions are more often determined by the need to pass the 10-year storm events, which can be a constraint in the siting of water quality swales within existing right of way (e.g., constrained by sidewalks).

Irrigation or Baseflow. Water quality swales should be located to avoid inputs of springs, irrigation systems, chlorinated wash-water, or other dry weather flows. Irrigation can be used to help vegetation growth within the first growing season and during droughts. A soil moisture sensor shall be installed. Irrigation plan shall be submitted for review.

Setbacks. It is not recommended to lace bioretention areas immediately adjacent to structures. to avoid the risk of seepage, a licensed PE should be consulted to determine the appropriate setbacks necessary to prevent bioretention infiltration from compromising structural foundations or pavement. At a minimum, bioretention basins should be located a horizontal distance of 100 feet from any water supply well and 50 feet from septic systems. Horizontal separation of 5 feet or the overall depth of the bioretention, whichever is greater, is required between the amended soils of the bioretention and any adjacent hardscape (i.e. parking lots or sidewalks). The bottom elevation of swales should be at least 1 foot below the invert of an adjacent roadbed.

Site Topography. Water quality swales should be used on sites with longitudinal slopes of less than 4%, but preferably less than 2%. Check dams can be used to reduce the effective slope of the swale and lengthen the contact time to enhance filtering and/or infiltration. Steeper slopes adjacent to the swale may generate rapid runoff velocities into the swale that may carry a high sediment loading (refer to pretreatment criteria in **Section 6.4**).

Utilities. Designers should consult local utility design guidance for the horizontal and vertical clearance between utilities and the swale configuration. No utility lines shall cross under water quality swales.

SECTION 6: DESIGN CRITERIA

6.1 SIZING OF WATER QUALITY CONVEYANCE AND WATER QUALITY TREATMENT SWALES

Sizing of the surface area (SA) for water quality swales is based on the computed Treatment Volume (T_v) of the contributing drainage area and the storage provided within the swale media and gravel layers and behind check dams. The required surface area (in square feet) is computed as the Treatment Volume (in cubic feet) divided by the equivalent storage depth (in feet). The equivalent storage depth is computed as the depth of the soil media, the gravel, and surface ponding (in feet) multiplied by the accepted porosity.

The accepted porosities are:

Table 5.3. Water Quality Swale Accepted Porosities

Material	Porosity Value (n)
Gravel (#57) Stone	0.40
Choker (#8) Stone Layer	0.40
Soil Media	0.25
Surface Layer	0.00
Surface Storage	1.00

The equivalent storage depth for a typical Level 1 design with a 4-inch gravel sump layer, 2 feet of media, and a 6-inch surface ponding depth is computed as:

Equation 5.1. Equivalent Storage Depth – Level 1

$$\text{Equivalent Storage Depth} = D_E = n_1(D_1) + n_2(D_2) + \cdots$$

$$D_E = (2 \text{ ft. x } 0.25) + (0.25 \text{ ft. x } 0.40) + (.5 \text{ ft. x } 1.00) = 1.7 \text{ft.}$$

The equivalent storage depth for a typical Level 2 design with a 12-inch gravel sump layer, 3 feet of media, and a 6-inch surface ponding depth is computed as:

Equation 5.2. Equivalent Storage Depth – Level 2

$$D_E = (3 \text{ ft. x } 0.25) + (1.0 \text{ ft. x } 0.40) + (.5 \text{ ft. x } 1.00) = 2.1 \text{ ft}$$

The effective storage depths will vary according to the actual design depths of the soil media and gravel layer.

Note: When using Equations 3 or 4 below to calculate the required surface area of a water quality swale that includes surface ponding (with check dams), the storage depth calculation (Equation 1 or 2) should be adjusted accordingly.

The Level 1 Water Quality Swale Surface Area (SA) is computed as:

Equation 5.3. Surface Area – Level 1

$$SA \text{ (sq. ft.)} = T_v/D_E \text{ ft.}$$

And the Level 2 Water Quality Swale SA is computed as:

Equation 5.4. Surface Area – Level 2

$$SA \text{ (sq. ft.)} = (1.1 * T_v)/D_E$$

NOTE: The volume reduced by upstream PTPs is supplemented with the anticipated volume of storage created by check dams along the swale length.

Where:
SA =Minimum surface area of Water Quality Swale (sq. ft.)
T_v =Treatment Volume (cu. ft.) = [(1 inch) (R_v)(A)]*3630,
A = Area in acres

The final water quality swale design geometry will be determined by dividing the SA by the swale length to compute the required width; or by dividing the SA by the desired width to compute the required length.

6.2 SOIL INFILTRATION RATE TESTING

The second key sizing decision is to measure the infiltration rate of subsoils below the water quality swale area to determine if an underdrain will be needed. The infiltration rate of the subsoil must exceed 0.5 inches per hour to avoid installation of an underdrain. The acceptable methods for on-site soil infiltration rate testing are outlined in **Appendix B**. A soil test shall be conducted for every 50 linear feet of water quality swale, with a minimum of two tests per swale.

6.3 WATER QUALITY SWALE GEOMETRY

Check dams. Check dams must be firmly anchored (keyed) into the side-slopes to prevent outflanking and be stable during the 10 year storm design event. The height of the check dam relative to the normal channel elevation should not exceed 12 inches. Each check dam should have a minimum of one weep hole or a similar drainage feature so it can dewater after storms. Armoring may be needed behind the check dam to prevent erosion. The check dam must be designed to spread runoff evenly over the water quality swale's filter bed surface, through a centrally located depression with a length equal to the filter bed width. In the center of the check dam, the depressed weir length should be checked for the depth of flow, sized for the appropriate design storm (see **Figure 5.3**). Check dams should be constructed of stone or concrete.

Drawdown. Water quality swales should be designed so that the desired Treatment Volume is completely filtered within 24 hours or less. This drawdown time can be achieved by using the soil media mix specified in **Section 6.6** and an underdrain along the bottom of the swale, or native soils with adequate permeability, as verified through testing (see **Section 6.2**).

Ponding Depth. Drop structures or check dams can be used to create ponding cells along the length of the swale. The maximum ponding depth in a swale should not exceed 12 inches at the most downstream point.

Shape. A parabolic shape is preferred for water quality swales for aesthetic, maintenance and hydraulic reasons. However, the design may be simplified with a trapezoidal cross-section, as long as the soil filter bed boundaries lay in the flat bottom areas.

Side Slopes. The side slopes of water quality swales shall be no steeper than 3H:1V for maintenance considerations. Flatter slopes are encouraged where adequate space is available, to enhance pretreatment of sheet

flows entering the swale. Swales should have a bottom width of from 2 to 8 feet to ensure that an adequate surface area exists along the bottom of the swale for filtering. If a swale will be wider than 8 feet, the designer should incorporate berms, check dams, level spreaders or multi-level cross-sections to prevent braiding and erosion of the swale bottom.

Swale Longitudinal Slope. The longitudinal slope of the swale should be moderately flat to permit the temporary ponding of the Treatment Volume within the channel. The recommended swale slope is less than or equal to 2% for a Level 1 design and less than or equal to 1% for a Level 2 design, though slopes up to 4% are acceptable if check dams are used. The minimum recommended slope for an on-line water quality swale is 0.5%. Refer to **Table 5.4** for check dam spacing based on the swale longitudinal slope.

Table 5.4. Typical Check Dam (CD) Spacing to Achieve Effective Swale Slope

Swale Longitudinal Slope	LEVEL 1	LEVEL 2
	Spacing[1] of 12-inch high (max.) Check Dams[2] to create an Effective Slope of 2%	Spacing[1] of 12-inch high (max.) Check Dams[2] to create an Effective Slope of 0 to 1%
0.5%	–	200 ft. to –
1.0%	–	100 ft. to –
1.5%	–	67 ft. to 200 ft.
2.0%	–	50 ft. to 100 ft.
2.5%	200 ft.	40 ft. to 67 ft.
3.0%	100 ft.	33 ft. to 50 ft.
3.5%	67 ft.	30 ft. to 40 ft.
4.0%	50 ft.	25 ft. to 33 ft.

[1] The spacing dimension is half of the above distances if a 6-inch check dam is used.
[2] Check dams require a stone energy dissipater at the downstream toe.

6.4 PRETREATMENT

Several pretreatment measures are feasible, depending on whether the specific location in the water quality swale system will be receiving sheet flow, shallow concentrated flow, or fully concentrated flow. See **Appendix A** for details.

6.5 CONVEYANCE AND OVERFLOW

The bottom width and slope of a water quality swale should be designed such that the velocity of flow from a 1-inch rainfall will not exceed 3 feet per second. Check dams may be used to achieve the needed runoff reduction volume, as well as to reduce the flow. Check dams should be spaced based on channel slope and ponding requirements, consistent with the criteria in **Table 5.5**.

The swale shall also convey the 2- and 10-year storms at non-erosive velocities with at least 6 inches of freeboard. The analysis should evaluate the flow profile through the channel at normal depth, as well as the flow depth over top of the check dams.

Water quality swales may be designed as off-line systems, with a flow splitter or diversion to divert runoff in excess of the design capacity to an adjacent conveyance system. Or, strategically placed overflow inlets may be placed along the length of the swale to periodically pick up water and reduce the hydraulic loading at the downstream limits.

6.6 FILTER MEDIA

The recommended bioretention soil mixture is generally classified as a loamy sand on the USDA Texture Triangle, with the following composition by volume: **85% to 88% sand; 8% to 12% soil fines; and 3% to 5% organic matter**. Sand shall consist of silica-based aggregate and shall meet the sieve sizes shown in **Table 5.5**. No substitutions for alternative materials such as "engineered sand" or recycled materials will be accepted.

Table 5.5. Sand sieve size requirements		
Sieve	**Size**	**% Passing**
3/8 in	9.50 mm	100
No. 4	4.75 mm	95 to 100
No. 8	2.36 mm	80 to 100
No. 16	1.18 mm	45 to 85
No. 30	0.60 mm	15 to 60
No. 50	0.30 mm	3 to 15
No. 100	0.15 mm	0 to 4
Effective Particle Size (D10) > 0.30 mm Uniformity Coefficient (D60/D10) < 0.40		

It may be advisable to start with an open-graded coarse silica sand material and proportionately mix in topsoil that will likely contain anywhere from 8% to 12% soil fines (sandy loam, loamy sand) to achieve the desired ratio of sand and fines. An additional 3% to 5% organic matter can then be added. (The exact composition of organic matter and topsoil material will vary, making particle size distribution and recipe for the total soil media mixture difficult to define in advance of evaluating the available material.)

6.7 UNDERDRAIN AND UNDERGROUND STORAGE LAYER

The underdrain should be constructed of 4 or 6-inch diameter perforated HDPE or PVC, which is placed on either a 3-inch layer of double-washed gravel (TDOT #57) for Level 1 or directly on a 12-inch sump layer of 1-inch stone for Level 2. The underdrain shall be encased in a gravel layer extending at least 3 inches above the surface of the pipe. This gravel layer should be covered with a 3-inch layer of choker stone (TDOT #8 or #89).

Some Level 2 water quality swale designs will not use an underdrain [(where soil infiltration rates meet minimum standards (see **Section 6.2**)]. For Level 2 designs with an underdrain, an underground storage layer, consisting of a minimum 12 inches of stone, shall be incorporated below the invert of the underdrain. The depth of the storage layer will depend on the target treatment and storage volumes needed to meet water quality criteria. The storage layer shall consist of clean, washed #57 stone.

If the underdrain is to daylight instead of tying into a storm structure, scour protection shall be provided based of the velocity, in feet per second, exiting the underdrain during the 10 year storm event.

All water quality swales shall include observation wells. The observation wells should be tied into any T's or Y's in the underdrain system, and should extend upwards to be above the surface, with a vented cap. In addition, cleanout pipes shall be provided.

6.8 LANDSCAPING AND PLANTING PLAN

Designers should choose grasses, herbaceous plants or trees that can withstand both wet and dry periods and relatively high velocity flows for planting within the channel. Salt tolerant grass species should be chosen for water quality swales receiving drainage from areas treated for ice in winter. Taller and denser grasses are preferable, although the species is less important than good stabilization and dense vegetative cover. Grass species should have the following characteristics: a deep root system to resist scouring; a high stem density with well-branched top growth; water-tolerance; resistance to being flattened by runoff; and an ability to recover growth following

inundation. A qualified landscape designer should be consulted for selection of appropriate plantings. See **Appendix C** for landscape plan requirements and all native plant lists.

6.9 WATER QUALITY SWALE MATERIAL SPECIFICATIONS

Table 5.6 outlines the standard material specifications for constructing water quality swales**.**

Table 5.6. Water Quality Swale Material Specifications

Material	Specification	Notes
Surface Layer	• Shredded hardwood mulch • River stone • Native grasses	Lay a 3-inch layer on the surface of the filter bed to suppress weed growth and prevent erosion
Filter Media Composition	Filter Media to contain (by volume): • 85% to 88% sand • 8% to 12% soil fines • 3% to 5% organic matter	The volume of filter media is based on 110% of the product of the surface area and the media depth, to account for settling.
Choking Layer	A 3- inch layer of choker stone (typically #8 or # 89 washed gravel) laid above the underdrain stone.	
Stone and/or Storage Layer	A 12 to 18 inch layer (depending on the desired depth of the storage layer) of #57 stone should be double-washed and clean and free of all soil and fines.	
Underdrains, Cleanouts, and Observation Wells	6-inch PVC or HDPE pipe, with 3/8-inch perforations.	If needed, install perforated pipe for the full length of the water quality swale. Use non-perforated pipe, as needed, to connect with the storm drain system.
Check Dams	Use non-erosive material such as wood, gabions, riprap, or concrete. All check dams should be underlain with filter fabric and include weep holes. Wood used for check dams should consist of pressure-treated logs or timbers, or water-resistant tree species such as cedar, hemlock, swamp oak or locust.	
Erosion Control Fabric	Where flow velocities dictate, use woven biodegradable erosion control fabric or mats that are durable enough to last at least 2 growing seasons.	

SECTION 7: SPECIAL CASE DESIGN ADAPTATIONS

7.1 SHALLOW BEDROCK AND GROUNDWATER CONNECTIVITY

Many parts of Franklin have shallow bedrock and groundwater, which can constrain the application of deeper bioretention areas (particularly Level 2 designs). If bedrock or groundwater is encountered during subsurface testing for the construction of the water quality swale, the bottom sump elevation of the design shall be above the lowest bedrock/refusal or groundwater elevation encountered in subsurface testing. Bedrock removal should be limited to unexpected outcroppings and rises not encountered in subsurface testing. Note that this is not a desirable design and should be utilized only when all other possibilities have been exhausted.

7.2 STEEP TERRAIN

In areas of steep terrain, water quality swales can be implemented with contributing slopes of up to 20% gradient, if a multiple cell design is used to dissipate erosive energy prior to filtering. This can be accomplished by terracing a series of water quality swale cells to manage runoff across or down a slope. The drop in elevation between cells should be limited to 1 foot and armored with river stone or a suitable equivalent. A greater emphasis on properly

engineered energy dissipaters and/or drop structures is warranted.

7.3 SITE SPECIFIC LIMITATIONS

Some sites may have areas identified as site specific limitations to infiltration of stormwater runoff. Site specific limitations shall be determined by the City engineer and approved through the Stormwater variance process. Sites with brownfield permits are an example of site specific limitations. Site specific limitations cannot be self-imposed or be caused by requirements within the City Ordinance. It should be noted that the site specific limitation may only occupy a portion of the entire proposed use, and that some "clean" areas (such as rooftops) can be diverted away to another infiltration or runoff reduction practice. Development proposals should be carefully reviewed to determine if any future operation, on all or part of the site, will be designated as a potential site specific limitation. Based on this designation, infiltration may be restricted or prohibited.

SECTION 8: CONSTRUCTION

8.1 CONSTRUCTION EROSION PREVENTION AND SEDIMENT CONTROL

Construction Stage EPSC Controls. Water quality swales should be fully protected by silt fence or construction fencing, particularly if they will provide an infiltration function (i.e., have no underdrains). Ideally, water quality swale areas should remain *outside* the limits of disturbance during construction to prevent soil compaction by heavy equipment.

Water quality swale locations may be used for small sediment traps or basins during construction. However, these must be accompanied by notes and graphic details on the EPSC plan specifying that the maximum excavation depth of the sediment trap/basin at the construction stage must (1) be at least 1 foot above the depth of the post-construction water quality swale installation, (2) contain an underdrain, and (3) specify the use of proper procedures for conversion from a temporary practice to a permanent one, including de-watering, cleanout and stabilization.

8.2 CONSTRUCTION SEQUENCE

The following is a typical construction sequence to properly install a water quality swale, although the steps may be modified to adapt to different site conditions.

Step 1. Protection during Site Construction. As noted above, water quality swales should remain outside the limit of disturbance during construction to prevent soil compaction by heavy equipment. However, this is seldom practical given that swales are a key part of the drainage system at most sites. In these cases, temporary EPSC such as dikes, silt fences and other similar measures should be integrated into the swale design throughout the construction sequence. Specifically, barriers should be installed at key check dam locations, erosion control fabric should be used to protect the channel, and excavation should be no deeper than 2 feet above the proposed invert of the bottom of the planned underdrain. Water quality swales that lack underdrains (and rely on filtration) must be fully protected by silt fence or construction fencing to prevent compaction by heavy equipment during construction.

Step 2. Installation should begin after the entire contributing drainage area has been stabilized by vegetation. The designer should check the boundaries of the contributing drainage area to ensure it conforms to original design. Additional EPSC may be needed during swale construction, particularly to divert stormwater from the water quality swale until the filter bed and side slopes are fully stabilized. Pretreatment cells should be excavated first to trap sediments before they reach the planned filter beds.

Step 3. Excavators or backhoes should work from the sides to excavate the water quality swale area to the appropriate design depth and dimensions. Excavating equipment should have scoops with adequate reach so they

do not have to sit inside the footprint of the water quality swale area.

Step 4. The bottom of the water quality swale should be ripped, roto-tilled or otherwise scarified at a depth of 12 inches to promote greater infiltration.

Step 5. Place the stone needed for storage layer over the filter bed. Perforate the underdrain pipe and check its slope. Add the remaining stone jacket, and then pack #57 stone to 3 inches above the top of the underdrain, and then add 3 inches of choker stone as a filter layer.

Step 6. Add the soil media in 12-inch lifts until the desired top elevation of the water quality swale is achieved. Wait a few days to check for settlement, and add additional media as needed.

Step 7. Install check dams and internal pretreatment features, as specified in the plan.

Step 8. Prepare planting holes for specified trees, shrubs, and grasses install erosion control fabric where needed, and install any temporary irrigation.

Step 9. Plant landscaping materials as shown in the landscaping plan, and water them weekly during the first 2 months. The construction contract should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction.

Step 10. Conduct a final construction inspection and develop a punch list for facility acceptance.

8.3 CONSTRUCTION INSPECTION

Inspections are needed during construction to ensure that the water quality swale is built in accordance with these specifications. Detailed inspection checklists should be used that include sign-offs by qualified individuals at critical stages of construction, to ensure that the contractor's interpretation of the plan is consistent with the designer's intent. Some common pitfalls can be avoided by careful construction supervision that focuses on the following key aspects of water quality swale installation.

- Check the filter media to confirm that it meets specifications and is installed to the correct depth.
- Check elevations such as the invert of the underdrain, inverts for the inflow and outflow points, and the ponding depth provided between the surface of the filter bed and the overflow structure.
- Ensure that caps are placed on the upstream (but not the downstream) ends of the underdrains.
- Inspect check dams and pretreatment structures to make sure they are properly installed and working effectively.
- Check that outfall protection/energy dissipation measures at concentrated inflow and outflow points are stable.

The real test of a water quality swale occurs after its first big storm. The post-storm inspection should focus on whether the desired sheet flow, shallow concentrated flows or fully concentrated flows assumed in the plan actually occur in the field. Also, inspectors should check that the water quality swale drains completely within 24 hour drawdown period. Minor adjustments are normally needed as a result of this post-storm inspection (e.g., spot reseeding, gully repair, added armoring at inlets or outfalls, and check dam realignment.

SECTION 9: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 10: MAINTENANCE

10.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

10.2. MAINTENANCE INSPECTIONS

Annual inspections are used to trigger maintenance operations such as sediment removal, spot revegetation and inlet stabilization. The following is a list of several key maintenance inspection points:

- Add reinforcement planting to maintain 95% turf cover or vegetation density. Reseed or replant any dead vegetation.
- Remove any accumulated sand or sediment deposits on the filter bed surface or in pretreatment cells.
- Inspect upstream and downstream of check dams for evidence of undercutting or erosion and remove trash or blockages at weepholes.
- Examine filter beds for evidence of braiding, erosion, excessive ponding or dead grass.
- Check inflow points for clogging and remove any sediment.
- Inspect side slopes and grass filter strips for evidence of any erosion, and repair as needed.
- Look for any bare soil or sediment sources in the contributing drainage area and stabilize immediately.

Ideally, yearly inspections should be conducted in the spring of each year and yearly inspection reports submitted to the City by July 1.

10.3 ROUTINE MAINTENANCE AND OPERATION

Once established, water quality swales have minimal maintenance needs outside of the spring clean-up, regular mowing of pretreatment areas only if needed, and pruning and management of trees and shrubs. The surface of the filter bed can become clogged with fine sediment over time, but this can be alleviated through core aeration or deep tilling of the filter bed. Additional effort may be needed to repair check dams, stabilize inlet points and remove deposited sediment from pretreatment cells.

Extended Detention

Description: Constructed stormwater detention basin that has a permanent pool (or micropool). Runoff from each rain event is captured and treated primarily through settling and biological uptake mechanisms.

Variations: Wet extended detention, micropool extended detention, multiple pond system

Components:
- Permanent pool / micropool – prevents re-suspension of solids
- Live storage above permanent pool – sized for a percentage of water quality volume and flow attenuation.
- Forebay – settles out larger sediments in an area where sediment removal will be easier
- Spillway system – spillway system(s) provides outlet for stormwater runoff when large storm events occur and maintains the permanent pool

Advantages/Benefits:
- Can be designed as a multi-functional BMP
- Cost effective
- Can be designed as an amenity within a development
- Wildlife habitat potential
- High community acceptance when integrated into a development

Disadvantages/Limitations:
- Potential for thermal impacts downstream
- Not recommended in karst terrain
- Community perceived concerns with mosquitoes and safety

Design considerations:
- Minimum contributing drainage area of 25 acres; 10 acres for micropool extended detention (Unless water balance calculations show support of permanent pool by a smaller drainage area)
- Sediment forebay or equivalent pretreatment must be provided
- Minimum length to width ratio = 3:1
- Maximum depth of permanent pool = 4’
- 3:1 side slopes or flatter around pond perimeter

Runoff Reduction Credit:

15% for design specified
0% if lined

Land Use Considerations:

X	**Residential**
X	**Commercial**
X	**Industrial**

Maintenance:
- Remove debris from inlet and outlet structures
- Maintain side slopes/remove invasive vegetation
- Monitor sediment accumulation and remove periodically

M	**Maintenance Burden** L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

An Extended Detention (ED) Pond relies on 24 to 48 hour detention of stormwater runoff after each rain event. Elevations and design shall allow the entire feature to drain within 72 hours. An under-sized outlet structure restricts stormwater flow so it backs up and is stored within the basin. The temporary ponding enables particulate pollutants to settle out and reduces the maximum peak discharge to the downstream channel, thereby reducing the effective shear stress on banks of the receiving stream. ED differs from stormwater detention, since it is designed to achieve a minimum drawdown time, rather than a maximum peak rate of flow (which is commonly used to design for peak discharge or flood control purposes and often detains flows for just a few minutes or hours). ED ponds rely on gravitational settling as their primary pollutant removal mechanism. Consequently, they generally provide fair-to-good removal for particulate pollutants, but low or negligible removal for soluble pollutants, such as nitrate and soluble phosphorus. The use of ED alone generally results in a low overall pollutant removal. As a result, ED is normally combined with other practices to maximize pollutant removal rates.

SECTION 2: PERFORMANCE

Table 6.1. Runoff Volume Reduction Provided by ED Ponds	
Stormwater Function	**Specified Design**
Runoff Volume Reduction (RR)	15%

SECTION 3: DESIGN TABLE

ED ponds must be designed with a Storage Volume, T_V. **Table 6.2** lists the criteria for qualifying designs. See Section 6 for more detailed design guidelines.

Table 6.2. Extended Detention (ED) Pond Criteria
Specified Design (RR:15)
$Tv^1 = 1.25*Rv*A*3630$
A minimum of 40% of Tv in the permanent pool (forebay, micropool, deep pool, or wetlands)
Length/Width ratio *OR* flow path = 3:1 or more
Length of the shortest flow path / overall length = 0.7 or more
Minimum T_v ED time = 24 hours
Maximum vertical Tv ED limit of 4 feet
Trees and wetlands in the planting plan
Includes additional cells or features (deep pools, wetlands, etc.) Refer to Section 5
CDA is greater than 10 acres unless water balance supports smaller contributing drainage area (CDA)

[1] A= Area in Acres

SECTION 4: TYPICAL DETAILS

Figure 6.1 portrays a typical schematic for an ED pond.

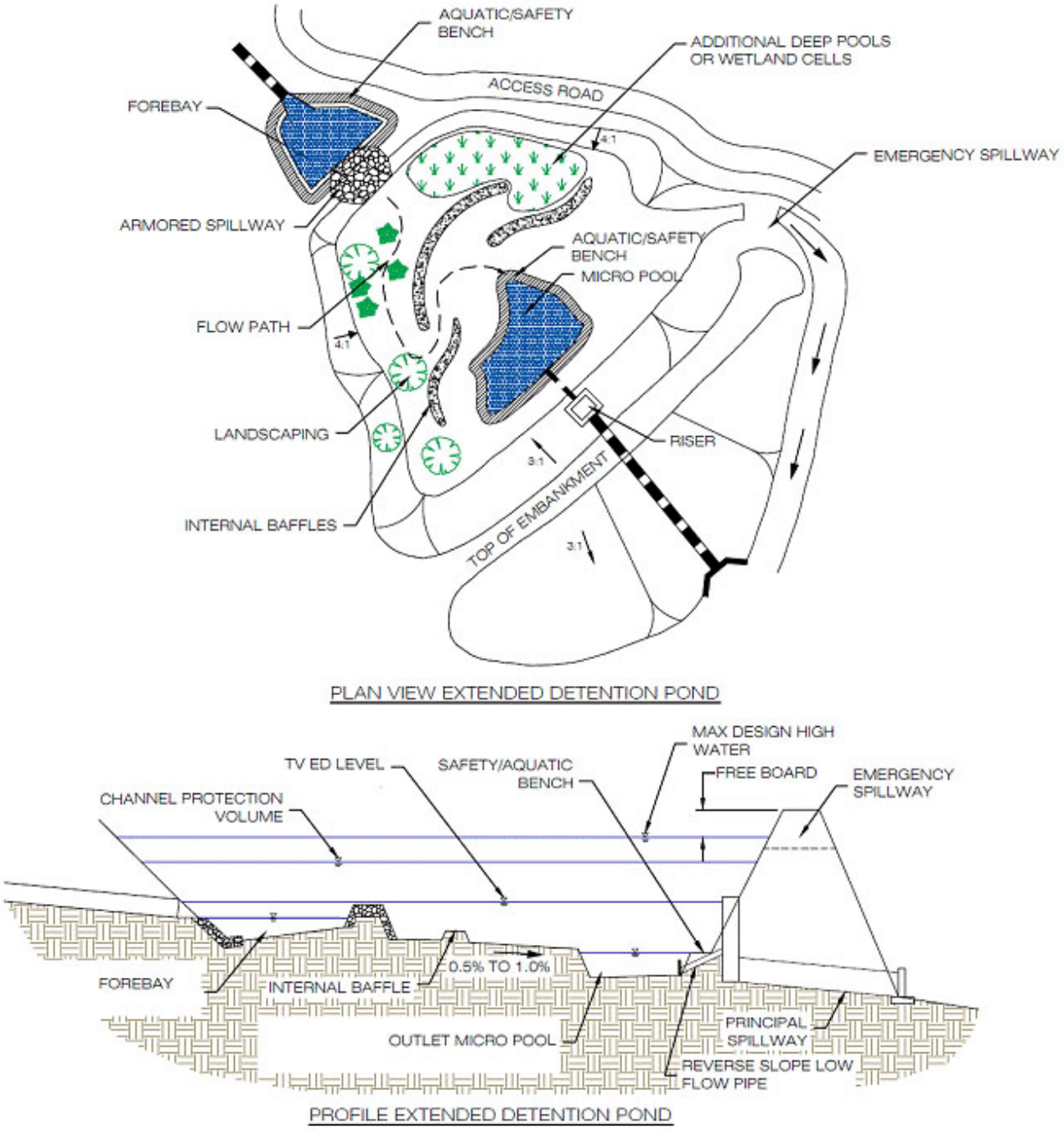


Figure 6.1. Typical Extended Detention Pond Details

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

The following feasibility issues need to be evaluated when ED ponds are considered as the final practice in a treatment train. Many of these issues will be influenced by the type of ED Pond being considered (refer to Design Applications at the end of this section).

Available Hydraulic Head. The depth of an ED pond is usually determined by the amount of hydraulic head available at the site. The bottom elevation is normally the invert of the existing downstream conveyance system to which the ED pond discharges. Typically, a minimum of 6 to 10 feet of head is needed for an ED pond to function.

Contributing Drainage Area. A minimum contributing drainage area of 10 acres is recommended for ED ponds in order to sustain a permanent micropool to protect against clogging. Extended detention may still work with drainage areas less than 10 acres, but designers should be aware that these "pocket" ponds will typically (1) have very small orifices that will be prone to clogging, (2) experience fluctuating water levels, and (3) generate more significant maintenance problems. Water balance calculations should also support a CDA less than 10 acres.

Depth-to-Water Table and Bedrock. If less than 3 feet of vertical separation exists between the bottom of the ED pond and the underlying soil-bedrock interface, ED ponds should not be used unless they have an acceptable liner.

Design Applications. Extended Detention is normally combined with other stormwater treatment options within the stormwater facility (e.g., wet ponds, and constructed wetlands) to enhance its performance and appearance.

Minimum Setbacks. ED ponds should be set back at least 10 feet from property lines, 25 feet from building foundations, 50 feet from septic system fields, and 100 feet from private wells.

Soils. The permeability of soils is seldom a design constraint for micropool ED ponds. Soil infiltration tests need to be conducted at proposed pond sites to estimate infiltration rates, which can be significant in Hydrologic Soil Group (HSG) A soils and some group B soils. Infiltration through the bottom of the pond is encouraged unless it will impair the integrity of the embankment. Geotechnical tests should be conducted to determine the infiltration rates and other subsurface properties of the soils underlying the proposed ED pond. If the site is on karst topography, an alternative practice or combination of practices should be employed at the site, if possible. The Extended Detention Basin should be the option of last resort and, if used in karst, must have an impermeable clay or (preferably) geosynthetic liner.

Space Required. A typical ED pond requires a footprint of 1% to 3% of its contributing drainage area, depending on the depth of the pond (i.e., the deeper the pond, the smaller footprint needed).

While ED ponds can provide for flood protection, they will rarely provide adequate runoff volume reduction and pollutant removal to serve as a stand-alone compliance strategy. Therefore, designers should always maximize the use of upland runoff reduction practices, (e.g., rooftop disconnections, small-scale infiltration, bioretention, and water quality swales) that reduce runoff at its source. Upland runoff reduction practices can be used to satisfy most or all of the runoff reduction requirements at most sites. Upland runoff reduction practices will greatly reduce the size, footprint and cost of the downstream ED pond.

SECTION 6: DESIGN CRITERIA

6.1 OVERALL SIZING

Designers can use a site-adjusted R_v (see **Section 1 Chapter 3** for appropriate equations), which reflects the use of upland runoff reduction practices, to compute the remaining treatment and flood protection volumes that must be

treated by the ED pond. ED ponds should then be designed to capture and treat the remaining runoff volume as necessary. Runoff treatment (T_v) credit may be taken for the entire water volume below the permanent pool elevation of any micropools, forebays and wetland areas, as well as, the temporary extended detention above the normal pool. A minimum of 40% of the T_v must be designed into the permanent pool.

Equation 6.1. ED Treatment Volume

$$T_v \text{ (cu. ft.)} = (\text{Original } T_v - \text{the volume reduced by an upstream BMP})$$

After calculating T_V, the forebay should be sized using guidance in **Section 6.4**.

The outlets must then be sized for appropriate storm events. If the pond is additionally going to address peak flow attenuation, the downstream impacts must be considered for the 2-through 100-year events. Refer to **Section 5 TSS-01** for instruction on design of outlet orifices and weirs.

6.2 TREATMENT VOLUME DRAWDOWN AND DETENTION DESIGN

Low flow orifices can be sized using the following equation, as provided in **Section 5 PTP-05**. If different equation is used or different type of low flow orifice is used, provide supporting calculations.

Equation 6.2. Area of Low Flow Orifice

$$a = \frac{2A(H - H_o)^{0.5}}{3600CT(2g)^{0.5}}$$

Where:

a	=	Area of orifice (ft^2)
A	=	Average surface area of the pond (ft^2)
C	=	Orifice coefficient, 0.66 for thin, 0.80 for materials thicker than orifice diameter
T	=	Drawdown time of pond (hrs), must be greater than 24 hours
g	=	Gravity (32.2 ft/sec^2)
H	=	Elevation when pond is full to storage height (ft)
Ho	=	Final elevation when pond is empty (ft)

Table 6.2 provides maximum ponding depths and other criteria for providing runoff volume reduction.

Once the low flow orifice has been sized, design embankments and emergency spillways, investigate potential dam hazard classifications, and finally design inlets, sediment forebays, outlet structures, maintenance access, and safety features. These items are detailed in both Section 6.5 and below.

6.3 REQUIRED GEOTECHNICAL TESTING

Soil borings should be taken below the proposed embankment, in the vicinity of the proposed outlet area, and in at least two locations within the proposed ED pond treatment area. Soil boring data is needed to (1) determine the physical characteristics of the excavated material, (2) determine its adequacy for use as structural fill or spoil, (3) provide data for structural designs of the outlet works (e.g., bearing capacity and buoyancy), (4) determine compaction/composition needs for the embankment, (5) determine the depth to groundwater and bedrock and (6) evaluate potential infiltration losses (and the potential need for a liner).

6.4 PRETREATMENT FOREBAY

Sediment forebays are considered to be an integral design feature to maintain the longevity of ED ponds. A forebay must be located at each major inlet to trap sediment and preserve the capacity of the main treatment cell. Other forms of pre-treatment for sheet flow and concentrated flow for minor inflow points should be designed consistent with pretreatment criteria found in **Appendix A**. The following criteria apply to forebay design:

- A major inlet is defined as an individual storm drain inlet pipe or open channel serving at least 10% of the ED pond's contributing drainage area.
- The forebay consists of a separate cell, formed by an acceptable barrier. (e.g., an earthen berm, concrete weir, gabion baskets, etc.).
- The forebay should be at least 4 feet deep and must be equipped with a variable width aquatic bench for safety purposes. The aquatic benches should be 4 to 6 feet wide at a depth of 18 inches below the water surface.
- The total volume of all forebays should be at least 15% of the total Treatment Volume. The relative size of individual forebays should be proportional to the percentage of the total inflow to the pond. Similarly, any outlet protection associated with the end section or end wall should be designed according to state or local design standards.
- The forebay should be designed in such a manner that it acts as a level spreader to distribute runoff evenly across the entire bottom surface area of the main treatment cell.
- The bottom of the forebay may be hardened (e.g., concrete, asphalt, or grouted riprap) in order to make sediment removal easier.

6.5 CONVEYANCE AND OVERFLOW

No Pilot Channels. Micropool ED ponds shall not have a low flow pilot channel, but instead must be constructed in a manner whereby flows are evenly distributed across the pond bottom, to promote the maximum infiltration possible.

Internal Slope. The maximum longitudinal slope through the pond should be approximately 0.5% to 1% to promote positive flow through the ED pond.

Primary Spillway. The primary spillway shall be designed with acceptable anti-flotation, anti-vortex, and trash rack devices. The spillway must generally be accessible from dry land.

Non-Clogging Low Flow Orifice. ED Ponds with drainage areas of 10 acres or less, where small diameter pipes are typical, are prone to chronic clogging by organic debris and sediment. Orifices less than 3 inches in diameter may require extra attention during design to minimize the potential for clogging. Designers should always look at upstream conditions to assess the potential for higher sediment and woody debris loads. The risk of clogging in outlet pipes with small orifices can be reduced by:

- Providing a micropool at the outlet structure:
  - Use a reverse-sloped pipe that extends to a mid-depth of the permanent pool or micropool.
  - Install a downturned elbow or half-round pipe over a riser orifice (circular, rectangular, V-notch, etc.) to pull water from below the micropool surface.
  - The depth of the micropool should be at least 4 feet deep, and the depth may not draw down by more than 2 feet during 30 consecutive days of dry weather in the summer.
- Providing an over-sized forebay to trap sediment, trash and debris before it reaches the ED pond's low-flow orifice.
- Installing a trash rack to screen the low-flow orifice.
- Using a perforated pipe under a gravel blanket with an orifice control at the end in the riser structure to supplement the primary outlet.

Emergency Spillway. ED ponds must be constructed with overflow capacity to pass the 100-year design storm event through either the Primary Spillway or a vegetated or armored Emergency Spillway.

Adequate Outfall Protection. The design must specify an outfall that will be stable for the 10- year design storm event. The channel immediately below the pond outfall must be modified to prevent erosion and conform to natural dimensions in the shortest possible distance. This is typically done by placing appropriately sized riprap, over filter fabric, which can reduce flow velocities from the principal spillway to non-erosive levels (3.5 to 5.0 fps depending on the channel lining material). Flared pipe sections that discharge at or near the stream invert or into a step pool arrangement should be used at the spillway outlet.

Inlet Protection. Inlet areas should be stabilized to ensure that non-erosive conditions exist during storm events up to the overbank flood event (i.e., the 10-year storm event). Inlet pipe inverts should generally be located at or slightly below the forebay pool elevation.

On-Line ED Ponds must be designed to detain the required T_v and either manage or be capable of safely passing larger storm events conveyed to the pond (e.g., 10-year flood protection, and/or the 100-year design storm event).

6.6. INTERNAL DESIGN FEATURES

Side Slopes. Side slopes leading to the ED pond should generally have a gradient of 4H:1V to 5H:1V. The mild slopes promote better establishment and growth of vegetation and provide for easier maintenance and a more natural appearance.

Long Flow Path. ED pond designs should have an irregular shape and a long flow path from inlet to outlet to increase water residence time, treatment pathways, and pond performance. In terms of flow path geometry, there are two design considerations: (1) the overall flow path through the pond, and (2) the length of the shortest flow path (Hirschman et al., 2009):

- The overall flow path can be represented as the length-to-width ratio *OR* the flow path. These ratios must be at least 3L:1W. Internal berms, baffles, or topography can be used to extend flow paths and/or create multiple pond cells.
- The shortest flow path represents the distance from the closest inlet to the outlet. The ratio of the shortest flow to the overall length must be at least 0.7. In some cases – due to site geometry, storm sewer infrastructure, or other factors – some inlets may not be able to meet these ratios. However, the drainage area served by these "closer" inlets should constitute no more than 20% of the total contributing drainage area.

Treatment Volume Storage. The total T_v storage may be provided by a combination of the permanent pool (in the form of forebays, deep pools, and/or wetland area) and extended detention storage.

Vertical Extended Detention Limits. The maximum T_v ED water surface elevation may not extend more than 4 feet above the basin floor or normal pool elevation. The maximum vertical elevation for ED detention over shallow wetlands is 1 foot. Frequent fluctuations in water elevations, or bounce effect, are not as critical for larger flood control storms (e.g., the 10-year design storm), and these events can exceed the 4 foot vertical limit if they are managed by a multi-stage outlet structure.

Safety Features.

- The principal spillway opening must be designed and constructed to prevent access by small children.
- End walls above pipe outfalls greater than 48 inches in diameter must be fenced to prevent a hazard.
- An emergency spillway and associated freeboard must be provided in accordance with applicable local or state dam safety requirements. The emergency spillway must be located so that downstream structures will not be impacted by spillway discharges.

- Both the safety bench and the aquatic bench should be landscaped with vegetation that hinders or prevents access to the pool.

6.7 LANDSCAPING AND PLANTING PLAN

A landscaping plan must be provided that indicates the methods used to establish and maintain vegetative coverage within the ED pond. Minimum elements of a plan include the following:

- Delineation of pond-scaping zones within the pond
- Selection of corresponding plant species
- The planting plan
- The sequence for preparing the wetland bed, if one is incorporated with the ED pond (including soil amendments, if needed)
- Sources of plant material
- The planting plan should allow the pond to mature into a native forest in the right places, yet keep mowable turf along the embankment and all access areas. The wooded wetland concept proposed by Cappiella *et al.*, (2005) may be a good option for many ED ponds.
- Woody vegetation may not be planted or allowed to grow within 15 feet of the toe of the embankment nor within 25 feet from the principal spillway structure.
- Avoid species that require full shade, or are prone to wind damage. Extra mulching around the base of trees and shrubs is strongly recommended as a means of conserving moisture and suppressing weeds.

6.8 MAINTENANCE REDUCTION FEATURES

Good maintenance access is needed so crews can remove sediments from the forebay, alleviate clogging and make riser repairs. The following ED pond maintenance issues can be addressed during design, in order to make on-going maintenance easier:

- Adequate maintenance access must extend to the forebay, micropool, any safety benches, riser, and outlet structure and must have sufficient area to allow vehicles to turn around.
- The riser should be located within the embankment for maintenance access, safety and aesthetics.
- Access roads must (1) be constructed of load-bearing materials or be built to withstand the expected frequency of use, (2) have a minimum width of 12 feet, and (3) have a profile grade that does not exceed 15%. Steeper grades are allowable if appropriate stabilization techniques are used, such as a gravel road.
- A maintenance right-of-way or easement must extend to the ED pond from a public or private road.

6.9 ED POND MATERIAL SPECIFICATIONS

ED ponds are generally constructed with materials obtained on-site, except for the plant materials, inflow and outflow devices (e.g., piping and riser materials), possibly stone for inlet and outlet stabilization, and filter fabric for lining banks or berms.

The basic material specifications for earthen embankments, principal spillways, vegetated emergency spillways and sediment forebays shall be as specified in Tennessee state guidelines and TSS-05, Dry Ponds in within this manual.

6.10 DAM SAFETY

Tennessee Safe Dams Act may apply to ponds with storage volumes and embankment heights large enough to fall under the regulation for dam safety, as applicable. Size emergency spillway for any overtopping of pond in case of rain event in excess of 100-year storm and for instances of malfunction or clogging of primary outlet structure.

SECTION 7: SPECIAL CASE DESIGN ADAPTATIONS

7.1 STEEP TERRAIN

The use of ED ponds is highly constrained at development sites with steep terrain.

7.2 KARST TERRAIN

Karst is found in some areas of the City. The presence of karst complicates both land development in general and stormwater design. Designers should always conduct geotechnical investigations in karst terrain to assess this risk during the project planning stage. Because of the risk of sinkhole formation and groundwater contamination in karst regions, *use of ED ponds is highly restricted* (see CSN Technical Bulletin No. 1, 2009). If these studies indicate that less than 3 feet of vertical separation exists between the bottom of the ED pond and the underlying soil-bedrock interface, ED ponds should not be used unless they have an acceptable liner.

7.3 MULTI-FUNCTIONAL USES

Recreational and other uses may be provided between storm runoff events, as shown in **Figure 6.2**.

Figure 6.2. Multi-Use Dry Detention Doubling as Sports Fields Englewood, CO

SECTION 8: CONSTRUCTION

8.1 CONSTRUCTION SEQUENCE

The following is a typical construction sequence to properly install an ED pond. The steps may be modified to reflect different dry ED pond designs, site conditions, and the size, complexity and configuration of the proposed facility.

Step 1: Use of ED pond as an EPSC. An ED pond may serve as a sediment basin during project construction. If this is done, the volume should be based on the more stringent sizing rule (erosion and sediment control requirement vs. water quality treatment requirement). Installation of the permanent riser should be initiated during the construction phase, and design elevations should be set with final cleanout of the sediment basin and conversion to the post-construction ED pond in mind. The bottom elevation of the ED pond should be lower than the bottom elevation of the temporary sediment basin. Appropriate procedures should be implemented to prevent discharge of turbid waters when the basin is being converted into an ED pond.

Step 2: Stabilize the Drainage Area. ED ponds should only be constructed after the contributing drainage area to

the pond is completely stabilized or if water is routed around them during construction. If the proposed pond site will be used as a sediment trap or basin during the construction phase, the construction notes should clearly indicate that the facility will be dewatered, dredged and re-graded to design dimensions after the original site construction is complete.

Step 3: Assemble Construction Materials on-site, make sure they meet design specifications, and prepare any staging areas.

Step 4: Clear and Strip the project area to the desired sub-grade.

Step 5: Install EPSC Controls prior to construction, including temporary de-watering devices and stormwater diversion practices. All areas surrounding the pond that are graded or denuded during construction must be planted with turf grass, native plantings, or other approved methods of soil stabilization.

Step 6: Excavate the Core Trench and Install the Spillway Pipe.

Step 7: Install the Riser or Outflow Structure and ensure the top invert of the overflow weir is constructed level at the design elevation.

Step 8: Construct the Embankment and any Internal Berms in 8 to 12-inch lifts and compact the lifts with appropriate equipment.

Step 9: Excavate/Grade until the appropriate elevation and desired contours are achieved for the bottom and side slopes of the ED pond.

Step 10: Construct the Emergency Spillway in cut or structurally stabilized soils.

Step 11: Install Outlet Pipe**s**, including downstream rip-rap apron protection and/or channel armor, as necessary.

Step 12: Stabilize Exposed Soils with temporary seed mixtures appropriate for the pond. All areas above the normal pool elevation should be permanently stabilized by hydroseeding or seeding over straw.

Step 13: Plant the Pond Area, following the pond-scaping plan (see **Section 6.7**).

8.2 CONSTRUCTION INSPECTION

Multiple inspections are critical to ensure that stormwater ponds are properly constructed. Inspections are recommended during the following stages of construction:

- Pre-construction meeting
- Initial site preparation (including installation of EPSC controls)
- Excavation/Grading (interim and final elevations)
- Installation of the embankment, the riser/primary spillway, and the outlet structure
- Implementation of the pond-scaping plan and vegetative stabilization
- Final inspection (develop a punch list for facility acceptance)

If the ED pond has a permanent pool, then to facilitate maintenance the contractor should measure the actual constructed pond depth at three areas within the permanent pool (forebay, mid-pond and at the riser), and they should mark and geo-reference them on an as-built drawing. This simple data set will enable maintenance inspectors to determine pond sediment deposition rates in order to schedule sediment cleanouts.

SECTION 9: MAINTENANCE

9.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

9.2 MAINTENANCE INSPECTIONS

Maintenance of ED ponds is driven by annual inspections that evaluate the condition and performance of the pond, including the following:

- Measure sediment accumulation levels in forebay.
- Monitor the growth of wetlands, trees and shrubs planted, and note the presence of any invasive plant species.
- Inspect the condition of stormwater inlets to the pond for material damage, erosion or undercutting.
- Inspect the banks of upstream and downstream channels for evidence of sloughing, animal burrows, boggy areas, woody growth, or gully erosion that may undermine embankment integrity.
- Inspect pond outfall channel for erosion, undercutting, rip-rap displacement, woody growth, etc.
- Inspect condition of principal spillway and riser for evidence of spalling, joint failure, leakage, corrosion, etc.
- Inspect condition of all trash racks, reverse sloped pipes or flashboard risers for evidence of clogging, leakage, debris accumulation, etc.
- Inspect maintenance access to ensure it is free of woody vegetation, and check to see whether valves, manholes and locks can be opened and operated.
- Inspect internal and external side slopes of the pond for evidence of sparse vegetative cover, erosion, or slumping, and make needed repairs immediately.

9.3 COMMON ONGOING MAINTENANCE ISSUES

ED ponds are prone to a high clogging risk at the ED low-flow orifice. This component of the pond's plumbing should be inspected at least twice a year after initial construction. The constantly changing water levels in ED ponds make it difficult to mow or manage vegetative growth. The bottom of ED ponds often become soggy, and water-loving trees such as willows may take over. The maintenance plan should clearly outline how vegetation in the pond will be managed or harvested in the future.

The maintenance plan should schedule a cleanup at least once a year to remove trash and floatables that tend to accumulate in the forebay, micropool, and on the bottom of ED ponds.

Frequent sediment removal from the forebay is essential to maintain the function and performance of an ED pond. Maintenance plans should schedule cleanouts every 5 to 7 years, or when inspections indicate that 50% of the forebay capacity has been filled. Sediments excavated from ED ponds are not usually considered toxic or hazardous and can be safely disposed by either land application or land filling.

SECTION 10: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in Appendix D. Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 11: COMMUNITY AND ENVIRONMENTAL CONCERNS

Extended Detention Ponds can generate the following community and environmental concerns that need to be addressed during design.

Aesthetics. ED ponds tend to accumulate sediment and trash, which residents are likely to perceive as unsightly and creating nuisance conditions. Fluctuating water levels in ED ponds also create a difficult landscaping environment. In general, designers should avoid designs that rely solely on *dry* ED ponds.

Existing Wetlands. ED ponds should never be constructed within existing *natural* wetlands, nor should they inundate or otherwise change the hydroperiod of existing wetlands.

Existing Forests. Designers can expect a great deal of neighborhood opposition if they do not make a concerted effort to save mature trees during design and pond construction. Designers should also be aware that even modest changes in inundation frequency can kill upstream trees (Cappiella *et al.,* 2007).

Safety Risk. ED ponds are generally considered to be safer than other pond options, since they have few deep pools. Steep side-slopes and unfenced headwalls, however, can still create some safety risks. Gentle side slopes should be provided to avoid potentially dangerous drop-offs, especially where ED ponds are located near residential areas.

Mosquito Risk. The fluctuating water levels within ED ponds have potential to create conditions that lead to mosquito breeding. Mosquitoes tend to be more prevalent in irregularly flooded ponds than in ponds with a permanent pool (Santana *et al*., 1994). Designers can minimize the risk by combining ED with a wet pond or wetland.

Sheet Flow

Description: Impervious areas are disconnected, and runoff is routed over a level spreader to sheet flow over adjacent vegetated areas. This slows runoff velocities, promotes infiltration, and allows sediment and attached pollutants to settle and/or be filtered by the vegetation. Disconnection is the process of redirecting flow from rooftop downspouts or impervious areas that are directly connected to the public stormwater system and directing flow to a storage facility, or in this case, an infiltration area through sheet flow.

Variations:
1) Disconnection to vegetated filter strips
2) Disconnection to conserved open space

Components:
- Level spreader – creates sheet flow
- Vegetated filter strip or open space with minimal slope

Advantages/Benefits:
- Cost effective
- Wildlife habitat potential
- High community acceptance

Disadvantages/Limitations:
- Small drainage area
- Sheet flow must be maintained to achieve design goals
- Often requires additional BMPs to achieve runoff reduction goals

Design considerations:
- Must have slopes between 2% and 6%
- Filter strips and conservation areas may be adjacent to and discharge to water quality buffers. Pre-approval by the City Engineer or his designee is required if any part of the filter strip is within the water quality buffer.

Selection Criteria:

50%-75% Runoff Reduction Credits

See Table 7.1

Land Use Considerations:

X	**Residential**
X	**Commercial**
X	**Industrial (with City approval)**

Maintenance:
- Maintain dense, healthy vegetation to ensure sheet flow
- Inspect regularly for signs of erosion

M **Maintenance Burden**
L = Low M = Moderate H = High

SECTION 1. DESCRIPTION

Filter strips are vegetated areas that treat sheet flow delivered from adjacent impervious areas by slowing runoff velocities and allowing sediment and attached pollutants to settle and/or be filtered by the vegetation. The two design variants of filter strips are (1) *Conserved Open Space* and (2) designed *Vegetated Filter Strips*. The design, installation, and management of these design variants are quite different, as outlined in this specification.

In both instances, stormwater must enter the filter strip or conserved open space as sheet flow. If the inflow is from a pipe or channel, an engineered level spreader must be designed in accordance with the criteria contained herein to convert the concentrated flow to sheet flow.

SECTION 2. PERFORMANCE

With proper design and maintenance, these practices can provide relatively high runoff reduction as shown in **Table 7.1**.

Table 7.1: Runoff Volume Reduction Provided by Filter Strips

Stormwater Function	Conservation Area		Vegetated Filter Strip	
	HSG Soils A and B	HSG Soils C and D	HSG Soils A	HSG Soils B [1], C and D
	Assume no CA[2] in Conservation Area		No CA[3]	With CA[2]
Runoff Vol. Reduction (RR)	75%	50%	50%	50%

[1] CSN (2008); CWP (2007)
[2] CA = Compost Amended Soils
[3] Compost amendments are generally not applicable for undisturbed A soils, although it may be advisable to incorporate them on mass-graded A or B soils and/or filter strips on B soils, in order to maintain runoff reduction rates.

SECTION 3. DESIGN TABLE

Conserved Open Space and Vegetated Filter Strips do not have two levels of design. Instead, each must meet the appropriate minimum criteria outlined in **Table 7.2** and **Section 6** to qualify for the indicated level of runoff reduction. In addition, designers must conduct a site visit prior to design to confirm topography and soil conditions.

Table 7.2. Filter Strip Design Criteria

Design Issue	Conserved Open Space	Vegetated Filter Strip
Soil and Vegetative Cover (Sections 6.1 and 6.2)	Undisturbed soils and native vegetation	Amended soils and dense turf cover or landscaped with herbaceous cover, shrubs, and trees
Overall Slope and Width (perpendicular to the flow) (Section 5)	0.5% to 3% Slope – Minimum 35 ft width 3% to 6% Slope – Minimum 50 ft width The first 10 ft. of filter must be 2% or less in all cases [2]	1% [1] to 4% Slope – Minimum 35 ft. width 4% to 6% Slope – Minimum 50 ft. width The first 10 ft. of filter must be 2% or less in all cases
Sheet Flow (Section 5)	Maximum flow length of 150 ft. from adjacent pervious areas; Maximum flow length of 75 ft. from adjacent impervious areas	
Concentrated Flow (Section 6.3)	Length of ELS[6] Lip = 13 lin. ft. per each 1 cfs of inflow if area has 90% Cover[3] Length = 40 lin. ft. per 1 cfs for[4] forested or re-forested areas (ELS[6] length = 13 lin.ft. min; 130 lin.ft. max.)	Length of ELS[6] Lip = 13 lin.ft. per each 1 cfs of inflow (13 lin.ft. min; 130 lin.ft. max.)
Construction Stage (Section 7)	Located outside the limits of disturbance and protected by ESC controls	Prevent soil compaction by heavy equipment
Typical Applications	Adjacent to stream or wetland buffer or forest conservation area	Treat small areas of Impervious Cover (e.g., 5,000 sf) close to source
Compost Amendments (Section 6.1)	No	Yes (B, C, and D soils)[5]
Boundary Spreader (Section 6.3)	GD [6] at top of filter	GD[6] at top of filter

[1] A minimum of 1 % is recommended to ensure positive drainage.

[2] For Conservation Areas with a varying slope, a pro-rated length may be computed only if the first 10 ft. is 2% or less.

[3] Vegetative Cover is described in **Section 6.2**.

[4] Where the Conserved Open Space is a mixture of native grasses, herbaceous cover and forest (or re-forested area), the length of the ELS [6] Lip can be established by computing a weighted average of the lengths required for each vegetation type. Refer to **Section 6.3** for design criteria

[5] The City may waive the requirement for compost amended soils for filter strips on B soils under certain conditions (see **Section 6.1**).

[6] ELS = Engineered Level Spreader; GD = Gravel Diaphragm; PB = Permeable Berm.

SECTION 4. TYPICAL DETAILS

Figure 7.1 shows a typical approach for sheet flow to a conserved open space (Cappiella *et al.*, 2006). **Figures 7.2 and 7.3** provide standard details for an engineered level spreader modeled off those developed by North Carolina State University (Hathaway and Hunt, 2006).

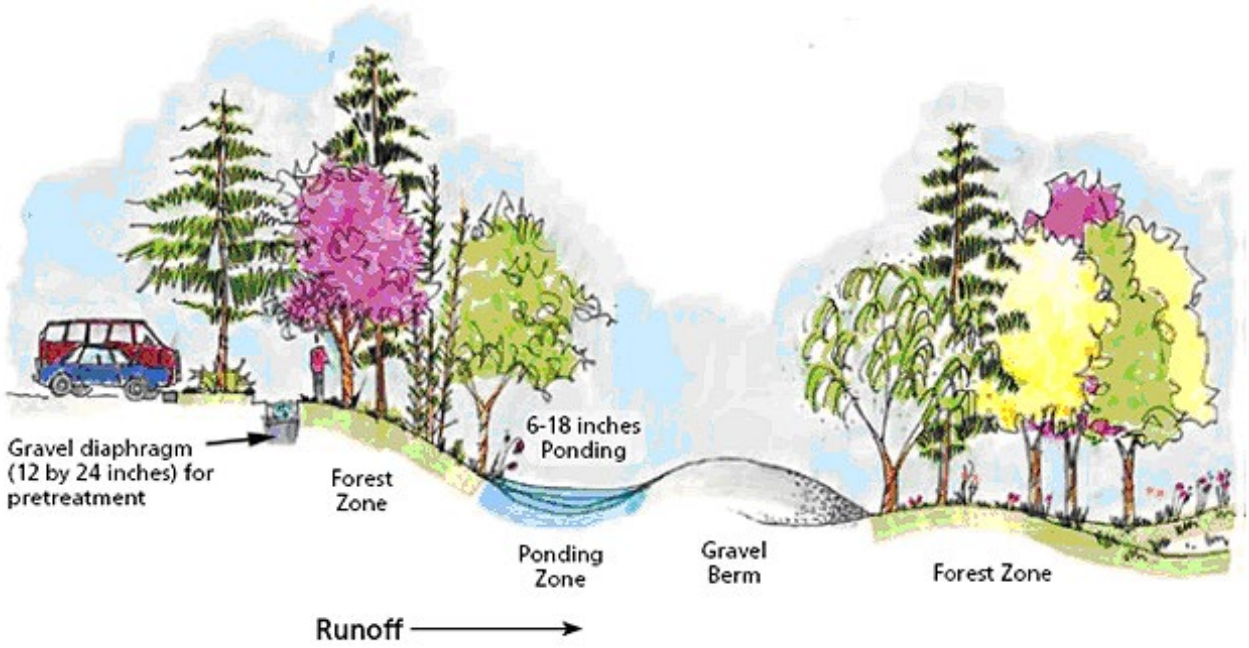


Figure 7.1. Typical Sheet flow to Conserved Open Space (Hathaway and Hunt 2006)

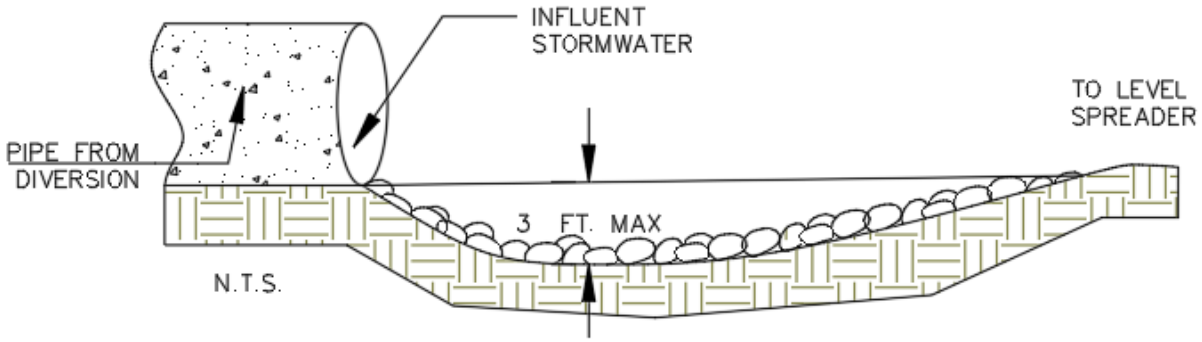


Figure 7.2. Level Spreader Forebay

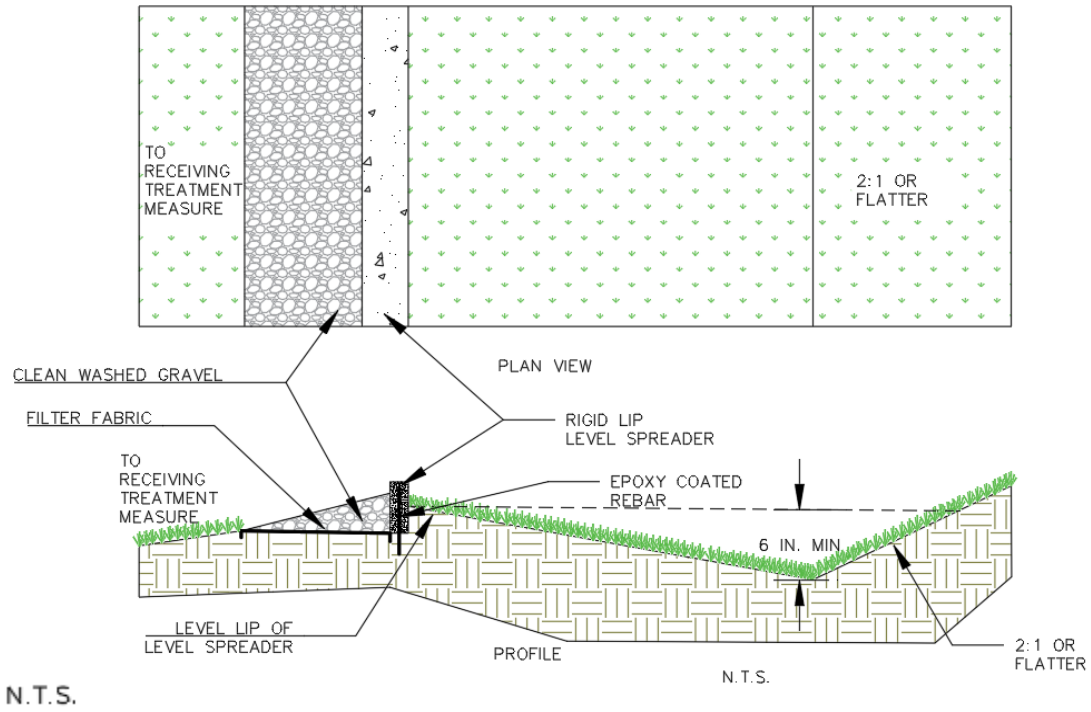


Figure 7.3: Section - Level Spreader with Rigid Lip

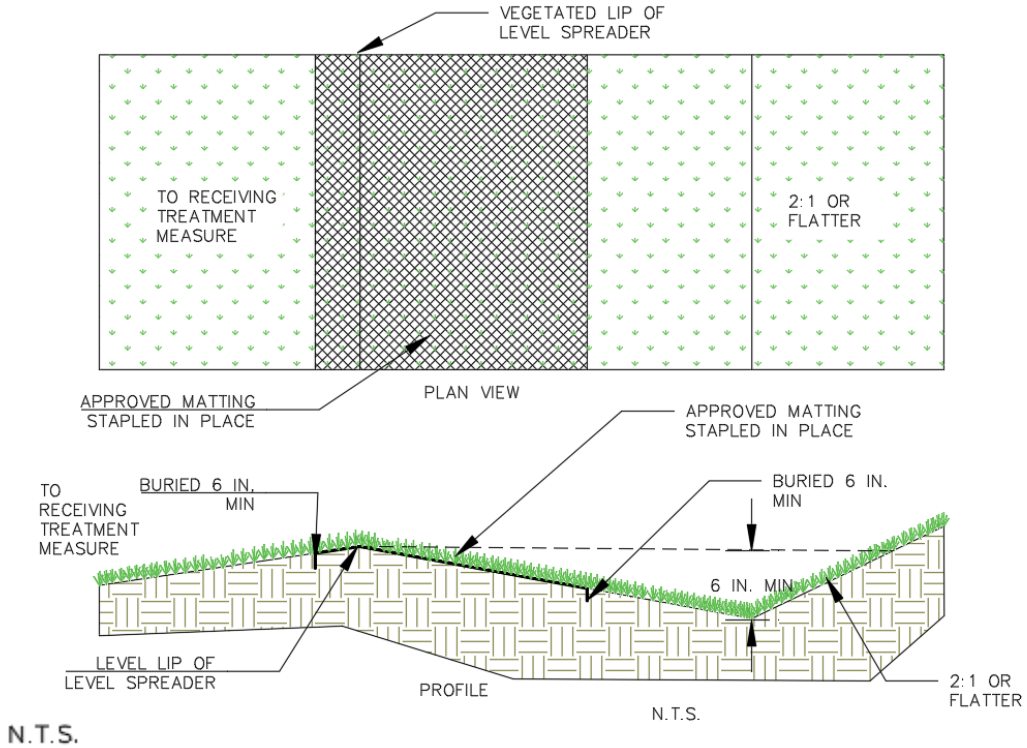


Figure 7.5: Section - Alternative Level Spreader with Vegetated Lip

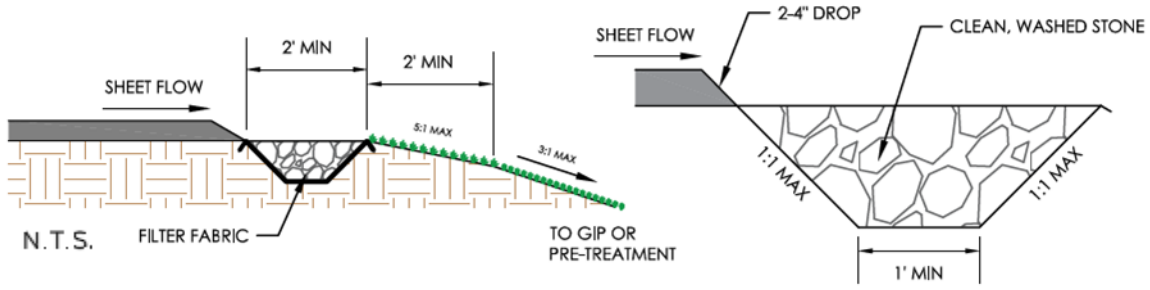


Figure 7.6 – Gravel Diaphragm – Sheet Flow Pre-treatment

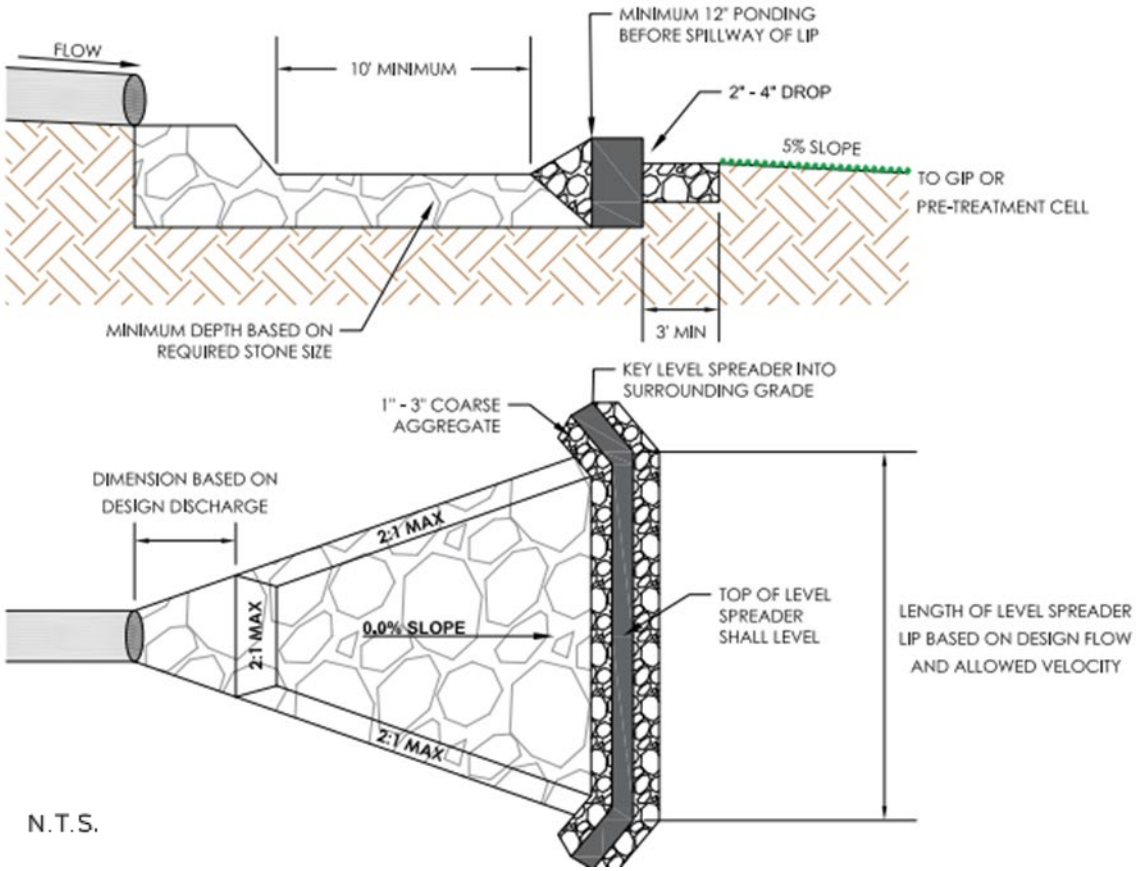


Figure 7.7: Level Spreader: Pipe or Channel Flow to Filter Strip or Preserved Open Space

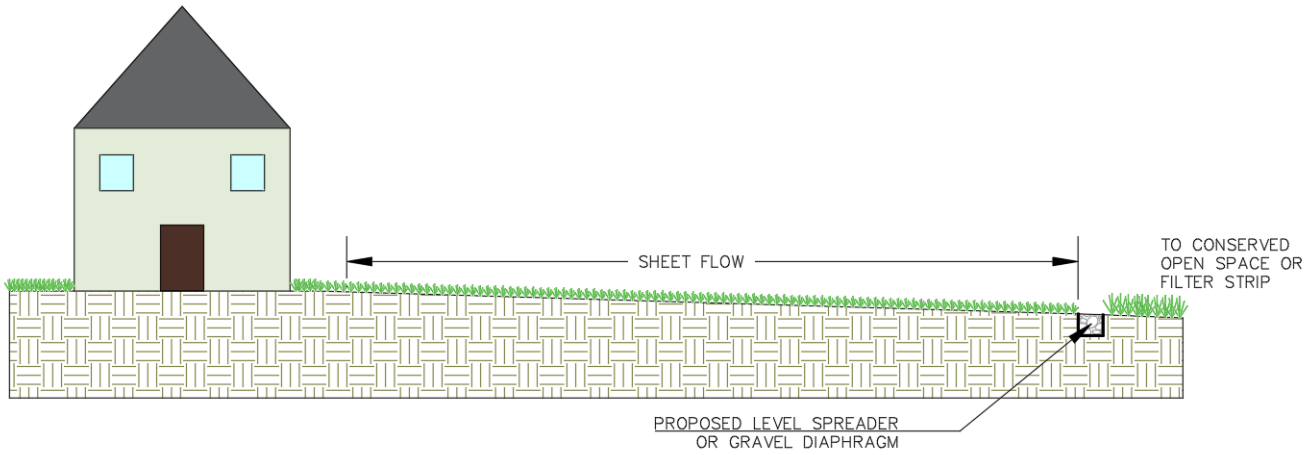


Figure 7.8: Simple Disconnection of a roof drain to downstream Preserved Open Space or Vegetated Filter Strip

SECTION 5. PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

5.1 CONSERVED OPEN SPACE

Designers may apply a runoff reduction credit to any impervious that is hydrologically connected and effectively treated by a protected conserved open space that meets the following eligibility criteria:

- No major disturbance shall occur within the conserved open space during or after construction (i.e., no clearing or grading is allowed except temporary disturbances associated with incidental utility construction, restoration operations, or management of nuisance vegetation). The conserved open space area shall not be stripped of topsoil. Some light grading may be needed at the boundary using tracked vehicles to prevent compaction.
- The limits of disturbance shall be clearly shown on all construction drawings and protected by acceptable signage and erosion control measures. The conserved open space shall not be included within the limits of disturbance.
- A long term vegetation management plan shall be prepared to maintain the conserved open space in a natural vegetative condition. Generally, conserved open space management plans do not allow any active management. However, a specific plan should be developed to manage the unintended consequences of passive recreation, control invasive species, provide for tree and understory maintenance.
- The conserved open space shall be protected by a green infrastructure easement that assigns the responsible party to ensure that no future development, disturbance, or clearing may occur within the area.
- The practice does **not apply** to jurisdictional wetlands or riparian buffers that are sensitive to increased inputs of stormwater runoff.

5.2 VEGETATED FILTER STRIPS

Vegetated filter strips are best suited to treat runoff from small segments of impervious cover (usually less than 5,000 sq. ft) adjacent to road shoulders, small parking lots and rooftops. Vegetated filter strips may also be used as pretreatment for another stormwater practice such as a water quality swale, bioretention, or infiltration areas. If enough pervious area is available at the site, larger areas of impervious cover can be treated by vegetated filter strips, using an engineered level spreader to recreate sheet flow.

Conserved open space and vegetated filter strips can be used in a variety of situations; however, there are several constraints to their use:

Filter Slopes and Widths. Maximum slope for both conserved open space and vegetated filter strips is 6%, in order to maintain sheet flow through the practice. In addition, the overall contributing drainage area must likewise be relatively flat to ensure sheet flow draining into the filter. Where this is not possible, alternative measures, such as an engineered level spreader, can be used. Minimum widths (flow path) for conserved open space and vegetated filter strips are dependent on slope, as specified in **Table 7.2**.

Soils. Vegetated filter strips are appropriate for all soil types, except fill soils. The runoff reduction rate, however, is dependent on the underlying Hydrologic Soil Groups (see **Table 7.1**) and whether soils receive compost amendments.

Contributing Flow Path to Filter. Vegetated filter strips are used to treat very small drainage areas of a few acres or less. The limiting design factor is the length of flow directed to the filter. As a rule, flow tends to concentrate after 75 feet of flow length for impervious surfaces, and 150 feet for pervious surfaces when flow concentrates, it moves too rapidly to be effectively treated by a vegetated filter strip, unless an engineered level spreader is used. When the existing flow at a site is concentrated, other green infrastructure practices shall be used instead of a vegetated filter strip.

Proximity of Underground Utilities. Underground pipes and conduits that cross the vegetated filter strip are not allowed.

Use with Riparian Buffers. Zone 1 riparian buffers can be used as a vegetated filter strip with pre-approval by the City Engineer or his designee. Any level spreader or gravel diaphragm shall be located outside of the riparian buffer limits. All vegetated filter strips located within the zone 1 buffer shall have a green infrastructure easement. No utilities shall cross the vegetated filter strip. All requirements for slopes and widths shall be met.

SECTION 6. DESIGN CRITERIA

6.1 COMPOST SOIL AMENDMENTS

Compost soil amendments will enhance the runoff reduction capability of a vegetated filter strip when located on hydrologic soil groups B, C, and D, subject to the following design requirements:

- The compost amendments should extend over the full length and width of the filter strip.
- The amount of approved compost material and the depth to which it must be incorporated is outlined in Appendix 7-A.
- The amended area will be raked to achieve the most level slope possible without using heavy construction equipment, and it will be stabilized rapidly with perennial grass and/or herbaceous species. It shall be seeded, not sodded.
- If slopes exceed 3%, a protective biodegradable fabric or matting shall be installed to stabilize the site prior to runoff discharge.
- Compost amendments shall not be incorporated until the gravel diaphragm and/or engineered level spreader are installed (see **Section 6.3**).
- The City may waive the requirement for compost amendments on HSG-B soils in order to receive credit as a filter strip if (1) the designer can provide verification of the adequacy of the on-site soil type, texture, and profile to function as a filter strip, and (2) the area designated for the filter strip will not be disturbed during construction.

6.2 PLANTING AND VEGETATION MANAGEMENT

Conserved Open Space. No grading or clearing of native vegetation is allowed within the conserved open space.

Reforested Conserved Open Space. At some sites, the conserved open space may be in turf or meadow cover or overrun with invasive plants and vines. In these situations, a landscape architect should prepare a reforestation plan for the conserved open space utilizing the reforestation specifications as described under **GIP-08, Reforestation**, with any credits and associated plans receiving approval by the City.

Vegetated Filter Strips. Vegetated filter strips should be planted at such a density to achieve a 90% grass/herbaceous cover after the second growing season. Performance has been shown to fall rapidly as vegetative cover falls below 80%. Filter strips shall be seeded, not sodded, whenever possible. Seeding establishes deeper roots, and sod may have muck soil that is not conducive to infiltration. The filter strip vegetation may consist of turf grasses, meadow grasses, other herbaceous plants, shrubs, and trees, as long as the primary goal of at least 90% coverage with grasses and/or other herbaceous plants is achieved. Designers should choose vegetation that stabilizes the soil and is salt tolerant. Vegetation at the toe of the filter, where temporary ponding may occur behind the permeable berm, shall be able to withstand both wet, with approximately 6 inches of ponding, and dry periods. The planting areas can be divided into zones to account for differences in inundation and slope.

6.3 GRAVEL DIAPHRAGMS, BERMS AND LEVEL SPREADERS

Gravel Diaphragms. A gravel diaphragm at the top of the slope is required for both conserved open space and vegetated filter strips that receive sheet flow. The gravel diaphragm is created by excavating a 2-foot wide and 1-foot deep trench that runs on the same contour at the top of the filter strip or conserved open space. The diaphragm serves two purposes. First, it acts as a pretreatment device, settling out sediment particles before they reach the practice. Second, it acts as a level spreader, maintaining sheet flow as runoff flows over the filter strip. Stone shall be sized based on the flows received. Refer to **Figure 7.6.**

- The flow should travel over the impervious area and to the practice as sheet flow and then drop 2 to 4 inches onto the gravel diaphragm. The drop helps to prevent runoff from running laterally along the pavement edge, where grit and debris tend to build up (thus allowing by-pass of the filter strip).
- A layer of filter fabric shall be placed between the gravel and the underlying soil trench.

Permeable Berm. Vegetated filter strips should be designed with a permeable berm at the toe of the filter strip to create a shallow ponding area. Runoff ponds behind the berm and gradually flows through outlet pipes in the berm or through a gravel lens in the berm with a perforated pipe. During larger storms, runoff may overtop the berm. The permeable berm shall have the following properties:

- A wide and shallow trench, 6 to 12 inches deep, shall be excavated at the upstream toe of the berm, parallel with the contours.
- The berm 6 to 12 inches high should be located down gradient of the excavated depression and should have gentle side slopes to promote easy mowing.
- Stone may be needed to armor the top of berm to handle extreme storm events.
- A permeable berm is not needed when vegetated filter strips are used as pretreatment to another stormwater practice.

Engineered Level Spreaders. The design of engineered level spreaders should conform to the following design criteria in order to ensure non-erosive sheet flow into the vegetated area.

The flow is directed through a stilling basin energy dissipater and then a level spreader such that the entire design storm for the conveyance system (typically a 10-year frequency storm) is discharged as sheet flow.

Key design elements of the engineered level spreader, as provided in **Figures 7.2 and 7.3**, include the following:

- High flow bypass provides safe passage for larger design storms through the filter strip. The bypass channel should accommodate all peak flows greater than the water quality design flow.

- A forebay should have a maximum depth of 3 feet (**Figure 7.2**). A permeable berm shall be used to prevent extended ponding within the forebayThe forebay is sized such that the surface area is 0.2% of the contributing impervious area. A forebay is not necessary if the concentrated flow is from the outlet of an extended detention basin or similar practice.
- The length of the level spreader shall be determined by the type of filter area and the design flow:
  - 13 feet of level spreader length per every 1 cubic foot per second (cfs) of inflow for discharges to a vegetated filter strip or conserved open space consisting of native grasses or thick ground cover;
  - 40 feet of level spreader length per every 1 cfs of inflow when the spreader discharges to a conserved open space consisting of forested or reforested area (Hathaway and Hunt, 2006).
  - Where the conserved open space is a mix of grass and forest (or re-forested), establish the level spreader length by computing a weighted average of the lengths required for each vegetation type.
  - The minimum level spreader length is 13 feet and the maximum is 130 feet.
  - For the purposes of determining the level spreader length, the peak discharge shall be determined using the rational equation with an intensity of 1-inch/hour.
- The level spreader lip shall be concrete, with a well-anchored footer, or other accepted rigid, non-erodible material.
- The ends of the level spreader section should be tied back into the slope to avoid scouring around the ends of the level spreader; otherwise, short-circuiting of the facility could create erosion.
- The width of the level spreader channel on the up-stream side of the level lip should be three times the diameter of the inflow pipe, and the depth should be 9 inches or one-half the culvert diameter, whichever is greater.
- The level spreader shall be placed 3 to 6 inches above the downstream natural grade elevation to avoid turf buildup. In order to prevent grade drops that re-concentrate the flows, a section of course aggregate, underlain by filter fabric, shall be installed just below the spreader to transition from the level spreader to natural grade.

Vegetated receiving areas down-gradient from the level spreader must be able to withstand the force of the flow coming over the lip of the device. It may be necessary to stabilize this area with temporary or permanent materials in accordance with the calculated velocity (on-line system peak, or diverted off-line peak) and material specifications, along with seeding and stabilization in conformance with the Tennessee Erosion and Sediment Control Handbook.

6.4 FILTER DESIGN MATERIAL SPECIFICATIONS

Table 7.3 describes materials specifications for the primary treatment within filter strips.

Table 7.3. Vegetated Filter Strip Materials Specifications

Material	Specification	Quantity
Gravel Diaphragm	Size of the stone used shall be sized based on the flow at a 10-year storm event.	Diaphragm should be 2 feet wide, 1 foot deep, and at least 3 inches below the edge of pavement.
Permeable Berm	40% excavated soil, 40% sand, and 20% gravel to serve as the media for the berm.	
Geotextile	Needled, non-woven, polypropylene geotextile meeting the following specifications: Grab Tensile Strength (ASTM D4632): > 120 lbs. Mullen Burst Strength (ASTM D3786): > 225 lbs./sq. in. Flow Rate (ASTM D4491): > 125 gpm/sq. ft. Apparent Opening Size (ASTM D4751): US #70 or #80 sieve	
Engineered Level Spreader	Level Spreader lip should be concrete, metal, or other rigid material; Reinforced channel on upstream of lip.	

Erosion Control Fabric or Matting	Where flow velocities dictate, use woven biodegradable erosion control fabric or mats that are durable enough to last at least 2 growing seasons.
Topsoil	If existing topsoil is inadequate to support dense turf growth, imported top soil (loamy sand or sandy loam texture), with less than 5% clay content, corrected pH at 6 to 7, a soluble salt content not exceeding 500 ppm, and an organic matter content of at least 2% shall be used. Topsoil shall be uniformly distributed and lightly compacted to a minimum depth of 6 to 8 inches
Compost	Compost shall be derived from plant material and provided by a member of the U.S. Composting Seal of Testing Assurance (STA) program, as outlined in **Appendix 7-A**.

SECTION 7: CONSTRUCTION

7.1 CONSTRUCTION SEQUENCE FOR CONSERVED OPEN SPACE AREAS

The conserved open space must be fully protected during the construction stage of development and kept outside the limits of disturbance on the Erosion Prevention and Sediment Control (EPSC) Plan.

- No clearing, grading or heavy equipment access is allowed except temporary disturbances associated with incidental utility construction, restoration operations or management of nuisance vegetation.
- The perimeter of the conserved open space shall be protected by a silt fence, chain link fence, orange safety fence, or other measures in order to meet stormwater pollution prevention sediment discharge requirements.
- The limits of disturbance should be clearly shown on site development plans, grading permit applications and/or concept plans and identified and shall be clearly marked in the field.
- Construction of the gravel diaphragm or engineered level spreader shall not commence until the contributing drainage area has been stabilized and perimeter EPSC has been removed and cleaned out.
- Some light grading may be needed at the filter strip boundary; this should be done with tracked vehicles to prevent compaction.
- Stormwater should not be diverted into the vegetated filter strip until the gravel diaphragm and/or level spreader are installed and stabilized.

7.2 CONSTRUCTION SEQUENCE FOR VEGETATED FILTER STRIPS

Vegetated filter strips can be within the limits of disturbance during construction. The following procedures should be followed during construction:

- Before site work begins, vegetated filter strip boundaries should be clearly marked.
- Only vehicular traffic used for filter strip construction should be allowed within 10 feet of the filter strip boundary.
- If existing topsoil is stripped during grading, it shall be stockpiled for later use.
- Construction runoff should be directed away from the proposed filter strip site, using perimeter silt fence, or, preferably, a diversion dike.
- Construction of the gravel diaphragm or engineered level spreader shall not commence until the contributing drainage area has been stabilized and perimeter EPSC has been removed and cleaned out.
- Vegetated filter strips require light grading to achieve desired elevations and slopes. This should be done with tracked vehicles to prevent compaction. Topsoil and or compost amendments should be incorporated evenly across the filter strip area, stabilized with seed, and protected by biodegradable erosion control matting or blankets.
- Stormwater should not be diverted into the filter strip until the turf cover is dense and well established.

7.3 CONSTRUCTION INSPECTION

Construction inspection is critical to obtain adequate spot elevations, to ensure the gravel diaphragm or engineered level spreader is completely level, on the same contour and constructed to the correct design elevation. As-built certification is required to ensure compliance with design standards. Inspectors should evaluate the performance of the Filter Strip after the first big storm to look for evidence of gullies, outflanking, undercutting or sparse vegetative cover. Spot repairs should be made, as needed.

SECTION 8. AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 9. MAINTENANCE

9.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

Any sheet flow GIP shall be covered by a green infrastructure easement to allow inspection and maintenance and be included in the site's LTMP to ensure that no future development, disturbance or clearing may occur within the area, except as stipulated in the vegetation maintenance plan.

9.2 MAINTENANCE INSPECTIONS

Annual inspections are used to trigger maintenance operations such as sediment removal, spot re-vegetation and level spreader repair. Ideally, inspections should be conducted in the non-growing season when it easier to see the flow path.

Inspectors should check to ensure that:

- Flows through the filter strip do not short-circuit the overflow control section;
- Debris and sediment does not build up at the top of the filter strip;
- Foot or vehicular traffic does not compromise the gravel diaphragm;
- Scour and erosion do not occur within the filter strip;
- Sediments are cleaned out of level spreader forebays and flow splitters; and
- Vegetative density exceeds a 90% cover in the boundary zone or grass filter.

9.3 ONGOING MAINTENANCE

Once established, vegetated filter strips have minimal maintenance needs outside of the spring clean-up, regular mowing, repair of check dams and other measures to maintain the hydraulic efficiency of the strip and a dense, healthy grass cover. Vegetated filter strips that consist of grass/turf cover should be mowed at least twice a year to prevent woody growth. Vegetated filter strips within the riparian buffer are no touch, no disturb. No vegetation maintenance activities shall be performed within the riparian buffer.

APPENDIX 7-A

DESIGN CRITERIA FOR AMENDING SOILS WITH COMPOST

SECTION 1: DESCRIPTION

Soil restoration is a practice applied after construction, to deeply till compacted soils and restore their porosity by amending them with compost. These soil amendments can reduce the generation of runoff from compacted urban lawns and may also be used to enhance the runoff reduction performance of filter strips.

SECTION 2: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

Compost amended soils are suitable for any pervious area where soils have been or will be compacted by the grading and construction process. They are particularly well suited when existing soils have low infiltration rates (HSG C and D) and when the pervious area will be used to filter runoff. The area or strip of amended soils should be hydraulically connected to the stormwater conveyance system. Soil restoration is recommended for sites that will experience mass grading of more than a foot of cut and fill across the site.

Compost amendments are not recommended where:

- Existing soils have high infiltration rates (e.g., HSG A and B), although compost amendments may be needed at mass-graded B soils in order to maintain runoff reduction rates.
- The water table or bedrock is located within 1.5 feet of the soil surface.
- Slopes exceed 10%.
- Existing soils are saturated or seasonally wet.
- They would harm roots of existing trees (keep amendments outside the tree drip line).
- The downhill slope runs toward an existing or proposed building foundation.
- The contributing impervious surface area exceeds the surface area of the amended soils.

Compost amendments can be applied to the entire pervious area of a development or be applied only to select areas of the site to enhance the performance of runoff reduction practices. Some common design applications include:

- Reduce runoff from compacted lawns.
- Increase runoff reduction within a vegetated filter strip.
- Increase the runoff reduction function of a tree cluster or reforested area of the site.

SECTION 3: DESIGN CRITERIA

3.1 SOIL TESTING

Soil tests are required during two stages of the compost amendment process. The first testing is done to ascertain pre-construction soil properties at proposed amendment areas. The initial testing is used to determine soil properties to a depth 1 foot below the proposed amendment area, with respect to bulk density, pH, salts, and soil nutrients. These tests should be conducted every 5,000 square feet, and are used to characterize potential drainage problems and determine what, if any, further soil amendments are needed.

The second soil test is taken at least one week after the compost has been incorporated into the soils. This soil analysis should be conducted by a reputable laboratory to determine whether any further nutritional requirements,

pH adjustment, and organic matter adjustments are necessary for plant growth. This soil analysis should be done in conjunction with the final construction inspection to ensure tilling or subsoiling has achieved design depths.

3.2 DETERMINING DEPTH OF COMPOST INCORPORATION

The depth of compost amendment is based on the relationship of the surface area of the soil amendment to the contributing area of impervious cover that it receives. **Table 7-A.1** presents some general guidance derived from soil modeling by Holman-Dodds (2004) that evaluates the required depth to which compost must be incorporated. Some adjustments to the recommended incorporation depth were made to reflect alternative recommendations of Roa Espinosa (2006), Balousek (2003), Chollak and Rosenfeld (1998) and others.

Table 7-A.1. Short-Cut Method to Determine Compost and Incorporation Depths

	Contributing Impervious Cover to Soil Amendment Area Ratio [1]			
	IC/SA = 0 [2]	IC/SA = 0.5	IC/SA = 0.75	IC/SA = 1.0 [3]
Compost (in) [4]	2 to 4 [5]	3 to 6 [5]	4 to 8 [5]	6 to 10 [5]
Incorporation Depth (in)	6 to 10 [5]	8 to 12 [5]	15 to 18 [5]	18 to 24 [5]
Incorporation Method	Rototiller	Tiller	Subsoiler	Subsoiler

Notes:

[1] IC = contrib. impervious cover (sq. ft.) and SA = surface area of compost amendment (sq. ft.)

[2] For amendment of compacted lawns that do not receive off-site runoff

[3] In general, IC/SA ratios greater than 1 should be avoided

[4] Average depth of compost added

[5] Lower end for B soils, higher end for C/D soils

Once the area and depth of the compost amendments are known, the designer can estimate the total amount of compost needed using the following estimator:

Equation 7.1. Compost Quantity Estimation

$$C = A * D * 0.0031$$

Where:

C	=	compost needed (cu. yds.)
A	=	area of soil amended (sq. ft.)
D	=	depth of compost added (in.)

3.3 COMPOST SPECIFICATIONS

The basic material specifications for compost amendments are outlined below:

- The compost shall be the result of the biological degradation and transformation of plant-derived materials under conditions that promote anaerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have a moisture content that has no visible free water or dust produced when handling the material. It shall meet the following criteria:

  a. 100% of the material must pass through a half inch screen
  b. The pH of the material shall be between 6 and 8
  c. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight
  d. The organic matter content shall be between 35% and 65%
  e. Soluble salt content shall be less than 6.0 mmhos/cm
  f. Maturity should be greater than 80%
  g. Stability shall be 7 or less
  h. Carbon/nitrogen ratio shall be less than 25:1
  i. Trace metal test result = "pass"
  j. The compost must have a dry bulk density ranging from 40 to 50 lbs./cu.ft.

SECTION 4: CONSTRUCTION

4.1 CONSTRUCTION SEQUENCE

The construction sequence for compost amendments differs depending whether the practice will be applied to a large area or a narrow filter strip. For larger areas, a typical construction sequence is as follows:

Step 1. Prior to building, the proposed area should be deep tilled to a depth of 2 to 3 feet using a tractor and sub-soiler with two deep shanks (curved metal bars) to create rips perpendicular to the direction of flow. (This step is usually omitted when compost is used for narrower filter strips.)

Step 2. A second deep tilling to a depth of 12 to 18 inches is needed after final building lots have been graded.

Step 3. It is important to have dry conditions at the site prior to incorporating compost.

Step 4. An acceptable compost mix is then incorporated into the soil using a roto-tiller or similar equipment at the volumetric rate of 1 part compost to 2 parts soil.

Step 5. The site should be leveled and seeds or sod used to establish a vigorous grass cover. Lime or irrigation may initially be needed to help the grass grow quickly.

Step 6. Areas of compost amendments exceeding 2500 square feet should employ simple erosion control measures, such as silt fence, to reduce the potential for erosion and trap sediment.

Reforestation

Description: Reforestation refers to trees planted in groups in urban areas such as: parking lots, right of ways (ROW), parks, schools, public lands, vacant land, and neighborhood open spaces, to provide shade and stormwater retention and to add aesthetic value.

Advantages/Benefits:

- Reduces effective impervious cover
- Reduces stormwater runoff
- Provides aesthetic value
- Provides rainfall interception
- Shade provides cooling and energy savings
- Provides habitat
- Provides pollutant removal
- Provides flow attenuation

Disadvantages/Limitations:

- Poor quality urban soils may require soil amendments or remediation
- Long-term maintenance is required for high tree survival rates
- Must be implemented over large areas to see significant reduction in stormwater runoff
- Time required for trees to mature
- Poor soils, improper planting methods, conflicts with paved areas and utilities, inputs from road salt, lack of water, or disease can lead to low survival rate
- Reforestation not allowed in riparian buffers

Design Considerations:

- Stormwater trees are limited to areas where there is enough space for fully grown trees as well as utilities and a separation distance from structures.
- Tree species with desirable stormwater control characteristics should be utilized. For trees receiving runoff, tree species must have a high tolerance for common urban pollutants. This includes salt tolerance if receiving runoff from areas treated for snow and ice. References for appropriate tree selection are included in **Table 8.2**.
- Soils play a significant role in pollutant removal and tree health. Selection of soils intended to improve stormwater controls should allow water to infiltrate into the soil, with planting soil characteristics and volume tailored to meet the needs of a healthy tree.
- Credit is subject to City approval.

Selection Criteria:

Twice the forest Rv factor for the corresponding soil type.

Equal to the forest Rv factor if amended soils are used in conjunction with reforestation.

***This GIP is subject to City approval**

Land Use Considerations:

X	**Residential**
X	**Commercial**
X	**Industrial**

Maintenance:

- Trees may require irrigation in dry periods

L	**Maintenance Burden** L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

Site reforestation involves planting trees at a development site with the explicit goal of establishing a natural forest canopy that will intercept rainfall, increase evapotranspiration rates, and enhance soil infiltration rates. Reforestation is subject to approval from the City Engineer.

SECTION 2: PERFORMANCE

The overall runoff reduction credits for reforestation through lower runoff coefficients are summarized in **Table 8.1**.

Table 8.1. Reforestation Runoff Coefficient Credit

Level 1 Design				**Level 2 Design**			
Twice the forest Rv factor for the corresponding soil type.				Equal to forest Rv factor if Amended Soils (See **GIP-07 A-7**) are used in conjunction.			
A	B	C	D	A	B	C	D
0.04	0.06	0.08	0.10	0.02	0.03	0.04	0.05
Impervious area may be routed to the reforestation area following the guidance and applying the Runoff Coefficient Credits detailed in **GIP-07**. The reforestation area should be treated as a vegetated filter strip for the application of this GIP.							

SECTION 3: DESIGN TABLE

The overall runoff reduction credits for reforestation through lower runoff coefficients are summarized in **Table 8.2.**

Table 8.2. Design Specifications for Reforestation	
Item	**Specifications for Level 1 and Level 2**
Area	Minimum contiguous area of 5,000 sq. ft.
Tree Type	No more than 20% of any single tree species. Consider composition of local forests in planting design. 2/3 of trees must be large canopy. See the USGS landfire map for delineation of forest type and the 2006 Descriptions of Ecological Systems for Modeling of LANDFIRE Biophysical Settings Ecological Systems of location US State TN. PFD for description of species within each forest type. Links: http://landfire.cr.usgs.gov/viewer/ http://www.tn.gov/environment/na/pdf/tn_eco_systems.pdf http://www.se-eppc.org/pubs/middle.pdf
Density	• 300 large canopy trees – species that normally achieve an overall height at maturity of thirty feet or more per acre • 10 shrubs substitute for 1 large canopy tree • 2 small canopy trees substitute for 1 large canopy tree Note: Adjustments to densities may be possible with CITY approval.
Canopy Rate	Achieve 75% forest canopy within first 10 years
Size	Tree - Minimum tree size 6-8 ft in height Shrub – 18-24 inches or 3 gallon size
Ground Cover	Entire area should be covered with 2-4 inches of organic mulch or a native seed mix

Reforestation areas are eligible under the following qualifying conditions:

- The minimum contiguous area of reforestation must be greater than 5,000 square feet, with no more than 20% of the area in any single tree species. The basic density of plantings is 300 large canopy trees per acre, approximately 12 feet on center. When shrubs are substituted for trees, there must be 10 shrubs per one large canopy tree. Two small canopy trees, such as Dogwoods or Red Buds, may be substituted for one large canopy tree. Adjustments can be made to these densities for areas of urban reforestation with the approval of the City. Reforestation should consider the composition of area forests, and two thirds of selected trees must be large canopy. Reforestation methods should achieve 75% forest canopy within ten years.
- The minimum size requirement for reforestation is saplings 6-8 feet in height. The minimum size requirement for shrubs is 18-24 inches, or 3 gallon size. In addition, the entire reforestation should be covered with 2-4 inches of organic mulch or with a native seed mix in order to help retain moisture and provide a beneficial environment for the reforestation.
- A long-term vegetation management plan must be prepared and filed with the City in order to demonstrate the ability to maintain the reforestation area in an appropriate forest canopy condition. The plan should include a scale drawing showing the area to be planted, along with a plant list which includes species, size, number, and packaging. In addition, the reforestation area shall be clearly identified on all construction drawings and EPSC plans during construction.
- The reforestation area must be protected by a perpetual stormwater easement or deed restriction which stipulates that no future development or disturbance may occur within the area.
- The planting plan must be approved by the City, including any special site preparation needs.
- The construction contract should contain a care and replacement warranty extending at least two growing seasons, to ensure adequate growth and survival of the plant community.

- The final size of the trees should be considered when designing the planting plan. Tennessee One-Call (811) must be contacted prior to the submission of the planting plan to ensure that no utilities will be impacted by the tree planting. The planting plan must also avoid placing trees under overhead utilities.
- If using the reforestation area as a vegetated filter strip to receive additional credit under **GIP-07**, follow all GIP design criteria and ensure that additional routed runoff does not cause erosion or degrade the quality of ground cover.

SECTION 4: DESIGN CONSIDERATIONS

Trees are often one of the most economical stormwater BMPs that can be introduced into urban ROWs. Tree canopies intercept rainfall before it becomes stormwater and the tree boxes into which trees are planted can be used to capture and treat runoff. Trees also reduce the urban heat island effect, improve the urban aesthetic and improve air quality. Data and modeling show that urban trees can remove over 50% of the moisture in the soil beneath their canopy. Refer to **Table 8.2** for native tree species. A list of native trees is also provided in **Appendix C**.

Tree plantings within the ROW must receive approval from Public Works. Vacant residential lots also provide reforestation opportunities. These lots can become an urban forest and an amenity to a neighborhood. Vegetation management plans must account for City rules, regulations, and codes regarding overgrown lots and safety concerns of the residents. Special criteria for reforesting empty residential lots include:

- The area between curb and sidewalk and a 10 foot wide buffer adjacent to the sidewalk (away from the street) shall be kept mowed and clear.
- While the trees are being established, mowing is permitted between the trees. Eventually, the canopy should shade out the grass and forest undergrowth will be established. Vegetation management plans should consider if residents would prefer the site mowed in perpetuity.

SECTION 5: DESIGN CRITERIA

5.1 RUNOFF REDUCTION CALCULATIONS

Level 1 Reforestation involves using soil types currently on a site, without soil amendments. Current soil should be preserved from compaction and disturbance during construction and should be clearly identified on all construction drawings and EPSC plans. Trees should be planted following tree selection criteria in **Table 8.2**. Use **Table 8.1** to find Rv factors for Level 1 which equal twice the forested area Rv factors.

Level 2 Reforestation requires the use of amended soils. Soil Amendment guidance is located in **GIP-07 7-A**. This area is then treated as original forested area for calculation purposes. Level 2 design allows for use of Forested Rv factors as shown in **Table 8.1**.

For both levels, once the forest area R_V is determined continue through the design process with weighted R_V calculations located in **Section 1 Chapter 3** of the Manual.

SECTION 6: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 7: MAINTENANCE

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

Mowing is not permitted in reforestation areas. The credit is based on a natural successional forest ecosystem undisturbed by man.

Additional maintenance activities include:

- Watering the trees as needed during dry periods
- Repairing areas of erosion or reseeding areas that are bare
- Removing trash and debris from area
- Replanting any trees that die throughout the year. (The construction contract should contain a care and replacement warranty extending at least two growing seasons, to ensure adequate growth and survival of the plant community.)

Green Roof

Description: A green roof is a layer of vegetation installed on top of a conventional flat or slightly sloped roof that consists of waterproofing material, root permeable filter fabric, growing media, and specially-selected plants.

Variations:

- Extensive green roofs have a thin layer of growing medium and are usually composed of sedums.
- Intensive green roofs have a thicker layer of growing medium and contain shrubs, trees and other vegetation.

Advantages/Benefits:

- Runoff volume reduction
- Provides flow attenuation
- Extends the life of a conventional roof by up to 20 yrs.
- Provides increased insulation and energy savings
- Reduces air pollution
- Provides habitat for wildlife
- Increases aesthetic value
- Provides sound insulation
- Provides water quality treatment
- Reduces urban heat island effect

Disadvantages/Limitations:

- Cost may be greater than a conventional roof, and feasibility is limited by load-bearing capacity of roof
- Must obtain necessary permits and comply with local building codes
- Requires more maintenance than a conventional roof
- Plant survival and waterproofing are potential issues
- May require irrigation

Selection Criteria:

LEVEL 1 – 80% Runoff Reduction Credit

LEVEL 2 – 90% Runoff Reduction Credit

Land Use Considerations:

[X] **Residential**

[X] **Commercial**

[X] **Industrial**

Maintenance:

- May include watering, fertilizing, and weeding, typically greatest in the first two years when plants are becoming established.
- Maintenance largely depends on the type of green roof system installed and the type of vegetation planted.

[M] **Maintenance Burden**
L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

Vegetated roofs (also known as *green roofs, living roofs* or *ecoroofs*) are alternative roof surfaces that typically consist of waterproofing, drainage materials and an engineered growing media that is designed to support plant growth. Vegetated roofs capture and temporarily store stormwater runoff in the growing media before it is conveyed into the storm drain system. A portion of the captured stormwater evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates and pollutant loads on development sites.

There are two different types of vegetated roof systems: *intensive* vegetated roofs and *extensive* vegetated roofs. Intensive systems have a deeper growing media layer that ranges from 6 inches to 4 feet thick, which is planted with a wider variety of plants, including trees. By contrast, extensive systems typically have much shallower growing media (under 6 inches), which is planted with carefully selected drought tolerant vegetation. Extensive vegetated roofs are much lighter and less expensive than intensive vegetated roofs and are recommended for use on most development and redevelopment sites.

NOTE: This specification is intended for situations where the primary design objective of the vegetated roof is stormwater management and, unless specified otherwise, addresses extensive roof systems.

Designers may wish to pursue other design objectives for vegetated roofs, such as energy efficiency, green building or LEED points, architectural considerations, visual amenities and landscaping features, which are often maximized with intensive vegetated roof systems. However, these design objectives are beyond the scope of this specification.

Vegetated roofs typically contain a layered system of roofing, which is designed to support plant growth and retain water for plant uptake while preventing ponding on the roof surface. The roofs are designed so that water drains vertically through the media and then horizontally along a waterproofing layer toward the outlet. Extensive vegetated roofs are designed to minimize maintenance requirements. Plant species are selected so that the roof does not need supplemental irrigation or fertilization after vegetation is initially established. Tray systems are also available with removable dividers which allow the media to meld together, creating a seamless appearance but reducing difficulty in construction.

SECTION 2: PERFORMANCE

The overall stormwater functions of vegetated roofs are summarized in **Table 9.1**.

Table 9.1: Runoff Volume Reduction Provided by Vegetated Roofs

Stormwater Function	Level 1 Design	Level 2 Design
Runoff Volume Reduction (RR)	80%	90%

SECTION 3: DESIGN TABLE

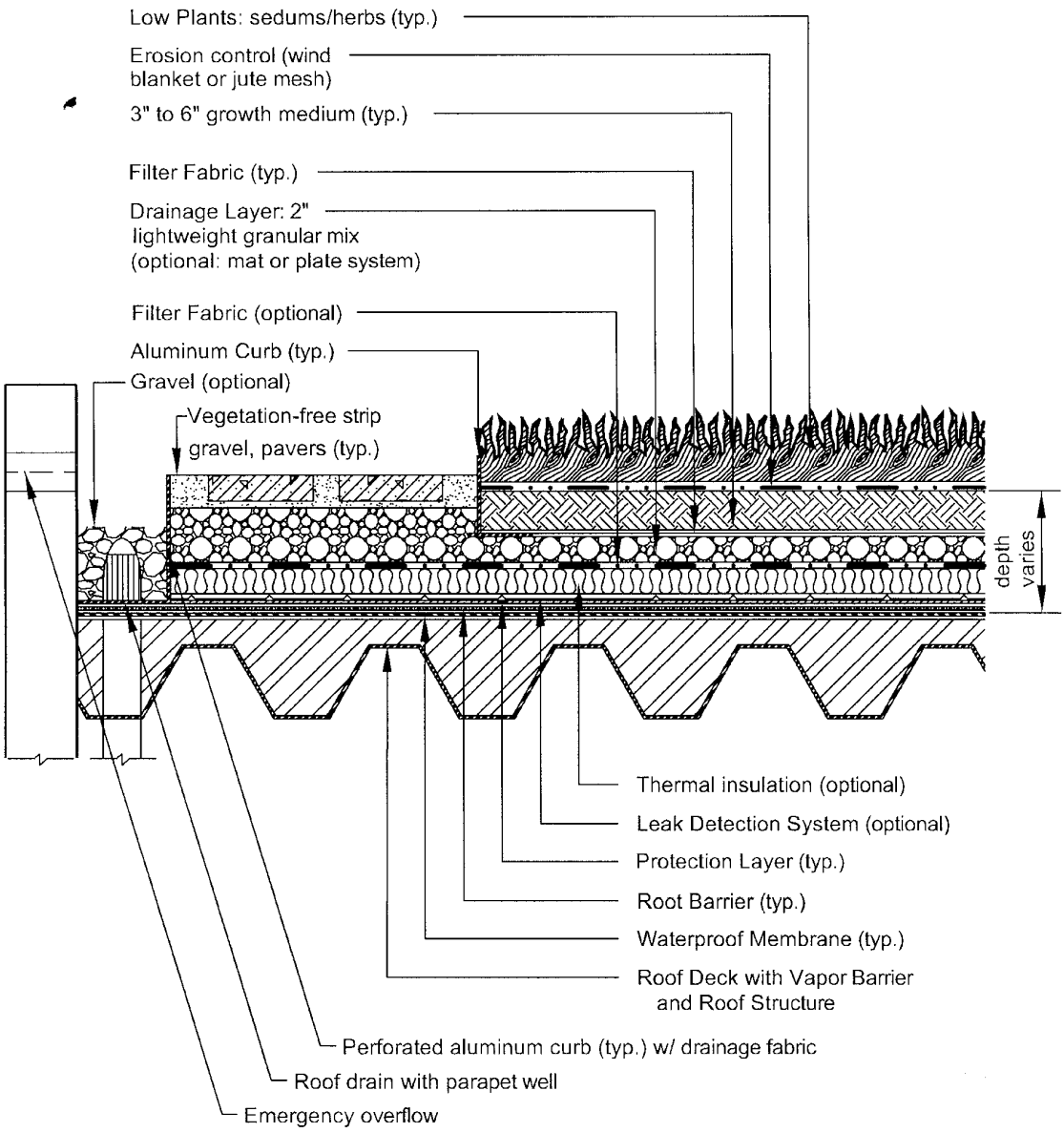
The major design goal for vegetated roofs is to maximize runoff volume reduction. The rooftops have little TSS loading or loading removal. Designers may choose the baseline design (Level 1) or choose an enhanced (Level 2) design that maximizes nutrient and runoff reduction. In general, most intensive vegetated roof designs will automatically qualify as being Level 2. **Table 9.2** lists the design criteria for Level 1 and 2 designs.

Table 9.2: Green Roof Design Guidance	
Level 1 Design (RR:80)	**Level 2 Design (RR: 90)**
Tv = 1.0 (Rv)[1] (A)/12	Tv = 1.1 (Rv) [1] (A)/12
Depth of media up to 6 inches	Media depth > 6 inches
No more than 15% organic matter in media	No more than 15% organic matter in media
All Designs: Must be in conformance to ASTM (2005) International Green (Vegetated) Roof Standards.	

[1]Rv represents the runoff coefficient for a conventional roof, which will usually be 0.95. The runoff reduction rate applied to the vegetated roof is for "capturing" the Treatment Volume (Tv) compared to what a conventional roof would produce as runoff.

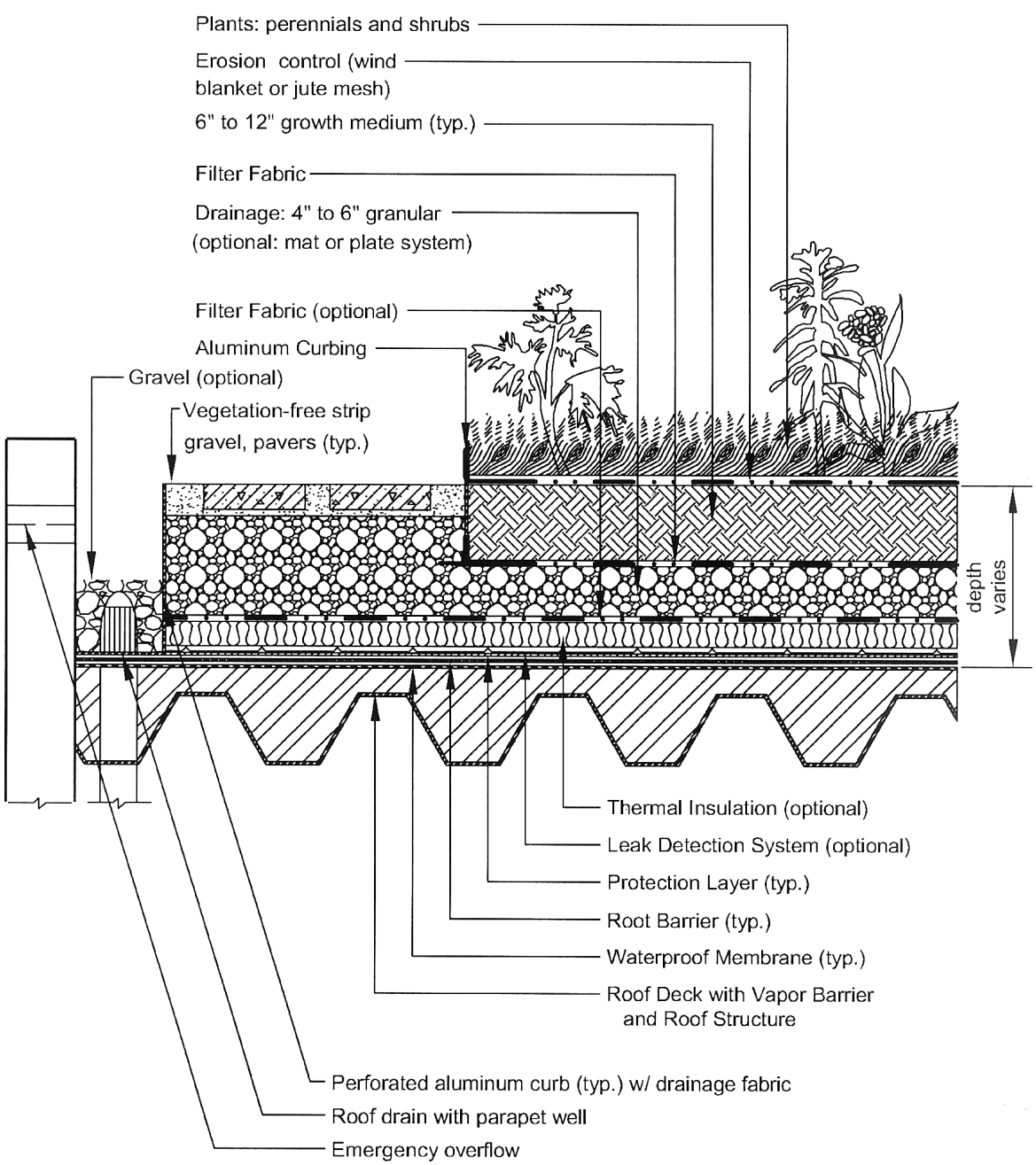
SECTION 4: TYPICAL DETAILS

Figure 9.1. Photos of Vegetated Roof Cross-Sections (source: B. Hunt, NCSU)



CROSS SECTION VIEW (NTS)

Figure 9.2. Typical Section – Extensive Vegetated Roof (Source: Northern VA Regional Commission)



CROSS SECTION (NTS)

Figure 9.3. Typical Section – Intensive Vegetated Roof (Source: Northern VA Regional Commission)

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

5.1 TYPICAL APPLICATIONS

Vegetated roofs are ideal for use on commercial, institutional, municipal and multi-family residential buildings. They are particularly well suited for use on ultra-urban development and redevelopment sites. Vegetated roofs can be used on a variety of rooftops, including the following:

- Non-residential buildings (e.g. commercial, industrial, institutional and transportation uses)
- Multi-family residential buildings (e.g. condominiums or apartments)
- Mixed-use buildings

5.2 COMMON SITE CONSTRAINTS

Building Codes. The vegetated roof design should comply with the City Building Codes with respect to roof drains and emergency overflow devices. If the green roof is designed to be accessible, the access must not only be convenient for installation and maintenance purposes, but also must adhere to City Building Codes and other regulations for access and safety.

Non-Vegetated Areas. Roof access paths, mechanical equipment, photovoltaic panels, and skylights are counted as part of the green roof for calculation purposes. These areas should not exceed 20% of the roof area counted as green roof.

Retrofitting Green Roofs. Key feasibility factors to consider when evaluating a retrofit include the area, age and accessibility of the existing roof, and the capability of the building's owners to maintain it. Options for green roof retrofits are described in Profile Sheet RR-3 of Schueler et al (2007). The structural capacity of the existing rooftop can be a major constraint to a green roof retrofit.

Risks of Leaky Roofs. Although well-designed and installed green roofs have less problems with roof leaks than traditional roofs, there is a perception among property managers, insurers and product fabricators that this emerging technology could have a greater risk of problems. For an excellent discussion on how to properly manage risk in vegetated roof installations, see Chapter 9 in Weiler and Scholz-Barth (2009).

Roof Access. Adequate access to the roof must be available to deliver construction materials and perform routine maintenance. Roof access can be achieved either by an interior stairway, through a penthouse or by an alternating tread device with a roof hatch or trap door not less than 16 square feet in area and with a minimum dimension of 24 inches. Designers should also consider how they will get construction materials up to the roof (e.g., by elevator or crane), and how construction materials will be stockpiled in the confined space.

Roof Pitch. Treatment volume (Tv) is maximized on relatively flat roofs (a pitch of 1 to 2%). Some pitch is needed to promote positive drainage and prevent ponding and/or saturation of the growing media. Vegetated roofs can be installed on rooftops with slopes up to 25% if baffles, grids, or strips are used to prevent slippage of the media. The effective Tv, however, diminishes on rooftops with steep pitches.

Roof Type. Vegetated roofs can be applied to most roof surfaces, although concrete roof decks are preferred. Certain roof materials, such as exposed treated wood and uncoated galvanized metal, may not be appropriate for vegetated rooftops due to pollutant leaching through the media.

Structural Capacity of the Roof. When designing a vegetated roof, designers must not only consider the stormwater storage capacity of the vegetated roof, but also its structural capacity to support the weight of the additional water. A conventional rooftop typically must be designed to support an additional 15 to 30 pounds per square foot for an extensive vegetated roof. As a result, a structural engineer, architect or other qualified professional shall be involved with all vegetated roof designs to ensure that the building is structurally sound.

SECTION 6: DESIGN CRITERIA

6.1 OVERALL SIZING

Vegetated roof areas should be sized to capture a portion of the Treatment Volume (Tv). The required size of a vegetated roof will depend on several factors, including the porosity and hydraulic conductivity of the growing media and the underlying drainage materials. Site designers and planners should consult with vegetated roof manufacturers and material suppliers for specific sizing guidelines. As a general sizing rule, the following equation can be used to determine the water quality treatment storage volume retained by a vegetated roof:

Equation 9.1. Treatment Volume for Green Roof

$$T_v = (RA * D * n)/12$$

Where,

T_v = storage volume (cu. ft.)
RA = vegetated roof area (sq. ft.)
D = media depth (in.)
n = media porosity (usually 0.3, but consult manufacturer specifications)

The resulting Tv can then be compared to the required Tv for the entire rooftop area (including all non-vegetated areas) to determine if it meets or exceeds the required Tv for Level 1 or Level 2 design, as shown in **Table 9.2**.

6.2 STRUCTURAL CAPACITY OF THE ROOF

Vegetated roofs can be limited by the additional weight of the fully saturated growing medium and plants, in terms of the physical capacity of the roof to bear structural loads. The designer should consult with a licensed structural engineer or architect to ensure that the building will be able to support the additional live and dead structural load and determine the maximum depth of the vegetated roof system and any needed structural reinforcement.

In most cases, fully-saturated extensive vegetated roofs have a maximum load of about 30 psf, which is fairly similar to traditional new rooftops (12 to 15 psf.) that have a waterproofing layer anchored with stone ballast. For an excellent discussion of vegetated roof structural design issues, consult Chapter 9 in Weiler and Scholz-Barth (2009) and ASTM E2397, *Standard Practice for Determination of Dead Loads and Live Loads Associated with Green (Vegetated) Roof Systems*.

6.3 FUNCTIONAL ELEMENTS OF A VEGETATED ROOF SYSTEM

A vegetated roof is composed of up to eight different systems or layers, from bottom to top, that are combined together to protect the roof and maintain a vigorous cover. Designers can employ a wide range of materials for each layer, which can differ in cost, performance, and structural load. The entire system as a whole must be assessed to meet design requirements. Some manufacturers offer proprietary vegetated roofing systems, whereas in other cases, the designer or architect must assemble their own system, in which case they are advised to consult Weiler and Scholz-Barth (2009), Snodgrass and Snodgrass (2006) and Dunnett and Kingsbury (2004).

1. ***Deck Layer.*** The roof deck layer is the foundation of a vegetated roof. It and may be composed of concrete, wood, metal, plastic, gypsum or a composite material. The type of deck material determines the

strength, load bearing capacity, longevity and potential need for insulation in the vegetated roof system. In general, concrete decks are preferred for vegetated roofs, although other materials can be used as long as the appropriate system components are matched to them.

2. *Waterproofing Layer.* All vegetated roof systems must include an effective and reliable waterproofing layer to prevent water damage through the deck layer. A wide range of waterproofing materials can be used, including built up roofs, modified bitumen, single-ply, and liquid-applied methods. The waterproofing layer must be 100% waterproof and have an expected lifespan as long as any other element of the vegetated roof system.

3. *Insulation Layer.* Many vegetated rooftops contain an insulation layer, usually located above, but sometimes below, the waterproofing layer. The insulation increases the energy efficiency of the building and/or protects the roof deck (particularly for metal roofs).

4. *Root Barrier (Optional).* The next layer of a vegetated roof system is an optional root barrier that protects the waterproofing membrane from root penetration.. Chemical root barriers or physical root barriers that have been impregnated with pesticides, metals or other chemicals that could leach into stormwater runoff should be avoided.

5. *Drainage Layer and Drainage System.* A drainage layer is then placed between the optional root barrier and the growing media to quickly remove excess water from the vegetation root zone. The drainage layer should consist of synthetic or inorganic materials that can retain water and provide efficient drainage. A wide range of prefabricated water cups or plastic modules can be used, as well as a traditional system of protected roof drains, conductors and roof leaders. The required depth of the drainage layer is governed by both the required stormwater storage capacity and the structural capacity of the rooftop. ASTM E2396 and E2398 can be used to evaluate alternative material specifications.

6. *Root-Permeable Filter Fabric.* A semi-permeable polypropylene filter fabric is normally placed between the drainage layer and the growing media to prevent the media from migrating into the drainage layer and clogging it.

7. *Growing Media.* The next layer in an extensive vegetated roof is the growing media, which is typically 4 to 6 inches deep for extensive roofs and 6 inches or more for intensive roofs. The depth and composition of the media is described in **Section 6.5**.

8. *Plant Cover.* The top layer of a vegetated roof typically consists of slow-growing, shallow-rooted, perennial, succulent plants that can withstand harsh conditions at the roof surface. An experienced design professional should be consulted to select the plant species best suited to a given installation. Guidance on selecting the appropriate vegetated roof plants for hardiness zones in Franklin can be found in Snodgrass and Snodgrass (2006). A mix of base ground covers (usually *Sedum* species) and accent plants can be used to enhance the visual amenity value of a green roof.

6.4 PRETREATMENT

Pretreatment is not needed for green roofs.

6.5 FILTER MEDIA COMPOSITION

The recommended growing media for extensive vegetated roofs is composed of approximately 80% to 90% lightweight inorganic materials, such as expanded slates, shales or clays, pumice, scoria or other similar materials. The remaining media should contain no more than 15% organic matter, normally well-aged

compost. The percentage of organic matter should be limited, since it can leach nutrients into the runoff from the roof and clog the permeable filter fabric. The growing media should have a maximum water retention capacity of around 30%. It is advisable to mix the media in a batch facility prior to delivery to the roof. More information on growing media can be found in Weiler and Scholz-Barth (2009) and Snodgrass and Snodgrass (2006).

The composition of growing media for intensive vegetated roofs may be different, and it is often much greater in depth (e.g., 6 inches to 4 feet). If trees are included in the vegetated roof planting plan, the growing media must provide enough volume for the root structure of mature trees.

6.6 CONVEYANCE AND OVERFLOW

The drainage layer below the growth media should be designed to convey the 10-year storm without backing water up to into the growing media. The drainage layer should convey flow to an outlet or overflow system such as a traditional rooftop drainage system with inlets set slightly above the elevation of the vegetated roof surface. Roof drains immediately adjacent to the growing media should be boxed and protected by flashing extending at least 3 inches above the growing media to prevent clogging.

6.7 VEGETATION AND SURFACE COVER

A planting plan must be prepared for a vegetated roof by a landscape architect, botanist or other professional experienced with vegetated roofs, and it must be reviewed and approved by the City.

Plant selection for vegetated rooftops is an integral design consideration, which is governed by local climate and design objectives. The primary ground cover for most vegetated roof installations is a hardy, low-growing succulent, such as *Sedum, Delosperma, Talinum, Semperivum* or *Hieracium* that is matched to the local climate conditions and can tolerate the difficult growing conditions found on building rooftops (Snodgrass and Snodgrass, 2006). Franklin lies in the transition zone between USDA Plant Hardiness Zones 6 and 7.

Other vegetation considerations:

- Plant choices can be much more diverse for deeper intensive vegetated roof systems. Herbs, forbs, grasses, shrubs and even trees can be used, but designers should understand they have higher watering, weeding and landscape maintenance requirements.
- The species and layout of the planting plan should reflect the location of building, in terms of its height, exposure to wind, snow loading, heat stress, orientation to the sun, and shading by surrounding buildings. In addition, plants should be selected that are fire resistant and able to withstand heat, cold and high winds.
- Designers should also match species to the expected rooting depth of the growing media, which can also provide enough lateral growth to stabilize the growing media surface. The planting plan should usually include several accent plants to provide diversity and seasonal color. For a comprehensive resource on vegetated roof plant selection, consult Snodgrass and Snodgrass (2006).
- It is also important to note that most vegetated roof plant species will *not* be native to the Southeast (which is in contrast to *native* plant recommendations for other stormwater practices, such as bioretention and constructed wetlands).
- Given the limited number of vegetated roof plant nurseries in the region, designers should order plants 6 to 12 months prior to the expected planting date. It is also advisable to have plant materials contract-grown.
- When appropriate species are selected, most vegetated roofs will not require supplemental irrigation, except during the first year that the vegetated roof is being established, or during periods of drought. Irrigation should thus be provided as needed for full establishment and during drought periods. The

planting window extends from the spring to early fall, although it is important to allow plants to root thoroughly before the first killing frost.

- Plants can be established using cuttings, plugs, mats, and, more rarely, seeding or containers. Several vendors also sell mats, rolls, or proprietary vegetated roof planting modules. For the pros and cons of each method, see Snodgrass and Snodgrass (2006).
- The goal for vegetated roof systems designed for stormwater management is to establish a full and vigorous cover of low-maintenance vegetation that is self-sustaining and requires minimal mowing, trimming or weeding.
- The vegetated roof design should include non-vegetated walkways (e.g., permeable paver blocks) to allow for easy access to the roof for weeding and making spot repairs.

6.8 MATERIAL SPECIFICATIONS

Standard specifications for North American vegetated roofs continue to evolve, and no universal material specifications exist that cover the wide range of roof types and system components currently available. The American Society for Testing and Materials (ASTM) has recently issued several overarching vegetated roof standards, which are described and referenced in **Table 9.3**.

Designers and reviewers should also fully understand manufacturer specifications for each system component listed in **Section 6.3**, particularly if they choose to install proprietary "complete" vegetated roof systems or modules.

Table 9.3. Extensive Vegetated Roof Material Specifications

Material	Specification
Roof	Structural Capacity should conform to ASTM E2397-05, *Practice for Determination of Live Loads and Dead Loads Associated with Green (Vegetated) Roof Systems*. In addition, use standard test methods ASTM E2398-05 for *Water Capture and Media Retention of Geocomposite Drain Layers for Green (Vegetated) Roof Systems*, and ASTME 2399-05 for *Maximum Media Density for Dead Load Analysis*.
Waterproof Membrane	See Chapter 6 of Weiler and Scholz-Barth (2009) for waterproofing options that are designed to convey water horizontally across the roof surface to drains or gutter. This layer may sometimes act as a root barrier.
Root Barrier (Optional)	Impermeable liner that impedes root penetration of the membrane.
Drainage Layer	1 to 2 inch layer of clean, washed granular material, such as ASTM D 448 size No. 8 stone. Roof drains and emergency overflow should be designed in accordance with City Codes.
Filter Fabric	Needled, non-woven, polypropylene geotextile. Density (ASTM D3776) > 16 oz./sq. yd., or approved equivalent. Puncture resistance (ASTM D4833) > 220 lbs., or approved equivalent.
Growth Media	85% lightweight inorganic materials and 15% organic matter (e.g. well-aged compost). Media should have a maximum water retention capacity of around 30%. Media should provide sufficient nutrients and water holding capacity to support the proposed plant materials. Determine acceptable saturated water permeability using ASTM E2396-05.
Plant Materials	Low plants such as sedum, herbaceous plants, and perennial grasses that are shallow-rooted, self-sustaining, and tolerant of direct sunlight, drought, wind, and frost. See ASTM E2400-06, *Guide for Selection, Installation and Maintenance of Plants for Green (Vegetated) Roof Systems*.

SECTION 7: CONSTRUCTION

7.1 CONSTRUCTION SEQUENCE

Given the diversity of extensive vegetated roof designs, there is no typical step-by-step construction sequence for proper installation. The following general construction considerations are noted:

- Construct the roof deck with the appropriate slope and material.
- Install the waterproofing method, according to manufacturer's specifications.
- Conduct a flood test to ensure the system is watertight by placing at least 2 inches of water over the membrane for 48 hours to confirm the integrity of the waterproofing system.
- Add additional system components (e.g., insulation, optional root barrier, drainage layer and interior drainage system, and filter fabric), taking care not to damage the waterproofing. Drain collars and protective flashing should be installed to ensure free flow of excess stormwater.
- The growing media should be mixed prior to delivery to the site. Media should be spread evenly over the filter fabric surface. The growing media should be covered until planting to prevent weeds from growing. Sheets of exterior grade plywood can also be laid over the growing media to accommodate foot or wheelbarrow traffic. Foot traffic and equipment traffic should be limited over the growing media to reduce compaction.
- The growing media should be moistened prior to planting, and then planted with the ground cover and other plant materials, per the planting plan, or in accordance with ASTM E2400. Plants should be watered immediately after installation and routinely during establishment.

- It generally takes 12 to 18 months to fully establish the vegetated roof. An initial fertilization using slow release fertilizer (e.g., 14-14-14) with adequate minerals is often needed to support growth. Watering is needed during the first summer. Hand weeding is also critical in the first two years (see Table 10.1 of Weiler and Scholz-Barth, 2009, for a photo guide of common rooftop weeds).
- Most construction contracts should contain a Care and Replacement Warranty that specifies a 75% minimum survival after the first growing season of species planted and a minimum effective vegetative ground cover of 75% for flat roofs and 90% for pitched roofs.

7.2 CONSTRUCTION INSPECTION

Inspections during construction are needed to ensure that the vegetated roof is built in accordance with these specifications. Detailed inspection checklists should be used that include sign-offs by qualified individuals at critical stages of construction and confirm that the contractor's interpretation of the plan is consistent with the intent of the designer and/or manufacturer.

An experienced installer should be retained to construct the vegetated roof system. The vegetated roof should be constructed in sections for easier inspection and maintenance access to the membrane and roof drains. Careful construction supervision is needed during several steps of vegetated roof installation, as follows:

- During placement of the waterproofing layer, to ensure that it is properly installed and watertight;
- During placement of the drainage layer and drainage system;
- During placement of the growing media, to confirm that it meets the specifications and is applied to the correct depth;
- Upon installation of plants, to ensure they conform to the planting plan;
- Before issuing use and occupancy approvals.

SECTION 8: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix, as required components of the as-built differ from measure to measure

SECTION 9: MAINTENANCE

9.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the LTMP Agreement.

9.2 MAINTENANCE INSPECTIONS

A vegetated roof should be inspected twice a year during the growing season to assess vegetative cover, and to look for leaks, drainage problems and any rooftop structural concerns (see **Table 9.4**). In addition, the vegetated roof should be hand-weeded to remove invasive or volunteer plants, and plants/media should be added to repair bare areas (refer to ASTM E2400). Many practitioners also recommend an annual application of slow-release fertilizer in the first few years after the vegetated roof is installed.

9.3 ROUTINE AND NON-ROUTINE MAINTENANCE TASKS

If a roof leak is suspected, it is advisable to perform an electric leak survey (i.e., Electrical Field Vector Mapping) to pinpoint the exact location, make localized repairs, and then reestablish system components and ground cover.

The use of herbicides, insecticides, and fungicides should be avoided, since their presence could hasten degradation of the waterproof membrane. Also, power-washing and other exterior maintenance operations should be avoided so that cleaning agents and other chemicals do not harm the vegetated roof plant communities.

Table 9.4. Typical Maintenance Activities Associated with Green Roofs

Activity	Schedule
Water to promote plant growth and survival.	As needed
Inspect the vegetated roof and replace any dead or dying vegetation.	Following Construction
Inspect the waterproof membrane for leaking or cracks.	Semi-annually
Annual fertilization.	As needed
Weeding to remove invasive plants.	As needed
Inspect roof drains, scuppers and gutters to ensure they are not overgrown or have organic matter deposits. Remove any accumulated organic matter or debris.	Semi-annually
Inspect the green roof for dead, dying or invasive vegetation. Plant replacement vegetation as needed.	As needed

Appendix A

Pretreatment Measures Design Standards

A.1 Pretreatment Forebay

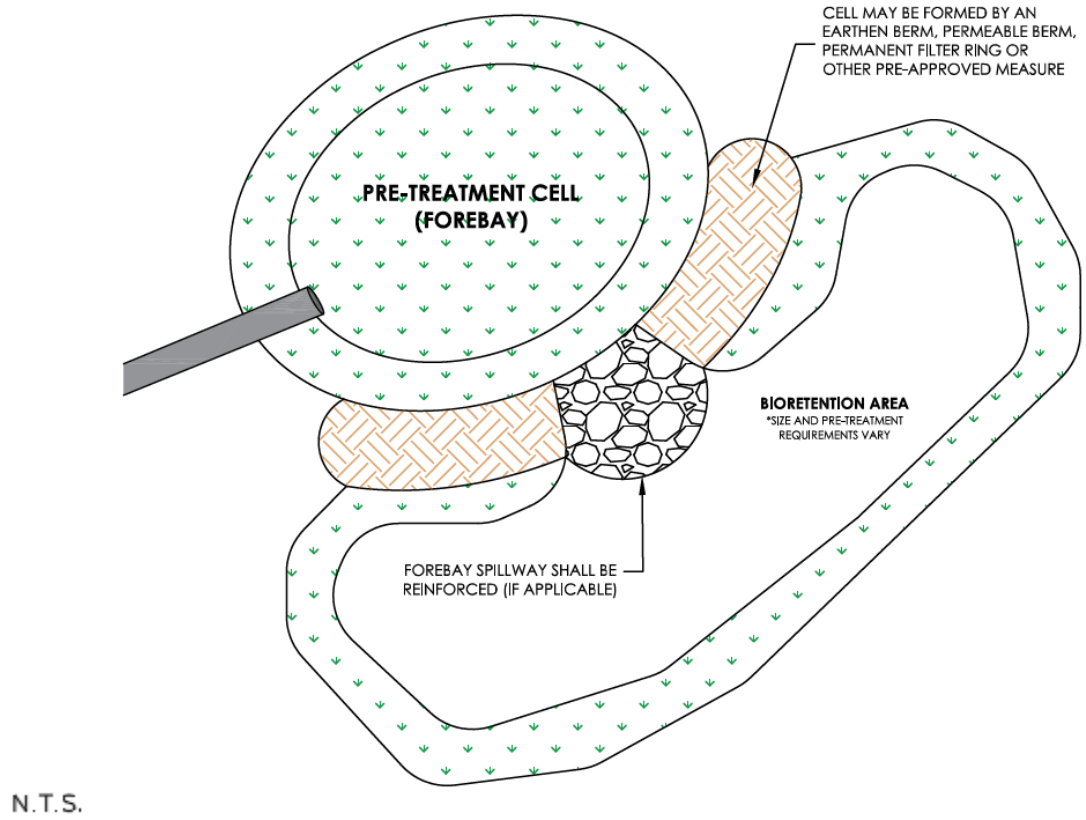


Figure A.1. Pretreatment Forebay Standard Detail

Used in concentrated flow conditions, forebays are located at piped inlets or curb cuts leading to the bioretention area and includes an energy dissipater sized for the expected rates of discharge. Forebays can be hard-lined, with concrete or grouted rip rap, to ease removal of accumulated material. Note that concrete-lined forebays may increase flow velocity without additional energy dissipation measures being incorporated. The forebay shall have a 2:1 length-to-width ratio. The forebay may be formed by a stone check dam or an earthen or rock berm. Pre-treatment forebays should not have underlying engineered soil media, in contrast to the main BMP. The ground surface of the pretreatment forebay should slope 1% towards the BMP to provide positive drainage to the surface of the BMP. Velocities entering the forebay shall be evaluated and additional measures provided as necessary to provide scour protection and energy dissipation through the forebay for the 10-year storm event. Exit velocities from the pretreatment forebay must be non-erosive for the 2-year design storm.

Table A.1. Sizing Requirements based on GIP	
GIP	**Sizing Requirement**
Level 1 Bioretention (GIP-01)	15% of Tv (exclusive)
Level 2 Bioretention (GIP-01)	15% of Tv (exclusive)
Level 1 Infiltration Trench (GIP-04)	15% of Tv (exclusive)
Level 2 Infiltration Trench (GIP-04)	15% of Tv (exclusive)
Water Quality Swale (GIP-05)	15% of Tv (exclusive)

The forebay pre-treatment volume required for concentrated flow entering a bioretention area is not included within the total treatment volume (Tv) required (see Equation A.1). Riprap used for energy dissipation within the forebay shall be sized per TDOT specifications. The treatment volume required for the forebay is computed as follows:

Equation A.1. Example Pretreatment Forebay Treatment Volume Sizing

$$Tv_{Forebay} = Total\ Tv * 0.15\ (level\ 1\ bioretention)$$

Where:

Total Tv = Total required Treatment Volume (cu. ft.)

$Tv_{Forebay}$ = Treatment Volume required for the forebay (see table A.1) (cu. ft.)

A.2 Gravel Flow Spreaders

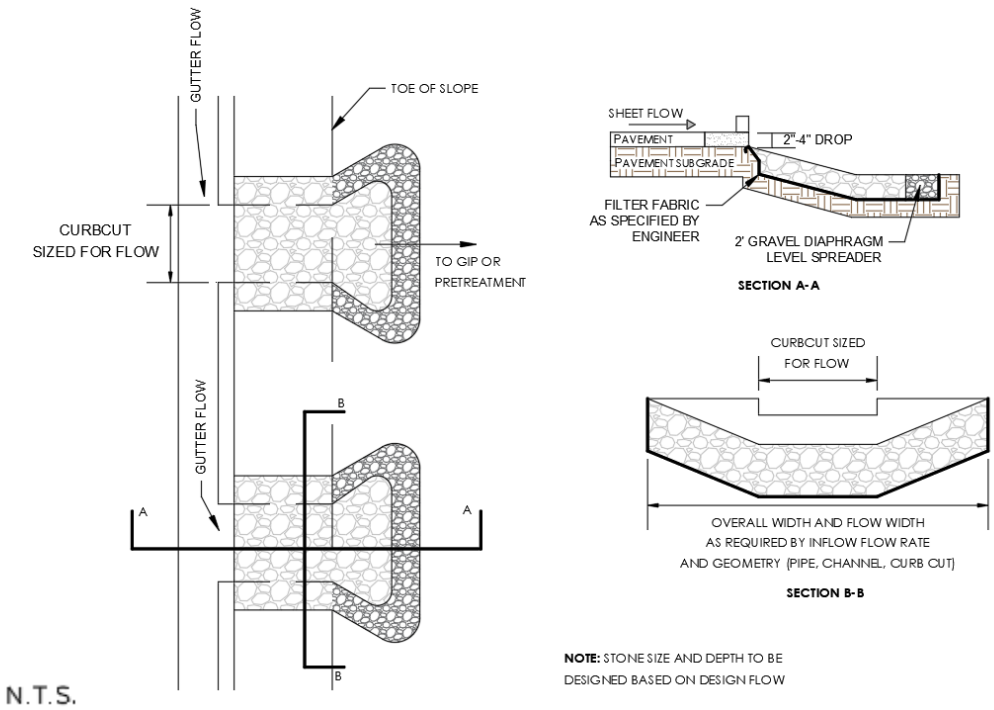


Figure A.2. Gravel Flow Spreader Standard Detail

Used in concentrated flow conditions, the gravel flow spreader is located at curb cuts, downspouts, or other small-scale concentrated inflow points, and should have a 2 to 4-inch elevation drop from a hard-edged surface into a gravel or stone diaphragm. The gravel should extend the entire width of the opening and create a level stone weir at the bottom or treatment elevation of the basin. Exit velocities from the gravel flow spreader must be non-erosive for the 2-year design storm. Gravel flow spreaders can be utilized as a pretreatment measure for the following:

- Bioretention Areas (GIP-01)
- Infiltration Trenches (GIP-04)
- Water Quality Swales (GIP-05)

A.3 Grass Filter Strips

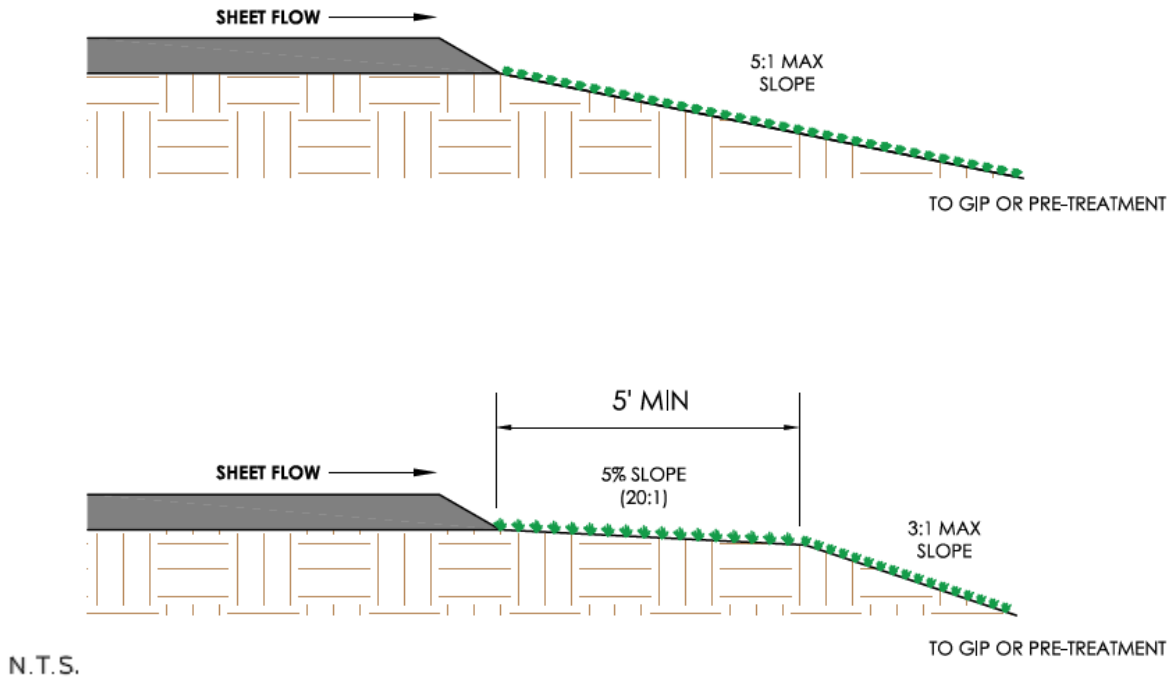


Figure A.3. Grass Filter Strip Standard Detail

Grass filter strips, or vegetated filter strips, can be utilized in sheet flow conditions only. Grass filter strips extend from the edge of pavement to the surface of the BMP at a 5:1 slope or flatter. Alternatively, provide a combined 5 feet of grass filter strip at a maximum 5% (20:1) slope and 3:1 or flatter side slopes on the bioretention basin or water quality swale.

For an infiltration trench receiving sheet flow from an adjacent drainage area, a grass filter strip with a minimum 25-foot length, as measured in the direction of flow, shall be implemented. A grass filter strip around the entire BMP is required if the facility is receiving runoff from both directions.

Grass filter strips are best suited to treat runoff from small catchment areas (less than 5,000 sq. ft. of impervious area.) Filter strips should be seeded, not sodded. If sod is to be used, sod shall be staked.

A.4 Gravel Diaphragm

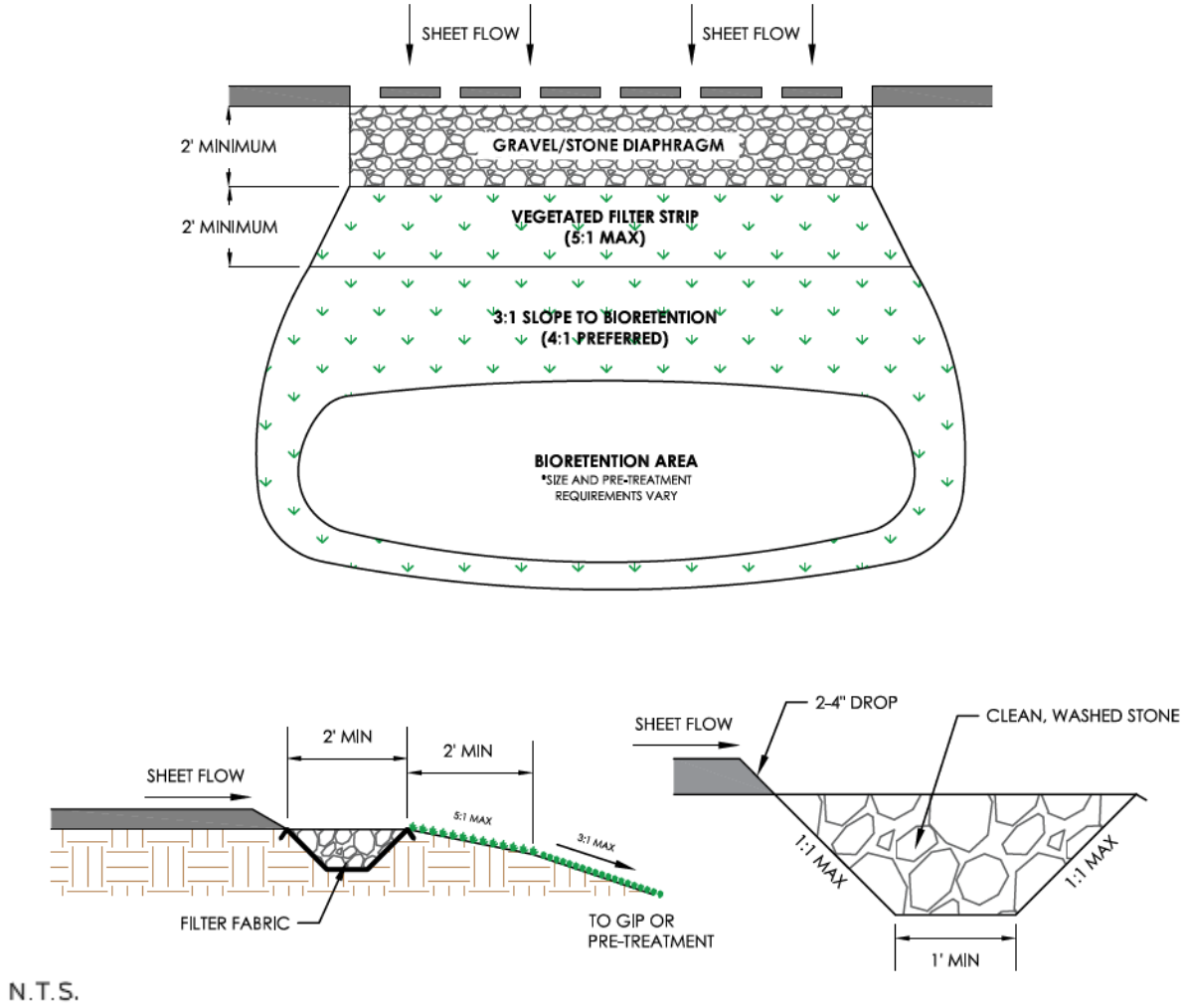


Figure A.4. Gravel Diaphragm Standard Detail

A gravel diaphragm located at the edge of the pavement should be oriented perpendicular to the flow path to pretreat lateral runoff and shall have a 2 to 4 inch drop from the edge of pavement. A layer of filter fabric shall be placed between the gravel and the underlying soils. The stone must be sized according to the calculated velocity of discharge in the 2 year storm event.

A.5 Level Spreaders

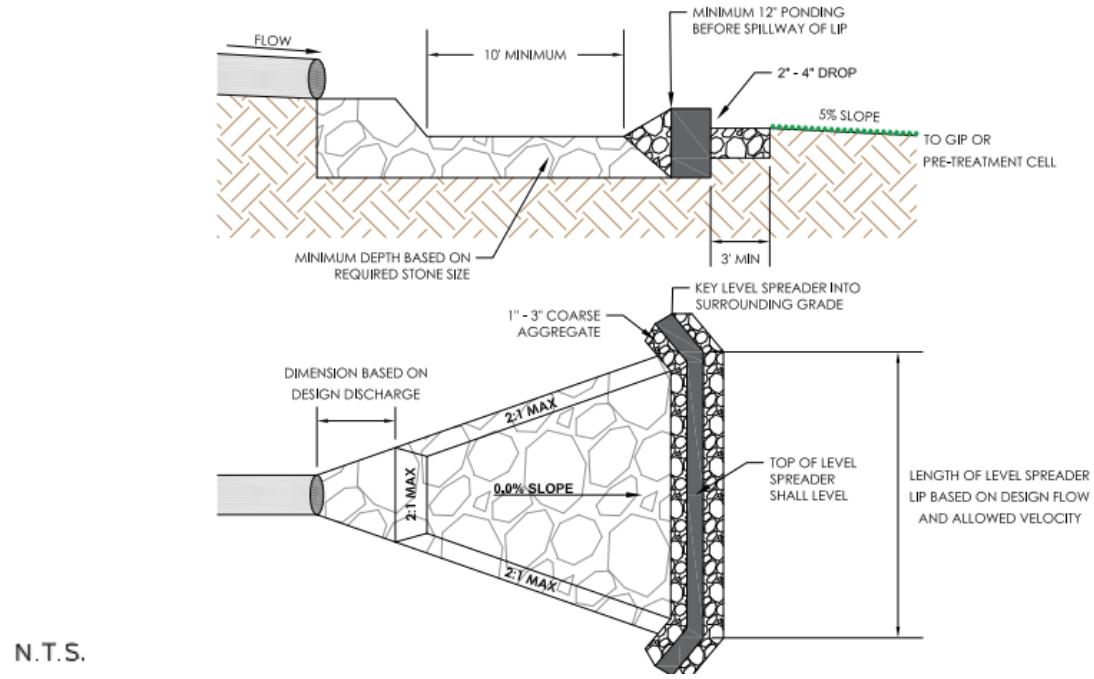


Figure A.5. Engineered Level Spreader Detail

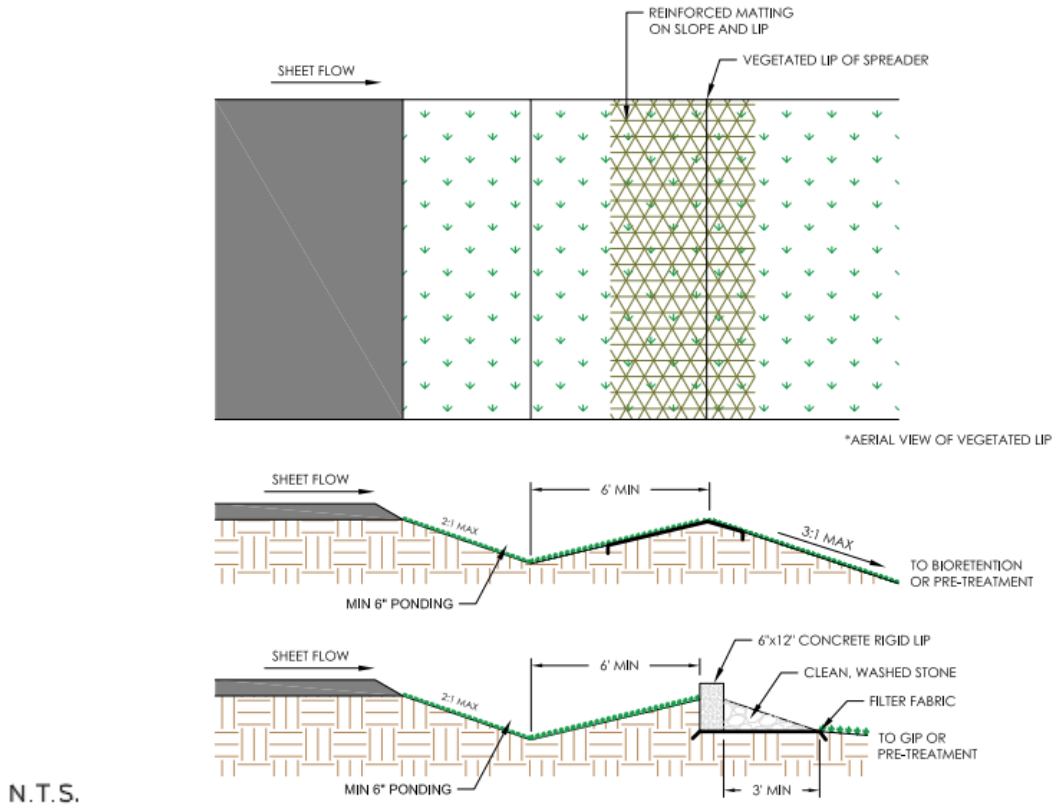


Figure A.6. Vegetated and Rigid Lip Level Spreader Detail

The design of engineered level spreaders should conform to the following design criteria in order to ensure non-erosive sheet flow into the green infrastructure practice.

Key design elements of the engineered level spreader, as provided in **Figures A.5 and A.6**, include the following:

- A forebay should have a maximum depth of 3 feet and gradually transition to a depth of 1 foot at the level spreader lip (**Figure A.5**). The forebay is sized such that the surface area is 0.2% of the contributing impervious area. (A forebay is not necessary if the concentrated flow is from the outlet of an extended detention basin or similar practice).
- The length of the level spreader should be determined by the design flow:
  - The minimum level spreader length is 13 feet and the maximum is 130 feet.
  - For the purposes of determining the level spreader length, the peak discharge shall be determined using the rational equation with an intensity of 1-inch/hour.
- The level spreader lip shall be concrete, with a well-anchored footer, or other accepted rigid, non-erodible material.
- The ends of the level spreader section should be tied back into the slope to avoid scouring around the ends of the level spreader; otherwise, short-circuiting of the facility could create erosion.
- The level spreader should be placed 3 to 6 inches above the downstream natural grade elevation to avoid turf buildup. In order to prevent grade drops that re-concentrate the flows, a 3-foot long section of coarse aggregate, underlain by filter fabric, should be installed just below the spreader to transition from the level spreader to natural grade.

The flow is directed through a stilling basin energy dissipater and then a level spreader such that the entire design storm for the conveyance system (typically a 10-year frequency storm) is discharged as sheet flow through the floodplain.

A.6 Proprietary Structures

An approved proprietary structure, such as a water quality unit, with demonstrated capability of reducing sediment and hydrocarbons may be used as a required pretreatment measure but shall not be credited toward meeting runoff reduction requirements.

APPENDIX B

B.1 INFILTRATION SOIL TESTING PROCEDURES

I. Test Pit/Boring Procedures

1. Number of test pits or standard borings:
    a. Bioretention and permeable pavement: Provide a minimum of 2 test pits or standard borings for each facility plus 1 additional test pit or boring per 5000 sf of surface area. (ex. 10,000 sf facility = 4 test pits)
    b. Infiltration trench and water quality swale: Provide one test pit or standard soil boring for every 50 linear feet of the proposed infiltration area, with a minimum of two per facility. (ex. 150 lf facility = 3 test pits)
2. The location of each test pit or standard soil boring should correspond to the location of the proposed infiltration area.
3. Excavate each test pit or penetrate each standard soil boring to a depth at least 2 feet below the bottom of the proposed infiltration area.
4. If the groundwater table is located within 2 feet of the bottom of the proposed facility, determine the depth to the groundwater table immediately upon excavation and again 24 hours after excavation is completed.
5. Determine the USDA or Unified Soil Classification system textures at the bottom of the proposed infiltration area and at a depth that is 2 feet below the bottom. All soil horizons should be classified and described.
6. If bedrock is located within 2 feet below the bottom of the proposed infiltration area, determine the depth to the bedrock layer.
7. Test pit/soil boring stakes should be left in the field to identify where soil investigations were performed.

II. Infiltration Testing Procedures

1. Number of infiltration tests:
    a. Bioretention and permeable pavement: Provide a minimum of 2 infiltration tests for each facility plus 1 additional test per 5000 sf of surface area. (ex. 10,000 sf facility = 4 infiltration tests)
    b. Infiltration trench and water quality swale: Provide one infiltration test for every 50 linear feet of the proposed infiltration area, with a minimum of two per facility. (ex. 150 lf facility = 3 infiltration tests)
2. The location of each infiltration test should correspond to the location of the proposed infiltration area.
3. Install a test casing (e.g., a rigid, 4 to 6 inch diameter pipe) to a depth 2 feet below the bottom of the proposed infiltration area.
4. Remove all loose material from the sides of the test casing and any smeared soil material from the bottom of the test casing to provide a natural soil interface into which water may percolate. If desired, a 2-inch layer of coarse sand or fine gravel may be placed at the bottom of the test casing to prevent clogging and scouring of the underlying soils. Fill the test casing with clean water to a depth of 2 feet, and allow the underlying soils to presoak for 24 hours.

5. After 24 hours, refill the test casing with another 2 feet of clean water and measure the drop in water level within the test casing after one hour. Repeat the procedure three (3) additional times by filling the test casing with clean water and measuring the drop in water level after one hour. A total of four (4) observations must be completed. The infiltration rate of the underlying soils may be reported either as the average of all four observations or the value of the last observation. The infiltration rate should be reported in terms of inches per hour.
6. Infiltration testing may be performed within an open test pit or a standard soil boring. After infiltration testing is completed, the test casing should be removed and the test pit or soil boring should be backfilled and restored.

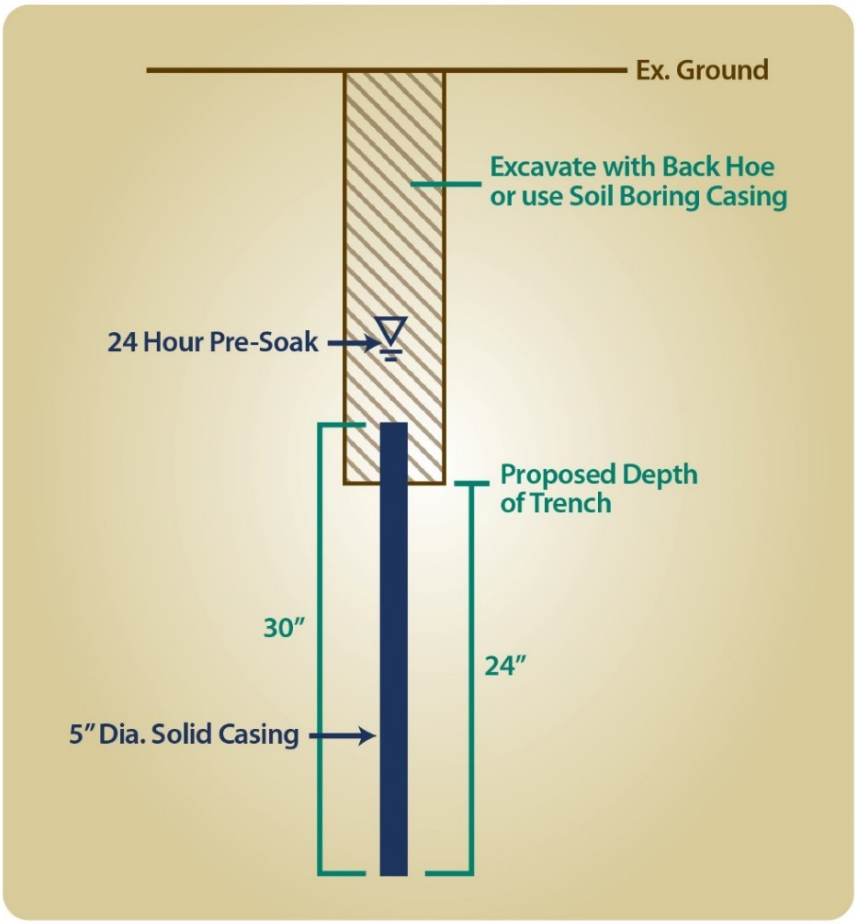


Figure 4-A. 1. Infiltration Test Schematic

B.2 SOIL INFILTRATION RATE TESTING

Table B.2 Required Number of Tests for Each GIP	
GIP	**Number of Tests**
Bioretention (GIP-01) **Urban Bioretention (GIP-02)** **Permeable Pavement (GIP-03)**	2 tests + 1 test per 5,000 ft^2 surface area
Infiltration Trench (GIP-04) **Water Quality Swale (GIP-05)**	1 test per 50 linear feet, 2 minimum

Appendix C

Landscape Plan Requirements for Biofiltration Practices and Native Plant Lists

All native plant lists are in Section 9 of this Appendix in **Tables C.3-C.7**.

SECTION 1: GENERAL GIP PLANTING REQUIREMENTS

**These general requirements apply to all GIP biofiltration practices (any area containing amended soils in the filter bed). Additional specific requirements or exceptions for each practice are denoted in their specific subsequent section.*

1.1 Planting Plans

A landscaping plan must be provided for each biofiltration (any area containing amended soils) area. Minimum plan elements shall include the proposed delineation of planting areas, the planting plan, including the size, the list of planting stock, sources of plant species, and the planting sequence, including post-nursery care and initial maintenance requirements. The planting area is defined as the area where amended soils are to be located, which does not include any pretreatment measures. The planting plan must address 100% of the planting area. The planting plan be shall be prepared by a qualified landscape architect, to tailor the planting plan to the site-specific conditions.

Native plant species are required for biofiltration as they are typically best acclimated for our region's climate. Ornamental species may be used for landscaping effect if they are not aggressive or invasive but must be first approved by the City's Stormwater Coordinator. **Tables C.3 – C.7** list native plant species suitable for use in biofiltration practices. Milkweed shall be required in all biofiltration practices and shall equal 5% or greater of overall planting schedule.

Irrigation can be utilized around biofiltration areas to encourage growth of the plants through the first growing season and any subsequent droughts. If irrigation is to be utilized, an irrigation plan shall be submitted to the City's Stormwater Coordinator for review and then subsequently included in the Long Term Maintenance Plan for the site. A soil moisture probe shall be shown as installed within the footprint of the bioretention area to prevent overwatering or baseflow from occurring.

The planting template refers to the form and combination of native trees, shrubs, and perennial ground covers that maintain the appearance and function of the biofiltration practice areas.

1.2 Plant Spacing

Table C.1 is for use only when plants are spaced equidistant from each other as shown in **Figure C.1**, below.

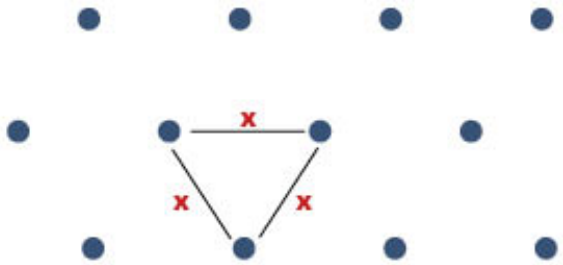


Figure C.1 Typical plant spacing where x equals distance on center (O.C.) of plant species.

Table C.1 Plant Spacing for Perennials, Grasses, Sedges and Shrubs	
Spacing (O.C.)	**Plants per 100 sq.ft.**
18" o.c.	51.2
24" o.c.	29
28" o.c.	22
30" o.c.	18.5
36" o.c.	12.8
42" o.c.	10
4' o.c.	7.23
5' o.c.	4.61
6' o.c.	3.2
8' o.c.	1.8

1.3 Soil Amendments for Tree Holes

Biofiltration practices that require trees in the planting schedule shall require tree holes in the filter bed that must be at least 4 feet deep (or as much as design allows) to provide enough soil volume for the root structure of mature trees. In addition, a more organic filter media is required within the planting holes for trees, with ratio of 50% sand, 30% topsoil and 20% acceptable leaf compost (or other as approved).

1.4 Groundcover

Groundcover for biofiltration practices shall either be a triple shredded hardwood mulch, river rock, or pine straw. In some situations, the City may consider alternative ground covers to mulch, river rock, and pine straw such as native groundcover, turf, and pea gravel. This alternative must be proposed, justified, and approved by the City's Stormwater Coordinator during the plan review process and will be dependent on location, use and maintenance of the proposed areas. If seeding of the area is specified, then hydroseeding shall be the method detailed on the landscape sheets for seed application and establishment in these areas. This is due to the high failure rate of conventional seeding methods that is experienced due to frequent and high water flow these features experience.

The following design consideration should be evaluated when choosing groundcovers.

- ***Mulch.*** A 3-inch layer of mulch on the surface of the filter bed enhances plant survival, suppresses weed

growth, and pretreats runoff before it reaches the filter media. Triple shredded, aged hardwood, especially cypress, makes a very good surface cover, as it retains a significant amount of nitrogen and typically will not float away. Shredded hardwood mulch will typically require annual replacement as a part of regular maintenance.

- *Pine Straw.* A 3-inch layer of pine straw on the surface of the filter bed provides many of the same benefits as mulch. In some biofiltration designs pine straw will resistant to floating and washing in frequent flow events. Pine straw still requires annual replacement and/or refreshing as part of a regular maintenance schedule.

- *River Rock.* River rock is often the preferred groundcover selected for biofiltration practices. This is due to its heavier weight which keeps it in place and provides a velocity dissipation effect which reduces filter bed erosion. River rock typically doesn't require annual replacement and provides for longer term stabilization solution. Higher upfront cost is typically offset when compared to annual replacement cost of mulch and pine straw as they compile annually. However, river rock does present its own challenges. During summer months river rock can absorb heat and create a heat island effect that can be detriment to the vegetation planted within the biofiltration practice. Lastly river rock size can vary, and when larger (>4") river rock is used compaction of the filter bed can occur. Care should be taken during installation and placement as to prevent soil compaction when using larger river rock. Plant material selected should be chosen to withstand the heat the river rock can produce.

SECTION 2: BIORETENTION

2.1 Landscape and Planting Plan

Bioretention areas shall be planted in accordance with a planting template. The choice of which planting template to use depends on the scale of bioretention, the context of the site in the urban environment, the filter depth, the desired landscape amenities, and the future owner's capability to maintain the landscape. In general, the vegetative goal is to achieve a surface area coverage of at least 75% in the first two years. For a bioretention area to qualify for Level 2 Design, a minimum of one tree must be planted for every 400 square feet. All bioretention areas shall include at least 5% of native milkweed vegetation within the planting plan.

The planting template refers to the form and combination of native trees, shrubs, and perennial ground covers that maintain the appearance and function of the bioretention area. Planting templates may be of the following types:

- *Ornamental planting.* This option includes perennials, sedges, grasses, shrubs and/or trees in a mass bed planting. This template is recommended for commercial sites where visibility is important. This template requires maintenance much like traditional landscape beds.

- *Meadow.* This is a lower maintenance approach that focuses on the herbaceous layer and may resemble a wildflower meadow or prairie. The goal is to establish a more natural look that may be appropriate if the facility is in a lower maintenance area (e.g., further from buildings and parking lots). Shrubs and trees may be incorporated.

- *Reforestation.* This option plants a variety of tree seedlings and saplings in which the species distribution is modeled on characteristics of existing local forest ecosystems. Trees are planted in groups with the goal of establishing a mature forest canopy. This template is appropriate for large bioretention areas located at wooded edges or where a wooded buffer is desired.

SECTION 3: GIP-02 URBAN BIORETENTION

3.1 Landscape and Planting Plan

The degree of landscape maintenance that can be provided will determine some of the planting choices for urban bioretention areas. The planting cells can be formal gardens or naturalized landscapes. Landscaping in the ROW should be designed to limit visual obstructions for pedestrian and vehicular traffic. **Tables C.8 - C.12** detail plants suitable for tree planters.

In areas where less maintenance will be provided and trash accumulation in shrubbery or herbaceous plants is a concern, consider a "turf and trees" landscaping model. Spaces for herbaceous flowering plants can be included. This may be attractive at a community entrance location.

Native trees or shrubs shall be used for urban bioretention areas. As with regular bioretention, selected perennials, shrubs, and trees must be tolerant of drought, and inundation. The landscape designer should also take into account that de-icing materials may accumulate in the bioretention areas in winter and could kill vegetation. Additionally, tree species selected shall meet the City of Franklin street tree requirements within the Zoning Ordinance.

SECTION 4: GIP-04 INFILTRATION TRENCH

4.1 Landscape and Planting Plan

The trench may be covered with permeable topsoil and planted with grass in a landscaped area. If sod is to be used it shall be a sand based or washed sod product.

SECTION 5: GIP-05 WATER QUALITY SWALE

5.1 Landscape and Planting Plan

Designers should choose grasses, herbaceous plants or trees that can withstand both wet and dry periods and relatively high velocity flows for planting within the channel. Salt tolerant grass species should be chosen for water quality swales receiving drainage from areas treated for ice in winter. Taller and denser grasses are preferable, although the species is less important than good stabilization and dense vegetative cover. Grass species should have the following characteristics: a deep root system to resist scouring; a high stem density with well-branched top growth; water-tolerance; resistance to being flattened by runoff; and an ability to recover growth following inundation. A qualified landscape designer should be consulted for selection of appropriate plantings. A nonfloatable mulch, such as river rock, should be used to prevent clogging of the check dams.

SECTION 6: GIP-07 SHEET FLOW

6.1 Landscape and Planting Plan

6.1.1 Conserved Open Space. No grading or clearing of native vegetation is allowed within the Conserved Open Space.

6.1.2 Reforested Conserved Open Space. At some sites, the Conserved Open Space may be in turf or meadow cover or overrun with invasive plants and vines. In these situations, a landscape architect shall prepare a reforestation plan for the Conserved Open Space utilizing the reforestation specifications as described under **GIP-08, Reforestation**, with any credits and associated plans receiving approval by the City Engineer.

6.1.3 Vegetated Filter Strips. Vegetated Filter Strips shall be planted at such a density to achieve a 90% grass/herbaceous cover after the second growing season. Performance has been shown to fall rapidly as vegetative cover falls below 80%. Filter strips shall be seeded, not sodded, whenever possible. Seeding establishes deeper roots, and sod may have muck soil that is not conducive to infiltration. The filter strip vegetation may consist of turf grasses, meadow grasses, other herbaceous plants, shrubs, and trees, as long as the primary goal of at least 90% coverage with grasses and/or other herbaceous plants is achieved. Designers should choose vegetation that stabilizes the soil and is salt tolerant. Vegetation at the toe of the filter, where temporary ponding may occur behind the permeable berm, shall be able to withstand both wet, with approximately 6 inches of ponding, and dry periods. The planting areas can be divided into zones to account for differences in inundation and slope.

SECTION 7: GIP-08 REFORESTATION

7.1 Landscape and Planting Plan

The credit given for the reforestation GIP is based on conditions representative of a natural forested area. The intent of these areas is to create a mature native successional undisturbed forest. There shall be no mowing, clearing, grading, construction, storage, or disturbance of vegetation in reforestation areas except as permitted by the City's Stormwater Coordinator. Reforestation areas are eligible under the following qualifying conditions:

- The minimum contiguous area of reforestation must be greater than 5,000 square feet, with no more than 20% of the area in any single tree species. The basic density of plantings is 300 large canopy trees per acre, approximately 12 feet on center. When shrubs are substituted for trees, there must be 10 shrubs per one large canopy tree. Two small canopy trees or understory trees, such as Dogwoods or Red Buds, may be substituted for one large canopy tree. Adjustments can be made to these densities for areas of urban reforestation with the approval of the City's Stormwater Coordinator. Reforestation should consider the composition of area forests, and two thirds of selected trees must be large canopy. Reforestation methods should achieve 75% forest canopy within ten years.
- The minimum size requirement for reforestation is saplings 6-8 feet in height. The minimum size requirement for shrubs is 18-24 inches, or 3 gallon size. or with a native seed mix in order to help retain moisture and provide a beneficial environment for the reforestation.
- A reforestation management plan shall be included in the Long Term Maintenance Plan and Agreement outlining long term management and maintenance objectives that will perpetuate a

mature native successional forested ecosystem. The plan shall address but be not limited to; irrigation needs, tree removal and replacement methods, ground cover goals for stabilization, yearly health surveys, and any other requirements set forth in this section or GIP 08. The plan shall have a scale drawing showing the area to be planted, along with a plant list which includes species, size, number, and packaging. In addition, the reforestation area shall be clearly identified on all construction drawings and EPSC plans during construction. Reference the GIP-08 section for further Long Term Maintenance Requirements.

- The reforestation area must be protected by a green infrastructure easement which stipulates that no future development or disturbance may occur within the area.
- The planting plan shall be approved by the City, including any special site preparation needs.
- The construction contract should contain a care and replacement warranty extending at least two growing seasons, to ensure adequate growth and survival of the plant community.
- The final size of the trees should be considered when designing the planting plan. Tennessee One-Call (811) must be contacted prior to the submission of the planting plan to ensure that no utilities will be impacted by the tree planting. The planting plan must also avoid placing trees under overhead utilities.
- If using the reforestation area as a vegetated filter strip to receive additional credit under **GIP-07**, follow all GIP design criteria and ensure that additional routed runoff does not cause erosion or degrade the quality of ground cover.

The overall runoff reduction credits for reforestation through lower runoff coefficients are summarized in **Table C.2.**

Table C.2. Design Specifications for Reforestation

Item	Specifications for Level 1 and Level 2
Area	Minimum contiguous area of 5,000 sq. ft.
Tree Type	No more than 20% of any single tree species. Consider composition of local forests in planting design. 2/3 of trees must be large canopy. See the USGS landfire map for delineation of forest type and the 2006 Descriptions of Ecological Systems for Modeling of LANDFIRE Biophysical Settings Ecological Systems of location US State TN .PFD for description of species within each forest type. Links: http://landfire.cr.usgs.gov/viewer/ http://www.tn.gov/environment/na/pdf/tn_eco_systems.pdf http://www.se-eppc.org/pubs/middle.pdf
Density	• 300 large canopy trees – species that normally achieve an overall height at maturity of thirty feet or more per acre • 10 shrubs substitute for 1 large canopy tree • 2 small canopy trees substitute for 1 large canopy tree Note: Adjustments to densities may be possible with CITY approval.
Canopy Rate	Achieve 75% forest canopy within first 10 years
Size	Tree - Minimum tree size 6-8 ft in height Shrub – 18-24 inches or 3 gallon size
Ground Cover	Entire area should be covered with 2-4 inches of organic mulch or a native seed mix

SECTION 8: GIP-09 GREEN ROOF

8.1 Landscape and Planting Plan

A planting plan must be prepared for a vegetated roof by a landscape architect and it must be reviewed and approved by the City.

Plant selection for vegetated rooftops is an integral design consideration, which is governed by local climate and design objectives. The primary ground cover for most vegetated roof installations is a hardy, low-growing succulent, such as *Sedum, Delosperma, Talinum, Semperivum* or *Hieracium* that is matched to the local climate conditions and can tolerate the difficult growing conditions found on building rooftops (Snodgrass and Snodgrass, 2006). Franklin lies in the transition zone between USDA Plant Hardiness Zones 6 and 7.

Other vegetation considerations:

- Plant choices can be much more diverse for deeper intensive vegetated roof systems. Herbs, forbs, grasses, shrubs and even trees can be used, but designers should understand they have higher watering, weeding and landscape maintenance requirements.
- The species and layout of the planting plan should reflect the location of building, in terms of its height, exposure to wind, snow loading, heat stress, orientation to the sun, and shading by surrounding buildings. In addition, plants should be selected that are fire resistant and able to withstand heat, cold and high winds.
- Designers should also match species to the expected rooting depth of the growing media, which can also provide enough lateral growth to stabilize the growing media surface. The planting plan should usually include several accent plants to provide diversity and seasonal color. For a comprehensive resource on vegetated roof plant selection, consult Snodgrass and Snodgrass (2006).
- It is also important to note that most vegetated roof plant species will not be native to the Southeast (which is in contrast to native plant recommendations for other stormwater biofiltration practices).
- Given the limited number of vegetated roof plant nurseries in the region, designers should order plants 6 to 12 months prior to the expected planting date. It is also advisable to have plant materials contract-grown.
- When appropriate species are selected, most vegetated roofs will not require supplemental irrigation, except during the first year that the vegetated roof is being established or during periods of drought. Irrigation should thus be provided as needed for full establishment and during drought periods. The planting window extends from the spring to early fall, although it is important to allow plants to root thoroughly before the first killing frost.
- Plants can be established using cuttings, plugs, mats, and, more rarely, seeding or containers. Several vendors also sell mats, rolls, or proprietary vegetated roof planting modules. For the pros and cons of each method, see Snodgrass and Snodgrass (2006).
- The goal for vegetated roof systems designed for stormwater management is to establish a full and vigorous cover of low-maintenance vegetation that is self-sustaining and requires minimal mowing, trimming or weeding.
- The vegetated roof design should include non-vegetated walkways (e.g., permeable paver blocks) to allow for easy access to the roof for weeding and making spot repairs.

SECTION 9: NATIVE PLANT LISTS

Table C.3. Popular Native Perennials for Bioretention – Full Sun						
Latin Name	**Common Name**	**Size**	**Spacing**	**Moisture**	**Color**	**Height**
Asclepias incarnate	Marsh milkweed	Plugs – 1 gal.	1 plant/24" o.c.	Wet	Pink	3-4'
Asclepias	Purple milkweed	Plugs – 1 gal.	1 plant/18" o.c.	Moist	Purple	3'
Asclepias syriaca	Common milkweed	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Orange	2-5'
Asclepias tuberosa	Butterfly milkweed	Plugs – 1 gal.	1 plant/18" o.c.	Dry-moist	Orange	2'
Asclepias verdis	Green milkweed	Plugs – 1 gal.	1 plant/18" o.c.	Moist	Green	2'
Asclepias verdicillata	Whorled milkweed	Plugs – 1 gal.	1 plant/18" o.c.	Moist	White	2.5'
Aster laevis	Smooth aster	Plugs – 1 gal.	1 plant/18" o.c.	Moist	Blue	2-4'
Aster novae-angliae	New England aster	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Blue	2-5'
Aster sericeus	Silky aster	Plugs – 1 gal.	1 plant/18" o.c.	Dry	Purple	1-2'
Chamaecrista	Partridge pea	Plugs – 1 gal.	1 plant/18" o.c.	Dry	Yellow	1-2'
Conoclinium	Mist flower	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Blue	1-2'
Coreopsis lanceolata	Lance-leaf coreopsis	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Yellow	6-8'
Echinacea pallida	Pale purple coneflower	Plugs – 1 gal.	1 plant/18" o.c.	Dry	Purple	2-3'
Echinacea purpurea	Purple coneflower	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	3-4'
Eupatorium	Boneset	Plugs – 1 gal.	1 plant/24" o.c.	Wet	White	3-5'
Eupatorium	Sweet Joe-Pye Weed	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Purple	3-6'
Iris virginica	Flag Iris	Plugs – 1 gal.	1 plant/18" o.c.	Moist-Wet	Blue	2'
Liatris aspera	Rough blazingstar	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	2-5'
Liatris microcephalla	Small-headed	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	3'
Liatris spicata	Dense blazingstar	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Purple	1.5'
Liatris squarrulosa	Southern blazingstar	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	2-6'
Lobelia cardinalis	Cardinal flower	Plugs – 1 gal.	1 plant/18" o.c.	Wet-moist	Red	2-4'
Monarda didyma	Bee balm	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Red	3'
Monarda fistulosa	Wild bergamot	Plugs – 1 gal	1 plant/18" o.c.	Moist	Purple	1-3'
Oenethera fruticosa	Sundrops	Plugs – 1 gal	1 plant/18" o.c.	Moist-dry	Yellow	
Penstemon digitalis	Smooth white	Plugs – 1 gal	1 plant/24" o.c.	Wet	White	2-3'
Penstemon hirsutus	Hairy beardtongue	Plugs – 1 gal	1 plant/18" o.c.	Dry	White	1-3'
Penstemon smallii	Beardtongue	Plugs – 1 gal	1 plant/18" o.c.	Moist	Purple	1-2'
Pycanthemum	Slender mountain mint	Plugs – 1 gal	1 plant/18" o.c.	Moist	White	1.5-2.5'
Ratibida piñata	Gray-headed	Plugs – 1 gal	1 plant/18" o.c.	Moist	Yellow	2-5'
Rudbeckia hirta	Black-eyed Susan	Plugs – 1 gal	1 plant/18" o.c.	Moist-dry	Yellow	3'
Salvia lyrata	Lyre-leaf sage	Plugs – 1 gal	1 plant/18" o.c.	Moist	Purple	1-2'
Solidago nemoralis	Gray goldenrod	Plugs – 1 gal.	1 plant/18" o.c.	Dry	Yellow	2'
Solidago rugosa	Rough-leaved	Plugs – 1 gal.	1 plant/18" o.c.	Wet	Yellow	1-6'
Veronacastrum	Culver's root	Plugs – 1 gal.	1 plant/24" o.c.	Dry	White	3-6'
Veronia veboracensis	Tall ironweed	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Purple	3-4'

Plant material size and grade to conform to "American Standards for Nursery Stock" American Association of Nurserymen, Inc. latest approved revision, ANSI Z-60-1

Table C.4. Popular Native Perennials for Bioretention – Shade						
Latin Name	**Common Name**	**Size**	**Spacing**	**Moisture**	**Color**	**Height**
Aquilegia canadensis	Wild columbine	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Pink	1-2.5'
Athyrium filix-femina	Lady Fern	1 gal.	1 plant/18" o.c.	Moist	Green	3'
Arisaema triphyllum	Jack-in-the-pulpit	Plugs – 1 gal.	1 plant/18" o.c.	Moist	Green	1.5-2.5'
Arisaema dricontium	Green dragon	Plugs – 1 gal.	1 plant/18" o.c.	Wet-moist	Green	3'
Asarum canadense	Wild ginger	Plugs – 1 gal.	1 plant/18" o.c.	Wet-moist	Red-brown	0.5-1'
Aster cardifolius	Blue wood aster	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Blue	1-3'
Aster novae-angliae	New England aster	Plugs – 1 gal.	1 plant/24" o.c.	Moist-dry	Blue/ purple	3-4'
Aster oblongifolius	Aromatic Aster	Plugs – 1 gal.	1 plant/24" o.c.	Moist-dry	Blue/ purple	1.5-3'
Coreopsis major	Tickseed coreopsis	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Yellow	3'
Dryopteris marginalis	Shield Fern	1 gal.	1 plant/18" o.c.	Moist	Green	2-3'
Geranium maculatum	Wild geranium	Plugs – 1 gal.	1 plant/18" o.c.	Moist	Pink	2'
Heuchera americana	Alumroot	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	1'
Iris cristata	Dwarf crested iris	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	4"
Lobelia siphilicata	Great blue lobelia	Plugs – 1 gal.	1 plant/18" o.c.	Wet-moist	Blue	1.5-3'
Lobelia cardinalis	Cardinal flower	Plugs – 1 gal.	1 plant/18" o.c.	Wet-moist	Red	2-4'
Mertensia virginica	Virginia bluebells	Plugs – 1 gal.	1 plant/18" o.c.	Moist	Blue	1.5'
Osmunda cinnamomea	Cinnamon Fern	1 gal.	1 plant/24" o.c.	Wet-moist	Green	3-4'
Phlox divericata	Blue phlox	Plugs – 1 gal.	1 plant/18" o.c.	moist	Blue	0.5-2'
Polemonium reptans	Jacob's ladder	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Blue	15"
Polystichum acrostichoides	Christmas fern	Plugs – 1 gal.	1 plant/24" o.c.	Moist-dry	Evergreen	2'
Stylophoru diphyllum	Wood poppy	Plugs – 1 gal.	1 plant/18" o.c.	Wet -moist	Yellow	1.5'

Plant material size and grade to conform to "American Standards for Nursery Stock" American Association of Nurserymen, Inc. latest approved revision, ANSI Z-60-1.

Table C.5. Popular Native Grasses and Sedges for Bioretention						
Latin Name	**Common Name**	**Size**	**Spacing**	**Moisture**	**Color**	**Height**
Carex grayi	Gray's Sedge	1 gal.	1 plant/24" o.c.	Moist	Green	3'
Carex muskingumensis	Palm Sedge	1 gal.	1 plant/24" o.c.	Moist	Green	3'
Carex stricta	Tussock Sedge	1 gal.	1 plant/24" o.c.	Moist	Green	3-4'
Chasmanthium latifolium	Upland Sea Oats	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Green	4'
Equisetum hyemale	Horsetail	Plugs – 1 gal.	1 plant/18" o.c.	Wet	Green	3'
Juncus effesus	Soft Rush	Plugs – 1 gal.	1 plant/24" o.c.	Wet-dry	Green	4-6'
Muhlenbergia capallaris	Muhly Grass	1 gal.	1 plant/24" o.c.	Moist	Pink	3'
Panicum virgatum	Switchgrass	1-3 gal.	1 plant/48" o.c.	Moist-dry	Yellow	5-7'
Schizachyrium scoparium	Little Blue Stem	1 gal.	1 plant/24" o.c.	Moist-dry	Yellow	3'
Sporobolus heterolepsis	Prairie Dropseed	1 gal.	1 plant/24" o.c.	Moist-dry	Green	2-3'

Plant material size and grade to conform to "American Standards for Nursery Stock" American Association of Nurserymen, Inc. latest approved revision, ANSI Z-60-1.

Table C.6. Popular Native Trees for Bioretention							
Latin Name	**Common Name**	**DT-FT**	**Light**	**Moisture**	**Notes**	**Flower Color**	**Height**
Acer rubrum	Red Maple	DT-FT	Sun-shade	Dry-wet	Fall color		50-70’
Acer saccharum	Sugar Maple		Sun-pt shade	Moist	Fall color		50-75’
Ameleanchier Canadensis	Serviceberry		Sun-pt shade	Moist-wet	Eatable berries	White	15-25’
Asimina triloba	Paw Paw		Sun-pt shade	Moist	Eatable fruits	Maroon	15-30’
Betula nigra	River Birch	FT	Sun-pt shade	Moist-wet	Exfoliating bark		40-70’
Carpinus caroliniana	Ironwood		Sun-pt shade	Moist		White	40-60’
Carya aquatica	Water Hickory	FT-DT	Sun	Moist	Fall color		35-50’
Cercus Canadensis	Redbud	DT	Sun-shade	Moist	Pea-like flowers, seed	Purple	20-30’
Chionanthus virginicus	Fringetree		Sun-pt shade	Moist	Panicled, fragrant	White	12-20’
Cladratis lutea	Yellowwood	DT	Sun	Dry-moist	Fall color	White	30-45’
Cornus florida	Flowering Dogwood		Part shade	Moist	Red fruit, wildlife	White	15-30’
Ilex opaca	American Holly	DT	Sun-pt shade	Moist	Evergreen	White	30-50’
Liquidambar styraciflua	Sweetgum	DT-FT	Sun-pt shade	Dry-moist	Spiny fruit		60-100’
Magnolia virginiana	Sweetbay Magnolia		Sun-pt shade	Moist-wet	Evergreen	White	10-60’
Nyssa sylvatica	Black Gum		Sun-Shade	Moist	Fall color		35-50’
Oxydendrum arboretum	Sourwood		Sun-pt shade	Dry-moist	Wildlife	White	20-40’
Platanus occidentalis	Sycamore	FT	Sun-pt shade	Moist	White mottled bark		70-100’
Quercus bicolor	Swamp White Oak	DT	Sun-pt shade	Moist-wet	Acorns		50-60’
Quercus nuttalli	Nuttall Oak	DT	Sun	Dry-moist	Acorns		40-60’
Quercus lyrata	Overcup Oak	FT	Sun	Moist	Acorns		40-60’
Quercus shumardii	Shumard Oak	DT	Sun	Moist	Acorns		40-60’
Rhamnus caroliniana	Carolina Buckthorn		Sun	Moist	Black fruit		15-30’
Salix nigra	Black Willow	FT	Sun-pt shade	Moist-wet	White catkins	Yellow	40-60’
Ulmus americana	American Elm	DT-FT	Sun-pt shade	Moist			
Salix nigra	Black Willow	FT	Pt shade	Moist-	White catkins	Yellow	40-60’

Size: min. 2” caliper if not reforestation. DT: Drought Tolerant FT: Flood Tolerant
Plant material size and grade to conform to “American Standards for Nursery Stock” American Association of Nurserymen, Inc. latest approved revision, ANSI Z-60-1.

Table C.7. Popular Native Shrubs for Bioretention								
Latin Name	**Common Name**	**DT FT**	**Light**	**Moisture**	**Spacing (0 C)**	**Notes**	**Flower Color**	**Height**
Aronia arbutifolia	Red Chokeberry	FT	Sun-pt shade	Dry-wet	4’	Red berries, wildlife	White	6-12’
Buddleia davidii	Butterfly Bush	DT	Sun-pt shade	Dry-moist	4’	Non-native	Blue	5’
Callicarpa Americana	American Beautyberry	DT	Sun-pt shade	Dry-wet	5’	Showy purple fruit	Lilac	4-6’
Cephalanthus occidentalis	Button Bush	FT	Sun-shade	Moist-wet	5’	Attracts wildlife	White	6-12’
Clethra alnifolia	Sweet Pepper Bush		Sun-pt shade	Dry-moist	3’	Hummingbird	White	5-8’
Cornus amomum	Silky Dogwood		Sun-shade	Moist-wet	6’	Blue berries, wildlife	White	6-12’
Corylus americana	American Hazelnut		Sun-pt shade	Dry-moist	8’	Eatable nuts, wildlife	Yellow	8-15’
Hamemelis virginiana	Witch-hazel		Sun-pt shade	Dry-moist	8’	Winter bloom	Yellow	10’
Hibiscus moscheutos	Swamp Mallow	FT	Sun	Moist-wet	30”	Cold-hardy	White – red	4-7’
Hydrangea quercifolia	Oakleaf Hydrangea	DT	Pt shade – shade	Moist	4’	Winter texture	White	3-6’
Hypericum frondosum	Golden St. John’s Wort	DT	Sun-pt shade	Dry-moist	30”	Semi-evergreen	Yellow	2-3’
Hypericum prolificum	Shrubby St. John’s Wort	DT	Sun-pt shade	Dry-moist	3’	Semi-evergreen	Yellow	3’
Ilex decidua (dwarf var.)	Possumhaw Viburnum	DT	Sun-pt shade	Moist	4-6’	Red berries		6-14’
Ilex glabra	Inkberry	DT	Sun-pt shade	Moist-wet	3’	Evergreen		4-8’
Ilex verticillata	Winterberry Holly	FT	Sun-pt shade	Moist-wet	3’	Red berries		10’
Itea virginica	Virginia Sweetspire	DT FT	Sun-shade	Moist-wet	4’	Fall color	White	4-8’
Lindera benzoin	Spicebush	DT	Pt shade – shade	Moist-wet	8’	Butterflies, wildlife	Yellow	6-12’
Viburnum dentatum	Arrowwood Viburnum		Sun-shade	Dry-wet	6’	Wildlife	White	6-8’

Size: minimum 3 gal. container or equivalent. DT: Drought Tolerant FT: Flood Tolerant

This list provides plant species; there are multiple varieties within each species.

Plant material size and grade to conform to “American Standards for Nursery Stock” American Association of Nurserymen, Inc. latest approved revision, ANSI Z-60-1.

Table C.8. Popular Native Perennials Suitable for Tree Planters – Full Sun						
Latin Name	**Common Name**	**Size**	**Spacing**	**Moisture**	**Color**	**Height**
Asclepias tuberosa	Butterfly milkweed	Plugs – 1 gal.	1 plant/18" o.c.	Dry-moist	Orange	2'
Aster novae-angliae	New England aster	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Blue	2-5'
Coreopsis lanceolata	Lance-leaf coreopsis	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Yellow	6-8'
Eupatorium purpureum	Sweet Joe-Pye Weed (Dwarf)	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Purple	3-6'
Iris virginica	Flag Iris	Plugs – 1 gal.	1 plant/18" o.c.	Moist-Wet	Blue	2'
Liatris spicata	Dense blazingstar	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Purple	1.5'
Penstemon digitalis	Smooth white beardtongue	Plugs – 1 gal	1 plant/24" o.c.	Wet	White	2-3'
Salvia lyrata	Lyre-leaf sage	Plugs – 1 gal	1 plant/18" o.c.	Moist	Purple	1-2'

C.9. Popular Native Perennials Suitable for Tree Planters – Shade						
Latin Name	**Common Name**	**Size**	**Spacing**	**Moisture**	**Color**	**Height**
Aquilegia canadensis	Wild columbine	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Pink	1-2.5'
Aster novae-angliae	New England aster	Plugs – 1 gal.	1 plant/24" o.c.	Moist-dry	Blue/ purple	3-4'
Aster oblongifolius	Aromatic Aster	Plugs – 1 gal.	1 plant/24" o.c.	Moist-dry	Blue/ purple	1.5-3'
Coreopsis lanceolata	Tickseed coreopsis	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Yellow	3'
Heuchera americana	Alumroot	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	1'

DT: Drought Tolerant
FT: Flood Tolerant

Table C.10. Popular Native Grasses and Sedges Suitable for Tree Planters						
Latin Name	**Common Name**	**Size**	**Spacing**	**Moisture**	**Color**	**Height**
Carex muskingumensis	Palm Sedge	1 gal.	1 plant/24" o.c.	Moist	Green	3'
Chasmanthium latifolium	Upland Sea Oats	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Green	4'
Equisetum hyemale	Horsetail	Plugs – 1 gal.	1 plant/18" o.c.	Wet	Green	3'
Juncus effesus	Soft Rush	Plugs – 1 gal.	1 plant/24" o.c.	Wet-dry	Green	4-6'
Muhlenbergia capallaris	Muhly Grass	1 gal.	1 plant/24" o.c.	Moist	Pink	3'
Panicum virgatum	Switchgrass	1-3 gal.	1 plant/48" o.c.	Moist - dry	Yellow	5-7'
Schizachyrium scoparium	Little Blue Stem	1 gal.	1 plant/24" o.c.	Moist-dry	Yellow	3'
Sporobolus heterolepsis	Prairie Dropseed	1 gal.	1 plant/24" o.c.	Moist-dry	Green	2-3'

Table C.11. Popular Native Trees Suitable for Tree Planters							
Latin Name	**Common Name**	**DT-FT**	**Light**	**Moisture**	**Notes**	**Flower Color**	**Height**
Acer rubrum	Red Maple	DT-FT	Sun-shade	Dry-wet	Fall color		50-70'
Betula nigra	River Birch	FT	Sun-pt shade	Moist-wet	Exfoliating bark		40-70'
Carpinus caroliniana	Ironwood		Sun-pt shade	Moist		White	40-60'
Carya aquatica	Water Hickory	FT-DT	Sun	Moist	Fall color		35-50'
Cercus Canadensis	Redbud	DT	Sun-shade	Moist	Pea-like flowers, seed pods	Purple	20-30'
Liquidambar styraciflua	Sweetgum (fruitless)	DT-FT	Sun-pt shade	Dry-moist			60-100'
Nyssa sylvatica	Black Gum		Sun-Shade	Moist	Fall color		35-50'
Platanus occidentalis	Sycamore	FT	Sun-pt shade	Moist	White mottled bark		70-100'
Quercus nuttalli	Nuttall Oak	DT	Sun	Dry-moist	Acorns		40-60'
Quercus lyrata	Overcup Oak	FT	Sun	Moist	Acorns		40-60'
Quercus shumardii	Shumard Oak	DT	Sun	Moist	Acorns		40-60'
Ulmus americana	American Elm	DT-FT	Sun-pt shade	Moist			

DT: Drought Tolerant
FT: Flood Tolerant

Table C.12. Popular Native Shrubs Suitable for Tree Planters							
Latin Name	**Common Name**	**DT-FT**	**Light**	**Moisture**	**Notes**	**Flower Color**	**Height**
Clethra alnifolia	Sweet Pepper Bush (Dwarf)		Sun-pt shade	Dry-moist	Hummingbirds	White	5-8’
Hydrangea quercifolia	Oakleaf Hydrangea	DT	Pt shade – shade	Moist		White	3-6’
Hypericum frondosum	Golden St. John’s Wort	DT	Sun-pt shade	Dry-moist	Semi-evergreen	Yellow	2-3’
Ilex glabra	Inkberry (Dwarf)	DT	Sun-pt shade	Moist-wet	Evergreen		4-8’

DT: Drought Tolerant
FT: Flood Tolerant

Appendix D

As-built Requirements for Green Infrastructure Practices and TSS Removal Practices

After the SCMs are installed, an as-built survey shall be performed. The as-built may be performed by a Registered Land Surveyor (RLS) or Professional Engineer (PE) registered with the State of Tennessee; however, the survey shall be reviewed by a PE, who shall provide a stamped certification letter stating that the site has been inspected and that the stormwater management system and stormwater control measures (both structural and non-structural) are complete and functional in accordance with the plans approved by the City and the overall design intent has been met. Coordinate data shall be presented in the State of Tennessee Plane System with the North American Datum 1983 (NAD83) and North American Vertical Datum (NAVD) of 1988. Submittals without a certification letter from a PE will be considered incomplete.

The City of Franklin Planning and Sustainability Department has requirements and a checklist for drainage as-builts which can be found at: https://www.franklintn.gov/government/departments-k-z/planning-and-sustainability/performance-agreements-sureties. Please ensure this document is reviewed prior to performing the survey and all items are addressed.

In addition to the abovementioned requirements set by the Planning and Sustainability Department, each SCM has specific information that needs to be provided as part of the as-built and PE certification letter. Below you will find each SCM with details of components that need to be documented.

GIP-01 Bioretention

1. Elevations shall be provided for inverts of the underdrain and outlet control structure and top of casting (overflow).
2. Elevations shall be provided for top of soil and top of surrounding berm.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
4. Curb cut location and width shall be verified, if applicable.

GIP-02 Urban Bioretention

1. Elevations shall be provided for inverts of the underdrain and outlet control structure and top of casting (overflow)
2. Elevations shall be provided for top of soil and top of surrounding area, berm, or wall.
3. Pretreatment measures shall be verified.
4. Surface area of the feature shall be provided.
5. Curb cut location and width shall be verified, if applicable.

GIP-03 Permeable Pavement

1. Underdrain inverts, if utilized, shall be verified.
2. Surface area of the permeable pavement shall be verified.
3. Curb cut location and width shall be verified, if applicable.

GIP-04 Infiltration Trench

1. Elevations shall be provided for invert of the underdrain and outlet control structure and top of casting (overflow)
2. Elevations shall be provided for top of trench and top of surrounding berm.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
4. Surface area of the feature shall be provided.
5. Curb cut location and width shall be verified, if applicable.

GIP-05 WQ Swale

1. Elevations shall be provided for inverts of the underdrain, check dams/check dam weirs, outlet control structure, and top of casting (overflow)
2. Elevations shall be provided for top of soil and top of surrounding berm.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
4. Surface area of the feature shall be provided.
5. Curb cut location and width shall be verified, if applicable.

GIP-06 Extended Detention

1. Elevations shall be provided for inverts of the outlet control structure, low flow orifice, top of casting (overflow), and all applicable features: forebay, micro pool, deep pool, wetland, dewatering device, etc.
2. Elevations shall be provided for top of surrounding berm and emergency spillway.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
4. Note the type of outlet structure (i.e. v-notch weir, riser, low flow orifice, etc.)

GIP-07 Sheet Flow

1. Elevations shall be provided for the top of any level spreader. Provide shots at each end and every 7 feet along the level lip.
2. Verify level spreader is properly installed to create sheet flow.
3. Verify vegetated filter strip or open space that receives sheet flow has minimal slope.
4. Verify paved area drains toward level spreader and pervious area.
5. Verify the proper vegetation has been established or protected.
6. If using amended soils, ensure proper installation by digging a test pit to verify the depth of mulch, amended soil and scarification.

GIP-08 Reforestation

This SCM requires certification from a Landscape Architect registered in the State of Tennessee to certify that the plantings have been installed per the approved plan and, if applicable, that the soil has been properly amended.

1. Provide the location, size, and species of the plantings.
2. Verify ground cover; organic mulch or establishment/germination native seed mix.

GIP-09 Green Roof

1. Profile view of facility including typical cross-sections with dimensions;
2. Growing medium elevations.
3. Stormwater piping associated with the site, including pipe materials, sizes, slopes, invert elevations at bends and connections.
4. Elevations of all overflow devices.
5. Planting and irrigation plan.

TSS-01 Stormwater Wet Pond

1. Elevations shall be provided for permanent pool, inverts of the outlet control structure, and top of casting (overflow).
2. Elevations shall be provided for top of surrounding berm and emergency spillway.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
4. Note the type of outlet structure (i.e. – v notch weir, riser, low flow orifice., etc)

TSS-02 Constructed Wetland

If components of the stormwater wetland constructed in the field differ from the design approved by the City, the as-built certification must: (1) Note the differences between the measure in the field and the design approved by the City; (2) Demonstrate that the design meets the requirements of the City's stormwater program and, if applicable, the City's floodplain management program; and/or (3) Propose additional measures to be included on the site to mitigate the differences.

1. Elevations shall be provided for the different areas of the wetland (i.e. deep water, low marsh, high marsh, etc.) permanent pool, inverts of the outlet control structure, low flow orifice, top of casting (overflow), and all applicable features: forebay, micro pool, deep pool, wetland, dewatering device, etc.
2. Elevations shall be provided for top of surrounding berm and emergency spillway.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.

TSS-03 Surface Sand Filter

1. Elevations shall be provided for inverts of the underdrain, bottom of forebay, top of sand bed, standpipe in forebay or berm separating forebay/sand bed, and overflow
2. Pretreatment measures shall be verified.
3. Forebay surface area and depth shall be provided.
4. Surface area of sand bed shall be provided.

TSS-04 Water Quality Swale

1. Elevations shall be provided for inverts of the underdrain, check dams/check dam weirs, outlet control structure, and top of casting (overflow)
2. Elevations shall be provided for top of soil and top of surrounding berm.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
4. Surface area of the feature shall be provided.
5. Curb cut location and width shall be verified, if applicable.

TSS-05 Dry Pond

1. Elevations shall be provided for bottom of pond, inverts of the outlet control structure, low flow orifice, top of casting (overflow), and all applicable features: forebay, micro pool, deep pool, wetland, dewatering device, etc.
2. Elevations shall be provided for top of surrounding berm and emergency spillway.
3. Elevations shall be provided for the top of any level spreader. Provide shots at each end and every 7 feet along the level lip.
4. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
5. Note the type of the outlet structure (i.e. – v notch weir, riser, low flow orifice, etc.)

TSS-06 Filter Strip

1. Ensure design flows spread evenly across filter strip.
2. Verify slope is between 2% and 6%.
3. Verify dimensions of filter strip.
4. Elevations shall be provided for the top of any level spreader. Provide shots at each end and every 7 feet along the level lip.

TSS-07 Grass Channel

1. Verify shape of the channel
2. Provide the length, average depth, average slope of each side of the channel, average width of the bottom of the channel, and average slope throughout the channel.

TSS-08 Underground Sand Filter

1. Verify the manufacturer and model information of the vault, if manufactured.
2. Provide location of cleanouts/manholes.
3. Provide elevations for inlet/outlet/underdrain inverts, top of filter bed (sand), and overflow weir.
4. Verify the vault is free of sediment and construction trash/debris.

TSS-09 Perimeter Sand Filter

1. Provide elevations for the center of each grate (inlet), bottom of forebay, weir, top of filter bed (sand), underdrain invert, and any overflow/spillway.
2. Forebay surface area and depth shall be provided.
3. Surface area of sand bed shall be provided.

TSS-10 Organic Filter

1. Elevations shall be provided for inverts of the underdrain, bottom of forebay, top of filter bed, standpipe in forebay or berm separating forebay/filter bed, and overflow
2. Pretreatment measures shall be verified.
3. Forebay surface area and depth shall be provided.
4. Surface area of filter bed shall be provided.

TSS-11 Gravity Oil Grit Separator

1. Verify the manufacturer and model information of the separator which has been installed.
2. Provide location of cleanouts/manholes.
3. Provide all applicable invert elevations.
4. Verify the separator is free of sediment and construction trash/debris

BEST MANAGEMENT PRACTICES MANUAL UPDATE

CITY OF FRANKLIN STORMWATER MANAGEMENT

RUNOFF REDUCTION CREDIT

- REDUCTION OF RV VALUE FOR NON-RESIDENTIAL REDEVELOPMENT SITES
- NO EXISTING WATER QUALITY PRACTICES ONSITE
- OUTPARCELS OR MIXED USE DEVELOPMENTS SHALL BE CONSIDERED ON A CASE BY CASE BASIS.
- APPLIES TO PROPERTY BOUNDARY AREAS ONLY.
- CONSIDERATION OF PARCEL ELIGIBILITY FOR REDEVELOPMENT RV REDUCTION SHALL BE BASED ON TOTAL EXISTING IMPERVIOUS AREA IN THE MOST RECENTLY APPROVED PUD AND/OR PLAT
- THERE ARE NO REDUCTIONS FOR WATER QUANTITY REQUIREMENTS.

RUNOFF REDUCTION CREDIT

- THE REDUCTION SHALL BE BASED ON THE EXISTING IMPERVIOUS COVERAGE ON THE DEVELOPMENT PLAN AS FOLLOWS:
  - TIER 1: 90-100% EXISTING IMPERVIOUS = TARGET RV VALUE SHALL EQUAL 0.40 OR MORE
  - TIER 2: 80-89.99% EXISTING IMPERVIOUS = TARGET RV VALUE SHALL EQUAL 0.35 OR MORE
  - TIER 3: 70-79.99% EXISTING IMPERVIOUS = TARGET RV VALUE SHALL EQUAL 0.30 OR MORE
  - TIER 4: 60-69.99% EXISTING IMPERVIOUS = TARGET RV VALUE SHALL EQUAL 0.25 OR MORE
- CHAPTER 1, SECTION 3 OF THE BMP MANUAL WILL BE UPDATED TO INCLUDE THESE CHANGES.

OVERALL UPDATES

- PRETREATMENT, PLANTING REQUIREMENTS, INFILTRATION TESTING PROCEDURE, AND AS-BUILTS ARE SEPARATED INTO APPENDICES
- AS-BUILTS WILL BE REQUIRED FOR PLANS APPROVED AFTER JANUARY 1, 2020. A COMMENT WILL BE MADE IN IDT AND A NOTE ON THE PLANS
- A CERTIFICATION LETTER WILL BE REQUIRED WITH AS-BUILTS
- EDITING AND FORMATTING DONE ON EACH GIP

MAJOR UPDATES

- SOIL STANDARDS, INCLUDING VOID RATIO, NOW CONSISTENT WITH THE STATE OF TENNESSEE
- MAXIMUM IMPERVIOUS DRAINAGE AREA INCREASED FROM 2.5 ACRES TO 5 ACRES TOTAL
- HYDRAULIC MODELING REQUIREMENTS HAVE BEEN UPDATED
- LEVEL 1 BIORETENTION AREAS CAN HAVE WALLS AROUND THE ENTIRE AREA. LEVEL 2 BIORETENTION CAN HAVE A MAXIMUM OF 50% OF THE PERIMETER A WALL
- FOREBAYS ARE NOW EXCLUSIVE OF THE TV REQUIREMENTS
- PRETREATMENT FOR BIORETENTION AREAS HAVE BEEN STREAMLINED
- BEDROCK IS NOT ALLOWED WITHIN THE CROSS SECTION OF THE GIP
- SHEET FLOW GIP ALLOWED WITHIN BUFFER WITH CITY ENGINEER APPROVAL

QUESTIONS?

Section 1 – Policies and Procedures

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1.3 Sources Of Pollution And Its Impacts
2 Principles Of Managing Stormwater Quality And Quantity
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4 References

Section 2 – Construction Management Practices

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Section 1 – Policies and Procedures

1 Introduction

1.1 Background and Purpose

New developments and redevelopments typically increase the amount of impervious area on a site which affects the flow of water as it rains by increasing the volume and rate of stormwater runoff. If not properly managed, increased peak flows and volumes could result in flooding and channel erosion. In addition, typical stormwater runoff from urban sites contains pollutants such as litter, sediment, oils and greases, nutrients and metals, bacteria, fertilizers and debris. These pollutants are commonly transported through municipal separate storm sewer systems (MS4s), from which they are often discharged untreated into local waterbodies. The City of Franklin has been designated by the U.S. Environmental Protection Agency (EPA) as a small MS4, and urbanized areas like the City of Franklin are required under Federal and State law, through the National Pollutant Discharge Elimination System (NPDES) Phase II Rule, to develop a stormwater management program in order to reduce the discharge of these stormwater pollutants and to achieve the stormwater treatment goals set forth by the U.S. EPA. The City of Franklin's Stormwater Management Ordinance gives authority to this Stormwater Management Manual in its municipal code.

> **Therefore, all new development and redevelopment within the City of Franklin must design, install and maintain stormwater quantity and quality controls as set forth within this Stormwater Management Manual as part of the City of Franklin's stormwater management program.**

The State of Tennessee NPDES MS4 Permit requires the development and implementation of permanent (post-construction) stormwater controls comprised of runoff reduction and pollutant removal from new development and redevelopment projects that disturb one acre or more. The Runoff Reduction Method (RRM) is the preferred control practice as it can achieve both volume control and pollutant removal. Site design standards require, in combination or alone, management measures that are designed, installed and maintained to infiltrate, evapotranspire, harvest and/or use, at a minimum, the first inch of every rainfall event preceded by 72 hours of no measurable precipitation. The first inch of rainfall must be 100% managed with no stormwater runoff being discharged from the site. For projects that cannot meet 100% of the runoff reduction requirements, the remainder of the stipulated amount of rainfall must be treated prior to discharge with a technology expected to remove 80% total suspended solids (TSS) in order to meet water quality requirements.

This Stormwater Management Manual has been compiled by the City of Franklin to assist planners, developers, contractors and various businesses and industries in complying with the guidelines set forth by the NPDES Phase II Rule. This manual is designed to support the stormwater management language set forth within the Ordinance by way of providing specific guidance for selection of Best Management Practices (BMPs) and elaborating on various practices. This manual will assist the City of Franklin in stormwater pollution prevention and water quality protection through impact-reducing site design, BMP selection, construction management, post-construction management, and good housekeeping measures.

1.2 How to Use This Manual

This Stormwater Management Manual contains the following sections:

Section 1 provides an introduction to the NPDES MS4 Permit requirements and the City of Franklin's stormwater management program. This section discusses the principles of site layout and the policies and procedures for selecting and designing water quality and water quantity controls required for all new development and redevelopment within the City. This section also presents an introduction to Low Impact Development (LID) design and Green Infrastructure Practices (GIPs).

Section 2 contains construction management practices (CP) that should be used for contractor and construction site operations. These management practices focus on good housekeeping measures and capturing pollutants from typical contractor and construction site activities.

Section 3 contains temporary construction site runoff management practices (TCP) that are consistent with those described in TDEC's Erosion and Sediment Control (E&SC) Handbook. The NPDES MS4 Permit requires the development and implementation of temporary construction site stormwater controls. This section provides guidance on the BMPs that have been approved for use by the City of Franklin.

Section 4 contains permanent erosion prevention and sediment control (PESC) measures which should be selected during the early planning phase of a project and included in the initial site design.

Section 5 contains permanent stormwater treatment controls (PTP) that are focused on green infrastructure practices and accepted 80% TSS treatment controls. These management practices should be selected during the site layout and early planning phase of the project in order to achieve the required runoff reduction.

Section 6 contains industrial and commercial treatment practices (ICP). These practices are similar to the construction management practices found within Section 2, but are intended for use in an industrial environment rather than on a construction site.

Section 7 contains other source control measures (SC) that predominately focus on the management of hazardous materials. These measures can be used in addition to the construction management practices and the industrial and commercial practices.

When planning and designing a site for development or redevelopment within the City of Franklin, this manual is best used in the order shown in Figure 1.

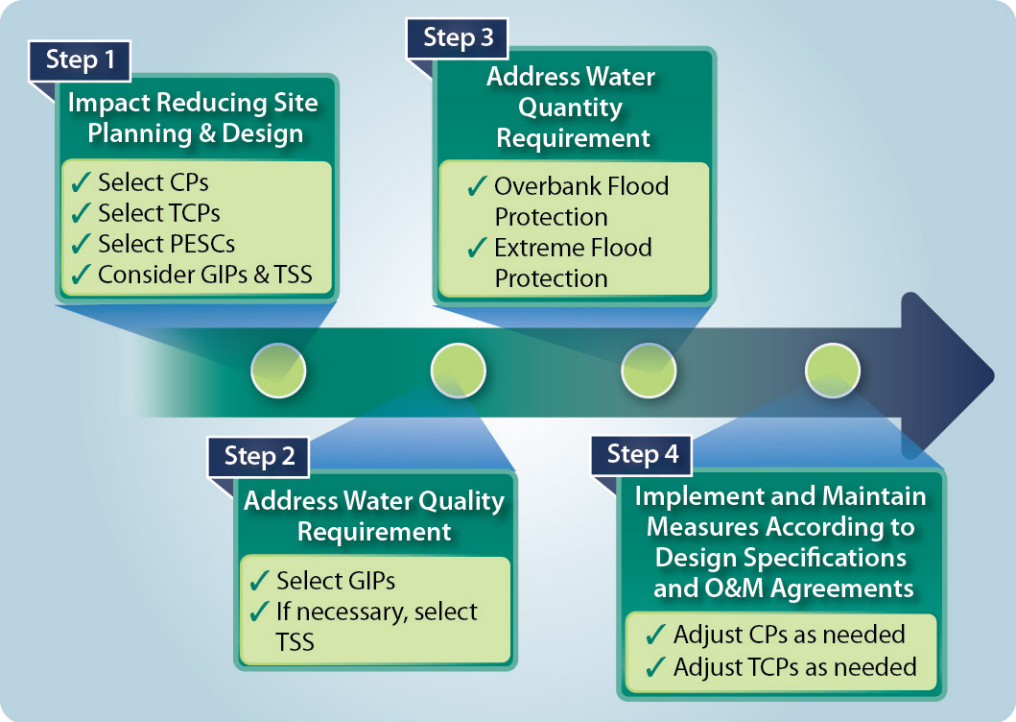


Figure 1 – Site Planning and Development Process

The fact sheets in this manual are designed for easy reference. They are categorized, focused, and concise to allow easy access and expedient use. Each fact sheet can be used as a stand-alone document that may be distributed to facilitate focused discussion about design and/or implementation of each management practice. However, the goals of Franklin's stormwater management program will not be met by simply installing BMPs. This manual is intended to guide the design of a project from start to finish, and stormwater management should be part of the site design considerations in the initial phase of conceptual design. There are some BMPs that require structural practices, though many are non-structural practices where everyday activities may be performed in a manner that limits the impact of stormwater runoff to surface water quality.

1.3 Sources of Pollution and Its Impacts

General Pollution Overview

Pollution entering Franklin's streams and channels has many sources and entry paths. Pollutants are generally either washed into surface waters by rainfall runoff or they enter through human activities such as connecting non-stormwater drains to the stormwater drainage system or by someone dumping waste into drains or streams directly. Franklin has programs of education, prevention and inspection to address the illicit connections or illegal dumping by individuals. This manual articulates Franklin's standards to reduce rainfall runoff of pollutants into our natural stream system.

Rainfall induced pollution enters primarily by two methods. The first is erosion and sedimentation (deposition) of sediment and the pollutants sediment contains. The second is the simple washoff of pollution that may lie on paved (impervious) surfaces. The following briefly describes these two general pollution sources.

Erosion and Sedimentation Overview

Short-term stormwater quality management predominately focuses on E&SC for construction sites; however, E&SC can also be a concern for fully developed sites. Soil erosion is the process by which soil particles are removed from land surfaces by wind, water or gravity. Natural erosion generally occurs at slow rates. However, the rate of erosion increases when land is cleared or altered and left disturbed. Erosion rates will increase when flow rates and velocities discharged from a site exceed the erosive range.

Clearing and grubbing activities during construction remove vegetation and disrupt the structure of the soil surface, leaving the soil susceptible to rainfall erosion, stream and channel erosion, and wind erosion if left untreated. Ultimately, the material suspended by erosion settles during sedimentation in downstream reaches.

Once eroded, soil particles may travel anywhere from a few inches to many miles before gravity causes them to settle. The settling of soil particles is a process known as sedimentation. Excessive levels of sedimentation can create problems such as clogging of storm drains, blockage in streams and channels, damage to existing habitat, and in some cases, formation of habitats in undesirable locations.

There are negative influences on channels, streams and rivers when sediment enters the waterways. As sediment volumes increase in waterways, the overall capacity decreases. This causes an increase in flooding as well as creates excessive maintenance needs.

1.3.1 Water Erosion

Rainfall events begin the water erosion process by dislodging minute soil particles. These soil particles then become suspended in the water droplet. The sediment laden water droplets accumulate on the soil until a sufficient quantity has developed to begin flowing under the forces of gravity.

The initial flow of sediment laden water generally consists of a thin, slow-moving sheet, known as sheet flow. In most cases, sheet flow does not prove to be highly erosive; however, it does begin the transport of the sediment that was previously suspended. Irregularities in soil surface and uneven topography will usually cause sheet flow to become concentrated into rivulets where flow causes an increase in velocity

and erosive energy. This increase in erosive energy of water flowing in rivulets creates small grooves, or rills, in the soil surface.

Rill erosion of the soil surface concentrates flows, which increases flow velocity and erosive energy due to gravitational forces. This results in deeper and wider rills that may join together with adjacent rills. Typically, rills run parallel to the slope and each other. In addition, rills are small enough to be stepped across, and are usually enlarged by direct erosion of the rill's sides and bottom by the action of flowing water.

Severe Gully Erosion

The joining together of several adjacent rills, or sufficient enlargement of a single rill, begins gully erosion. In most cases gullies run parallel to the slope and may have one or more lateral branches. Gullies are enlarged by the following four key actions:

1. Gullies often have a "head cut" at the upstream end, which progresses its way upstream as water flowing into the gully erodes away the lip of the head. A waterfall working its way upstream can exemplify this. This can be seen in the picture above.
2. The flow in a gully tends to undercut the banks. Once the banks are sufficiently under cut, the banks will collapse into the gully where the collapsed soil is then washed away.
3. The collapse of banks into the gully causes flowing water to be diverted around the temporary blockage of soil. This temporary blockage of soil increases the velocity along one or both banks, which results in increased bank erosion.
4. The concentration of flows in the gully may result in scour of the gully floor until a stable slope is obtained.

1.3.2 Stream and Channel Erosion

Construction activities often require the disturbance of streams and channels. Once vegetation or other bank protection measures are disturbed, flows may begin to erode the unprotected soil.

Construction activities often result in the disturbance of channel and stream flow. However, this should only happen when traversing banks such as a temporary channel and stream crossing, culvert installation, bridge construction, etc. By diverting flows within the channel, velocities are generally increased in some areas to compensate for decreases in other areas. The increase in velocity may exceed those normally experienced by the channel, resulting in bank erosion and bottom scour.

Construction activities and the construction of facilities that increase the quantity and rate of runoff as well as how runoff is conveyed often increases the quantity and flow rate to streams and channels. The increased quantity and rate of flow can cause bank erosion and bottom scour.

1.3.3 Wind Erosion

Dust is defined as solid particles or particulate matter small enough to remain suspended in the air for a period of time and large enough to eventually settle out of the air. Dust from a construction site originates as inorganic particulate matter from rock and soil surfaces and material storage piles. The majority of dust

generated and emitted into the air at a construction site is related to earth moving operations, demolition, construction traffic on unpaved surfaces, and wind over disturbed soil surfaces.

1.3.4 Factors Influencing Erosion

There are five primary factors that influence erosion: soil characteristics, vegetative cover, topography, climate, and rainfall.

Soil Characteristics – Particle size, particle gradation, organic content, soil structure, and soil permeability are all characteristics that contribute to the determination of a soil's erodibility. These characteristics affect the stability and infiltration capacity of the soil. Less permeable soil has an increased risk of runoff and erosion. Typically, soils that contain high percentages of silts and clays are the most erodible.

Channel flow is also affected by soil characteristics in that tractive-force or shear stress developed by flowing water over the channel banks and bottom may cause soil particles to move and become suspended into the runoff. The "permissible shear" stress indicates the stress that the channel banks and bottom can sustain without jeopardizing stability. It is possible to increase the allowable shear stress in the channel by utilizing "soft/green" or "hard" armoring on the channel bottom and banks.

Vegetative Cover – Vegetative cover creates an erosion shield by stabilizing the soil. In addition, vegetative cover protects soil from direct rain, and also decreases the velocity of runoff. This allows greater infiltration as well as maintains the soil's capacity to absorb water. Vegetative root structures create a favorable soil structure, improving its stability and permeability.

Topography – Slope is a key element in determining the volume and velocity of runoff. An increase in the slope length, and/or steepness causes an increase in the runoff rate, and consequently, an increase in the potential for erosion.

Climate – High precipitation areas as well as areas with freeze/thaw cycles have significant effects on soil stability and structure.

Rainfall – Frequency, intensity, and duration are fundamental factors in determining the amounts of erosion produced. In Tennessee, the erosion risk period is typically highest in the wet season (typically December through May), which coincides with a period of minimal vegetative cover.

Pollution Washoff Overview

There are a number of pollutants that wash off into streams. The following describes the most common.

1.3.5 Nutrients

Fertilizers, pesticides, construction chemicals, and solid waste contain phosphorus and nitrogen, which can result in excessive or accelerated growth of vegetation or algae. This increase in vegetation results in the impairment of lakes and other water resources and the growth of algae results in the depletion of dissolved oxygen, potentially resulting in fish kills.

1.3.6 Oxygen Demanding Substances

The biological decomposition of organic matter in stormwater depletes the amount of dissolved oxygen (DO), which causes biochemical oxygen demand (BOD). BOD measures the degree of dissolved oxygen depletion by expressing the amount of easily oxidized organic matter present in water. In addition, certain non-organics materials in the water can intensify DO depletion.

1.3.7 Metals

Artificial surfaces such as galvanized metal, paint, or preserved wood contain metals that can enter stormwater as their surfaces corrode, flake, dissolve, decay, or leach. These metals that are found in urban stormwater often originate from passenger vehicles. Over half the trace metal load carried in stormwater is associated with sediments to which these eroded metals attach. Heavy metals are of concern because they are toxic to aquatic organisms, can be bioaccumulative, and have the potential to contaminate drinking water supplies.

1.3.8 Pesticides

Pesticides are herbicides, insecticides, and rodenticides that are commonly used on construction sites, lawns, parks, golf courses, etc. Excessive or improper application of theses pesticides may result in direct water contamination, indirect water pollution by aerosol drift, or erosion of treated soil and subsequent transport into surface waters.

1.3.9 Oil, Grease, and Fuels

These products are widely used and may spill, leak, or be dumped on the ground where they can wash into waterways. Sources include leaks during normal vehicle use, hydraulic line failure, spills during fueling, and inappropriate disposal of drained fluids. These products can cause harm to plant and animal life.

1.3.10 Other Toxic Chemicals

Synthetic organic compounds such as adhesives, cleaners, sealants, and solvents are often improperly applied, and may also be improperly stored and disposed of. Accidental spills, improper storage or deliberate dumping of these chemicals onto the ground or into storm drains causes environmental harm to receiving waters.

1.3.11 Miscellaneous Wastes

Miscellaneous wastes include wash water from concrete mixers, paints and painting equipment cleaning activities, solid organic wastes resulting from trees and shrubs removed during land clearing, wood and paper materials, food and containers, such as paper, aluminum, and metal cans, industrial or heavy commercial process wash/cooling water, vehicle washing, other commercial or industrial wastes and sanitary wastes.

2 Principles of Managing Stormwater Quality and Quantity

Successful and effective stormwater management is a two-fold process: one management principle is related to the quality of runoff and the potential pollutants that can be carried within stormwater runoff and deposited untreated into local surface waters; the other is related to the increased quantity of stormwater runoff and related flooding and maintenance issues. Stormwater volume in itself is a potential trigger for stormwater pollution as an increase in the volume of stormwater runoff can also increase the likelihood for pollutant transport and channel erosion.

An increase in development has led to an increase in impervious area and therefore an increase in runoff volume, flow rate and pollution. Stormwater quality management involves reduction of runoff volume and appropriate treatment of any polluted stormwater that that does run off. Stormwater quantity management involves slowing, detaining, and/or controlling the volume and flow rate of runoff from "major" storm events ranging from the 2 to the 500-year statistical storm frequency.

Communities are increasingly moving towards Green Infrastructure Practices (GIPs) – or a combination of green and conventional stormwater management practices – to manage stormwater. Green Infrastructure (GI), as used in this Manual, is a term that refers to a subset of Low Impact Development (LID) structural systems and practices that support the principles of LID and make use of volume-reducing designs and calculations. Green Infrastructure systems are an innovative approach to urban stormwater management that do not rely on the conventional end-of-pipe structural methods. Rather, they are an ecosystem-based approach that strategically integrates stormwater controls throughout an urban landscape to attempt to maintain a site's pre-development conditions. Targeted community or watershed goals and objectives are addressed through the use of structural and non-structural techniques such as permeable pavement, bioretention/rain gardens, rain barrels, and public outreach.

This chapter discusses the principles of managing stormwater quality and quantity. The technical details for designing for stormwater quality and quantity requirements are described in Chapters 3 and 4 of this section, respectively.

2.1 Introduction to Green Infrastructure Practices

The overall goal of GIPs is to reduce stormwater runoff volume and to treat pollutant loads close to the source where they are generated. In doing so, GIPs provide many stormwater management benefits; such as improved water quality, flow management, groundwater recharge, and channel protection. GIPs minimize the hydrologic impacts of urban development on the surrounding environment by intrinsically linking stormwater management to urban design and landscape architecture. This is accomplished with appropriate site planning and through the direction of stormwater towards small-scale systems dispersed throughout the site. These systems should be carefully selected based on the site's topographic and climatic conditions. Correctly pairing land uses with GIPs is an important first step in site planning. GIPs, located in Section 5, should be matched with land use and setting, as listed in the GIP criteria fact sheets and detailed in each GIP discussion.

Why Green / Low Impact Development

Current development patterns and traditional storm water management techniques have resulted in large amounts of impervious surfaces in cities across the country. Conventional development approaches to stormwater management often use practices to quickly and efficiently convey water away from developed

areas. This results in larger volumes of runoff flowing directly to channels, streams, rivers and combined sewer systems as well as any pollutants contained in the runoff.

In contrast, LID utilizes a system of source controls and small-scale, decentralized treatment practices to help maintain the hydrologic function of the landscape by allowing water to infiltrate, evapotranspire, or be reused onsite. The conservation of open space, the reduction of impervious surfaces, and the use of small-scale storm water controls, such as green roofs, are just a few of the LID practices that can help maintain predevelopment conditions and keep greater volumes of runoff from routing to the stormwater system. LID techniques can offer the following many benefits to the City of Franklin:

Community

- Protect flora and fauna
- Balance growth needs with environmental protection
- Reduce municipal infrastructure and utility maintenance costs (streets, curbs, gutters, sidewalks, storm sewers)
- Encourage private sector participation in green stormwater infrastructure at residential, commercial, and industrial facilities
- Decrease flooding risks for small storms
- Create attractive, natural and multifunctional public spaces

Developers

- Reduce land clearing and grading costs
- Potentially reduce infrastructure costs (streets, curbs, gutters, sidewalks)
- Reduce storm water management costs
- Potentially reduce municipal permitting fees and increase lot yields
- Increase lot and community marketability

Environment

- Preserve integrity of ecological and biological systems
- Protect site and regional water quality by reducing sediment, nutrient, and pollutant loads to water bodies
- Reduce impacts to terrestrial and aquatic plants and animals
- Preserve trees and natural vegetation
- Mitigate the heat island effect and reduce energy use

2.2 Introduction to Best Management Practice Selection

Stormwater management measures must be applied in the form of structural and non-structural BMPs as detailed within this manual. This section is in two parts. Temporary BMPs are designed to address construction activities, while permanent BMPs are designed to address long-term stormwater management objectives. Effective planning for both short and long term goals allows for an easy transition from

temporary to permanent controls and favorable results with respect to cost and performance. Each unique project has specific risks that can be addressed through properly selected BMPs. In order to reach this goal, specific project risks must first be identified, BMP objectives defined, BMPs determined, and lastly the appropriate BMPs selected.

Define BMP Objectives

The initial step in the selection and use of BMPs is to define objectives. BMP objectives must address development and construction activities as well as existing industry, businesses, and private parties whose activities may contribute to overall water quality. These activities are all unique and require specific knowledge of the pollution risks associated with each activity. This knowledge is essential in selecting BMPs effectively. The following BMP objectives supplement the standards set forth by the City's Stormwater Management Ordinance:

1. **Practice Good Housekeeping**: Proper management of pollutant sources and modification of construction activities can prevent pollutants from draining or being transported off-site.
2. **Contain Waste**: Dispose of all construction waste in designated areas, and prevent stormwater run-on and run-off from these areas.
3. **Minimize Disturbed Areas**: Land clearing should take place only in areas that will be under active construction within a few months of the time of clearing. Phased clearing of a large development is recommended. Land clearing during the rainy season should be avoided if at all possible. Sensitive areas such as steep slopes, riparian buffers, and natural watercourses should never be disturbed if at all possible.
4. **Stabilize Disturbed Areas**: Temporary stabilization techniques should be utilized in areas where there are disturbed soils that are not undergoing active construction. Upon final completion of a construction activity, permanent landscaping, and stabilization should be applied.
5. **Protect Slopes and Channels**: Steep and unstable slopes should not be disturbed if they are outside of the approved grading plan area. Runoff should be conveyed from the top of the slope in a safe manner ensuring that the slope is stabilized as soon as possible. Natural channels should not be disturbed if at all possible. Temporary and permanent channel crossings require stabilizing as quickly as possible to ensure that increases in runoff velocity caused by the project do not erode the channel.
6. **Control Site Perimeter:** Upstream runoff should be diverted either around or through the construction project in a safe manner. These diversions should be designed to ensure that downstream property would not be damaged. In addition, all runoff exiting the construction site should be free of excessive sediment, and other pollutants.
7. **Control Internal Erosion:** Sediment laden water should be detained or otherwise treated within the site to avoid potential pollution to water resources.

Site characteristics and specific contractor activities affect the potential for erosion and pollution by other potential pollutants contained in materials and chemicals used on the construction site. While determining BMP objectives, the following factors should be considered:

1. **Site conditions including the following:**

- Soil type, including underlying soil strata that are likely to be exposed to stormwater.
- Natural terrain and slope.
- Final slopes and grades.
- Location of concentrated flows, storm drains, channels, and streams.
- Existing vegetation and ground cover.

2. **Climatic factors including the following:**
   - Seasonal rainfall patterns.
   - Appropriate design storm, which takes into account quantity, intensity, and duration of rainfall.
3. **Type of construction activity.**
4. **Construction schedules, construction sequencing, and phasing of construction.**
5. **Size of construction project and areas to be graded.**
6. **Location of the construction activity relative to adjacent uses and public improvements.**
7. **Types of construction materials and potential pollutants present or that will be brought on-site.**
8. **Floodplain, Floodway, and riparian buffer requirements.**

Determine BMPs

Once the BMP objectives are defined, specific BMPs should be determined. In order to determine the appropriate BMPs to use, a plan for the project will be needed. This plan should contain enough detail that drainage patterns, topography, and existing and permanent stormwater control structures can be located with ease. The plan will be required in order to obtain a Stormwater Management Permit, which is required for all development and redevelopment as identified in the City of Franklin Municipal Code. The plan should identify the following information, in addition to any plan requirements set forth by the Code:

1. Stormwater entrance and exiting locations. Sheet and Channel flow for the existing and final grading contours should be included. This should be in accordance with the master stormwater management plan for the specific watershed.
2. Identify locations of steep slopes and unlined channels that are subject to high rates of erosion. Long, steep slopes over 100 feet in length are considered as areas of moderate to high erosion potential. Soil bioengineering is preferred for stabilization over rip rap, and other hard armoring techniques. (See City of Franklin Municipal Code)
3. Categorize slopes as:
   a. Low Erosion Potential (0 to 5 percent slope)
   b. Moderate Erosion Potential (5 to 10 percent slope)
   c. High Erosion Potential (slope greater than 10 percent)

4. Identify sensitive areas and water resources that should not be disturbed such as wetlands, springs, sinkholes, floodplains, floodways, areas to be used for infiltrative GIPs for post construction, sensitive areas or riparian buffers,including other areas where site improvements will not be constructed. Clearing limits should be identified to prevent disturbance of these areas during construction activities.
5. Identify tributary areas for each outfall location. The approximate area of each tributary should be calculated.
6. Identify locations where contractor activities may have a risk of causing a runoff or polluted discharge. (See Section 2, Construction Management Practices, for additional information.)

This plan will allow easy identification of BMPs that need to be considered on a particular construction project. Planning prior to the commencement of construction and phasing construction activities always prove to be more cost effective than treatment of stormwater after the fact. Preventative maintenance is simpler and less costly than correcting a problem that has already occurred.

Once BMP objectives have been determined, the BMP selection process illustrated in Figure 2 below should be utilized. The BMP selection process is used to determine the BMP objectives that will be met by the various BMPs. Many BMPs can achieve more than one objective, which should be taken into account during the selection process. This allows for selecting the most cost-effective BMP. For example, it is not always necessary to install extensive sediment trapping controls during construction. In fact, sediment trapping should be used only as a short-term measure for active construction areas, and replaced by permanent stabilization measures as soon as possible. However, it should be noted that perimeter/outfall control in the form of permanent detention ponds should be built first and used as temporary sediment control during construction. After construction is complete and the tributary area is stabilized, the permanent outlet configuration can be reestablished.

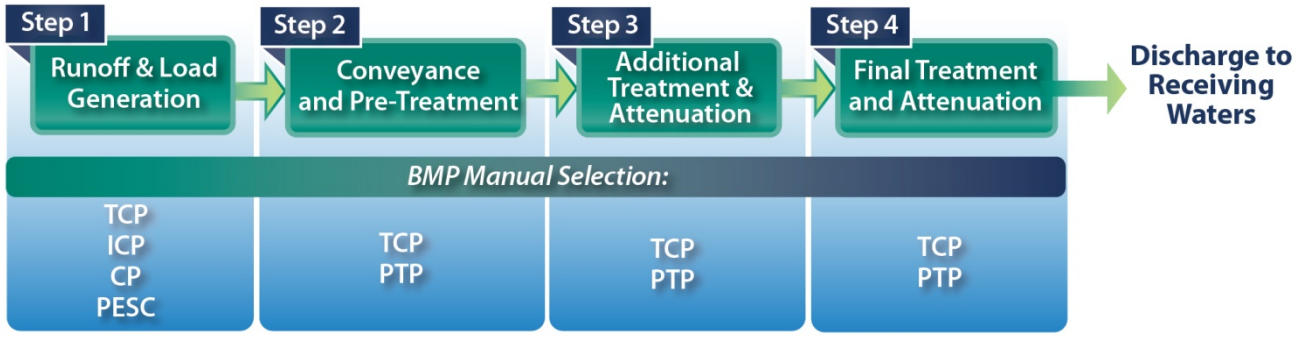


Figure 2 – BMP Selection Process

Temporary BMPs for Construction Activities

Temporary BMPs include many different "good housekeeping" methods as well as short term E&SC activities. The steps involved in utilizing temporary BMPs include design by a Professional Engineer, review and approval by the City of Franklin, implementation, maintenance and inspection. The construction site operator and licensed professional engineer should be responsible for the design and implementation of these BMPs. The contractor bears the responsibility for constructing, maintaining, implementing, and seeking help when it is apparent that the BMPs are not meeting their objectives.

2.2.1 Construction Management Practices

Contractor activities can result in stormwater runoff pollution if not properly managed. The appropriate BMPs shall be utilized to minimize the potential for stormwater pollution. It is recognized that all BMPs are not effective on every construction site. It is important that all BMPs are considered, and that those which are effective for the project at hand should be selected. Considerations for selecting BMPs for contractor activities include the following:

1. **Consider precipitation events**. BMPs may be different on rainy days vs. dry days, winter vs. summer, etc. For instance, a material storage area may be covered with a tarp during the rainy season, but not in the summer. However, plans should be made for some amount of rain, even if it is not expected to generate a flooding event.
2. **Consider the amount of material used**. Less intensive BMP implementation may be necessary if a minimal amount of pollutant containing material is used. Remember that different materials pollute in different amounts.
3. **Consider the volume of water used**. The larger the volume of water used and wastewater generated, the more likely that pollutants transported by this water will reach the stormwater system or be transported off-site.
4. **Consider the site conditions**. BMPs selected will differ depending on whether the activity is conducted on a slope or flat ground, near a stormwater structure or watercourse, etc. Anticipating problems and conducting activities away from certain sensitive areas will reduce the cost and inconvenience of performing BMPs.
5. **Consider accidents**. Pre-establishing a BMP for each conceivable pollutant discharge may be very costly and significantly disrupt construction. As a rule of thumb, establish controls for common (daily or weekly) activities and be prepared to respond quickly to accidents.
6. **Define the difference**. Not everything can or will be deemed an accident and may be classified as negligent disregard of proper practices.

Keep in mind that the BMPs for contractor activities are suggested practices that may or may not apply in every case. Construction personnel should be instructed to develop additional or alternative BMPs that are more cost-effective for a particular project. The best BMP is a construction work force aware of the pollution potential of their activities and committed to a clean worksite. BMP Fact Sheets for Construction Management Practices (CPs) are provided in Section 2 of this manual.

2.2.2 Construction Site Runoff Management Practices

BMPs for erosion and sediment control are selected to meet the BMP objectives based on specific site conditions, construction activities, and cost-effectiveness. Different BMPs may be needed at different times during construction since construction activities are constantly changing the site conditions.

E&SC must begin with the initial prevention of erosion. This can be accomplished through soil protection techniques that will prevent the runoff of soil particles. Erosion and sedimentation will most likely occur to some degree due to active construction areas, and BMP s must be selected to address these issues once they have occurred. Sediment Control BMPs allow sedimentation to be removed from flows before these flows exit the construction site. Consequently, the best protection on active construction sites is generally obtained through simultaneous application of both E&SC BMPs. This combination is effective because it

prevents most erosion before it begins and has the ability to capture sediments that become suspended before the transporting flows leave the construction site.

The following general items are provided to aid in preparing the project plans and choosing appropriate E&SC BMPs:

Minimize Disturbed Areas - Project layout and schedule should be compared with on-site management measures that can limit the exposure of the project site to erosion and sedimentation. The City of Franklin Municipal Code sets standards that require responsible construction practices. The following BMPs should be considered in order to reach the desired goals:

1. Do not disturb any portion of the site unless an improvement is to be constructed there immediately.
2. Staging and timing of construction, grading, clearing, etc. can minimize the size of exposed areas and the length of time the areas are exposed and subject to erosion. For example, only areas that are actively involved in cut and fill operations or are otherwise being graded should be exposed.
3. Retain existing vegetation and ground cover where feasible, especially along watercourses and along the downstream perimeter of the site.
4. Construction should be completed as quickly as possible.
5. Landscaping or other stabilization techniques should be installed immediately after the land has been graded to its final contour.
6. Denuded areas should be kept to a minimum during the wet months of December through May.

Stabilize Disturbed Areas – Stabilization is very important because it protects the soil from being eroded away. Stabilization techniques may include vegetative, chemical, or physical soil coverings. It is important to keep in mind that any soil which is exposed is subject to erosion due to a rainfall event, runoff flowing over the soil, wind blowing across that soil, and vehicles driving on the soil. Consequently, it is important that all soil is covered, other than that which is undergoing active construction. Locations on a construction site that are more susceptible to erosion are:

1. Slopes
2. Highly erosive soils
3. Construction entrances
4. Water resource channels
5. Soil stockpiles

Site Perimeter – BMPs for regulating flow in and out of the site perimeter should be a priority. The following ideas should be considered:

1. Disturbed areas or slopes that drain toward adjacent properties, storm drain inlets or receiving waters, should be protected with temporary linear barriers (continuous berms, silt fences, sand bags, etc.) to reduce or prevent sediment discharge while construction in the area is active. In addition, the contractor should be prepared to stabilize those soils with EP measures prior to the onset of rain.

2. When grading has been completed, the areas should be protected with EP controls such as mulching, seeding, planting, or emulsifiers. The combination of EP measures and SC measures should remain in place until the area is permanently stabilized.
3. Significant offsite flows (especially concentrated flows) that drain onto disturbed areas or slopes should be controlled through use of continuous berms, earth dikes, drainage swales, and lined ditches that will allow for controlled passage or containment of flows.
4. Concentrated flows that are discharged off of the site should be controlled through outlet protection, velocity dissipation devices, and level spreaders in order to prevent erosion of downstream areas.
5. Perimeter controls should be placed everywhere runoff enters or leaves the site. They are usually installed just before clearing, grubbing, and rough grading begin. Additional controls within the interior of the construction site should supplement perimeter controls once rough grading is complete.

Internal Swales and Ditches – Until permanent facilities have been constructed, flows are directed toward internal swales, curbs, and ditches. Design and implementation criteria should include the following:

1. Temporary stormwater facilities are susceptible to erosion from concentrated flows, and should be stabilized through temporary check dams, geotextile mats, and under extreme erosive conditions by lining with concrete.
2. Long or steep slopes should be terraced at regular intervals in order to slow the runoff, and to allow for small amounts of sediment to settle out.
3. Slope benches may be constructed with either ditches along them or back-sloped at a gentle angle toward the hill. These benches and ditches intercept runoff before it can reach an erosive velocity and divert it to a stable outlet.
4. A rough surface such as tall grass can be installed to reduce overland flow velocities.

Internal Erosion - After all erosion and sediment control BMPs have been utilized, excessive sediment should be removed from stormwater both within and along the perimeter of the project site. To prevent erosion temporary barriers or traps should slow the velocity of sediment-laden water. This flow should then enter a pond where soil particles may settle. Appropriate strategies for implementing sedimentation controls include:

- Sediment-laden water should be directed to temporary sediment traps.
- Locate sediment basins and traps at low points below disturbed areas.
- Existing and proposed storm drainage structures should be protected from sediment clogging by implementation of inlet protection for area drains and curb inlets.
- Temporary sediment traps or ponds should be constructed at stormwater outfalls for the site.
- Stormwater detention ponds should be excavated early in the project so that they can serve as sedimentation ponds during construction. Remove accumulated sediment and landscape the ponds when the upstream drainage area is stabilized.
- Temporary sediment barriers such as:

- Silt Fence
- Baffles
- Filter Ring
- Filter Berm
- Tubes and Wattles

Stormwater Inlets and Outfalls – All stormwater inlets, including drop inlets, and pipe inlets, should be protected from sediment intrusion if the area draining to the inlet has been disturbed. This protection may include sand bags, sediment traps, or other similar devices. In addition internal outfalls must be protected to reduce scour from high velocity flows leaving pipes or other drainage facilities.

BMPs for Temporary Construction Site Runoff Management Practices (TCPs) are covered in more detail in Section 3 of this manual.

Permanent Erosion Prevention and Sediment Control BMPs

Permanent BMPs are the final improvements to the configuration of the project. They are designed for long-term management of stormwater pollution after construction activities are complete. Example Permanent BMPs include permanent vegetation, buffer zones, bioengineered stream bank stabilization and channel linings. There is no single BMP that will address all long-term stormwater quality problems. A multi-level strategy is required that incorporates source controls, a series of on-site treatment controls, and community-wide treatment controls. This concept was presented earlier in Figure 2, BMP Selection Process. Permanent BMP selection should be considered in the early planning stages of development.

The BMP Fact Sheets for Permanent Erosion Prevention and Sediment Control (PESC) are provided in Section 4 of this manual.

Permanent Stormwater Quality Treatment Controls

Permanent Stormwater Quality Treatment Controls may include Green Infrastructure Practices (GIPs) such as bioretention, swales, detention ponds, and a variety of other features as well as 80% TSS Treatment Practices such as constructed wetlands, sand filters, and filter strips. Licensed professional engineers are responsible for selection of these management practices. These practices should be included in the early planning stages of development. It is important to consider which treatment controls are most efficient and appropriate for the site. In addition, the long-term maintenance responsibilities should be identified in the plans and specifications to prevent future disputes. Typically, this responsibility is left to either the public or private owner of the property. The contractor and owner are responsible for properly constructing and maintaining the permanent controls.

Permanent Stormwater Quality Treatment Controls are implemented most effectively when they are tied in with the actual project design. They are typically selected during the planning phase, in conjunction with the approval of the tentative plan designed during the design phase of a project. When stormwater controls are considered as part of the design, they are conceptually planned and consequently, more effective. The following should be considered in the design process.

1. Is a detention/retention facility required for flood control? Often, facilities are required to maintain peak runoff at predevelopment levels to reduce downstream conveyance system

damage and other costs associated with flooding. Most permanent BMPs can be incorporated into flood control detention/retention facilities with modest design refinements and limited increase in land area and cost.

2. Planned open spaces that have slopes less than 5% may be merged with stormwater quality/ quantity facilities. Such integrated, multi-use areas may achieve several objectives at a modest cost.
3. Infiltration BMPs may serve as groundwater recharge facilities, although soil conditions are critical to their success. Detention/retention areas may be created in landscaped areas of the project, and vegetated swales/filters may be used as roadside/median or parking lot median vegetated areas.

The BMP Fact Sheets for Permanent Stormwater Treatment Controls (PTPs) including GIPs and 80% TSS Treatment Practices are provided in Section 5 of this manual.

2.2.3 Effectiveness of Green Infrastructure Practices

GIPs are intended to mimic the natural hydrologic condition and allow stormwater to infiltrate into the ground, evapotranspire into the air, or be captured for reuse. Typical GIPs include: sheet flow, infiltration practices, permeable pavement, bioretention, reforestation, tree box filters, green roofs, and assorted other practices.

These GIPs are designed to meet multiple stormwater management objectives, including reductions in runoff volume, peak flow rate reductions, and water quality protection. Multiple small, localized controls may be combined into a treatment train to provide comprehensive stormwater management. The GIPs listed in this section have been designed to be integrated into many common urban land uses on both public and private property, and may be constructed individually, or as part of larger construction projects. Decentralized management strategies are encouraged to be tailored to individual sites; which can eliminate the need for large-scale, capital-intensive centralized controls; and may improve the water quality in Franklin's water resources.

This Manual includes nine of the most common GIPs, shown in summary Table 1 and Table 2. These tables are included to facilitate selection of the most appropriate practices for a given situation. Fact sheets are included in Section 5 for each practice and provide a brief introduction to the practice, details on performance, suitability, limitations, and maintenance requirements. In addition, each practice is assigned a percentage of volume control based on the particular GIP's ability to control volume from smaller storms and from the first flush of larger storms. Not only does reducing runoff volume decrease the amount of

stormwater discharged to sewers, channels and streams, but it is also the most effective stormwater pollution control available.

Table 1 – Effectiveness of BMPs in Meeting Stormwater Management Objectives			
Practices	**Volume**	**Peak Discharge**	**Water Quality**
Bioretention	●	●	●
Urban Bioretention	◉	◉	●
Permeable Pavement	●	●	◉
Infiltration Trench	●	●	●
Water Quality Swales (Dry)	◉	◉	●
Extended Detention	○	●	○
Downspout Disconnection	◉	◉	◉
Grass Channels	○	○	○
Sheet Flow	●	●	◉
Reforestation	●	●	●
Rain Tanks/Cisterns*	◉	○	○
Green Roofs	◉	●	●

* A single cistern typically provides greater volume reduction than a single rain tank

● High effectiveness ◉ Medium effectiveness ○ Low effectiveness

Rankings are qualitative. “High effectiveness” means that one of the GIP’s primary functions is to meet the objective. “Medium effectiveness” means that a GIP can partially meet the objective but should be used in conjunction with other BMPs. “Low effectiveness” means that the GIP’s contribution to the objective is a byproduct of its other functions, and another decentralized control should be used if that objective is important.

Table 2 – Green Stormwater Infrastructure Land Use and Land Area Selection Matrix								
Practices	Criteria							
	Land Use							Land Area Required
	Schools	Com.	Indust.	SF Res.	MF Res.	Parks/Open Space	Roads/ Roadside	
Bioretention	●	●		●	●	●	●	◉
Urban Bioretention	◉	●			●	●	●	○
Permeable Pavement	●	●	◉	●	●	●	●	○
Infiltration Trench	●	●		●	●	●	◉	○
Water Quality Swales (Dry)	●	●			●		●	◉
Extended Detention	●	●	●		●		●	○
Downspout Disconnection	●	◉		●	●	●		○
Grass Channels	●	●		●	●	◉	●	◉
Sheet Flow	●	●		●	●	◉	●	◉
Reforestation	◉		◉	◉	◉	●	●	○/●
Rain Tanks/Cisterns	●	◉	◉	●	●			○
Green Roofs	●	●	●		●			○

● - Well suited for land use applications or high relative dedicated land area required.
◉ - Average suitability for land use applications or moderate relative dedicated land area required.
○ - Low relative dedicated land area required.
Blank – Not applicable for land use.

2.3 Integrated Site Design

The City of Franklin has established a three-part Integrated Site Design (ISD) process in the consideration of stormwater management goals. The ISD process fits well into the general process of land development and serves to assist the designer in making maximum use of the natural features of the site to treat and handle stormwater runoff in a way that integrates such practices into the site layout. Best Management Practice layout planning is accomplished through the ISD process and includes impact reducing site design, integrated stormwater sizing criteria and operations and maintenance of permanent stormwater practices.

Impact-Reducing Site Planning and Design Principles

The first step in the ISD process is to utilize impact-reducing site design principles for stormwater management. Impact-reducing site design includes a number of site design techniques such as preserving natural features and resources, effectively laying out the site elements to reduce impact to the watershed, reducing the amount of impervious surfaces, and utilizing natural features on the site for stormwater management. The goal is to minimize impacts of development by reducing the amount of runoff and pollutants that are generated from a development or redevelopment site, and provide for some nonstructural on-site treatment and control of runoff. Impact-reducing site design concepts can be viewed as both water quantity and water quality management tools that can reduce the size and cost of required structural stormwater controls — sometimes eliminating the need for them entirely — while maintaining or even increasing the value of the property. This site design approach can result in a more natural and cost-effective stormwater management system that better mimics the natural hydrologic conditions of the site, has a lower maintenance burden and increases sustainability.

Step 1: Identify and Delineate Natural Features and Resources

The first step in the impact-reducing site design process is to identify and delineate the natural features and resources that can be used in the protection of water resources by reducing stormwater runoff, providing runoff storage, reducing flooding, preventing soil erosion, promoting infiltration, and removing stormwater pollutants. The design engineer should collect and review information on the existing site conditions and delineate existing site features such as:

- Areas of undisturbed vegetation
- Floodplains and riparian areas
- Ridgetops and steep slopes
- Natural drainage pathways
- Water resource channels and streams
- Aquifers and recharge areas
- Wetlands
- Soil types
- Other natural features or critical areas
- Other features that should be identified in this step are adjacent areas, existing developed areas, and existing stormwater facilities and infrastructure.

Step 2: Conserve Natural Features and Resources

The conservation of natural features such as floodplains, soils, and vegetation helps to retain predevelopment hydrology functions, thus reducing runoff volumes. Impacts to natural features should be minimized by reducing the extent of construction and development practices that adversely impact predevelopment hydrology functions. This includes:

- Building upon the least porous soils or limiting construction activities to previously disturbed soils
- Avoiding mass clearing and grading, and limiting the clearing and grading of land to the minimum needed to construct the development and associated infrastructure
- Avoiding disturbance of vegetation and soil on slopes and near surface waters
- Leaving undisturbed riparian buffers along both sides of the water resource, as defined in the City of Franklin Municipal Code
- Preserving sensitive environmental areas, historically undisturbed vegetation, and native trees
- Conforming to watershed, conservation, and open space plans
- Designing development to fit the site terrain, and building roadways parallel to contour lines wherever possible
- Clustering development to preserve porous soils, natural streams, natural channels and natural slopes
- Avoid floodplains

Step 3: Manage Stormwater Close to the Source

Redirecting runoff back into the ground, close to the point of origin, provides both environmental and economic benefits. Traditional stormwater systems, which collect and convey stormwater, generally increase flows and are likely to suffer failures over time. Techniques include:

- Use GIPs to infiltrate stormwater into the ground instead of concentrating the flow and routing it offsite
- Disconnect impervious surfaces wherever feasible

Step 4: Design to Reduce Runoff Impacts

After conservation areas have been delineated, there are additional opportunities in the preliminary stages of a site design for avoiding downstream stormwater impacts from the development. These primarily deal with the location and configuration of lots or structures on the site and include the following recommendations and options:

- Fit the design to the terrain
- Reduce the limits of clearing and grading (i.e., limit clearing and grading areas to what is absolutely necessary)
- Locate development in less sensitive areas (e.g., outside of wetlands)

- Utilize open space
- Use nontraditional lot designs for residential areas (think outside the box)
- Consider creative development design
- Preserve riparian buffers and undisturbed areas
- Use natural drainage paths instead of storm sewer infrastructure
- Use vegetated swales instead of curb and gutter
- Drain runoff to pervious areas

Step 5: Reduce and Disconnect Impervious Cover

Reducing and disconnecting impervious surfaces increases the rainfall that infiltrates into the ground. Impervious areas should be reduced by maximizing landscaping and using pervious pavements. In addition, the amount of impervious areas hydraulically connected to impervious conveyances (e.g., driveways, walkways, culverts, streets, or storm drains) should be reduced as much as possible. Examples include:

- Installing green roofs
- Directing roof downspouts to vegetated areas, bioretention,, or planter boxes, and routing runoff into vegetated swales instead of gutters
- Using porous pavements where permitted
- Installing shared driveways that connect two or more homes or installing residential driveways with center vegetated strips
- Allowing for shared parking in commercial areas
- Encouraging building developers to increase their number of floors instead of their building's footprint

Step 6: Minimize Soil Compaction

Soil compaction disturbs native soil structure, reduces infiltration rates, and limits root growth and plant survivability. When protected, local soils can have a significant infiltration capacity, and can help meet design requirements. While soil compaction is necessary to provide structurally sound foundations, areas away from foundations are often excessively compacted by vehicle and foot traffic during construction. Minimizing soil compaction can be achieved by:

- Reducing disturbance through design and construction practices
- Limiting areas of access for heavy equipment
- Avoiding extensive and unnecessary clearing and stockpiling of topsoil
- Maintaining existing topsoil and/or using quality topsoil during construction

Integrated Stormwater Sizing Criteria

The second step in the ISD process is to utilize an integrated sizing approach for meeting the City's stormwater runoff **quantity** and **quality** management requirements. These criteria allow the site engineer

to calculate the stormwater control volumes required for water quality and flood protection. The purpose is to provide a framework for designing (sizing) a stormwater management system to:

- Reduce the volume of stormwater runoff and remove runoff pollutants to improve water quality;
- Reduce downstream overbank flooding; and
- Safely pass or reduce the runoff from extreme storm events.

The Integrated Stormwater Sizing Criteria is an integrated set of criteria or design standards that allow the site engineer to size and design structural stormwater controls to address the above objectives. The criteria are summarized in Table 3.

Table 3 - Summary of Sizing Criteria for Stormwater Control and Mitigation

Sizing Criteria		Description
Water Quantity	**Water Quality**	Infiltrate, evapotranspire, harvest and/or use, at a minimum, the first inch of every rainfall event preceded by 72 hours of no measurable precipitation. For projects that cannot meet 100% of the runoff reduction requirement, the remainder of the stipulated amount of rainfall must be treated prior to discharge with a technology expected to remove 80% total suspended solids (TSS).
	Overbank Flood Protection	Provide peak discharge control of the 2, 10, 25, and 50-year storm event on the stormwater management system, adjacent property, and downstream facilities and property to reduce overbank flooding through detention.
	Extreme Flood Protection	Evaluate the effects of the 100-year storm on the stormwater management system, adjacent property, and downstream facilities and property. Manage the impacts of the extreme storm event through detention controls and/or floodplain management.

Each of the integrated stormwater sizing criteria are intended to be used with one another to address the overall stormwater impacts from a development site. When used as a comprehensive set, the integrated criteria control the entire range of hydrologic events, from the smallest runoff-producing rainfalls to the 100-year storm. Figure 3 graphically illustrates the relative volume requirements of each of the integrated stormwater sizing criteria and demonstrates that the criteria are generally "nested" within one another, (i.e., the extreme flood protection volume requirement also contains the overbank flood protection volume and the water quality treatment volume). This nesting provides efficiency when constructing and maintaining stormwater controls.

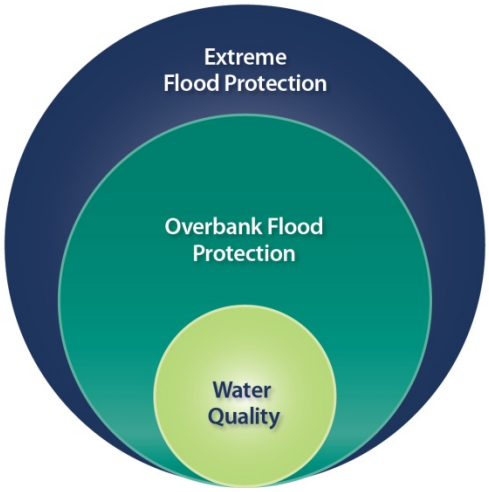


Figure 3 – Representation of the Integrated Stormwater Sizing Criteria

The integrated stormwater sizing criteria is described in more detail below.

2.3.1 Water Quality

Hydrologic studies show that small-sized, frequently occurring storms account for the majority of rainfall events that generate stormwater runoff. Consequently, the runoff from these storms also accounts for a large portion of the annual pollutant loadings. Therefore, by treating these frequently occurring smaller rainfall events and a portion of the stormwater runoff from larger events, it is possible to effectively mitigate the water quality impacts from a developed area whether located in the headwater reaches of the watershed or close in proximity to a 4th order stream.

The Runoff Reduction Method (RRM), presented in Chapter 3, can achieve both volume control and pollutant removal stormwater management goals. For projects that cannot meet 100% of the runoff reduction requirement, the remainder of the stipulated amount of rainfall must be treated prior to discharge with a technology expected to remove 80% TSS in order to comply with the City's NPDES Phase II MS4 Permit. This combined approach allows the designer to apply RRM design principles along with 80% TSS design principles to meet the compliance standard.

Chapter 3.1 of this manual provides technical details regarding RRM. Chapter 3.2 provides technical details regarding the RRM and 80% TSS fall back combined methodology.

The City of Franklin reserves the right to require other treatment goals for other pollutants of concern based on other regulatory requirements or needs (e.g. Total Maximum Daily Load studies).

2.3.2 Overbank Flood Protection (Qp)

An increase in impervious areas by development increases the potential for downstream flooding. The purpose of overbank flood protection is to prevent an increase in the frequency and magnitude of damaging out-of-bank flooding (i.e. flow events that exceed the capacity of the channel and enter the floodplain). It is intended to protect downstream properties from flooding at middle-frequency storm events. The Overbank Flood Protection criterion specifies that the post-development 2, 10, 25, and 50-year, 24-hour

storm peak discharge rate (denoted Qp) not exceed the pre- development (or undisturbed natural conditions) discharge rate.

2.3.3 Extreme Flood Protection (Qf)

The intent of the extreme flood protection is to prevent flood damage from infrequent but large storm events, maintain the boundaries of the mapped 100-year floodplain, and protect the physical integrity of the structural stormwater controls as well as downstream stormwater and flood control facilities. The Extreme Flood Protection criterion specifies that all stormwater management facilities be designed to control runoff for the 100-year, 24 hour storm (denoted Qf) so that the rate at which flow is released over the entire runoff discharge period is equal to or less than predevelopment flows.

Operations and Maintenance

The third and final step in the ISD process is to provide for operation and maintenance (O&M) oversight of the water quality and quantity BMPs. Without proper care and maintenance, the BMPs ability to perform its design function is reduced and it is no longer in compliance with City regulations.

A Stormwater Management Facilities O&M Agreement is required to be submitted with all Stormwater Permit Applications. If final configuration of the stormwater system changes from the design, the O&M Agreement must be updated to reflect changes. As part of the O&M Agreement, a Long Term BMP Maintenance Plan must be developed by the design professional engineer (Found in Section 5). This plan includes a description of the stormwater system, the required inspections, the inspection schedule, and how the inspections should be documented. A report must be submitted to the City of Franklin by July 1 of each year that includes documentation of the inspection and maintenance activities performed.

Additional O&M guidance for Green Infrastructure controls and TSS Practices can be found within each design specification located in Section 5.

3 Post Construction Water Quality

3.1 The Runoff Reduction Method

Introduction

3.1.1 Background

The Runoff Reduction Method (RRM) will serve as the basis for Franklin's approach to Green Infrastructure (GI) requirements in the NPDES Phase II MS4 Permit. The basic RRM derivation can be found in original References 11 and 12. The RRM has been slightly modified and localized for the middle Tennessee region.

In the past, Franklin's pollution reduction approach focused mainly on engineered controls to reduce stormwater pollution as runoff flowed through structural controls, and required that they meet an 80% or more removal efficiency of total suspended solids. Open space land use was of only minor importance. Under the RRM, every land surface will now have an assigned rating in terms of volume of rainfall capture. For example, if open space can infiltrate a significant rainfall event, and it can be credited with 100% TSS removal for all the volume it infiltrates, then the open space itself becomes an effective control. Even impervious surfaces capture a small amount of water and therefore do not generate 100% runoff.

Volume removal is the focus of this approach; and volume reduction equals pollution reduction. Thus, understanding and calculating every aspect of a site's land condition in relation to volume removal is important.

3.1.2 Objectives

The basis for the RRM is a rainfall volume capture goal. The City of Franklin's site design standards require, in combination or alone, management measures that are designed, installed and maintained to infiltrate, evapotranspire, harvest and/or use, on average, the first inch of every rainfall event preceded by 72 hours of no measurable precipitation. The RRM was designed to fulfill several complimentary objectives:

- Meet the one-inch capture requirement under the NPDES MS4 Permit;
- Reflect local hydrologic and land conditions;
- Encourage and incentivize the use of natural solutions; and
- Provide an approach that is simple and effective for a range of development projects

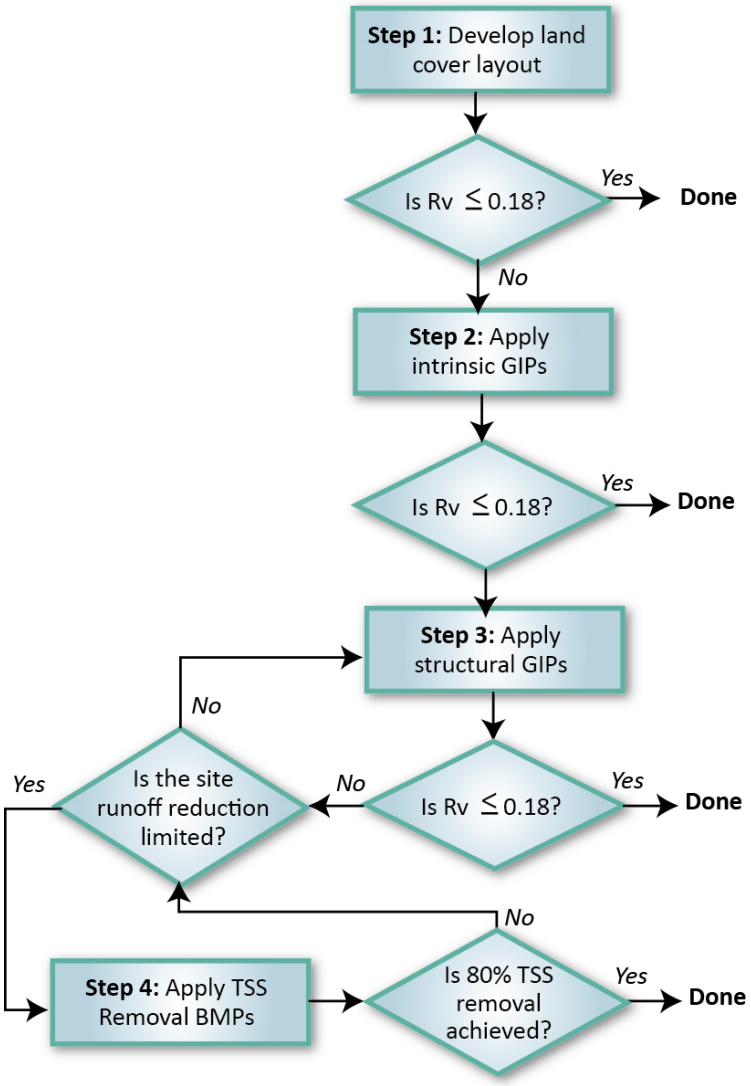
It was found that these objectives could largely be met through the use of a single overarching design standard, backed by specific volume-capture standards for structural controls and rainfall intensity scaled runoff coefficients for other land uses. To be eligible for approval of a site design under this approach the designer must lay out the site such that the total rainfall for a one-inch event of moderate intensity is captured and treated on site through a combination of infiltration, evapotranspiration, harvest and/or use. This objective is accomplished through site layout and GIP design.

The first step in determining if the standard is met is to determine the volumetric runoff coefficient, Rv, which is the percentage of fallen precipitation that runs off of a specific land use area (See Equation 1). Rv within this method reflects a site's post-development runoff volume for storms in the one-inch or larger

range. Based on national studies and standards, and supported by local rainfall-runoff analysis for middle Tennessee soils, it was found that an Rv value of 0.18 generally indicates the capture of the first one-inch of rainfall. Storms larger than one inch may cause runoff.

Each land use is assigned an Rv value. Once Rv values have been developed, they must be weighted for the respective areas. If the weighted Rv for the whole site is 0.18 or less, then the standard has been met. If the Rv standard has not been met, GIPs consisting of intrinsic designs and structural controls devised to capture the remaining required volume are added to the design. These effectively modify the Rv value for contributing drainage areas to that intrinsic design or control. These are shown in Tables 4 and 5.

In summary, in meeting this standard the designer will have carefully considered the effective use of: (1) land cover that reduces runoff; (2) more intrinsic site design GIPs that further reduce runoff; and (3) structural GIPs that capture the remaining volume required to meet the compliance standard. In each step the Rv values and supporting design specifications have been carefully crafted to effectively meet compliance standards while retaining focus on natural approaches. In every case values have been localized through the balanced use of the most recent data sources and continuous simulation modeling of local conditions.



3.1.3 Conceptual Steps in the Runoff Reduction Method

The RRM follows the steps shown below:

Step 1: Reduce Runoff Through Land Use and Ground Cover Decisions

This step focuses on the "background" land cover and how much rainfall it removes from runoff. Design activities in Step 1 focus on impervious area minimization, reduced soil disturbance, forest preservation, etc. The goal is to minimize impervious cover and mass site grading and to maximize the retention of forest and vegetative cover, natural areas and undisturbed soils, especially those most conducive to landscape-scale infiltration.

Calculations for the RRM Step 1 include the computation of volumetric runoff coefficients (Rv) for land use and Hydrologic Soil Group (HSG) combinations (including impervious cover). Site cover runoff coefficients are shown in Table 4.

Step 2: Apply Environmental Site Design Practices (Non-Structural GIPs)

If the target volume capture (Rv ≤ 0.18) has not been attained in Step 1 then Step 2 is required. This step focuses on implementing the more intrinsic GIPs during the early phases of site layout. In this step the designer enhances the ability of the background land cover to reduce runoff volume through the planned and engineered use of such practices as sheet flow, and planned reforestation. Each of these practices is assigned an ability to reduce one-inch of rainfall in a storm of moderate intensity; and this assignment is captured in the Runoff Removal Credit or the RR Credit. RR Credit values for non-structural GIPs are shown in Table 5.

Step 3: Apply Structural GIPs

If the target one-inch capture volume (Rv ≤ 0.18) has not been attained, Step 3 is required. In this step, the designer experiments with combinations of more structural GIPs on the site. In each case, the designer estimates the area to be treated by each GIP to incrementally meet the overall runoff reduction goal. Such engineered practices as infiltration trenches, bioretention, green roofs, permeable pavement, etc. are envisioned. Design and sizing standards have been created for each of these GIPs to insure their ability to meet the one-inch volume capture still required after Steps 1 and 2 have been implemented. RR Credit values for structural GIPs are also shown in Table 5.

The guidance for the effectiveness of the various GIPs is expressed in terms of percent volume reduction (Runoff Reduction Credit). At the end of Step 3, the designer must have achieved the required one-inch volume capture – accomplished by attaining an area weighted Rv value of 0.18 or less.

However, if the Runoff Reduction Performance Standard has not been achieved after Step 3 and the development is determined to be runoff reduction limited (i.e., runoff reduction practices cannot be implemented at the site sufficiently to meet the Runoff Reduction Performance Standard), then the site designer must request approval to use TSS Removal Best Management Practices (BMPs) and, if approved, proceeds to Step 4.

Step 4: Apply TSS Removal BMPs

The application of TSS Removal BMPs will occur only if the Runoff Reduction Performance Standard has not been achieved in Steps 1 through 3, and the site is approved for TSS Removal BMPs because it is runoff reduction limited. In this step, the designer will capture the remainder of the required 1-inch rainfall that was not captured in the Runoff Reduction Method design (in steps 1 through 3), and will treat this volume to the Pollutant Removal Performance Standard of 80% TSS Removal. TSS Removal BMPs such as stormwater wetlands, sand filters, and wet ponds can be used for this purpose.

Technical Details

3.1.4 Step 1: Land use Rv Values

The volumetric runoff coefficient (Rv) is the ratio of the runoff divided by the target rainfall. The Rv values refer to the ratio of rainfall that falls on and is discharged from each drainage area. If 45% of the rainfall for storms in the one-inch range and larger is discharged from the site, the Rv value equals 0.45. Unlike a Rational Method C Factor, for example, Rv is not a constant individual storm-based value, but is rainfall intensity and total depth dependent. Rv values could be developed for individual storms, seasons, or even on an annual basis. Table 4 shows the Rv values that are applicable for the City of Franklin in order to estimate runoff from larger storms of moderate intensity meeting the one-inch and greater standard.

Table 4 - Site Cover Runoff Coefficients

Soil Condition	Volumetric Runoff Coefficient (R_V)			
IMPERVIOUS COVER	0.95			
HYDROLOGIC SOIL GROUP	**A**	**B**	**C**	**D**
FOREST COVER	0.02	0.03	0.04	0.05
TURF	0.15	0.18	0.20	0.23

These values serve as the basis for Step 1 in application of the RRM. The development of an area-weighted estimate of the total site Rv value using site land uses is shown below in Equation 1. Example 1 on the following page demonstrates Step 1 using Equation 1

$$\text{Weighted Rv} = \frac{[(Rv_1 \times A_1) + (Rv_2 \times A_2) + \cdots]}{(A_1 + A_2 + \cdots)} \qquad \textbf{Equation 1}$$

EXAMPLE 1 STEP 1

The first step is to layout the project site and divide it into sub-areas of a specific land use type and Rv. As shown in Figure 4 below, if we have a 10 acre site and 50% of the site was impervious, 20% forest, and 30% turf grass all over HSG B Soils the Rv value would be:

$$\text{Weighted Rv} = \frac{[(\text{Rv}_1 \times \text{A}_1) + (\text{Rv}_2 \times \text{A}_2) + (\text{Rv}_3 \times \text{A}_3)]}{(\text{A}_1 + \text{A}_2 + \text{A}_3)}$$

$$\text{Weighted Rv} = \frac{[(0.95 \times 5.0\text{ac}) + (0.03 \times 2.0\text{ac}) + (0.18 \times 3.0\text{ac})]}{(5.0\text{ac} + 2.0\text{ac} + 3.0\text{ac})}$$

$$\text{Weighted Rv} = 0.54$$

That is, 54% of the rainfall for storms in the range of one-inch and greater runs off. This step does not consider the flow path of the runoff but simply the land use. The requirement is the capture of the first inch of rainfall and an Rv of 0.18 or less. Additional GIPs must be planned and implemented to meet the required Rv for the site.

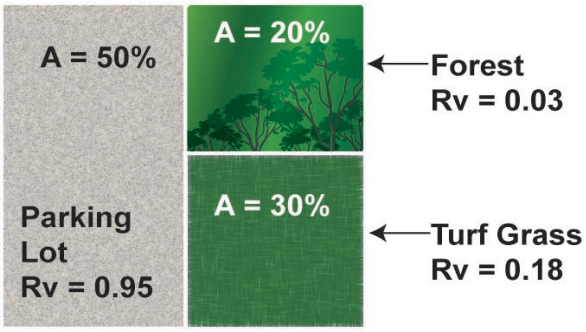


Figure 4 – Site Example with Land Uses

3.1.5 Redevelopment Rv Reduction

Reduction of a sites overall water quality treatment value (Rv value) may be granted by the City Engineer for qualifying non-residential redevelopment sites. Existing outparcels or mixed use developments that contain both residential and commercial uses may qualify but shall be considered on a case by case basis by the City Engineer. Redevelopment Rv reductions are aimed at encouraging older (pre-green infrastructure and TSS requirements) predominately impervious developments in which no existing water quality practices are in place to promote healthier watersheds through infiltration-based water quality practices.

Consideration of parcel eligibility for Redevelopment Rv reduction shall be based on total existing impervious area included in the currently approved development plan. If the parcel in question was developed before the implementation of development plan recordings, then the bases for impervious area will be based on the limits of the current plat of record for that development. This applies to the land located

within the site's property lines. Detailed criteria of eligibility for incentives shall be in accordance with that outlined in the City's current BMP manual and may be revised at any time by the City Engineer. The target Rv value for sites that qualify are stated below. Incremental percentage reductions between target Rv values will not be given.

- Tier 1: 90%-100% Existing Impervious = Target Rv value shall equal .60 or more
- Tier 2: 80%-89.99% Existing Impervious = Target Rv value shall equal .65 or more
- Tier 3: 70%-79.99% Existing Impervious = Target Rv value shall equal .70 or more
- Tier 4: 60%-69.99% Existing Impervious = Target Rv value shall equal .75 or more

3.1.6 Steps 2 and 3: Green Infrastructure Practice Rv Values

Steps 2 and 3 of the RRM involve the planning and design of Green Infrastructure Practices (both intrinsic Step 2 and structural Step 3) to reduce runoff from sub-areas in Step 1. Each sub-area's Rv may be reduced by allowing runoff to flow into downstream GIPs. After GIPs are implemented the total site Rv is recalculated using the GIP modified Rv for each sub-area. In order to satisfy the City's requirement the site Rv must be 0.18 or less. Table 5 lists acceptable GIPs and the assigned Runoff Reduction Credits (RR Credit) for each. These RR Credit values correspond with the values listed in each GIP's specification. Several GIP's in Table 5 have two levels of design options, the two levels refer to specific design requirements contained in the specification sheets within Section 5 of this manual.

Table 5 - Green Infrastructure Practices Runoff Reduction Credit Percentages

Green Infrastructure Practice	% Rainfall Volume Removed/Captured – RR Credit							
	Level 1**				Level 2**			
1. Bioretention	60				80			
2. Urban Bioretention	60				N/A			
3. Permeable Pavement	45				75			
4. Infiltration Trench	50				90			
5. Water Quality Swale	40				60			
6. Extended Detention	15				N/A			
7. Sheet Flow *	50				75			
8. Reforestation (A, B, C, D soils)	96	94	92	90	98	97	96	95
9. Green Roof	80				90			

*See GIP for additional RR Credits.

**See GIP for additional information of the distinction between Level 1 and Level 2 design.

Note that the first six GIPs themselves occupy site land area. Because of their ability to absorb the rain that falls on them they are assigned the corresponding Forest Cover Rv values by soil type from Table 6.

Table 6 - Green Infrastructure Practice Cover Coefficients				
Green Infrastructure Practice	Forest Cover Rv Values for GIPs by Hydrologic Soil Group			
	A	B	C	D
Bioretention Urban Bioretention Permeable Pavement Infiltration Trench Water Quality Swale Extended Detention	0.02	0.03	0.04	0.05

To calculate the Modified Rv value for a sub-area flowing through a GIP, use Equation 2 shown below.

$$\text{Modified Sub-area Rv} = (\text{Sub-area Rv})(1 - \text{RR Credit}) \qquad \textbf{Equation 2}$$

The Modified Sub-area Rv equals the Sub-area Rv as treated by a GIP. Example 1 is continued below and demonstrates Steps 2 and 3 using Equation 2 above.

EXAMPLE 1 - STEP 2 & 3

In Step 2 and 3, the designer uses intrinsic and structural GIPs to reduce the weighted Rv. Continuing with Example 1 Step 1 and using Figure 4, the impervious area has an Rv value of 0.95, half of the parking area can be discharged through one intrinsic GIP, sheet flow level 2 over turf (Table 5: 75% RR Credit for HSG B soil). The other half of the parking area can be discharged through one structural GIP, bioretention with level 2 design (Table 5: 80% RR Credit). The following modified Rv would result using Equation 2: (Note that the forest and turf do not drain to the bioretention area)

$$\text{Sheet Flow (Level 2) Modified Sub-area Rv} = 0.95 * (1-0.75) = 0.24$$

$$\text{Bioretention Modified Sub-area Rv} = 0.95 * (1-0.80) = 0.19$$

Thus, the intrinsic GIP, sheet flow level 2 via a level spreader reduces half the impervious area's Rv from 0.95 to **0.24** and the bioretention facility meeting the level 2 design criteria would cause the remainder of the impervious area's Rv to be reduced from 0.95 to **0.19**. Additionally, the bioretention area occupies land area and can be given a Forest Cover on HSG B soil Rv.

Recalculating the weighted Rv using Equation 1 results in the following:

$$\text{Weighted Rv} = \frac{[(\mathbf{0.24} \times 2.5\text{ac}) + (\mathbf{0.19} \times 2.5\text{ac}) + (\mathbf{0.03} \times 0.14ac) + (0.03 \times 2.0\text{ac}) + (0.18 \times 2.86\text{ac})]}{(10\text{ac})}$$

$$\text{Weighted Rv} = 0.17$$

Using sheet flow via a level spreader over HSG B soil and a bioretention area meeting the Level 2 design criteria runoff from the impervious area is treated and the weighted Rv is reduced to just below the requirement of 0.18.

3.1.7 Rv Calculations for GIPs in Series

The calculation of volume removal rate for controls in series can be complex and specific GIP dependent. The upstream control has the benefit of initially handling runoff from the many small storms while the second GIP in series must handle the overflow from the first – a set of fewer and larger storms. Therefore, the ability to capture instantaneous volumes and store them for later removal is key for the downstream controls. Only the first six controls in Table 5 can be used as the downstream GIP in series: bioretention, urban bioretention, permeable pavement, infiltration trench, water quality swale, and extended detention.

The following equation shall be used for calculation of the Modified Subarea Rv for GIPs in series:

$$\text{Modified Sub-area Rv}_{\text{SERIES}} = \text{Sub-area Rv}(1 - RR_1 \text{ Credit})(1 - RR_2 \text{ Credit}) \quad \textbf{Equation 3}$$

Where Subarea Rv is the area weighted Rv of the land cover flowing into the first GIP in the series (e.g. Subarea Rv = 0.95 for 100% impervious area, *or* if 50% of the area was impervious and 50% of the area was turf on HSG B soil then the Sub-area Rv is 0.57). RR_1 Credit is the percent volume reduction credit for the first GIP in the series from Table 5 and RR_2 Credit is the percent volume reduction credit for the second

GIP in the series from Table 5. Credit will be granted for no more than two structural controls used in series.

EXAMPLE 2 - GIPs in Series

This example demonstrates how to treat an impervious area by two structural GIPs in series. A 5.0 acre site is 80% impervious (4 ac), 0.75 acre is turf grass, and 0.25 ac is forested. The underlying soils are all HSG C. The impervious area is discharged to two water quality swales level 2 (Table 5: 60% RR Credit) into two bioretention areas level 1 (Table 5: 60% RR Credit). Calculate the Rv for each of the three sub areas of the site – only the impervious area is demonstrating GIPs in series:

(1) Impervious area is discharged through water quality swales and bioretention areas
Modified Sub-area Rv_{SERIES} = 0.95*(1-0.60)(1-0.60) = 0.15

(2) Turf grass HSG C Rv = 0.20

(3) Forest in C Soil Rv = 0.04

Weighted Rv for criteria attainment using Equation 1 is:

$$\text{Weighted Rv} = \frac{[(\mathbf{0.15} \times 4 \text{ ac}) + (\mathbf{0.20} \times 0.75 \text{ ac}) + (\mathbf{0.04} \times 0.25\ ac)]}{(5 \text{ ac})}$$

$$\text{Weighted Rv} = 0.15$$

This equation says that 95% of the rainfall runs off the impervious area and enters the water quality swales of which 60% of is held in the designed swale. The remainder of the prescribed volume would enter the bioretention facility (the largest storms) and 60% of which is captured designed as a level 1 facility allowing approximately 15% to runoff the site in the design situation on an average annual basis.

EXAMPLE 3 - GIPs in Series

A 2.0 acre site is 75% impervious (2 ac), and 0.5 acre is turf grass. The underlying soils are all HSG B. The impervious area consists of a parking lot and building. The building is 0.5 acres and is discharged to a Level 2 Bioretention (Table 5: 80% RR Credit). The parking lot is 1.0 acre and contains 0.5 acre of level 1 pervious pavers (Table 5: 45% RR Credit), the remainder of the runoff not credited by the pavers is captured by a level 2 bioretention (Table 5: 80% RR Credit). Calculate the Rv for each of the two sub areas of the site – only the impervious area from the parking lot is demonstrating GIPs in series:

(1) Parking lot impervious area is discharged and captured by pervious pavers and then by level 2 bioretention

Modified Sub-area Rv_{SERIES} = 0.95*(1-0.45)(1-0.80) = 0.11

(2) Building is discharged to a Level 2 Bioretention

Modified Sub-area Rv = 0.95*(1-0.80) = 0.19

(3) Turf grass HSG B Rv = 0.18

Weighted Rv for criteria attainment using Equation 1 is:

$$\text{Weighted Rv} = \frac{[(\mathbf{0.11} \times 1\text{ ac}) + (\mathbf{0.19} \times 0.5\text{ ac}) + (\mathbf{0.18} \times 0.5\ ac)]}{(2\text{ ac})}$$

$$\text{Weighted Rv} = 0.15$$

This equation says that 95% of the rainfall runs off the parking lot impervious area enters the pervious pavers and bioretention of which 45% is held in the pavers and 80% of the remainder is held in the bioretention practice. The runoff from the building impervious is captured by the bioretention and when the turf grass (HSG B) is taken into account on an average annual basis 15% runs off the site. Thus, this site meets the Rv target of 0.18 Rv or 18% runoff on an average annual basis.

3.1.8 Sizing of Media-Based GIPs

The following guidance is provided for sizing media based GIPs types of facilities. Details for each type of GIP are provided within Section 5 of this manual. All media-based GIPs shall be sized to provide storage volume for the complete runoff from one inch of rain over the contributing drainage area (CDA). Thus all media storage GIPs shall be sized using the following equations:

$$\text{Tv} = \text{Mult.}\left[\text{P(CDA)(Rv)}\left(\frac{43{,}560\text{ ft}^2}{1\text{ ac}}\right)\left(\frac{1\text{ ft}}{12\text{ in}}\right)\right] = \text{n(D)(SA)} \qquad \textbf{Equation 4}$$

where:

Tv = GIP treatment volume in cubic feet
Mult. = the multiplier for the GIP from Table 7, if applicable

CDA	=	the contributing drainage area in acres to the GIP.
P	=	1 inch
Rv	=	runoff coefficient for the CDA, if an upstream GIP is used the Rv would be the reduced Modified Sub-area Rv
SA	=	surface area in square feet of the GIP
D	=	media depth of GIP in feet
n	=	Porosity
(D)(n)	=	D_E if more than one media type is required (Equation 5 below)

Note that the Rv value above is for the total area draining to the control. The Treatment Volume (Tv) must be calculated for the volume of runoff from one inch of rainfall that will be discharged to the GIP from the contributing drainage area. Therefore, when using Equation 4 to calculate Tv for a solitary GIP, RR Credits cannot be applied in the calculation of the weighted Rv. When using the equation to calculate Tv for GIPs in series, the weighted Rv can include consideration of the GIP credit that is provided by the upstream GIP when calculating the Tv for the downstream GIP. The resulting Tv is then applicable to the treatment volume that will be required for the downstream GIP. (This methodology is incorporated into the tool)

Table 7 - Multipliers for GIPs for use in Equation 4

Green Infrastructure Practice	Multiplier	
	Level 1	Level 2
1. Bioretention	1	1.25
2. Urban Bioretention	1	n/a
3. Permeable Pavement	1	1.1
4. Infiltration Trench	1	1.1
5. Water Quality Swale	1	1.1
6. Extended Detention	1.25	n/a

Table 8 provides basic volume-based specifications for the standard recommended soil-based media and gravel. Soil-based media is used for GIPs: bioretention, water quality swales and urban bioretention. Gravel is used for design alternatives for the above listed GIPs, as well as, the storage layers for permeable pavement and infiltration trenches.

Average porosity of non-compacted soil and gravel is assumed to be 0.40. Field capacity of the soil is the amount of moisture typically held in the soil/gravel after any excess water from rain events has drained and varies greatly between soil-based media and gravel.

Table 8 - Media Volume-Based Specifications

Parameter	Value	
	Porosity	Field Capacity
Soil-Based Media[1]	0.25	0.25
Gravel[2]	0.40	0.04
Ponding	1.0	NA

1. Soil-Based Media GIPs - bioretention, water quality swales and tree planter boxes
2. Gravel GIPs – design alternatives for GIPs in 1, storage layers for permeable pavement and infiltration trenches

To find the equivalent storage depth for media-based GIPs with multiple layers of media, the equivalent storage depth must be calculated using the following equation:

$$\text{Equivalent Storage Depth} = D_E = n_1(D_1) + n_2(D_2) + \cdots \qquad \textbf{Equation 5}$$

Where, n1 and D1 are for the first layer, etc.

EXAMPLE 4 – Treatment Volume Calculation

Using Example 1, the bioretention level 2 treatment volume will need to be calculated to design the practice. The area draining to the bioretention area is completely impervious (2.5 acres) therefore the Rv is 0.95 (note: if the contributing drainage area to the bioretention area was comprised of 50% impervious area and 50% turf HSG B the Rv used in the treatment volume calculation below would be 0.57). The Rv of the contributing drainage area in this example is 0.95.

$$Rv = 0.95$$

The bioretention structure is level 2 and thus will have 1.25 multiplier (Table 7) for the treatment volume, a media depth of 36 inches and a maximum of 6 inches of ponding. The Equivalent Depth = (3 ft)(0.4) + (0.5 ft)(1.0) = 1.7 ft. Then by application of Equations 4 and 5, solving for SA:

$$Tv = 1.25 \times 1\text{in} \times 2.5\text{ac} \times 0.95\left(\frac{43{,}560\ \text{ft}^2}{1\ \text{ac}}\right)\left(\frac{1\ \text{ft}}{12\ \text{in}}\right)$$

$$Tv = 10{,}777\ \text{ft}^3$$

$$Tv = n(D_E)(SA)$$
$$10{,}777\ \text{ft}^3 = 1.7\ \text{ft}\ (SA)$$
$$SA = 6{,}339\ \text{ft}^2$$

The design treatment volume that the bioretention area must capture is 10,777 ft^3, the required surface area if the bioretention cell was designed with 36 inches of media and 6 inches of ponding is 6,339 ft^2. The surface area required would significantly decrease if the designer chose to increase the media depth.

3.1.9 Calculation of Curve Numbers with Volume Removed

The removal of volume by GIPs changes the runoff depth entering downstream stormwater quantity structures. An approximate approach to accounting for this in reducing the size of peak flow detention facilities is to calculate an "effective SCS curve number" (CNadj) which is less than the actual curve number (CN). CNadj can then be used in hydrologic calculations and in routing. The method can also be used for other hydrologic methods in which a reduction in runoff volume is possible.

Equation 6 provides a way to calculate a total runoff if the rainfall and curve number are known.

$$Q = \frac{(P - 0.2 \times S)^2}{(P + 0.8 \times S)} \quad \text{and} \quad S = \frac{1000}{CN} - 10 \qquad \textbf{Equation 6}$$

Equation 6 is the standard SCS rainfall-runoff equation where P is the inches of rainfall for the 24-hour design storm (Table 9), and Q is the total runoff in depth for that storm in inches.

Table 9 - Franklin 24-Hour Rainfall Depths	
Return Period (Years)	**Rainfall Depth (Inches)**
2	3.68
5	4.48
10	5.12
25	6.02
50	6.75
100	7.51

The adjusted total runoff in depth entering the flood control facility downstream of a GIP is calculated by taking the difference in the original total runoff in depth and the depth captured by the GIP (Tv from Equation 4) expressed in watershed inches using Equation 7 where CDA is the drainage area in acres for the subarea in question.

$$Q_{adj} = Q - \frac{12 * Tv}{43{,}560 * CDA}$$ **Equation 7**

Equation 8 provides a method to calculate the modified curve number once the Qadj is found.

$$CN_{adj} = \frac{1000}{10+5P+10Q_{adj}-10\left(Q_{adj}{}^{2}+1.25Q_{adj}P\right)^{1/2}}$$ **Equation 8**

The steps in calculating an adjusted Curve Number (CNadj) are:

Step 1. Calculate Total Runoff for Storm (Q)

Choose the design return period, and using that rainfall as P, calculate an initial Q using Equation 6 and the calculated site curve number.

Step 2. Calculate GIP Capture Volume (Tv)

Compute the captured volume in the GIP control using Equation 4 or proven cistern volume assuming a 72 hour inter-event dry period since the last cistern filling event.

Step 3. Calculate Adjusted Total Runoff (Qadj)

As shown in Equation 7, subtract Tv expressed in watershed inches from Q computed in Step 1.

Step 4. Calculate Adjusted Curve Number (CNadj)

Using Qadj and the P corresponding to the return period in question (the P from step 1), calculate the adjusted
CN using Equation 8.

Step 5. Use CNadj in routing calculations for the specific return period in question.

3.2 The Runoff Reduction Method and 80% TSS Combined Methodology

Introduction

The combined methodology has been developed to address the requirement in Tennessee's NPDES Phase II MS4 Permit that states "For projects that cannot meet 100% of the runoff reduction requirement…, the remainder of the stipulated amount of rainfall must be treated prior to discharge with a technology reasonably expected to remove 80% total suspended solids (TSS)." If Runoff Reduction techniques are not acceptable for use on the site as a whole or on portions of a contributing drainage area, the permit requires the remaining rainfall to be treated by practices that remove 80% TSS. This approach allows the designer to apply TSS Reduction Method (TRM) treatment applications to supplement the RRM in order to meet overall compliance on a site. As a note, the site volumetric runoff coefficient, Rv, is calculated using the RRM methodology in Chapter 3.1. The method presented herein is an attempt to bridge the volume requirement (1in.) and the pollutant removal requirement of 80% TSS Reduction.

3.2.1 Site Limiting Conditions

Runoff Reduction Methodology (RRM) is the preferred pathway in complying with the City's water quality criteria. Therefore an attempt to utilize green infrastructure practices, promoting infiltration, capture and reuse of the first inch of rainfall preceded by 72 hours of no measureable rainfall is required. If a site can be designed using RRM GIPs, the designer is to follow the prescribed methodology in Chapter 3.1 of this manual. However, if "site limiting" conditions exist where infiltration practices would negatively affect the landscape and water resources in the area, the TRM methodology may be used to meet the City's water quality criteria upon the City's approval.

Potential site limiting conditions are listed below:

- Where the potential for introducing pollutants into groundwater exists, unless pretreatment is provided;
- Where pre-existing soil contamination is present in areas subject to come in contact with infiltrated runoff;
- Where sinkholes or other karst features are present on the site;
- Where the site has a historic or archaeological significance that cannot be disturbed as determined by the State Historic Preservation Office;
- Where utility conflicts preclude the use of Green Infrastructure Practices;
- Where steep slopes are present and slope failure may occur (stamped geotechnical report must be presented to City Engineer); and
- Other site limitations as determined by the City Engineer.

Cost of implementing green infrastructure/runoff reduction measures shall not be considered a limitation.

3.2.2 TSS Reduction Method

When the use of TSS Removal BMPs is approved by the City, the Runoff Reduction Requirement can be set aside at the value obtained by the site designer using the Runoff Reduction Method to the extent possible. Runoff Reduction should not be dismissed altogether, as the volume captured using the Runoff Reduction Method will be accounted for in calculations for TSS Removal. The remaining volume must then be managed to achieve the Pollutant Removal Performance Standard of 80% TSS Removal. TSS Removal BMPs such as dry ponds, sand filters, and wet ponds can be used for this purpose.

This section provides the policies, tables and equations that will be used to calculate compliance with the Pollutant Removal Performance Standard. Design specifications for TSS Removal BMPs are provided in Section 5.

The TSS Removal BMPs that are deemed acceptable for use to attain the Pollutant Removal Standard are listed in Table 10. The table presents the TSS removal percentage (%) assigned to each BMP, which will be used to calculate the weighted TSS Removal % (weighted TSS) for the capture volume for comparison with the Pollutant Removal Performance Standard. If the weighted TSS ≥ 80%, then the Performance Standard is achieved.

The TSS Removal % values shown in Table 10 are conservative median pollutant reduction percentages for design purposes that have been derived from existing sampling data, modeling and professional judgment. A BMP design may be capable of exceeding these performances; however, the values in the table are median values that can be achieved over time when the structural BMP is sized, designed, constructed and maintained in accordance with required specifications in this manual. The actual % TSS removal value for a BMP in any single storm event may be higher or lower, depending upon a number of factors, including the inflow pollutant concentration, type of storm event, and maintenance condition of the BMP.

Table 10 - Approved TSS PTP Applications

Structural Control	TSS Removal Credit (%)
General Application BMPs	
Stormwater Wet Pond	80
Constructed Wetland	80
Surface Sand Filter	80
Water Quality Swale	80
Limited Application BMPs	
Organic Filter	80
Underground Sand Filter	80
Perimeter Sand Filter	80
Dry Pond	60
Filter Strip	50
Grass Channel	50
Gravity (Oil-Grit) Separator	40

Technical Details

3.2.3 Calculation of % TSS Removal for TSS Removal BMPs in Series

The case of two or more TSS Removal BMPs in series, where stormwater treated in one BMP and discharged into another BMP for further treatment, is called a treatment train. How and why BMPs might be used in series is discussed in Chapter 2 of this Manual. This section presents the calculation of the total % TSS removal for BMPs in series.

Equation 9 shall be used to calculate the total % TSS removal for a treatment train comprised of two or more TSS Removal BMPs.

$$TSS_{train} = TSS_{up} + TSS_{down} - \frac{(TSS_{up}\ x\ TSS_{down})}{100} \qquad \textbf{Equation 9}$$

Where:

TSS_{train} = TSS Removal % for treatment train (%)
TSS_{up} = TSS Removal % for the upstream BMP, from Table 10 (%)
TSS_{down} = TSS Removal % for the downstream BMP, from Table 10 (%)

Several situations are possible:

A. For development sites where the treatment train provides the only stormwater treatment on the site, it is required that $TSS_{train} \geq 80\%$ to meet the Pollutant Removal Standard.

B. For development sites that have other TSS Removal BMPs for stormwater treatment that are not included in the treatment train, TSS_{train} must be included in Equation 9 in the calculation of the overall % TSS removal for the site.

C. Equation 9 is not used when the TSS Removal BMP is placed in series with an upstream GIP. While the upstream GIP is considered to provide 100% TSS removal to its storage volume, it's pollutant removal ability is not considered because the Pollutant Removal Performance Standard is applied only to the remainder of the NPDES-MS4 permit stipulated volume (i.e., the volume required to treat the entire 1 inch of rainfall) that is not managed by the GIP. Thus, the storage volume of the GIP is not a part of this remaining volume and so the GIP is not included in the calculation of % TSS removal.

3.2.4 Calculation of % TSS Removal for Flow-through Situations

BMPs within a treatment train may sometimes be separated by a contributing drainage area. In this case, Equation 10 is used, since some of the flow entering the downstream BMP has not been treated by the upstream BMP.

$$\mathbf{TSS_{train}} = \frac{\mathbf{TSS_{up}A_{up}} + \mathbf{TSS_{down}CDA_{down}} + \frac{\mathbf{TSS_{down}CDA_{up}\left(100 - TSS_{up}\right)}}{\mathbf{100}}}{\mathbf{CDA_{up} + CDA_{down}}} \qquad \textbf{Equation 10}$$

Where:

TSS_{train} = TSS Removal % for treatment train (%)
TSS_{up} = TSS Removal % for the upstream BMP, from Table 9 (%)
TSS_{down} = TSS Removal % for the downstream BMP, from Table 9 (%)
CDA_{up} = Contributing drainage area for the upstream BMP (acres)
CDA_{down} = Contributing drainage area for the downstream BMP (acres)

Several situations are possible:

A. For development sites where the treatment train provides the only stormwater treatment on the site, it is required that $TSS_{train} \geq 80\%$ to meet the Pollutant Removal Standard.

B. For development sites that have other TSS Removal BMPs for stormwater treatment that are not included in the treatment train, TSS_{train} must be included in Equation 10 in the calculation of the overall % TSS removal for the site.

C. Equation 10 is not used when the TSS Removal BMP is placed in series with an upstream GIP because the storage volume of the GIP is not a part of the remaining capture volume that must be treated by the TSS Removal BMP.

3.2.5 Determining the TSS Treatment Volume

There are two basic scenarios for the application of TSS Removal BMPs on a development site, depending on the extent to which the Runoff Reduction Method will be applied at the development and whether the site designer wishes to use a GIP and a TSS Removal BMP in series. If the latter, several different GIP-TSS BMP series combinations can occur depending upon whether one or both of the requirements of the two-pronged Runoff Reduction Performance Standard are met (i.e., weighted Rv ≤ 0.18 and GIPs can capture the entire Tv_{GIP}). The various circumstances that could occur when using TSS Removal BMPs are as follows:

1. **A TSS Removal BMP is used alone on a runoff reduction limited site where no GIPs or Runoff Reduction can be used or achieved -** To calculate the treatment volume needed for the site, the designer will use the following equation:

$$\mathbf{Tv_{TSS} = P \times Rv \times A \times \frac{43560 \frac{ft^2}{ac}}{12 \frac{in}{ft}}} \qquad \textbf{Equation 11}$$

2. **A TSS Removal BMP is used in series with an upstream GIP –** Equations 12, 13 and 14 will be used to calculate the TSS Treatment Volume Tv_{TSS} when a TSS Removal BMP is used in combination with an upstream GIP.

$$\mathbf{Tv_{TSS} = A + B} \qquad \textbf{Equation 12}$$

Where:
Tv_{TSS} = the volume of runoff that must be treated by TSS Removal BMPs to comply with the Pollutant Removal Performance Standard
A = the TSS treatment volume if $Tv_{actual} < Tv_{GIP}$, where:
Tv_{actual} = the actual storage volume of the proposed upstream GIP(s)

Tv_{GIP} = the *entire capture volume from the 1-inch rainfall event*, from Equation 4, presented previously in this Chapter 3.1

If $Tv_{GIP} = Tv_{actual}$, then A = 0. See Equation 13 to calculate A.

B = the TSS treatment volume if the weighted Rv > 0.18 after application of the Runoff Reduction Method. If weighted Rv ≤ 0.18, then B = 0. See Equation 14 to calculate B.

$$\mathbf{A} = \frac{\mathbf{Mult.}\left(\mathbf{P} \times \mathbf{Rv} \times \mathbf{A} \times \frac{\mathbf{43560}\frac{\boldsymbol{ft^2}}{\boldsymbol{ac}}}{\mathbf{12}\frac{\boldsymbol{in}}{\boldsymbol{ft}}}\right) - \mathbf{Tv_{actual}}}{\mathbf{Mult.}} \qquad \textbf{Equation 13}$$

$$\mathbf{B} = \mathbf{P} \times \mathbf{Rv}(\mathbf{1} - \mathbf{RRCredit}) \times \mathbf{A} \times \frac{\mathbf{43560}\frac{\boldsymbol{ft^2}}{\boldsymbol{ac}}}{\mathbf{12}\frac{\boldsymbol{in}}{\boldsymbol{ft}}} \qquad \textbf{Equation 14}$$

Where:

Mult. = the Multiplier for the GIP included in the GIP design specifications in Section 5.

P = the rainfall depth, 1 inch

Rv = the weighted Rv of the contributing drainage area to the GIP. (e.g., if the entire contributing drainage area to the GIP is impervious, then Rv = 0.95.) Use tables and equations in Chapter 3.1 of this Section to assist in the calculation of Rv.

A = the contributing drainage area to the GIP or BMP (acres)

Tv_{actual} = the treatment volume that can be captured by the upstream GIP(s)

RRCredit the runoff reduction credit for the GIP that is located upstream of the TSS Removal BMP, Table 5.

Equations 12, 13 and 14 can be combined to form Equation 15.

$$\mathbf{Tv_{TSS}} = \left[\frac{\mathbf{Mult.}\left(\mathbf{P} \times \mathbf{Rv} \times \mathbf{A} \times \frac{\mathbf{43560}}{\mathbf{12}}\right) - \mathbf{Tv_{actual}}}{\mathbf{Mult.}}\right] + \left(\mathbf{P} \times \mathbf{Rv}(\mathbf{1} - \mathbf{RRCredit}) \times \mathbf{A} \times \frac{\mathbf{43560}}{\mathbf{12}}\right) \qquad \textbf{Equation 15}$$

There are several possible combinations for GIPs and BMPs working in series. Table 11 lists the combinations and the form of Equation 12 that is used.

Table 11 - Possible GIP-TSS Series Combinations			
Scenario	**Complies with Runoff Reduction Performance Standard?**		**Form of Equation 12 that is used to calculate Tv_{TSS}**
	Rv ≤ 0.18	**GIPs capture entire Tv_{GIP}**	
GIP-TSS Combination 1	No	Yes	$\boldsymbol{Tv_{TSS} = B}$
GIP-TSS Combination 2	Yes	No	$\boldsymbol{Tv_{TSS} = A}$
GIP-TSS Combination 3	No	No	$\boldsymbol{Tv_{TSS} = A + B}$

The following examples show how Equations 12 through 15 are applied to developments to determine the TSS treatment volume.

EXAMPLE 5 GIP-TSS Combination 1

A site designer performing water quality calculations for a 3 acre commercial parking lot development that is runoff reduction limited. A Level 1 infiltration trench on C soil (Table 5: RR Credit = 50%) manages the Tv_{GIP} for the rainfall that falls on the 2.5 acre parking lot but does not lower the weighted Rv for the site sufficiently to achieve Rv ≤ 0.18. The use of other GIPs is not feasible so the designer plans to place a wet pond downstream of the infiltration trench to further handle the runoff. The area of the infiltration trench is 0.2 acres and it has an Rv = 0.04 (Forest on C soil). For the purpose of water quality calculations, the area of the wet pond (0.3 acres) is not included. (Note, this area is typically included for channel protection and peak flow calculations.) Determine the treatment volume for the wet pond.

The Rv for the contributing drainage area to the GIP is determined using Equation 1:

$$\text{Weighted Rv} = \frac{(0.95 \times 2.5 \text{ ac}) + (0.04 \times 0.2 \text{ ac})}{(2.7 \text{ ac})} = 0.88$$

The treatment volume of the wet pond is calculated using Equation 14 (or Equation 15), where A = 0 because the parking lot has sufficient storage volume to manage Tv_{GIP}. So, Equation 15 becomes:

$$Tv_{TSS} = P \times Rv(1 - RRCredit) \times A \times \frac{43560}{12} = 1 \times 0.88(1 - 0.50) \times 2.7ac \times \frac{43560}{12}$$

$$Tv_{TSS} = 4{,}312 \text{ ft}^3$$

Note that the % TSS Removal for the wet pond = 80%, so a properly sized pond will be sufficient to meet the Pollutant Removal Performance Standard of 80% TSS Removal.

EXAMPLE 6 GIP-TSS Combination 2

A site designer performing water quality calculations for a 5 acre development that is runoff reduction limited. The site's weighted Rv is less than 0.18 due to the use of a Level 2 bioretention GIP, but it does not have sufficient storage volume available to capture the entire volume from the 1 inch rainfall. The land cover at the development is as follows: 4 acres of impervious surface (Rv = 0.95) and 1 acre of forest on C soil (Rv = 0.04). The entire development discharges to Level 2 bioretention GIPs which will capture no more than 8,500 ft^3 of runoff. Overflow from the GIPs discharge to a wet pond. Determine the treatment volume for the wet pond.

The weighted Rv for the development without consideration of the GIPs or the TSS Removal BMP is determined using Equation 1.

$$\text{Weighted Rv} = \frac{(0.95 \times 4\text{ ac}) + (0.04 \times 1\text{ ac})}{(5\text{ ac})} = 0.77$$

The Weighted Rv for the site after Level 2 bioretention GIPs are applied is as follows:

$$\text{Weighted Rv} = \frac{(0.95 \times (1 - 0.80) \times 4\text{ ac}) + (0.04 \times 1.0\text{ ac})}{(5\text{ ac})} = 0.16$$

The required treatment volume for the development is calculated using Equation 13 (or Equation 15), where B = 0 because Rv was less than 0.18. So, Equation 15 becomes:

$$\text{Tv}_{\text{TSS}} = \left[\frac{\text{Mult.}\left(\text{P} \times \text{Rv} \times \text{A} \times \frac{43{,}560}{12}\right) - \text{Tv}_{\text{actual}}}{\text{Mult.}}\right]$$

$$\text{Tv}_{\text{TSS}} = \left[\frac{1.25\left(1 \times 0.77 \times 5\text{ac} \times \left(\frac{43560}{12}\right)\right) - 8{,}500\text{ ft3}}{1.25}\right]$$

$$\text{Tv}_{\text{TSS}} = \frac{17{,}469\text{ft}^3 - 8{,}500\text{ft}^3}{1.25} = 7{,}176\text{ ft}^3$$

Note that the % TSS Removal for the wet pond = 80%, so a properly sized pond will be sufficient to meet the Pollutant Removal Performance Standard of 80% TSS Removal.

EXAMPLE 7 GIP-TSS Combination 3

A site designer performing water quality calculations for a 4.5 acre development that is runoff reduction limited. The site's weighted Rv is 0.30 due to the use of a Level 2 water quality swale GIP to treat the 2.5 acre impervious area. The site does not have sufficient storage volume available to capture the entire volume from the 1 inch rainfall in the GIP and an Rv of 0.18 has not been met. The land cover at the development is as follows: 2.5 acres of impervious surface (Rv = 0.95) and 2.0 acres of meadow/turf on C soil (Rv = 0.20). The entire development discharges to the Level 2 water quality swale GIP which can capture no more than 5,500 ft^3. Overflow from the GIP discharges to a wet pond. Determine the treatment volume for the wet pond.

The weighted Rv for the development without consideration of the GIP or the TSS Removal BMP is determined using Equation 1.

$$\text{Weighted Rv} = \frac{(0.95 \times 2.5\text{ ac}) + (0.20 \times 2.0\text{ ac})}{(4.5\text{ ac})} = 0.61$$

The Weighted Rv for the site after a Level 2 water quality swale GIP is applied is as follows:

$$\text{Weighted Rv} = \frac{(0.95 \times (1 - 0.60) \times 2.5\text{ ac}) + (0.20 \times 2.0\text{ ac})}{(4.5\text{ ac})} = 0.30$$

The required treatment volume for the development is calculated using Equation 15:

$$\text{Tv}_{\text{TSS}} = \left[\frac{\text{Mult.}\left(\text{P} \times \text{Rv} \times \text{A} \times \frac{43{,}560}{12}\right) - \text{Tv}_{\text{actual}}}{\text{Mult.}}\right] + \left(\text{P} \times \text{Rv}(1 - \text{RRCredit}) \times \text{A} \times \frac{43560}{12}\right)$$

$$\text{Tv}_{\text{TSS}} = \left[\frac{1.1\left(1 \times 0.61 \times 4.5\text{ ac} \times \left(\frac{43{,}560}{12}\right)\right) - 5{,}500\text{ ft}^3}{1.1}\right] + \left(1 \times 0.61(1 - 0.60) \times 4.5\text{ ac} \times \frac{43560}{12}\right)$$

$$\text{Tv}_{\text{TSS}} = \frac{10{,}961\text{ft}^3 - 5{,}500\text{ft}^3}{1.1} + 3{,}986\text{ ft}^3 = 8{,}951\text{ft}^3$$

Note that the % TSS Removal for the wet pond = 80%, so a properly sized pond will be sufficient to meet the Pollutant Removal Performance Standard of 80% TSS Removal.

4 References

1. *California Storm Water Best Management Practice Handbooks*, Camp Dresser & McKee et.al. for the California SWQTF, 1993.
2. *Caltrans Storm Water Quality Handbooks*, Camp Dresser & McKee et.al. for the California Department of Transportation, 1997.
3. Chow, Ven Te. *Open Channel Hydraulics*, McGraw-Hill, Inc., 1959.
4. *Landcare Field Guide – An Introduction to Land Degradation*, Cullen Gunn.
5. Roesner, L.A., Aldrich, J., Hartigan, J.P., et.al., *Urban Runoff Quality Management – WEF Manual of Practice No. 23 / ASCE Manual and Report on Engineering Practice No. 87*, 1998.
6. *Sevenmile Creek Basin Pilot Stormwater Quality Master Plan*, Camp Dresser & McKee et.al. for the Metropolitan Nashville and Davidson County Department of Public Works, February, 2000.
7. *Storm Water Technology Fact Sheet - Wet Detention Ponds*, United States Environmental Protection Agency, 832-F-99-048, September 1999.
8. *Storm Water Management for Construction Activities – Developing Pollution Prevention Plans and Best Management Practices*, U.S. Environmental Protection Agency, 482N, September 1992.
9. *Users Manual 1.06: Watershed Management Model*, Camp Dresser & McKee for Rouge River National Wet Weather National Demonstration Project for the U.S. Environmental Protection Agency, August 1998.
10. *Metropolitan Nashville – Davidson County Stormwater Management Manual, Volume 5 – Low Impact Development,* Metropolitan Government of Nashville and Davidson County, Metro Water Services, June 2012.
11. *CSN Tech. Bull. No. 4, Technical Support for the Bay-Wide Runoff Reduction Method, Ver. 2.0, Chesapeake Stormwater Network, (undated).*
12. *Technical Memorandum: The Runoff Reduction Method, Center for Watershed Protection, April 2008.*
13. *Precipitation-Frequency Atlas of the United States.* NOAA Atlas 14, Volume 2, Version 3.0, G. M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley, NOAA, National Weather Service, Silver Spring, Maryland, 2006.

Section 5
Permanent Stormwater Treatment Controls (PSTCs)

Section 5 – Permanent Stormwater Treatment Controls (PSTC)

5.1 Introduction

This section presents the BMP fact sheets for Permanent Stormwater Treatment Controls (PSTC). PSTCs are intended to treat stormwater runoff in the long-term. Unlike many of the other BMP types, these can be designed to achieve both stormwater quantity and quality management objectives. The Long Term Maintenance Plan (LTMP) and Agreement is also included as a part of this section on the following page. PSTCs can also be classified as stormwater control measures (SCMs).

5.2 Management Practice Fact Sheets

This section contains the following BMP fact sheets.

Green Infrastructure Permanent Treatment Practice Fact Sheets			
Fact Sheet ID	**Description**	**Fact Sheet ID**	**Description**
GIP – 01	Bioretention	**GIP – 08**	Reforestation
GIP – 02	Urban Bioretention	**GIP – 09**	Green Roof
GIP – 03	Permeable Pavement	**Appendix A**	Pretreatment Details
GIP – 04	Infiltration Trenches	**Appendix B**	Infiltration Testing Procedures
GIP – 05	Water Quality Swale	**Appendix C**	Recommended Plants for Biofiltration Practices
GIP – 06	Extended Detention Pond	**Appendix D**	As-Built Requirements
GIP – 07	Sheet Flow		

TSS Permanent Treatment Practice Fact Sheets			
Fact Sheet ID	**Description**	**Fact Sheet ID**	**Description**
TSS – 01	Stormwater Wet Ponds	**TSS – 07**	Grass Channels
TSS – 02	Constructed Wetlands	**TSS – 08**	Underground Sand Filters
TSS – 03	Surface Sand Filters	**TSS – 09**	Perimeter Sand Filters
TSS – 04	Water Quality Swales	**TSS – 10**	Organic Filters
TSS – 05	Dry Ponds	**TSS – 11**	Gravity (Oil-Grit) Separators
TSS – 06	Filter Strips		

Each fact sheet has a quick reference guide indicating what pollutant constituents the BMP is targeting and implementation requirements. The BMPs presented in this section are intended to serve as permanent treatment measures. Additional details are provided in sections covering Temporary Construction Site Runoff Management Practices (TCPs) for practices that are intended to function on a short-term basis (lasting only as long as construction activities) and Permanent Erosion Prevention and Sediment Control (PESC) for practices that are intended to function on a long-term basis.

The City of Franklin approves of the use of underground detention, including concrete vaults, and HDPE corrugated pipe and arched pipe systems, which may be designed to meet detention requirements. Corrugated metal pipe is not an approved material for use in underground detention or other permanent installation in The City of Franklin.

Bioretention

Description: Bioretention cells are vegetated, shallow depressions that treat stormwater runoff. Captured runoff is treated by filtration through an engineered soil medium and is then either infiltrated into the subsoil or exfiltrated through an underdrain.

Variations:
Constructed without an underdrain in soils with measured infiltration rates greater than 0.5 inch per hour, and with an underdrain in less-permeable soils.

Advantages/Benefits:
- Reduced runoff volume
- Reduced peak discharge rate
- Reduced Total Suspended Solids (TSS)
- Reduced pollutant loading
- Reduced runoff temperature
- Groundwater recharge (if soils are sufficiently permeable)
- Habitat creation
- Enhanced site aesthetics
- Reduced heat island effect

Disadvantages/Limitations:
- Problems with installation can lead to failure
- Minimum 2-foot separation from groundwater and bedrock is required
- Suitable for pollution hotspots only with underdrain and liner

Design Considerations:
- Maximum contributing impervious drainage area of 5 acres
- Slope of drainage area = 1 – 5% or terraced to slow flow

Roadway Applications
- Use within public ROW may be permitted subject to additional restrictions and City approval. See GIP-02 for more information

Selection Criteria:

Level 1 – 60% Runoff Reduction Credit

Level 2 – 80% Runoff Reduction Credit

Land Use Considerations:

[x] **Residential**

[x] **Commercial**

[x] **Industrial (with City approval)**

Maintenance:
- Regular maintenance of landscaping to maintain healthy vegetative cover
- Irrigation when necessary during first growing season
- Periodic trash removal

Maintenance Burden

[M]

L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

Individual bioretention cells can serve impervious drainage areas of 5 acres or less, though multiple distinct cells may be designed parallel to each other to accommodate larger areas once approved by City staff. Surface runoff is directed into a shallow landscaped depression that incorporates many of the pollutant removal mechanisms that operate in forested ecosystems. The primary component of a bioretention practice is the filter bed, which has a mixture of sand, soil and organic material as the filtering media, typically with a surface mulch layer. During storms, runoff temporarily ponds up to 12 inches above the mulch layer and then rapidly filters through the bed. If the subsoil infiltration rate is 0.5 inches per hour or less, the filtered runoff is collected in an underdrain and returned to the storm drain system. The underdrain consists of a perforated pipe in a gravel layer installed along the bottom of the filter bed. Underdrains can also be installed beneath a portion of the filter bed, above a stone "sump" layer, or eliminated altogether, thereby increasing stormwater infiltration.

Bioretention can also be designed to infiltrate runoff into native soils. This can be done if the soil infiltration rate is greater than 0.5 inches per hour, the groundwater table and bedrock is low, and the risk of groundwater contamination is low.

SECTION 2: PERFORMANCE

The overall runoff reduction capabilities of bioretention in terms of the Runoff Reduction Method are summarized in **Table 1.1**. Bioretention creates a good environment for runoff reduction, filtration, biological uptake, and microbial activity, and provides high pollutant removal. Bioretention can become an attractive landscaping feature with high amenity value and community acceptance.

Table 1.1. Runoff Volume Reduction Provided by Bioretention Basins

Stormwater Function	Level 1 Design	Level 2 Design
Runoff Volume Reduction (RR)	60%	80%

Sources: CSN (2008) and CWP (2007)

SECTION 3: DESIGN TABLE

Table 1.2. Bioretention Design Criteria	
Level 1 Design (RR: 60)	**Level 2 Design (RR: 80)**
Sizing (Section 6.1)	**Sizing** (Section 6.1)
Surface Area (sq. ft.) = Tv / Equivalent Storage Depth[1]	**Surface Area (sq. ft.)** = (1.25*Tv) / Equivalent Storage Depth[1]
Minimum Surface Area: 3% of total drainage area	
Maximum Contributing Impervious Drainage Area = 5 acres	
Maximum Ponding Depth = 12 inches	
Filter Media Depth Minimum = 24 inches; **Maximum** = 6 feet	**Filter Media Depth Minimum** = 36 inches; **Maximum** = 6 feet
Media & Surface Cover (Section 6.6) = mixed on-site or supplied by vendor; the final composition shall be: 85% to 88% sand; 8% to 12% soil fines; and 3% to 5% organic matter	
Sub-soil Testing (Section 6.2): Testing is required. Min. infiltration rate > 0.5 inch/hour in order to remove the underdrain requirement.	**Sub-soil Testing** (Section 6.2): Testing is required. Min. infiltration rate > 0.5 inch/hour in order to remove the underdrain requirement.
Underdrain (Section 6.7) = PVC or Corrugated HDPE with clean-outs ***OR***, none, underdrain may be eliminated if soil infiltration requirements are met (**Section 6.2**)	**Underdrain & Underground Storage Layer** (Section 6.7) = PVC or Corrugated HDPE with clean-outs, and a minimum 12-inch stone sump below the invert; ***OR***, none, underdrain may be eliminated if soil infiltration requirements are met (**Section 6.2**)
Inflow: sheet flow or concentrated flow	
Geometry (Section 6.3): length of shortest flow path/overall length = 0.3; ***OR***, other design methods used to prevent short- circuiting	**Geometry** (Section 6.3): length of shortest flow path/overall length = 0.8; ***OR***, other design methods used to prevent short-circuiting
Pretreatment (Section 6.4): a pretreatment cell/forebay and enhanced check dam or any approved measure for sheet flow conditions.	**Pretreatment** (Section 6.4): a pretreatment cell/forebay and enhanced check dam or any approved measure for sheet flow conditions.
Conveyance & Overflow (Section 6.5)	**Conveyance & Overflow** (Section 6.5)
Planting Plan (Section 6.8): a planting template to include perennials, grasses, sedges or shrubs to achieve a surface area coverage[2] of at least 75% within 2 years by using the recommended spacing in **Appendix C.**	**Planting Plan** (Section 6.8): a planting template to include perennials, grasses, sedges, or shrubs to achieve a surface area coverage[2] of at least 75% within 2 years by using the recommended spacing in **Appendix C**. **MUST** also include trees planted at 1 tree/400 s.f.
Building Setbacks [3] (Section 5):	
Long Term Maintenance Requirements (Section 10)	

[1]Storage depth is the sum of the porosity (n) of the soil media and gravel layers multiplied by their respective depths, plus the surface ponding depth. Refer to **Section 6.1**.

[2]Surface area coverage in reference to planting is the percentage of vegetative cover in a planting area.

[3]These are recommendations for simple building foundations. If an in-ground basement or other special conditions exist, the design shall be reviewed by a licensed engineer. Also, a special footing or drainage design may be used to justify a reduction of the setbacks noted above.

SECTION 4: TYPICAL DETAILS

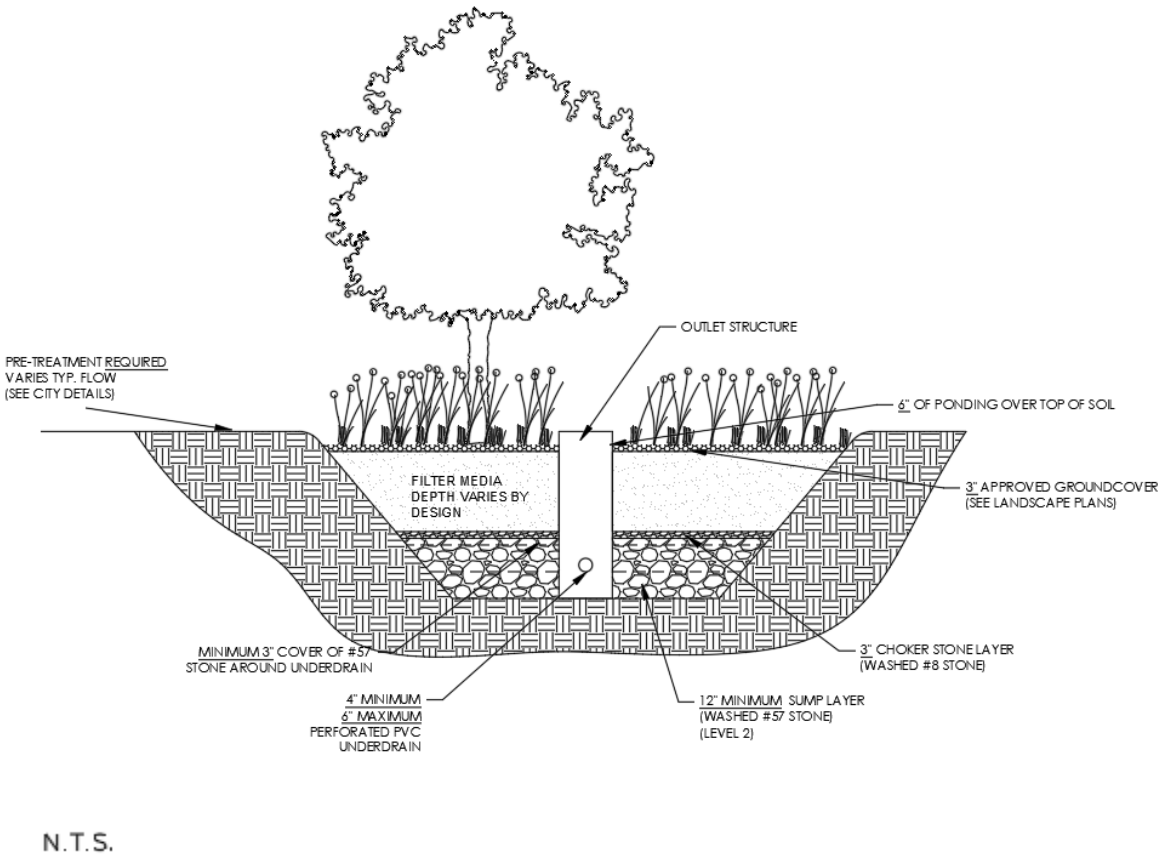


Figure 1.2. Typical Detail of Bioretention

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

5.1 PHYSICAL FEASIBILITY

Bioretention can be applied in most soils or topography since runoff simply percolates through an engineered soil bed and can be returned to the stormwater system if the infiltration rate of the underlying soils is low. Key constraints with bioretention include the following:

Accessibility. Bioretention facilities require periodic maintenance and shall be accessible to various types of equipment. A path of travel for equipment no less than 12 feet in width shall be provided for the bioretention facility. Each bioretention onsite shall have one point of vehicle access.

Applications. Bioretention areas have been used at commercial, institutional, and residential sites in spaces that are traditionally pervious and landscaped. It should be noted that special care must be taken to provide adequate space for pretreatment for bioretention cells in high traffic areas. Typical locations for bioretention areas could include parking lot islands and edges, courtyards, and unused pervious areas onsite.

Available Space. Planners and designers can assess the feasibility of using bioretention based on a simple relationship between the contributing drainage area and the corresponding required surface area. The bioretention surface area shall be a minimum 3% of the contributing drainage area. The minimum length and width dimensions of the bioretention area shall both be 10 feet.

Contributing Drainage Area (CDA). Bioretention works best with smaller contributing drainage areas, where it is easier to achieve flow distribution over the filter bed without experiencing erosive velocities and excessive ponding times. Typical drainage area size can range from 0.1 acres to a maximum of 5 acres of impervious cover, with no more than 2.5 acres impervious drainage area per inlet to the bioretention forebay, due to limitations on the ability of bioretention to effectively manage large volumes and peak rates of runoff. However, if hydraulic considerations are adequately addressed to manage the potentially high peak inflow of drainage areas larger than 5 acres total contributing impervious area, (such as off-line or low-flow diversions, splitter structures, etc.), there may be case-by-case instances where the City may allow these recommended maximums to be exceeded. In such cases, the bioretention facility should be located centrally within the drainage area so as to capture the Treatment Volume (T_v) equally from the entire contributing area, and not fill the entire volume from the immediately adjacent area, thereby bypassing the runoff from the more remote portions of the site. In all cases, reduction of inflow velocities and means of even distribution across the bioretention surface shall be demonstrated in the design of the bioretention.

Curb cuts. If curb cuts are to be used in the design of the bioretention area, the designer shall provide calculations showing the curb cut can safely pass the 10 year storm event.

Floodplains. Bioretention areas should be constructed outside the limits of the 100-year floodplain. While not prohibited from use in floodplain areas, designers should be aware of the resulting increased maintenance burden for the property owner.

Irrigation or Baseflow. The planned bioretention area shall not receive baseflow, chlorinated wash-water or other such flows that are not stormwater runoff, except for irrigation as necessary for the survival of plantings within the bioretention area. If irrigation is to be placed within the bioretention area footprint, an irrigation plan shall be submitted to the City for review and approval. A soil moisture sensor shall be included in all irrigation plans submitted.

Setbacks. It is not recommended to place bioretention areas immediately adjacent to structures. to avoid the risk of seepage, a licensed PE should be consulted to determine the appropriate setbacks necessary to prevent bioretention infiltration from compromising structural foundations or pavement. At a minimum, bioretention basins should be located a horizontal distance of 100 feet from any water supply well and 50 feet from septic systems. Horizontal separation of at least 5 feet or the overall depth of the bioretention, whichever is greater, is required between the amended soils of the bioretention and any adjacent hardscape (i.e. parking lots or sidewalks). Please see **GIP-02** for additional information on ROW applications and where setbacks from structures, roadways, sidewalks and other hardscape cannot be met.

Subsurface Constraints. Vertical constraints such as retaining walls, structures, or other impermeable barriers are limited to a maximum of 50% of the Level 2 bioretention perimeter. Level 1 bioretention areas can have vertical constraints around the entire perimeter but shall meet all requirements for a Level 1 bioretention area. If requirements cannot be met, see the **GIP-02**. Bioretention shall always have 2 feet of separation from the water table to ensure that groundwater does not intersect the filter bed. Mixing can lead to possible groundwater contamination or failure of the bioretention facility. If bedrock is encountered during testing or construction of the bioretention area, the bottom sump elevation of the BMP design shall be above the lowest bedrock/refusal elevation encountered in subsurface testing.

Utilities. Designers should ensure that future tree canopy growth in the bioretention area will not interfere with existing overhead utility lines. Interference with underground utilities and any associated utility easements shall also be avoided, particularly water and sewer lines. No below-grade utilities are allowed within the footprint of bioretention areas, including pretreatment. No overhead utilities are allowed over bioretention areas incorporating tree plantings.

SECTION 6: DESIGN CRITERIA

6.1 SIZING OF BIORETENTION PRACTICES

6.1.1 Stormwater Quality

Sizing of the surface area (SA) for bioretention practices is based on the computed Treatment Volume (T_v) required for the contributing drainage area and the storage provided in the facility. The required surface area (in square feet) is computed as the Treatment Volume (in cubic feet) divided by the equivalent storage depth (in feet). The equivalent storage depth is computed as the depth of gravel, media, and surface ponding (in feet) multiplied by the accepted porosity.

The accepted porosities (n) are (see **Table 1.3** below):

Table 1.3. Bioretention Accepted Porosities	
Material	**Porosity Value (n)**
Gravel (#57 Stone) Underdrain and Sump Layer	0.40
Choker (#8 Stone) Layer	0.40
Bioretention Soil Media	0.25
Surface Cover	0.00
Surface Storage	1.00

The mulch and choker stone layer shall not be used in calculations for the equivalent depth due to the variability of material and porosity values.

The equivalent storage depth for a typical Level 1 design with 2 ft of media and a 6-inch surface ponding depth is therefore computed as:

Equation 1.1. Bioretention Level 1 Design Storage Depth

$$\text{Equivalent Storage Depth} = D_E = n_1(D_1) + n_2(D_2) + \cdots$$

$$D_E = (2\ ft. \times 0.25) + (0.5 \times 1.0) = 1.30\ ft.$$

Where n_1 and D_1 are for the first layer, etc.

The equivalent storage depth for a typical Level 2 design with a 1 foot gravel sump layer, 3 feet of media, and a 6-inch surface ponding depth is computed as:

Equation 1.2. Bioretention Level 2 Design Storage Depth

$$D_E = (1\ ft. \times 0.25) + (3\ ft. \times 0.40) + (0.5 \times 1.0) = 2.10\ ft.$$

While this method is simplistic, simulation modeling has proven that it yields a total storage volume somewhat equivalent to 80% total average rainfall volume removal for infiltration rates from 0.5 in/hr. through 1.2 in/hr.

Therefore, the Level 1 Bioretention Surface Area (SA) is computed as:

Equation 1.3. Bioretention Level 1 Design Surface Area

$$SA\ (sq.\ ft.) = (T_v) / D_E$$

And the Level 2 Bioretention Surface Area is computed as:

Equation 1.4. Bioretention Level 2 Design Surface Area

$$SA\ (sq.\ ft.) = (1.25 * Tv) / D_E$$

Where:

SA = Minimum surface area of bioretention filter (sq. ft.)
D_E = Equivalent Storage Depth (ft.)
T_v = Treatment Volume (cu. ft.) = [(1.0 in.)(R_v)(A)*3630]

Where: A = Area in acres
(NOTE: R_v = the composite runoff coefficient from the RR Method. A table of R_V values and the equation for calculating a composite Rv is located in Section 1 Chapter 3 of this manual)

Equations 1.1 through 1.4 should be modified if the storage depths of the soil media (max. 6 feet), gravel layer, or ponding depth (max. 12 inches) vary in the actual design or with the addition of any surface or subsurface storage components (e.g., additional area of surface ponding, subsurface storage chambers, etc.).

6.1.2 Stormwater Quantity

It is recommended that rain events larger than the 1 inch storm bypass bioretention areas to prevent additional maintenance burden. If designed with sufficient volume and appropriate outlet structures, designers can utilize the bioretention area as both water quality and peak flow attenuation.

Surface Storage. The ponding maximum ponding depth for any bioretention area is 12 inches from the top of soil elevation. 6 inches of ponding is recommended for plant survivability.

Subsurface Storage. Additional volume can be provided for peak flow attenuation by increasing the depth of the media or stone. Additional subsurface storage will not be allowed without sufficient infiltration rates. The maximum excavation depth from final grade for bioretention areas is 10 feet.

Adjusted CN. The removal of runoff volume by bioretention changes the runoff depth entering downstream flood control facilities. An approximate approach to accounting for this in reducing the size of peak flow detention facilities is to calculate an "effective SCS curve number" (CN_{adj}), which is less than the actual curve number (CN). CN_{adj} can then be used in hydrologic calculations and in routing. The method can also be used for other hydrologic methods in which a reduction in runoff volume is possible. Adjusted curve numbers shall not be used where underdrains discharge any portion of the treatment volume to the downstream facilities.

Hydraulic Modeling Requirements. Due to the variability of infiltration rates over time, specific rates of infiltration shall not to be utilized in hydraulic modeling for bioretention facilities. Note that for design calculations and sizing of detention facilities to be accurate, infiltration must be confirmed by on-site infiltration testing. Where underdrains are utilized, they shall be included in hydraulic modeling, with only the "sump" portion below the underdrain being completely removed from the downstream runoff volume. The bioretention area shall be modeled using an equivalent volume based on the equivalent depth calculation. The underdrain shall be modeled as an equivalent orifice.

6.1.3 Pretreatment Forebay Sizing

The volume of the pretreatment forebay required for concentrated flow entering a bioretention area based on, but exclusive of the total treatment volume (Tv) required (see **Section 6.4**). Riprap used for energy dissipation within the forebay shall be sized per TDOT specifications. The sizing of the pretreatment forebay is computed as:

Equation 1.5. Pretreatment Forebay Treatment Volume Sizing

$$Tv_{Forebay} = Tv * 0.15\ (Level\ 1\ Bioretention)$$

$$Tv_{Forebay} = (1.25*Tv) * 0.25 \text{ (Level 2 Bioretention)}$$

Where:

Tv = Total required Treatment Volume (cu. ft.)
$Tv_{Forebay}$ = Treatment Volume required for the forebay (see Section 6.4) (cu. ft.)

6.1.4 Sizing of Velocity Dissipation for an Underdrain

Velocity dissipation for underdrains that daylight rather than tying into the storm drain system is required to prevent scouring. The discharge rate for the 1-inch storm should be determined by using the contributing drainage basin to the specific bioretention area. Below is the method for determining the velocity of flow (fps) from an underdrain within a bioretention area (**Figure 1.2**). Riprap used as energy dissipation shall be sized per TDOT specifications.

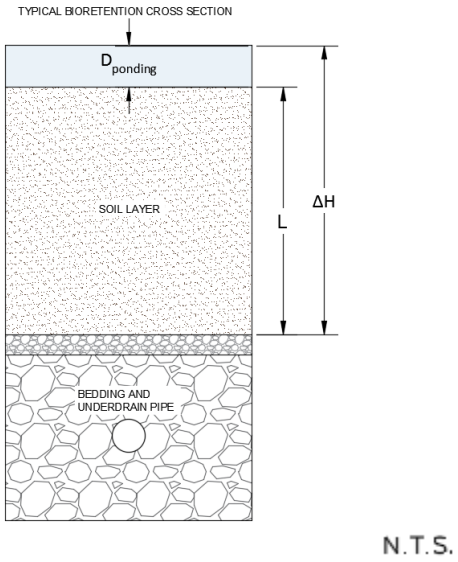


Figure 1.2: Cross Section of Bioretention for Underdrain Sizing

Equation 1.6. Determine Cross Section Flow

$$A = V_{ud} / D_{ponding}$$

Where:

A = flow cross sectional area (sq. ft.)
V_{ud} = Runoff Volume (cu. ft.)
$D_{ponding}$ = Depth of ponded water (ft.)

Equation 1.7. Determine the Infiltration Rate through the Soil

$$q = (K* \Delta H)/L$$

Where:

q = flow per cross sectional unit (in./hr.)
K = hydraulic conductivity of the amended soil (in./hr.) (typically 1 in./hr.)
ΔH = change in hydraulic head from the ponding depth to the bedding layer (ft.)
L = thickness of the soil layer (ft.)

Equation 1.8. Determine the total flow through the Underdrain

$$Q = q * A$$

Where:

Q = total flow through the underdrain (cu. ft./s)
q = flow per cross sectional unit (in./hr.)
A = flow cross sectional area (sq. ft.)

Equation 1.9. Determine the velocity through the Underdrain

$$V = Q/A_{ud}$$

Where:

V = velocity of water leaving underdrain (ft./s)
Q = total flow through the underdrain (cu. ft./s)
A_{ud} = cross sectional area of the underdrain (sq. ft.)

6.2 SOIL INFILTRATION RATE TESTING

In order to determine if an underdrain will be needed, and to accurately assess the expected reduction in runoff volume for sizing of detention facilities, one must measure the infiltration rate of subsoils at the bottom sump elevation of the bioretention area. The infiltration rate of subsoils must exceed 0.5 inch per hour in order to remove the underdrain requirement for bioretention basins. On-site soil infiltration rate testing procedures are outlined in **Appendix B**. The number of soil tests varies base on the size of the bioretention area:

- < 1,000 ft² = 2 tests
- 1,000 – 10,000 ft² = 4 tests
- >10,000 ft² = 4 tests + 1 test for every additional 5,000 ft²

If bedrock is encountered during subsurface testing for the construction of the bioretention area, the bottom sump elevation of the BMP design shall be above the lowest bedrock/refusal elevation encountered in subsurface testing. If, during construction, infiltration rates are suspected to have decreased due to machinery, material storage, or other causes of compaction of the underlying soils, additional infiltration testing may be required to verify pre-construction infiltration rates have not been reduced.

6.3 BMP GEOMETRY

The side slopes of the bioretention area shall be no steeper than 3H:1V for maintenance considerations. Flatter slopes are encouraged to enhance pretreatment where adequate space is available.

Bioretention basins shall be designed with internal flow path geometry such that the treatment mechanisms provided by the bioretention are not bypassed or short-circuited. Examples of short-circuiting include inlets or curb cuts that are very close to outlet structures, or incoming flow that is diverted immediately to the underdrain through stone layers. For these bioretention areas to have an acceptable internal geometry, the "travel time" from each inlet to the outlet should be maximized, and incoming flow must be distributed as evenly as possible across the filter surface area. The designer shall ensure that incoming flow is spread as evenly as possible across the filter surface to maximize the treatment potential.

One important characteristic is the length of the shortest flow path compared to the overall length, as shown in **Figure 1.3** below. In this figure, the ratio of the shortest flow path to the overall length is represented as:

Equation 1.10. Ratio of Shortest Flow Path to Overall Length

$$SFP / L$$

Where:

SFP = length of the shortest flow path

L = length from the most distant inlet to the outlet for multiple inlet bioretention areas or length from the most distant edge of soil media to the outlet structure for single inlet bioretention areas

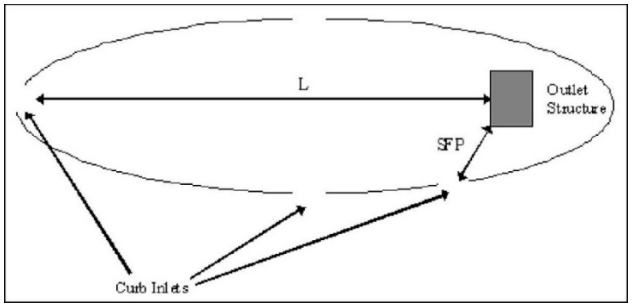


Figure 1.3. Diagram showing shortest flow path as part of BMP geometry (source: VADCR, 2010)

For Level 1 designs, the SFP/L ratio must be 0.3 or greater; the ratio must be 0.8 or greater for Level 2 designs. In some cases, due to site geometry, some inlets may not be able to meet these ratios. However, the drainage area served by such inlets shall constitute no more than 20% of the contributing drainage area. Alternately, the designer may incorporate other design features that prevent short-circuiting, including features that help spread and distribute runoff as evenly as possible across the filter surface.

6.4 PRETREATMENT

Pretreatment of runoff entering bioretention areas is necessary to trap coarse sediment particles before they reach and prematurely clog the filter bed. Pretreatment measures shall be designed to evenly spread runoff across the entire width of the bioretention area. Flow from the pretreatment area to the bioretention filter bed shall not exceed 2 feet per second. Several pretreatment measures are feasible, depending on the scale of the bioretention practice and whether it receives sheet flow or concentrated flows. See **Table 1.4** for pretreatment requirements based on the type of flow. Pretreatment measures shown below are examples and a combination of the other forms of pretreatment can be utilized. See **Appendix A** for more details.

Table 1.4 Required Pretreatment Elements for Bioretention Areas

Flow Type	Level 1 Options	Level 2 Options
Concentrated/Point Flow	• Forebay ○ 15% pretreatment volume (exclusive of total treatment volume) ○ Enhanced check dam (TDOT EC-STR-6A) ○ Slightly sloped bottom without stone • Proprietary structure (City approval)	• Forebay ○ 25% pretreatment volume (exclusive of total treatment volume) ○ Enhanced check dam (TDOT EC-STR-6A) ○ Slightly sloped bottom without stone • Proprietary structure (City approval)
Sheet Flow	Gravel diaphragm to grass filter strip	
Upstream GIP	Outlet and scour protection required at upstream GIP outfall	

6.5 CONVEYANCE AND OVERFLOW

On-line Bioretention: An overflow structure shall always be incorporated into on-line designs to safely convey

larger storms through the bioretention area. The following criteria apply to overflow structures:

- The overflow associated with the 100-year design storms shall be controlled so that velocities are non-erosive at the outlet point (i.e., to prevent downstream erosion).
- A common overflow system within bioretention practices consists of an outlet structure, which is scaled for the application, where the top of the structure is placed at the maximum water surface elevation of the bioretention area (typically 6 inches, maximum 12 inches, above the surface of the filter bed).
- The filter bed surface shall be flat so that the bioretention area fills up evenly.

Off-line Bioretention: Off-line designs are preferred. One common approach is to create an alternate flow path at the inflow point into the structure such that when the maximum ponding depth is reached, the incoming flow is diverted past the facility. In this case, the higher flows do not pass over the filter bed and through the facility, and additional flow is able to enter as the ponding water filtrates through the soil media.

Another option is to utilize a low-flow diversion or flow splitter at the inlet to allow only the Treatment Volume to enter the facility. This may be achieved with a weir or curb opening sized for the target flow, in combination with a bypass channel. Using a weir or curb opening helps minimize clogging and reduces the frequency of required maintenance. Due to the tight tolerances required for flow splitter structures, reliance on pipe invert elevations is not an approved method of splitting stormwater flows. Flow splitting structures shall incorporate an adjustable internal weir that can be adjusted in the field to account for as-built elevations which may differ slightly from the design plans.

6.6 FILTER MEDIA

The filter media and surface cover are the two most important elements of a bioretention facility in terms of long-term performance. The following are key factors to consider in determining an acceptable soil media mixture.

General Filter Media Composition. The recommended bioretention soil mixture is generally classified as a loamy sand on the USDA Texture Triangle, with the following composition by volume: **85% to 88% sand; 8% to 12% soil fines; and 3% to 5% organic matter**. Sand shall consist of silica-based aggregate and shall meet the sieve sizes shown in **Table 1.6**. No substitutions for alternative materials such as "engineered sand" or recycled materials will be accepted.

Table 1.6. Sand sieve size requirements

Sieve	Size	% Passing
3/8 in	9.50 mm	100
No. 4	4.75 mm	95 to 100
No. 8	2.36 mm	80 to 100
No. 16	1.18 mm	45 to 85
No. 30	0.60 mm	15 to 60
No. 50	0.30 mm	3 to 15
No. 100	0.15 mm	0 to 4
Effective Particle Size (D10) > 0.30 mm Uniformity Coefficient (D60/D10) < 0.40		

It may be advisable to start with an open-graded coarse silica sand material and proportionately mix in topsoil that will likely contain anywhere from 8% to 12% soil fines (sandy loam, loamy sand) to achieve the desired ratio of sand and fines. An additional 3% to 5% organic matter can then be added. (The exact composition of organic matter and topsoil material will vary, making particle size distribution and recipe for the total soil media mixture difficult to define in advance of evaluating the available material.)

Infiltration Rate. The bioretention soil media should have a minimum infiltration rate of 1 inch per hour (a proper soil mix will have an initial infiltration rate that is significantly higher). Verification of the infiltration rates of installed amended soils can be performed per ASTM D3385-18.

Depth. The standard minimum filter bed depth ranges from 24 and 36 inches for Level 1 and Level 2 designs, respectively. If trees are included in the bioretention planting plan, tree planting holes in the filter bed shall be deeper to provide enough soil volume for the root structure of mature trees. Use perennials or shrubs instead of trees to landscape shallower filter beds.

Mulch. A 3-inch layer of mulch on the surface of the filter bed enhances plant survival, suppresses weed growth, and helps pretreats runoff before it reaches the filter media. Shredded, aged hardwood, especially cypress, makes a very good surface cover, as it retains a significant amount of nitrogen and typically will not float away. Shredded hardwood mulch will require replacement as a part of regular maintenance.

6.7 UNDERDRAIN AND UNDERGROUND STORAGE LAYER

Level 1 designs require a 4 to 6 inch diameter PVC or HDPE underdrain surrounded by a 3 inch jacket of 1 inch (#57) stone unless the infiltration rate of the surrounding soils is greater than 0.5 inches per hour. Some Level 2 designs will not use an underdrain (where soil infiltration rates meet minimum standards; see **Section 6.2** and **Table 1.2**). For Level 2 designs with an underdrain, an underground storage layer, or "sump", of a minimum of 12 inches of #57 stone shall be incorporated below the invert of the underdrain. The underground storage layer must not extend beyond the footprint of the overlying filter media.

The maximum size of pipe that can be located within the bioretention footprint is 6 inches. Larger stormwater trunk lines shall be outside of the footprint of the bioretention or may be within the berm if there is sufficient setback from the filter media footprint to prevent undermining of the trunk line. Storm lines that convey flow away from the bioretention area (from the outlet structure through the berm, for instance) may exceed the maximum diameter of 6 inches. The depth of the storage layer will depend on the target treatment and storage volumes needed to meet water quality criteria. The storage layer shall consist of clean, washed #57 stone or an approved infiltration module.

If the underdrain is to daylight instead of tying into a storm structure, scour protection shall be provided based of the velocity, in feet per second, exiting the underdrain during the 10 year storm event (see **Section 6.1.4**).

All bioretention basins shall include observation wells. The observation wells should be tied into any T's or Y's in the underdrain system, and should extend upwards to be above the surface, with a vented cap. In addition, cleanout pipes shall be provided.

6.8 BIORETENTION PLANTING PLANS

A landscaping plan must be provided for each bioretention area. Minimum plan elements shall include the proposed bioretention template to be used, delineation of planting areas, the planting plan, including the size, the list of planting stock, sources of plant species, and the planting sequence, including post-nursery care and initial maintenance requirements. The planting area is defined as the area disturbed by construction events. The planting plan must address 100% of the planting area. It is highly recommended that the planting plan be prepared by a qualified landscape architect, in order to tailor the planting plan to the site-specific conditions.

Native plant species are preferred over non-native species, but some ornamental species may be used for landscaping effect if they are not aggressive or invasive. **Appendix C** lists native plant species suitable for use in bioretention.

The choice of which planting template to use depends on the scale of bioretention, the context of the site in the urban environment, the filter depth, the desired landscape amenities, and the future owner's capability to maintain the landscape. In general, the vegetative goal is to achieve a surface area coverage of at least 75% in the first two years. For a bioretention area to qualify for Level 2 Design, a minimum of one tree must be planted for every 400 square feet. All bioretention areas shall include at least 5% of native milkweed vegetation within the planting plan.

6.9 BIORETENTION MATERIAL SPECIFICATIONS

Table 1.5. Bioretention Material Specifications		
Material	**Specification**	**Notes**
Surface Layer	• Shredded hardwood mulch • River stone • Native grasses	Lay a 3-inch layer on the surface of the filter bed to suppress weed growth and prevent erosion
Filter Media Composition	Filter Media to contain a mix of topsoil, sand and organic matter to achieve the following final composition (by volume): • 85% to 88% sand; • 8% to 12% soil fines; and • 3% to 5% organic matter	The volume of filter media placed shall be based on 110% of the plan volume, to account for settling or compaction.
Choker Layer	Use a 3-inch layer of #8 or #89 stone above the stone layer.	Meet TDOT Construction Specifications.
Underdrain Layer	12-inch layer of 1-inch stone (#57 stone) shall be washed and clean and free of all fines.	Underdrain shall have a minimum of 3 inches of stone above the top of pipe.
Underdrains	Use a 4 or 6-inch corrugated HDPE or PVC pipe with 3/8-inch perforations at 6 inches on center; position each underdrain on a minimum 0.5% slope located no more than 20 feet from the next pipe.	Lay the perforated pipe under the length of the bioretention cell and install non-perforated pipe as needed to connect with the storm drain system. Install T's and Y's as needed, depending on the underdrain configuration.
Cleanouts, and Observation Wells	6 inch SDR 35 PVC pipe with vented cap or anchor plate	Cleanouts are required at the upper end of the underdrain. The number of observation wells equals the number of test pits required for infiltration testing (Appendix B)
Storage Layer	#57 clean washed stone	Meet TDOT Construction Specifications.
Plant Materials	**Shrubs**: Minimum 3 gal or 18-24" at 4' o.c. (or 1plant/15 s.f.). **Grasses, sedges, perennials**: Size and max. spacing as called for in Tables 1.4, 1.5 and 1.6 herein. **Trees**: Minimum size 2" caliper, maximum spacing for Level 2 design of 1 tree/400 s.f. (NOTE: the 2" cal, minimum allows it to be counted toward landscape ordinance requirements)	Establish plant materials as specified in the landscaping plan and the recommended plant list.

SECTION 7: SPECIAL CASE DESIGN ADAPTATIONS

7.1 SHALLOW BEDROCK AND GROUNDWATER CONNECTIVITY

Many parts of Franklin have shallow bedrock and groundwater, which can constrain the application of deeper bioretention areas (particularly Level 2 designs). If bedrock or groundwater is encountered during subsurface testing for the construction of the bioretention area, the bottom sump elevation of the bioretention design shall be above the lowest bedrock/refusal or groundwater elevation encountered in subsurface testing. Bedrock removal should be limited to unexpected outcroppings and rises not encountered in subsurface testing.

Note that this is not a desirable design and should be utilized only when all other possibilities have been exhausted.

In cases where the reduced curve number method is to be utilized in stormwater quality calculations, no bedrock shall be located within 2 feet of the bottom grade of the bioretention area.

7.2 KARST

Karst regions are found in much of Middle Tennessee. Infiltrative practices, such as bioretention areas, shall not be used in any areas with high risk of sinkhole formations or in areas of known sinkholes. Increasing stormwater runoff to sinkholes is prohibited.

7.3 SITE SPECIFIC LIMITATIONS

Some sites may have areas identified as site specific limitations to infiltration of stormwater runoff. Site specific limitations shall be determined by the City engineer and approved through the Stormwater variance process. Sites with brownfield permits are an example of site specific limitations. Site specific limitations cannot be self-imposed or be caused by requirements within the City Ordinance. It should be noted that the site specific limitation may only occupy a portion of the entire proposed use, and that some "clean" areas (such as rooftops) can be diverted away to another infiltration or runoff reduction practice. Development proposals should be carefully reviewed to determine if any future operation, on all or part of the site, will be designated as a potential site specific limitation. Based on this designation, infiltration may be restricted or prohibited.

SECTION 8: CONSTRUCTION

8.1 CONSTRUCTION SEQUENCE

Construction Stage Erosion and Sediment Controls. Bioretention areas should be fully protected by silt fence or construction fencing, particularly if they will rely on infiltration (i.e., have no underdrains.) Ideally, bioretention should remain outside the limit of disturbance during construction to prevent soil compaction by heavy equipment. Bioretention basin locations may be used as small sediment traps or basins during construction. However, these must be accompanied by notes and graphic details on the erosion prevention and sediment control (EPSC) plan specifying that (1) the maximum excavation depth at the construction stage must be at least 1 foot above the post-construction installation, and (2) the facility must contain an underdrain. The plan must also show the proper procedures for converting the temporary sediment control practice to a permanent bioretention facility, including dewatering, cleanout and stabilization.

8.2 BIORETENTION INSTALLATION

The following is a typical construction sequence to properly install a bioretention basin. These steps may be modified to reflect different bioretention applications or expected site conditions:

Step 1. Construction of the bioretention area should begin after the entire contributing drainage area has been stabilized with vegetation). **THIS IS THE MOST IMPORTANT FACTOR DETERMINING THE SUCCESS OR FAILURE OF THE BIORETENTION AREA. BIORETENTION AREAS WILL**

FAIL IF SEDIMENT IS ALLOWED TO FLOW INTO THEM. It may be necessary to block certain curb cuts or other inlets while the bioretention area is being constructed. The proposed site should be checked for existing utilities prior to any excavation.

Step 2. The designer and the installer should have a preconstruction meeting, checking the boundaries of the contributing drainage area and the actual inlet elevations to ensure they conform to original design. Since other contractors may be responsible for constructing portions of the site, it is quite common to find subtle differences in site grading, drainage and paving elevations that can produce hydraulically important differences for the proposed bioretention area. The designer should clearly communicate, in writing, any project changes determined during the preconstruction meeting to the installer and the plan review/inspection authority.

Step 3. Temporary EPSC controls are needed during construction of the bioretention area to divert stormwater away from the bioretention area until it is completed. Special protection measures such as erosion control fabrics may be needed to protect vulnerable side slopes from erosion during the construction process.

Step 4. Any pretreatment cells should be excavated first and then sealed to trap sediments.

Step 5. Excavators or backhoes should work from the sides to excavate the bioretention area to its appropriate design depth and dimensions. Excavating equipment should have scoops with adequate reach so they do not have to sit inside the footprint of the bioretention area. Contractors should use a cell construction approach in larger bioretention basins, whereby the basin is split into 500 to 1,000 sq. ft. temporary cells with a 10-15 foot earth bridge in between, so that cells can be excavated from the side.

Step 6. Scarify the bottom soils to a depth of 6 to 12 inches to promote greater infiltration.

Step 7. If a stone storage layer will be used, place the appropriate depth of #57 stone on the bottom, install the perforated underdrain pipe, pack #57 stone to 3 inches above the underdrain pipe, and add approximately 3 inches of choker stone, #8, as a filter between the underdrain layer and the soil media layer. If a stone storage layer is not used, the pipe may be placed within the underdrain layer.

Step 8. Deliver or prepare the soil media and store it on an adjacent impervious area or plastic sheeting. Apply the media in 12-inch lifts until the desired top elevation of the bioretention area is achieved. Install 110% of the required soil volume to compensate for future settlement.

Step 9. Prepare planting holes for any trees and shrubs, install the vegetation, and water them during weeks of no rain for the first two months. Install any temporary irrigation.

Step 10. Place the surface cover in both cells (mulch, river stone or turf), depending on the design.

Step 12. Conduct the final construction inspection (see **Section 9**).

8.3 CONSTRUCTION INSPECTION

Use detailed inspection checklists that require sign-offs by qualified individuals at critical stages of construction to ensure that the contractor's interpretation of the plan is consistent with the designer's intent.

SECTION 9: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 10: OPERATION AND MAINTENANCE

10.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

10.2 FIRST YEAR MAINTENANCE OPERATIONS

Successful establishment of bioretention areas requires that the following tasks be undertaken in the first year following installation:

Initial inspections. For the first 6 months following construction, the site should be inspected at least twice after storm events that exceed 0.5 inch of rainfall.

Spot Reseeding. Inspectors should look for bare or eroding areas in the contributing drainage area or around the bioretention area, and make sure they are immediately stabilized with grass cover.

Fertilization. One-time, spot fertilization may be needed for initial plantings.

Watering. Depending on rainfall, watering may be necessary once a week during the first 2 months, and then as needed during first growing season (April-October).

Remove and replace dead plants. Since up to 10% of the plant stock may die off in the first year, construction contracts should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction. The typical thresholds below which replacement is required are 85% survival of plant material and 100% survival of trees.

10.3 MAINTENANCE INSPECTIONS

It is highly recommended that a spring maintenance inspection and cleanup be conducted at each bioretention area. The following is a list of some of the key maintenance problems to look for:

- Check to see if 75% to 90% cover (mulch plus vegetative cover) has been achieved in the bed, and measure the depth of the remaining mulch. If the mulch layer is less than 3 inches, additional mulch is required.
- Check for sediment buildup at inflow points, curb cuts, gravel diaphragms or pavement edges that prevents flow from reaching the filter bed, and check for other signs of bypassing. Remove accumulated sediment.
- Check for any winter- or salt-killed vegetation and replace with hardier species from the approved plant list.
- Note presence of accumulated sand, sediment and trash in the pretreatment cell or filter beds and remove it.
- Inspect bioretention side slopes and grass filter strips for evidence of any rill or gully erosion, and repair and stabilize any erosion issues found.
- Check the bioretention bed for evidence of mulch flotation, excessive ponding, dead plants or concentrated flows, and take appropriate remedial action.
- Look for any bare soil or sediment sources in the contributing drainage area and stabilize them immediately.
- Check for clogged or slow-draining soil media, often caused by a crust formed on the top layer or inappropriate soil media composition. Remediate as necessary to restore proper filtration characteristics.

10.4 ROUTINE AND NON-ROUTINE MAINTENANCE TASKS

Maintenance of bioretention areas should be integrated into routine landscape maintenance tasks. If landscaping contractors will be expected to perform maintenance, their contracts should contain specifics on unique bioretention landscaping needs, such as maintaining elevation differences needed for ponding, proper mulching, sediment and trash removal, and limited use of fertilizers and pesticides. A customized maintenance schedule must be prepared for each bioretention facility, since the maintenance tasks will differ depending on the scale of bioretention, the landscaping template chosen, and the type of surface cover. A generalized summary of common maintenance tasks and their frequency is provided in **Table 1.10**.

The most common non-routine maintenance problem involves the presence of standing water for extended periods. If water remains on the surface for more than 24 hours after a storm, adjustments to the grading or underdrain repairs may be needed. The surface of the filter bed should also be checked for accumulated sediment or a fine crust that builds up after the first several storm events. There are several methods that can be used to rehabilitate the filter bed (try the easiest things first, as listed below):

- Open the underdrain observation well or cleanout and pour in water to verify that the underdrains are functioning and not clogged or otherwise in need of repair. The purpose of this check is to see if there is standing water all the way down through the soil. If there is standing water on top, but not in the underdrain, then there is a clogged soil layer. If the underdrain and stand pipe indicates standing water, then the underdrain must be clogged and will need to be snaked.
- Remove accumulated sediment and till 2 to 3 inches of sand into the upper 8 to 12 inches of soil.
- Install sand wicks from 3 inches below the surface to the underdrain layer. This reduces the average concentration of fines in the media bed and promotes quicker drawdown times. Sand wicks can be installed by excavating or augering (using a tree auger or similar tool) down to the gravel storage zone to create vertical columns which are then filled with a clean open-graded coarse sand material (ASTM C-33 concrete sand or similar approved sand mix for bioretention media). A sufficient number of wick drains of sufficient dimension should be installed to meet the design dewatering time for the facility.
- Remove and replace some or all of the soil media.

Table 1.10. Suggested Annual Maintenance Activities for Bioretention

Maintenance Tasks	Frequency
Mowing of grass filter strips and bioretention turf cover	At least 4 times a year
Spot weeding, erosion repair, trash removal, and mulch raking	Twice during growing season
Add reinforcement planting to maintain desired vegetation density	As needed
Remove invasive plants using recommended control methods	As needed
Stabilize the contributing drainage area to prevent erosion	As needed
Spring inspection and cleanup	Annually
Supplement mulch to maintain a 3 inch layer	Annually
Prune trees and shrubs	Annually
Remove sediment in pretreatment cells and inflow points	Once every 2 to 3 years
Replace the mulch layer	Every 3 years

SECTION 11: COMMUNITY & ENVIRONMENTAL CONCERNS

11.1 ENVIRONMENTAL AND COMMUNITY ISSUES

The following is a list of several other community and environmental concerns that may also arise when infiltration practices are proposed:

Nuisance Conditions. Poorly designed infiltration practices can create potential nuisance problems such as

basement flooding, poor yard drainage and standing water. In most cases, these problems can be minimized through proper adherence to the setback, soil testing and pretreatment requirements outlined in this specification.

Mosquito Risk. Infiltration practices have some potential to create conditions favorable to mosquito breeding, if they clog and have standing water for extended periods. Proper installation and maintenance of the bioretention area will prevent these conditions from occurring.

Groundwater Injection Permits. Groundwater injection permits are required if the infiltration practice is deeper than the longest surface area dimension of the practice (EPA, 2008). Designers should investigate whether a proposed infiltration practice is subject to Tennessee groundwater injection well permit requirements

Urban Bioretention

Description: Urban Bioretention is similar to traditional bioretention practices, except that the bioretention is fit into concrete-sided containers within urban landscapes, such as planter boxes or tree planters. Captured runoff is treated by filtration through an engineered soil medium and is then either infiltrated into the subsoil or exfiltrated through an underdrain.

Variations:

- Stormwater planters – in landscaping areas between buildings and roadways or sidewalks
- Green Street swales and planters – on street edge of sidewalk where street landscaping is normally installed
- Proprietary planting cells

Advantages/Benefits:

- Reduced runoff volume
- Reduced peak discharge rate
- Reduced TSS
- Reduced pollutant loading
- Reduced runoff temperature
- Groundwater recharge (if soils are sufficiently permeable)
- Habitat creation
- Enhanced site aesthetics
- Reduced heat island effect

Disadvantages/Limitations:

- Separation from groundwater is required
- Not suitable for pollution hotspots

Design considerations:

- Maximum contributing drainage area of 2,500 square feet. For drainage areas > 2,500 square feet see GIP-01.
- Underdrain required
- Design to drain within 24 hours
- Maximum running slope of 3%
- Must not create a fall or tripping hazard. Consider edge protection or Knee walls when adjacent to pedestrian routes.

Roadway Applications

- City approval is required for use within public ROW
- Stormwater can be conveyed by sheet flow or curb cuts
- Design as a series of cells running parallel to roadway
- Impermeable liner must be installed roadside to protect roadway base

Selection Criteria:

LEVEL 1 – 60% Runoff Reduction Credit

Land Use Considerations:

[x] **Residential**

[x] **Commercial**

[x] **Industrial (with CITY Approval)**

Maintenance:

- Regular maintenance of landscaping to maintain healthy vegetative cover
- Irrigation when necessary during first growing season
- Periodic trash removal

Maintenance Burden

[M]

L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

Urban bioretention practices are similar in function to regular bioretention practices except they are adapted to fit into "containers" within urban landscapes. Typically, urban bioretention is installed within an urban streetscape, urban landscaping beds, tree planters, and plazas. Urban bioretention is not intended for large commercial areas, nor should it be used to treat small sub-areas of a large drainage area such as a parking lot. Rather, urban bioretention is intended to be incorporated into small fragmented drainage areas such as shopping or pedestrian plazas within a larger urban development. Urban Bioretention within the Right of Way (ROW) required City approval and shall only be used to treat water that falls in the ROW.

Urban bioretention features hard edges, often with vertical concrete sides, as contrasted with the gentler earthen slopes of regular bioretention. If these practices are outside of the ROW, they may be open-bottomed, to allow some infiltration of runoff into the sub-grade but shall always include an underdrain.

Stormwater planters take advantage of limited space available for stormwater treatment by placing a soil filter in a container located above ground or at grade in landscaping areas between buildings and roadways with an impermeable liner protection (**Figure 2.1**). The small footprint of foundation planters is typically contained in a precast or cast-in-place concrete vault. Other materials may include molded polypropylene cells and precast modular block systems. Stormwater planters must be outside the ROW if they are treating roof water or runoff from areas outside of the ROW.

Figure 2.1. Stormwater Planters (source: City of Portland, OR)

Green Street swales and planters are installed in the sidewalk zone near the street where urban street trees are normally installed. The soil volume for the tree pit is increased and used as a stormwater storage area (**Figure 2.2**). The surface of the enlarged planting area may be mulch, grates or pervious pavement (if outside the ROW). Large and shared rooting space and a reliable water supply increase the growth and survival rates in this otherwise harsh planting environment.

Figure 2.2. Green Street Planters on Deaderick St., Nashville, TN

SECTION 2: PERFORMANCE

The runoff reduction function of an urban bioretention area is described in **Table 2.1**.

Table 2.1. Runoff Volume Reduction Provided by Urban Bioretention Areas		
Stormwater Function	**Level 1 Design**	**Level 2 Design**
Runoff Volume Reduction (RR)	60%	Level 1 Design Only

Sources: CSN (2008) and CWP (2007)

SECTION 3: DESIGN TABLE

Design criteria for urban bioretention are detailed in **Table 2.2**, below.

Table 2.2. Urban Bioretention Design Criteria
Level 1 Design Only (RR: 60)
Sizing (Refer to **Section 6.1**): Surface Area (sq. ft.) = Tv/Equivalent Storage Depth[1]
Maximum Drainage Area: 2,500 sq. ft.
Maximum Ponding Depth: 6 inches
Filter Media Depth: minimum = 30 inches; recommended maximum = 48 inches
Underdrain = 4 or 6 inch PVC or HDPE with clean-outs (Refer to **Section 6.9**)
Gravel layer depth: minimum = 10 inches
Media and Surface Cover: (Refer to **Section 6.5**)
Sub-soil testing: (Refer to **GIP-01**, **Section 6.2**)
Inflow: sheet flow, curb cuts, trench drains, and roof drains, etc.
Building Setbacks: (Refer to **Section 5**)
Long Term Maintenance Plan: (Refer to **Section 9**)

[1] Storage depth is the sum of the porosity (n_r) of the soil media and gravel layers multiplied by their respective depths, plus the surface ponding depth. Refer to **Section 6.1**.

SECTION 4: TYPICAL DETAILS

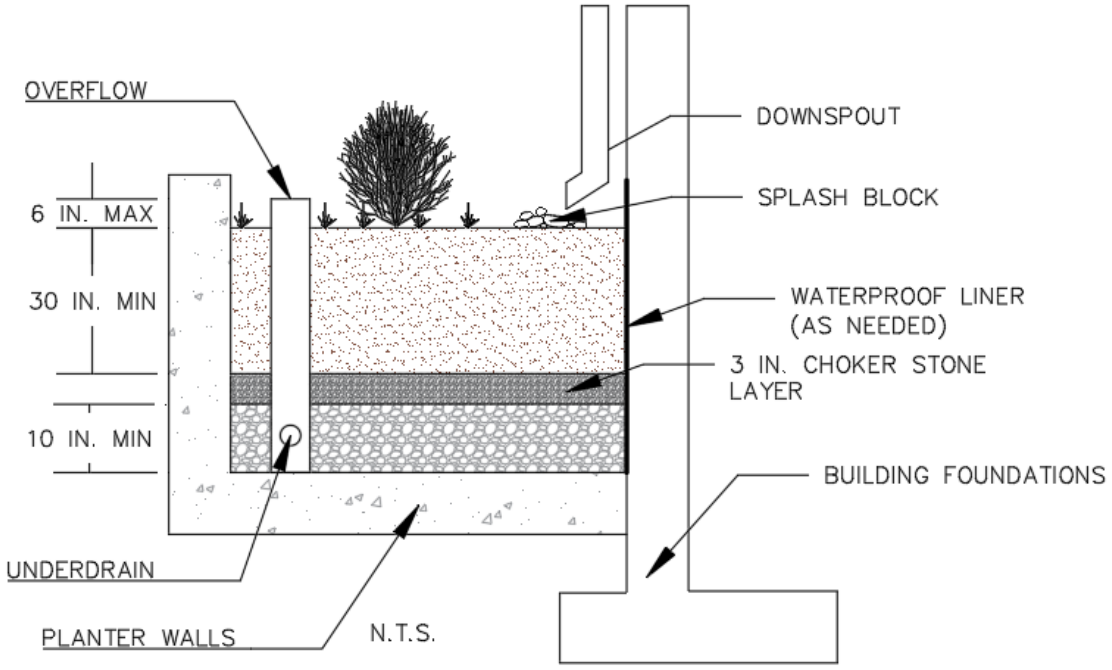


Figure 2.3. Stormwater Planter Cross-Section

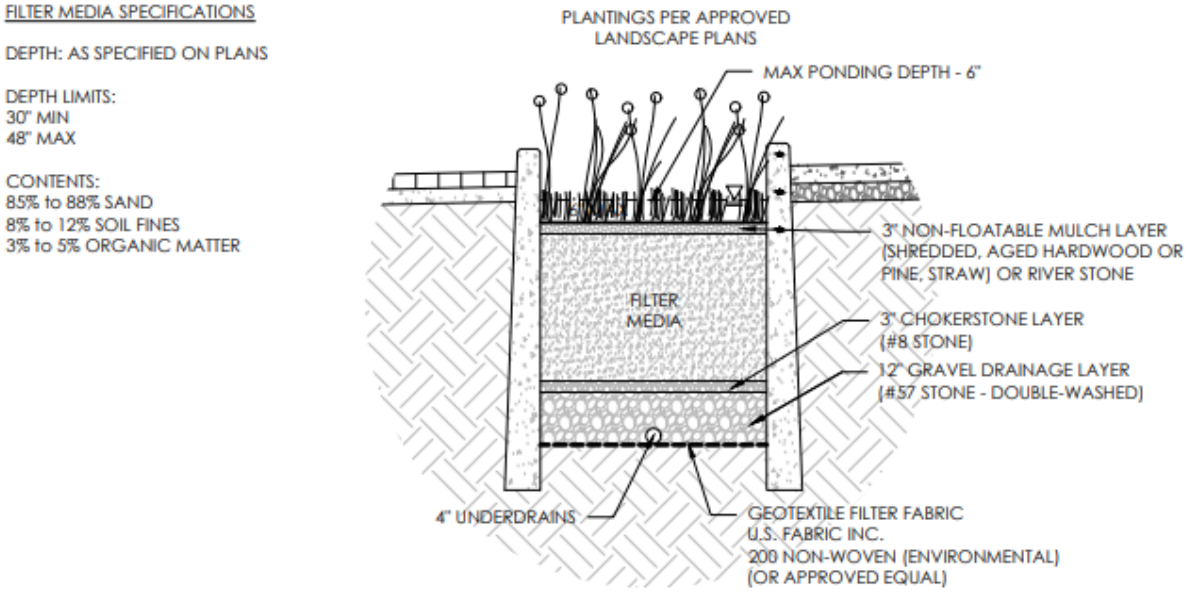


Figure 2.4. Typical Urban Bioretention Detail

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

In general, urban bioretention has the same constraints as regular bioretention, along with a few additional constraints as noted below:

Adequate Drainage. Urban bioretention practice elevations must allow the untreated stormwater runoff to be discharged at the surface of the filter bed and ultimately connect to the local storm drain system.

Available Hydraulic Head. In general, 3 feet of elevation difference is needed between the downstream storm drain invert and the inflow point of the urban bioretention practice. This is generally not a constraint, due to the standard depth of most storm drains systems.

Contributing Drainage Area. Urban bioretention is limited to 2,500 sq. ft. of impervious drainage area. However, this is considered a general rule; larger drainage areas may be allowed with sufficient flow controls and other mechanisms to ensure proper function, safety, and community acceptance. The drainage areas in these urban settings are typically considered to be 100% impervious. While multiple planters or swales can be installed to maximize the treatment area in ultra-urban watersheds, urban bioretention is not intended to be used as treatment for large impervious areas (such as parking lots).

Curb cuts. If curb cuts are to be used in the design of the bioretention area, the designer shall provide calculation showing the curb cut can safely pass the 10 year storm event.

Minimizing External Impacts. Because urban bioretention practices are installed in urban settings, individual units may be subject to higher public visibility, greater trash loads, pedestrian use traffic, vandalism, and even vehicular loads. These practices should be designed in ways that prevent, or at least minimize, such impacts. Designers should clearly recognize the need to perform frequent landscaping maintenance to remove trash, check for clogging, and maintain vigorous vegetation. The urban landscape context may feature naturalized landscaping or a more formal design. When urban bioretention is used in sidewalk areas of high foot traffic, designers shall not impede pedestrian movement or create a safety hazard and maintain the American with Disabilities Act (ADA) required path of travel. Designers may also install low fences (such as a low garden fence), grates or other measures to prevent damage from pedestrian short-cutting across the practices.

Setbacks. If an impermeable liner and an underdrain are used, no setback is required from the building. Otherwise, the urban bioretention practice shall be at least 10 feet down gradient from the building. Building designers shall always be made aware of stormwater BMPs in close proximity to buildings so that appropriate precautions are taken for basement, footing and foundation designs.

Utilities. Urban bioretention practices frequently compete for space with a variety of utilities. Since they are often located parallel to the ROW, care should be taken to provide utility-specific horizontal and vertical setbacks. No below-grade utilities are allowed within the footprint of the urban bioretention areas. No overhead utilities are allowed over urban bioretention areas incorporating tree plantings.

SECTION 6: DESIGN CRITERIA

Urban bioretention practices are similar in function to regular bioretention practices except they are adapted to fit into "containers" within urban landscapes. Therefore, special sizing accommodations are made to allow these practices to fit in very constrained areas where other surface practices may not be feasible.

6.1 SIZING OF URBAN BIORETENTION

The required surface area of the urban bioretention filter is calculated by dividing the Treatment Volume by the Equivalent Storage Depth (**Equation 2.2** below), in the same manner as it is calculated for traditional bioretention. The equivalent storage depth is computed as the depth of media, gravel, or surface ponding (in feet) multiplied by the accepted void ratio.

The accepted porosities (n) are:

Table 2.3. Urban Bioretention Accepted Porosities	
Material	**Porosity Value (n)**
Gravel (#57) Stone	0.40
Soil Media	0.25
Surface Storage	1.00

Equation 2.1. Urban Bioretention Equivalent Storage Depth

$$\text{Equivalent Storage Depth} = D_E = n_1(D_1) + n_2(D_2) + \cdots$$

The equivalent storage depth for an urban bioretention facility with a 30-inch media depth, 12-inch gravel layer, and a 6-inch surface ponding depth is therefore computed as:

$$D_E = (2.5 \text{ ft.} \times 0.25) + (1 \text{ ft.} \times 0.40) + (0.5 \text{ ft.} \times 1.0) = 1.9 \text{ ft.}$$

Where n_1 and D_1 are for the first layer, etc.

Surface Area (SA) is computed as:

Equation 2.2. Urban Bioretention Sizing

$$SA \text{ (sq. ft.)} = T_v \text{ (cu. ft.)} / D_E$$

Where:

SA = the surface area of the urban bioretention facility (in sq. ft.)
D_E = Equivalent Storage Depth (ft.)
T_v = the required Treatment Volume (in cu. ft.)

Equation 2.3. Treatment Volume

$$Tv = [(1.0 \text{ in.})(R_v)(A)/12]$$

Where:

Tv = the required Treatment Volume (in cu. ft.)
A = the contributing drainage area (in sq. ft.)
R_v = Runoff Coefficient found in Section 1 Chapter 3 of this Manual

Equations 2.1 and 2.2 should be modified if the storage depths of the soil media, gravel layer, or ponded water vary in the actual design.

6.2 GENERAL DESIGN CRITERIA FOR URBAN BIORETENTION

Design of urban bioretention should follow the general guidance presented in this Bioretention design

specification. The actual geometric design of urban bioretention is usually dictated by other landscape elements such as buildings, sidewalk widths, utility corridors, retaining walls, etc. Designers can divert fractions of the runoff volume from small impervious surfaces into urban bioretention that is integrated with the overall landscape design. Inlets and outlets shall be located as far apart as possible. The ground surface of the urban bioretention cell shall be flat. The soil media depth shall be a minimum of 30 inches. If large trees and shrubs are to be installed, soil media depths should accommodate. Urban bioretention located adjacent to walkways must incorporate ADA-compliant edge protection and shall not present a fall or tripping hazard. All urban bioretention practices shall be designed to fully drain within 24 hours

6.3 PRETREATMENT

Velocity dissipation shall be provided at any inlet into the urban bioretention area. The inlet(s) to urban bioretention should be stabilized using coarse aggregate stone, splash block, river stone or other acceptable energy dissipation measures. The following forms of inlet stabilization are recommended:

- Stone energy dissipaters.
- Sheet flow over a depressed curb with a 3-inch drop.
- Curb cuts allowing runoff into the bioretention area.
- Covered drains that convey flows under sidewalks from the curb or from downspouts (if the bioretention area is outside of the ROW).
- Grates or trench drains that capture runoff from the sidewalk or plaza area.

Pretreatment is not required with urban bioretentions, but it is highly recommended to improve functionality. Options overlap with those of regular bioretention practices. However, the materials used may be chosen based on their aesthetic qualities in addition to their functional properties. For example, river rock may be used in lieu of rip rap. Other pretreatment options may include one of the following:

- A trash rack between the pretreatment cell and the main filter bed. This will allow trash to be collected from one location.
- A trash rack across curb cuts. While this trash rack may clog occasionally, it keeps trash in the gutter, where it can be picked up by street sweeping equipment.
- A pretreatment area above ground or a manhole or grate directly over the pretreatment area

6.4 CONVEYANCE AND OVERFLOW

Overflows can either be diverted from entering the bioretention cell or dealt with via an overflow inlet. Optional methods include the following:

- Size curb openings to capture only the Treatment Volume and bypass higher flows through the existing gutter.
- Use landscaping type inlets or standpipes with trash guards as overflow devices.
- Use a pretreatment chamber with a weir design that limits flow to the filter bed area.

6.5 FILTER MEDIA

The filter media and surface cover are the two most important elements of a bioretention facility in terms of long-term performance. The following are key factors to consider in determining an acceptable soil media mixture.

General Filter Media Composition. The recommended bioretention soil mixture is generally classified as a loamy sand on the USDA Texture Triangle, with the following composition by volume: **85% to 88% sand; 8% to 12% soil fines; and 3% to 5% organic matter**. Sand shall consist of silica-based aggregate and shall meet the sieve sizes shown in **Table 1.6**. No substitutions for alternative materials such as "engineered sand" or recycled materials will be accepted.

Table 1.6. Sand sieve size requirements		
Sieve	**Size**	**% Passing**
3/8 in	9.50 mm	100
No. 4	4.75 mm	95 to 100
No. 8	2.36 mm	80 to 100
No. 16	1.18 mm	45 to 85
No. 30	0.60 mm	15 to 60
No. 50	0.30 mm	3 to 15
No. 100	0.15 mm	0 to 4
Effective Particle Size (D10) > 0.30 mm Uniformity Coefficient (D60/D10) < 0.40		

It may be advisable to start with an open-graded coarse silica sand material and proportionately mix in topsoil that will likely contain anywhere from 8% to 12% soil fines (sandy loam, loamy sand) to achieve the desired ratio of sand and fines. An additional 3% to 5% organic matter can then be added. (The exact composition of organic matter and topsoil material will vary, making particle size distribution and recipe for the total soil media mixture difficult to define in advance of evaluating the available material.)

Mulch. A 3-inch layer of mulch on the surface of the filter bed enhances plant survival, suppresses weed growth, and helps pretreats runoff before it reaches the filter media. Shredded, aged hardwood, especially cypress, makes a very good surface cover, as it retains a significant amount of nitrogen and typically will not float away. Shredded hardwood mulch will require replacement as a part of regular maintenance.

6.6 SPECIFIC DESIGN ISSUES FOR STORMWATER PLANTERS

Since stormwater planters are often located near building foundations, waterproofing by using a watertight concrete shell or an impermeable liner is required to prevent seepage. The building architect shall be notified if a stormwater planter is to be utilized to ensure any impermeable liner is shown on the corresponding building plans.

6.7 SPECIFIC DESIGN ISSUES FOR GREEN STREETS SWALES AND PLANTERS

- The bottom of the soil layer must be a minimum of 4 inches below the root ball of any plants to be installed.
- Green streets design sometimes cover portions of the stone storage layer with pervious pavers (if outside the ROW). Green streets design can provide additional storage volume within stone storage layers beneath pervious pavers and sidewalks adjacent to urban bioretention cells.
- Installing a tree pit grate over filter bed media is one possible solution to prevent pedestrian traffic and trash accumulation.
- Low, wrought iron fences can help restrict pedestrian traffic across the tree pit bed and serve as a protective barrier if there is a drop-off from the pavement to the urban bioretention cell.
- A removable grate capable of supporting typical H-20 axle loads may be used to allow the tree to grow through it.
- Removable grates in pedestrian areas shall be ADA compliant.
- Each tree needs a minimum of 100 square feet of shared root space.
- Proprietary tree pit devices are acceptable, provided they conform to this specification.

6.8 PLANTING AND LANDSCAPING CONSIDERATIONS

The degree of landscape maintenance that can be provided will determine some of the planting choices for urban bioretention areas. The planting cells can be formal gardens or naturalized landscapes. Landscaping in the ROW should be designed to limit visual obstructions for pedestrian and vehicular traffic. See **Appendix C** for all planting and landscaping requirements, as well as all native plant lists.

In areas where less maintenance will be provided and trash accumulation in shrubbery or herbaceous plants is a concern, consider a "turf and trees" landscaping model. Spaces for herbaceous flowering plants can be included. This may be attractive at a community entrance location.

Native trees or shrubs are preferred for urban bioretention areas, although some ornamental species may be used. As with regular bioretention, selected perennials, shrubs, and trees must be tolerant of drought, and inundation. The landscape designer should also consider that de-icing materials may accumulate in the bioretention areas in winter and could kill vegetation. Additionally, tree species selected shall meet the City of Franklin street tree requirements within the Zoning Ordinance.

6.9 UNDERDRAIN AND UNDERGROUND STORAGE LAYER

The unique components for urban bioretention may include the inlet control device, a concrete box or other containing shell, protective grates, and an underdrain that daylights to another stormwater practice or connects to the storm drain system. The underdrain should consist of perforated pipe greater than or equal to 4 inches in diameter, placed in a layer of washed #57 stone. It shall have a minimum of 3 inches of washed #57 laid above the pipe and have a minimum slope of 0.5%.

All bioretention basins shall include observation wells. The observation wells should be tied into any T's or Y's in the underdrain system, and should extend upwards to be above the surface, with a vented cap. In addition, cleanout pipes shall be provided.

6.10 URBAN BIORETENTION MATERIAL SPECIFICATIONS

Table 2.4. Urban Bioretention Material Specification

Material	Specification	Notes
Surface Layer	• Shredded, aged hardwood mulch • River stone • Native grasses	Lay a 3-inch layer on the surface of the filter bed to suppress weed growth and prevent erosion
Filter Media Composition	Filter Media to contain a mix of topsoil, sand and organic matter to achieve the following final composition (by volume): • 85% to 88% sand; • 8% to 12% soil fines; and • 3% to 5% organic matter	The volume of filter media placed shall be based on 110% of the plan volume, to account for settling or compaction.
Choker Layer	Use a 3-inch layer of #8 or #89 stone above the stone layer.	Meet TDOT Construction Specifications

Reservoir Layer	10 or 12-inch layer of 1-inch stone (#57 stone) should be washed and clean and free of all fines.	3 inches of #57 stone should cover the underdrain with stone above the top of the pipe
Underdrains	Use a 4 or 6-inch corrugated HDPE or PVC pipe with 3/8-inch perforations at 6 inches on center; position each underdrain on a minimum 0.5% slope located no more than 20 feet from the next pipe.	Lay the perforated pipe under the length of the bioretention cell and install non-perforated pipe as needed to connect with the storm drain system. Install T's and Y's as needed, depending on the underdrain configuration.
Cleanouts, and Observation Wells	4 or 6 inch SDR 35 PVC pipe with vented cap or anchor plate	Cleanouts are required at the upper end of the underdrain. The number of observation wells equals the number of test pits required for infiltration testing (Appendix B)
Storage Layer	#57 clean washed stone	Meet TDOT Construction Specifications

SECTION 7: CONSTRUCTION

The construction sequence and inspection requirements for urban bioretention are generally the same as other bioretention practices. Consult the construction sequence and inspection guidance provided in the main bioretention design specification **(GIP-01)**. In cases where urban bioretention is constructed in the road or ROW, the construction sequence may need to be adjusted to account for traffic control, pedestrian access and utility notification.

Urban bioretention areas should only be constructed after the drainage area to the facility is completely stabilized. The specified growth media should be placed and spread by hand with minimal compaction, in order to avoid compaction and maintain the porosity of the media. The media should be placed in 12 inch lifts with no machinery allowed directly on the media during or after construction. The media should be overfilled above the proposed surface elevation, as needed, to allow for natural settling. Lifts may be lightly watered to encourage settling. After the final lift is placed, the media should be raked (to level it), saturated, and allowed to settle prior to installation of plant materials.

SECTION 8: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 9: OPERATION AND MAINTENANCE

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

Routine operation and maintenance are essential to gain public acceptance of highly visible urban bioretention areas. Weeding, pruning, the removal and replacement of dead vegetation and trash removal should be done as

needed to maintain the aesthetics necessary for community acceptance. During drought conditions, it may be necessary to water the plants, as would be necessary for any landscaped area.

To ensure proper performance, installers should check that stormwater infiltrates properly into the soil within 24 hours after a storm. If excessive surface ponding is observed, corrective measures include inspection for soil compaction and underdrain clogging. Consult the maintenance guidance outlined in **Table 2.5 and (GIP-01)**.

Table 2.5. Suggested Annual Maintenance Activities for Urban Bioretention	
Maintenance Tasks	**Frequency**
Spot weeding, erosion repair, trash removal, and mulch raking	Twice during growing season
Add reinforcement planting to maintain desired vegetation density	As needed
Remove invasive plants using recommended control methods	As needed
Stabilize the contributing drainage area to prevent erosion	As needed
Spring inspection and cleanup	Annually
Supplement mulch to maintain a 3 inch layer	Annually
Prune trees and shrubs	Annually
Remove accumulated sediment and fines at inflow points	Once every 2 to 3 years
Replace the mulch layer	Every 3 years

SECTION 10: RIGHT OF WAY DESIGN CONSIDERATIONS

Green Street swales and planters are applicable along roads. Approval by City of Franklin staff is required before the use of application within the ROW. They can be used along curbside in urban areas with stormwater being conveyed by sheet flow or curb cuts. Green Street swales and planters can also be designed as a series of cells running parallel to roadway. A reinforced concrete wall must separate the road subgrade from the bioretention feature. Segmental block walls shall not be used for urban bioretention areas within the ROW.

Permeable Pavement

Description: Permeable pavements allow stormwater runoff to filter through voids in the pavement surface into an underlying stone reservoir, where it is temporarily stored and/or infiltrated. Porous paving systems have several design variants. The four major categories are: 1) pervious concrete; 2) modular block systems; 3) porous asphalt and 4) grass and gravel pavers. All have a similar structure, consisting of a surface pavement layer, an underlying stone aggregate reservoir layer and a filter layer or fabric installed on the bottom. Porous asphalt shall not be used within the City of Franklin.

Variations: permeable interlocking pavers, concrete grid pavers, plastic reinforced grid pavers

Advantages/Benefits:

- Runoff volume reduction
- Can increase aesthetic value
- Provides water quality treatment

Disadvantages/Limitations:

- Cost
- Maintenance
- Limited to low traffic areas with limited structural loading
- Potential issues with handicap access
- Infiltration can be limited by underlying soil property
- Not effective on steep slopes

Applications:

- Best used in low traffic and low load bearing areas
- Parking lots (particularly overflow areas)
- Driveways (commercial)
- Sidewalks (outside the Right of Way)
- Emergency access roads, maintenance roads and trails, etc.

Manufacturer recommendations for installation shall supersede any requirement within the BMP manual

Selection Criteria:

LEVEL 1 – 45% Runoff Reduction Credit

LEVEL 2 – 95% Runoff Reduction Credit

Land Use Considerations:

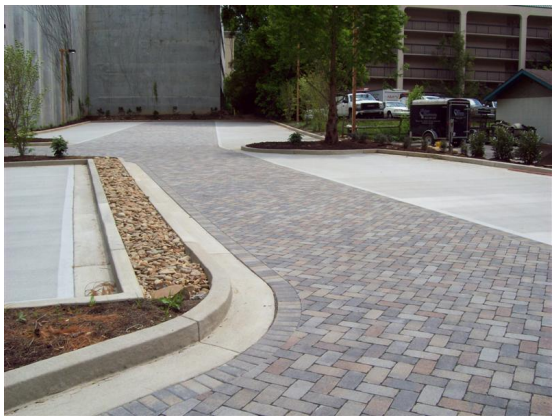
X	**Residential**
X	**Commercial**
X	**Industrial**

Maintenance:

- Turf pavers can require mowing, fertilization, and irrigation. Plowing is possible, but requires use of skids
- Sand, salt, and deicers shall not be applied
- Adjacent areas should be fully stabilized with vegetation to prevent sediment-laden runoff from clogging the surface
- A vacuum-type sweeper or high-pressure hosing (for porous concrete) should be used for cleaning

H	**Maintenance Burden** L = Low M = Moderate H = High

SECTION 1: DESCRIPTION



Permeable pavements are alternative paving surfaces that allow stormwater runoff to filter through voids in the pavement surface into an underlying stone reservoir, where it is temporarily stored and/or infiltrated. Permeable pavements consist of a surface pavement layer, an underlying stone aggregate reservoir layer and a filter layer or fabric installed on the bottom (See **Figure 3.1** below).

The thickness of the reservoir layer is determined by both a structural and hydraulic design analysis. The reservoir layer serves to retain stormwater and supports the design traffic loads for the pavement. In low-infiltration soils, some of the filtered runoff is collected in an underdrain and returned to the storm drain system. If infiltration rates in the native soils permit, permeable pavement can be designed with a sump beneath the underdrain, to enable full infiltration of runoff. A combination of these methods can be used to infiltrate a portion of the filtered runoff.

Permeable pavement is typically designed to treat stormwater that falls on the actual pavement surface area, but it may also be used to accept run-on from small adjacent impervious areas, such as impermeable driving lanes or rooftops. However, careful sediment control is needed for any run-on areas to avoid clogging of the down-gradient permeable pavement. Permeable pavement has been used at commercial, institutional, and residential sites in spaces that are traditionally impervious. Permeable pavement promotes a high degree of runoff volume reduction and nutrient removal, and it can also reduce the effective impervious cover of a development site.

SECTION 2: PERFORMANCE

The overall runoff reduction of permeable pavement is shown in **Table 3.1**.

Table 3.1. Runoff Volume Reduction Provided by Permeable Pavement		
Stormwater Function	**Level 1 Design**	**Level 2 Design**
Runoff Volume Reduction (RR)	45%	95%

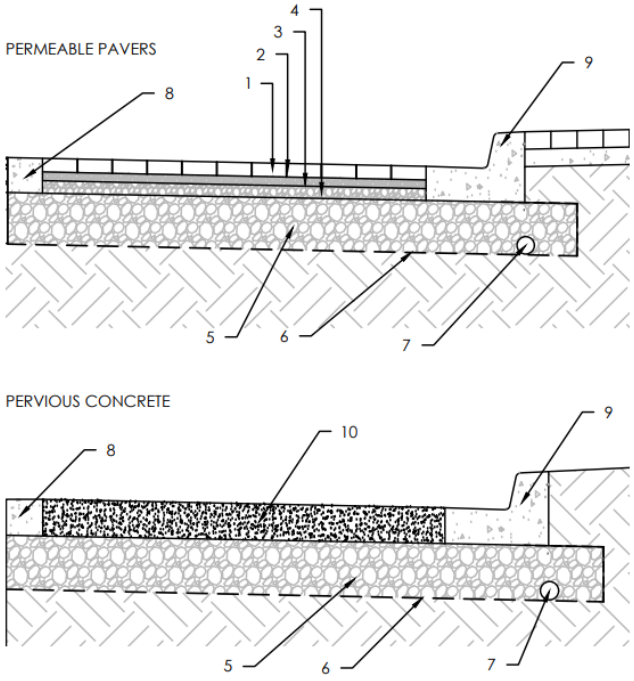
SECTION 3: DESIGN TABLE

The major design goal of permeable pavement is to maximize runoff reduction. To this end, designers may choose to use a baseline permeable pavement design (Level 1) or an enhanced design (Level 2) that maximizes runoff reduction. To qualify for Level 2, the design must meet all design criteria shown in the right hand column of **Table 3.2**.

Table 3.2. Permeable Pavement Design Criteria	
Level 1 Design	**Level 2 Design**
Sizing (Section 6.1): Tv [1]= (1)(Rv)(A) 3630	**Sizing (Section 6.1)**: Tv [1]= (1.1)(Rv)(A) 3630
Sub-soil Testing (Section 6.2): Testing is required. Min. infiltration rate > 0.5 inch/hour in order to remove the underdrain requirement.	**Sub-soil Testing** (Section 6.2): Testing is required. Min. infiltration rate > 0.5 inch/hour in order to remove the underdrain requirement.
Contributing Drainage Area (Section 5): Twice the permeable surface area.	**Contributing Drainage Area (Section 5)**: No additional contributing drainage area allowed.
Underdrain (Section 6.8) = PVC or Corrugated HDPE with clean-outs. Underdrains are required. (**Section 6.2**)	**Underdrain & Underground Storage Layer** (Section 6.7) = PVC or Corrugated HDPE with clean-outs, and a minimum 12-inch stone sump below the invert. Underdrains are required. (**Section 6.2**)
Long Term Maintenance Requirements (Section 11)	

1. A = Area in acres

SECTION 4: TYPICAL DETAILS



1	3 1/8" THICKNESS CONCRETE PAVERS 8,000 PSI STRENGTH
2	1/4" JOINTS NO. 8 STONE
3	2" BEDDING COURSE NO. 8 AGGREGATE
4	3" OPEN-GRADED BASE NO. 57 STONE
5	12" STONE SUBBASE NO. 2 STONE
6	GEOTEXTILE FILTER FABRIC U.S. FABRIC INC. 200 NON-WOVEN (ENVIRONMENTAL) (OR APPROVED EQUAL)
7	4" OR 6" P.V.C. UNDERDRAIN
8	RIBBON CURB (SEE C.O.F. STANDARD CURB DETAIL)
9	STANDARD C.O.F. CURB AS SPECIFIED ON PLANS
10	PERVIOUS CONCRETE PER ACI STANDARD

Figure 3.1. Typical Detail of Concrete Pavers and Permeable Concrete

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

Since permeable pavement has a very high runoff reduction capability, it should always be considered as an alternative to conventional pavement. Permeable pavement is subject to the same feasibility constraints as most infiltration practices, as described below.

Contributing Drainage Area. Any external drainage area contributing runoff to permeable pavement should not exceed twice the surface area of the Level 1 permeable pavement and shall be as close to 100% impervious as possible. Level 2 designs shall only treat the rainfall that falls on its surface. Careful sediment source control and/or a pre-treatment strip or sump (e.g., stone or gravel) should be used to control sediment run-on to the permeable pavement section if there is any permeable run-on upgradient. It is recommended to not place permeable pavement under tree cover or near overhanging landscaping.

Available Space. A prime advantage of permeable pavement is that it does not require its surface area to be set aside solely for stormwater management and can still be utilized for vehicular or pedestrian. This can be important for tight sites and areas with high land costs where usable surface area is at a premium.

Pavement Subgrade Slope. The subgrade slope of a permeable pavement installation shall be as flat as possible (i.e., 0% longitudinal slope) to enable even distribution and infiltration of stormwater. However, a maximum longitudinal slope of 1% is permissible if an underdrain is employed. Lateral slopes should be 0%. The subgrade of the permeable pavement shall be an even slope both longitudinally and laterally to establish a level reservoir layer. Designers should consider using a terraced subgrade design for permeable pavement in sloped areas, especially

when the local slope is several percent or greater. An overflow for larger design storms shall be provided. The surface slope shall be a maximum of 10% but is recommended to be less than 1%.

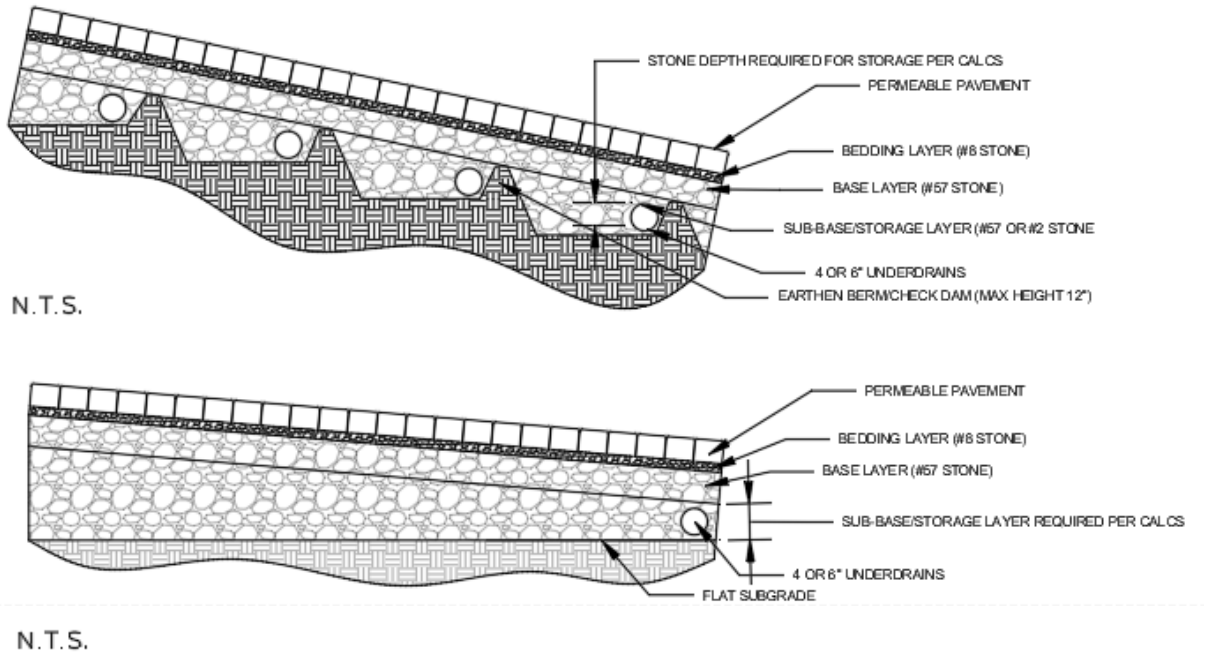


Figure 3.2. Typical Detail of Terraced and Flat Subgrade

Minimum Hydraulic Head. The elevation difference needed for permeable pavement to function properly is generally nominal, although 2 to 4 feet of head may be needed to drive flows through underdrains. Flat terrain may affect proper drainage permeable pavement designs, so underdrains shall have a minimum 0.5% slope.

Subsurface Constraints. A high groundwater table may cause runoff to pond at the bottom of the permeable pavement system. Therefore, a minimum vertical distance of 2 feet must be provided between the bottom of the subgrade of the permeable pavement and the seasonal high water table. The bottom subgrade of the permeable pavement system shall be above the bedrock/refusal depth provided with the geotechnical report.

Utilities. No utilities shall be located under the permeable pavement. All wet utilities shall be hydraulically disconnected to prevent a direct connection to the MS4.

Setbacks. Permeable pavement shall not be hydraulically connected to structure foundations, in order to avoid harmful seepage. It is not recommended to place permeable pavement immediately adjacent to structures. To avoid the risk of seepage, a licensed PE should be consulted to determine the appropriate setbacks necessary to prevent pavement infiltration from compromising structural foundations or pavement. At a minimum, small- and large-scale pavement applications shall be located a minimum horizontal distance of 100 feet from any water supply well, 50 feet from septic systems, and at least 5 feet down-gradient from dry or wet utility lines.

High Loading Situations. Permeable pavement is not intended to treat sites with high sediment, trash, or landscape debris loads, since such loads will cause the practice to clog and fail.

Limitations. Permeable pavement can be used as an alternative to most types of conventional pavement at residential, commercial and institutional developments; however, it is not currently approved for use in the Right of Way (ROW).

SECTION 6: DESIGN CRITERIA

6.1 SIZING OF PERMEABLE PAVEMENT

Structural Design. If permeable pavement will be used in a parking lot or other setting that involves vehicles, the pavement surface must be able to support the maximum anticipated traffic load. The structural design process will vary according to the type of pavement selected, and the manufacturer's specific recommendations shall be consulted. The thickness of the permeable pavement and reservoir layer must be sized to support structural loads and to temporarily store the design storm volume (e.g., the water quality, channel protection, and/or flood control volumes). On most new development and redevelopment sites, the structural support requirements will dictate the depth of the underlying stone reservoir.

The structural design of permeable pavements involves consideration of four main site elements:

- Total traffic;
- In-situ soil strength;
- Environmental elements; and
- Bedding and Reservoir layer design.

The resulting structural requirements may include, but are not limited to, the thickness of the pavement, filter, and reservoir layer. Designers should note that if the underlying soils have a low California Bearing Ratio (CBR) (less than 4%), they may need to be compacted to at least 95% of the Standard Proctor Density, which generally rules out their use for infiltration.

Designers should determine structural design requirements by consulting transportation design guidance sources, such as the following:

- TDOT Roadway Design Guidelines (latest edition);
- AASHTO Guide for Design of Pavement Structures (latest edition); and,
- AASHTO Supplement to the Guide for Design of Pavement Structures (latest edition).

Hydraulic Design. Permeable pavement is typically sized to store the complete water quality Treatment Volume (T_v) or another design storm volume in the reservoir layer. Modeling has shown that this simplified sizing rule approximates an 80% average rainfall volume removal for subsurface soil infiltration rates up to one inch per hour. More conservative values are given because both local and national experience has shown that clogging of the permeable material can be an issue, especially with larger contributing areas carrying significant soil materials onto the permeable surface.

The infiltration rate typically will be less than the flow rate through the pavement, so that some underground reservoir storage will usually be required. Designers should initially assume that there is no outflow through underdrains, using **Equation 3.1** to determine the depth of the reservoir layer, assuming runoff fully infiltrates into the underlying soil:

Equation 3.1. Depth of Reservoir Layer with no Underdrain

$$d_p = \frac{\{(d_c \times R) + P - (i/2 \times t_f)\}}{n}$$

Where:

d_p = The depth of the reservoir layer (ft.)

d_c = The depth of runoff from the contributing drainage area (not including the permeable paving surface)

		for the Treatment Volume (T_v/A_c), or other design storm (ft.)
R	=	A_c/A_p = The ratio of the contributing drainage area (A_c, not including the permeable paving surface) to the permeable pavement surface area (A_p) [NOTE: The maximum value for the Level 1 design is R = 2, (the external drainage area A_c is twice that of the permeable pavement area Ap; and for Level 2 design R = 0 (the drainage area is made up solely of permeable pavement A_p].
P	=	The rainfall depth for the Treatment Volume (Level 1 = 1 in.; Level 2 = 1.1 in.), or other design storm (ft.)
i	=	The field-verified infiltration rate for native soils (ft./day)
t_f	=	The time to fill the reservoir layer (day) – typically 2 hours or 0.083 day
n	=	The porosity for the reservoir layer (0.4)

The maximum allowable depth of the reservoir layer is constrained by the maximum allowable drain time, which is calculated using **Equation 3.2**.

Equation 3.2. Maximum Depth of Reservoir Layer

$$d_{p-max} = \frac{(i/2 \times t_d)}{n}$$

Where:

d_{p-max}	=	The maximum depth of the reservoir layer (ft.)
i	=	The field-verified infiltration rate for native soils (ft./day)
t_d	=	The maximum allowable time to drain the reservoir layer, typically 1 to 2 days
n	=	The porosity for the reservoir layer (0.4)

The following design assumptions apply to **Equations 3.1 and 3.2**:

- The contributing drainage area (A_c) should not contain pervious areas.
- For design purposes, the native soil infiltration rate (i) should be the field-tested soil infiltration rate divided by a factor of safety of 2. The minimum acceptable native soil infiltration rate is 0.5 inches/hr.
- The porosity (n) for No. 57 stone = 0.40
- Max. drain time for the reservoir layer should be not less than 24 or more than 48 hours.

If the depth of the reservoir layer is too great (i.e. d_p exceeds $d_{p\text{-}max}$), or the verified soil infiltration rate is less than 0.5 inches per hour, then the design method typically changes to account for underdrains. The storage volume in the pavements must account for the underlying infiltration rate and outflow through the underdrain. In this case, the design storm should be routed through the pavement to accurately determine the required reservoir depth. Alternatively, the designer may use **Equations 3.3 through 3.5** to approximate the depth of the reservoir layer for designs using underdrains.

Equation 3.3 can be used to approximate the outflow rate from the underdrain. The hydraulic conductivity, *k*, of gravel media is very high (~17,000 ft./day). However, the permeable pavement reservoir layer will drain increasingly slower as the storage volume decreases (i.e. the hydraulic head decreases). To account for this change, a conservative permeability coefficient of 100 ft./day can be used to approximate the average underdrain outflow rate.

Equation 3.3. Outflow through Underdrain

$$q_u = k \times m$$

Where:

q_u	=	Outflow through the underdrain (per outlet pipe, assumed 6-inch diameter)(ft./day)
k	=	Hydraulic conductivity for the reservoir layer (ft./day – assume 100 ft./day)
m	=	Underdrain pipe slope (ft./ft.)

Once the outflow rate through the underdrain has been approximated, **Equation 3.4** is used to determine the depth of the reservoir layer needed to store the design storm.

Equation 3.4. Depth of Reservoir Layer with Outflow through Underdrain

$$d_p = \frac{\{(d_c \times R) + P - (i/2 \times t_f) - (q_u \times t_f)\}}{n}$$

Where:

d_p	=	Depth of the reservoir layer (ft.)
d_c	=	Depth of runoff from the contributing drainage area (not including the permeable pavement surface) for the Treatment Volume (Tv/A_c), or other design storm (ft.)
R	=	A_c/A_p = The ratio of the contributing drainage area (A_i (not including the permeable pavement surface) to the permeable pavement surface area (A_p)
P	=	The rainfall depth for the Treatment Volume (Level 1 = 1 inch; Level 2 = 1.1 inch), or other design storm (ft.)
i	=	The field-verified infiltration rate for the native soils (ft./day)
t_f	=	The time to fill the reservoir layer (day) – typically 2 hours or 0.083 day
n	=	The porosity for the reservoir layer (0.4)
q_u	=	Outflow through Underdrain (ft/day)

The maximum allowable depth of the reservoir layer is constrained by the maximum allowable drain time, which is calculated using **Equation 3.5**.

Equation 3.5. Maximum Depth of Reservoir Layer with Outflow through Underdrain

$$d_{p-max} = \frac{\{(i/2 \times t_d) - (q_u \times t_d)\}}{n}$$

Where:

d_{p-max}	=	The maximum depth of the reservoir layer (ft.)
i	=	The field-verified infiltration rate for the native soils (ft./day)
n	=	The porosity for the reservoir layer (0.4)
t_d	=	The time to drain the reservoir layer (day – typically 1 to 2 days)
q_u	=	Outflow through Underdrain (ft/day)

If the depth of the reservoir layer is still too great (i.e. d_p exceeds $d_{p\text{-}max}$), the number of underdrains can be increased, which will increase the underdrain outflow rate.

Permeable pavement can also be designed to address, in whole or in part, the detention storage needed to comply with channel protection and/or flood control requirements. Permeable pavement shall have an underdrain if being used for detention storage. The designer can model various approaches by factoring in storage within the stone aggregate layer and any outlet structures used as part of the design. Routing calculations can also be used to provide a more accurate solution of the peak discharge and required storage volume.

Once runoff passes through the surface of the permeable pavement system, designers should calculate outflow pathways to handle subsurface flows. Subsurface flows can be regulated using underdrains, the volume of storage in the reservoir layer, and the bed slope of the reservoir layer.

6.2 SOIL INFILTRATION RATE TESTING

All permeable pavement systems shall have an underdrain. On-site soil infiltration rate testing procedures are outlined in **Appendix B**. The same frequency of soil borings must be taken to confirm the underlying soil properties at the depth where infiltration is designed to occur (i.e., to ensure that the depth to water table, depth to bedrock, or karst is defined).

Table 3.3. Required Infiltration Testing per Sq.Ft of pavement			
Impervious Area Treated	250 to 1,000 sq. ft.	1,000 to 10,000 sq. ft.	More than 10,000 sq. ft.
Required Soil Tests	Two per practice	Four per practice	Four + one per every additional 5000 ft^2

6.3 TYPE OF SURFACE PAVEMENT

Pervious concrete, permeable interlocking concrete pavers, concrete grid pavers, and plastic reinforced grid paver surfaces are permitted.

6.4 INTERNAL GEOMETRY AND DRAWDOWNS

- ***Elevated Underdrain.*** To promote greater runoff reduction for permeable pavement located on marginal soils, an elevated underdrain should be installed with a stone jacket that creates a 12 to 18 inch deep storage layer *below* the underdrain invert. The void storage in this layer can help qualify a site to achieve Level 2 design.
- ***Rapid Drawdown.*** When possible, permeable pavement should be designed so that the target runoff reduction volume stays in the reservoir layer for at least 36 hours before being discharged through an underdrain.
- ***Conservative Infiltration Rates.*** Designers should always decrease the measured infiltration rate by a factor of 2 during design, to approximate long term infiltration rates.

6.5 PRETREATMENT

Pretreatment for most permeable pavement applications is not necessary, since the surface acts as pretreatment to the reservoir layer below. For areas where there is a transition from conventional pavements to permeable pavement, a ribbon curb shall be installed between to two pavements to prevent settling and prevent fines from clogging the surface of the permeable pavement.

6.6 CONVEYANCE AND OVERFLOW

Permeable pavement designs should include methods to convey larger storms (e.g., 2-yr, 10-yr) to the storm drain system. The following is a list of methods that can be used to accomplish this:

- Place a perforated pipe horizontally near the top of the reservoir layer to pass excess flows after water has filled the base. The placement and/or design should be such that the incoming runoff is not captured (e.g., placing the perforations on the underside only).
- Increase the thickness of the top of the reservoir layer by as much as 6 inches (i.e., create freeboard). The design computations used to size the reservoir layer often assume that no freeboard is present.
- Create underground detention within the reservoir layer of the permeable pavement system. Reservoir storage may be augmented by plastic or concrete pipes, arch structures, etc. Corrugated metal is not permitted.
- Route excess flows to another detention or conveyance system that is designed for the management of extreme event flows.
- Set the storm drain inlets flush with the elevation of the permeable pavement surface to effectively convey excess stormwater runoff past the system (typically in remote areas). The design should also make allowances for relief of unacceptable ponding depths during larger rainfall events.

6.7 RESERVOIR LAYER

The thickness of the reservoir layer is determined by runoff storage needs, the infiltration rate of in situ soils, structural requirements of the pavement sub-base, depth to water table and bedrock, and frost depth conditions. A professional should be consulted regarding the suitability of the soil subgrade.

- The reservoir below the permeable pavement surface should be composed of clean, washed stone aggregate and sized for both the storm event to be treated and the structural requirements of the expected traffic loading.
- The storage layer may consist of clean washed No. 57 stone, although No. 2 stone is preferred because it provides additional storage and structural stability.

6.8 UNDERDRAINS

The use of underdrains is required for each permeable pavement system due to compaction needed for the Proctor Density Test. Each underdrain shall be installed at a minimum 0.5% slope located 20 feet or less from the next pipe (or equivalent corrugated HDPE may be used for smaller load-bearing applications). Perforated pipe installed for the full length of the permeable pavement cell, and non-perforated pipe, as needed, is used to connect with the storm drain system. T's and Y's shall be installed as needed, depending on the underdrain configuration. Extend cleanout pipes to the surface with vented caps or traffic rated lids at the Ts and Ys. Underdrains can also be used to manage extreme storm events to keep detained stormwater from backing up into the permeable pavement.

- An underdrain(s) shall have at least a 3 inch stone jacket around the underdrain.
- An underdrain(s) can also be installed and capped at a downstream structure as an option for future use if maintenance observations indicate a reduction in the soil permeability.

6.9 MAINTENANCE REDUCTION FEATURES

Maintenance is a crucial element to ensure the long-term performance of permeable pavement. The most frequently cited maintenance problem is surface clogging caused by organic matter and sediment, which can be reduced by the following measures:

- *Protecting the Bottom of the Reservoir Layer.* There are two options to protect the bottom of the reservoir layer from intrusion by underlying soils. The first method involves covering the bottom with nonwoven, polypropylene geotextile that is permeable, although some practitioners recommend avoiding the use of filter fabric since it may become a future plane of clogging within the system. Permeable filter fabric is still recommended to protect the excavated sides of the reservoir layer, in order to prevent soil piping. The second method is to form a barrier of choker stone and sand. In this case, underlying native soils should be

separated from the reservoir base/subgrade layer by a thin 2 to 4 inch layer of clean, washed, choker stone (ASTM D 448 No. 8 stone) covered by a layer of 6 to 8 inches of course sand.

- ***Observation Well.*** An observation well, consisting of a well-anchored, perforated 4 to 6 inch (diameter) PVC pipe that extends vertically to the bottom of the reservoir layer, should be installed at the downstream end of all large-scale permeable pavement systems. The observation well should be fitted with a lockable cap or traffic rated lid installed flush with the ground surface (or under the pavers) to facilitate periodic inspection and maintenance. The observation well is used to observe the rate of drawdown within the reservoir layer following a storm event.
- ***Overhead Landscaping.*** Check the area of parking lots required to be in landscaping. Large-scale permeable pavement applications should be carefully planned to integrate this landscaping in a manner that maximizes runoff treatment and minimizes the risk that sediment, mulch, grass clippings, leaves, nuts, and fruits will inadvertently clog the paving surface.

SECTION 7: Material Specifications

Permeable pavement material specifications vary according to the specific pavement product selected. **Table 3.4** describes general material specifications for the component structures installed beneath the permeable pavement. **Table 3.4** provides specifications for general categories of permeable pavements. Designers should consult manufacturer's technical specifications for specific criteria and guidance.

Table 3.4. Material Specifications for Underneath the Pavement Surface

Material	Specification	Notes
Permeable Pavement System	Permeable Interlocking Concrete Pavers[1] Pervious Concrete[2] Reinforced Turf Systems[3] Reinforced Gravel Systems[4]	ASTM C936[1] ASTM C1688/C16188M & ACI 522[2] ASTM D638[3] ASTM D638[4]
Bedding Layer	#8 or #89 clean, washed stone	Meet TDOT Construction Specifications
Reservoir Layer	#57 or #2 clean, washed stone	Meet TDOT Construction Specifications. Depth is based on the pavement structural and hydraulic requirements.
Underdrain	4 to 6 inch diameter perforated HDPE or PVC pipe with 3/8-inch perforations at 6 inches on center;	(AASHTO M 252) Place perforated pipe at base of the reservoir layer at the lower end of the paver cell
Cleanout	6 inch SDR 35 PVC pipe with vented cap	Use traffic rated castings where required. Provide cleanouts at the upper end of the underdrain.
Filter Fabric/Sand Choker Layer	Filter Fabric (125 gpm/sq.ft.)[1] 2 to 4 inch layer of coarse sand[2]	AASHTO M288-06, ASTMD4491 & D4751[1] Meet TDOT Construction Specifications[2]
Impermeable Liner (if needed)	Use a thirty mil (minimum) PVC Geomembrane liner covered by 8 to 12 oz./sq. yd.[2] non-woven geotextile.	

[1] Specifications for Permeable Interlocking Concrete Pavers

[2]Specifcations for Pervious Concrete

[3]Specifications for Reinforced Turf Systems

[4]Specifications for Reinforced Gravel Systems

SECTION 8: SPECIAL CASE DESIGN ADAPTATIONS

The design adaptation described below permits permeable pavement to be used on a wider range of sites.

However, it is important not to force this practice onto marginal sites. Other runoff reduction practices are often preferred alternatives for difficult sites.

8.1 SHALLOW BEDROCK

Many parts of Franklin have shallow bedrock, which can constrain the application of deeper permeable paver systems. If bedrock is encountered during construction of the permeable pavement system, the bottom subgrade of the permeable paver system shall be above the bedrock/refusal depth provided with the geotechnical report.

8.2 KARST

Karst regions are found in much of Middle Tennessee. Infiltrative practices, such as permeable pavement, shall not be used in any areas with high risk of sinkhole formations or in areas of know sinkholes.

8.3 SITE SPECIFIC LIMITATIONS

Some sites may have areas identified as site specific limitations to infiltration of stormwater runoff. Site specific limitations shall be determined by the City engineer and approved through the Stormwater variance process. Sites with brownfield permits are an example of site specific limitations. Site specific limitations cannot be self-imposed or be caused by requirements within the City Ordinance. It should be noted that the site specific limitation may only occupy a portion of the entire proposed use, and that some "clean" areas (such as rooftops) can be diverted away to another infiltration or runoff reduction practice. Development proposals should be carefully reviewed to determine if any future operation, on all or part of the site, will be designated as a potential site specific limitation. Based on this designation, infiltration may be restricted or prohibited.

SECTION 9: CONSTRUCTION

Experience has shown that proper installation is absolutely critical to the effective operation of a permeable pavement system.

9.1 NECESSARY EROSION & SEDIMENT CONTROLS

- All permeable pavement areas should be fully protected from sediment intrusion by silt fence or construction fencing, particularly if they are intended to infiltrate runoff.
- Permeable pavement areas should remain outside the limit of disturbance during construction to prevent soil compaction by heavy equipment. Permeable pavement areas should be clearly marked on all construction documents and grading plans. To prevent soil compaction, heavy vehicular and foot traffic should be kept out of permeable pavement areas during and immediately after construction.
- During construction, care should be taken to avoid tracking sediments onto any permeable pavement surface to avoid clogging.
- Any area of the site intended ultimately to be a permeable pavement area should generally not be used as the site of a temporary sediment basin.
- Where locating a sediment basin on an area intended for permeable pavement is unavoidable, the invert of the sediment basin must be a minimum of 2 feet above the final design elevation of the bottom of the aggregate reservoir course.
- All sediment deposits in the excavated area should be carefully removed prior to installing the subbase, base and surface materials

9.2 PERMEABLE PAVEMENT CONSTRUCTION SEQUENCE

The following is a typical construction sequence to properly install permeable pavement:

Step 1. Construction of the permeable pavement shall only begin after the entire contributing drainage area has been stabilized. The proposed site should be checked for existing utilities prior to any excavation. Do not install the system in rain or snow, and do not install frozen bedding materials.

Step 2. As noted above, temporary EPSC measures are needed during installation to divert stormwater away from the permeable pavement area until it is completed. Special protection measures such as erosion control fabrics may be needed to protect vulnerable side slopes from erosion during the excavation process. The proposed permeable pavement area must be kept free from sediment during the entire construction process. Construction materials that are contaminated by sediments must be removed and replaced with clean materials.

Step 3. Where possible, excavators or backhoes should work from the sides to excavate the reservoir layer to its appropriate design depth and dimensions. For micro-scale and small-scale pavement applications, excavating equipment should have arms with adequate extension so they do not have to work inside the footprint of the permeable pavement area (to avoid compaction). Contractors can utilize a cell construction approach, whereby the proposed permeable pavement area is split into 500 to 1000 sq. ft. temporary cells with a 10 to 15 foot earth bridge in between, so that cells can be excavated from the side. Excavated material should be placed away from the open excavation so as to not jeopardize the stability of the side walls.

Step 4. The native soils along the bottom and sides of the permeable pavement system should be scarified or tilled to a depth of 3 to 4 inches prior to the placement of the filter layer or filter fabric. In large scale paving applications with weak soils, the soil subgrade may need to be compacted to 95% of the Standard Proctor Density to achieve the desired load-bearing capacity. (NOTE: This effectively eliminates the infiltration function of the installation, and it must be addressed during hydrologic design.)

Step 5. If filter fabric is to be installed on the bottom and the sides of the reservoir layer, the strips should overlap down-slope by a minimum of 2 feet, and be secured a minimum of 4 feet beyond the edge of the excavation. Where the filter layer extends beyond the edge of the pavement (to convey runoff to the reservoir layer), install an additional layer of filter fabric 1 foot below the surface to prevent sediments from entering into the reservoir layer. Excess filter fabric should not be trimmed until the site is fully stabilized.

Step 6. Provide a minimum of 2 inches of aggregate above and below the underdrains. The underdrains should slope down towards the outlet at a grade of 0.5% or steeper. The up-gradient end of underdrains in the reservoir layer should be capped. Where an underdrain pipe is connected to a structure, there shall be no perforations within 1 foot of the structure. Ensure that there are no perforations in clean-outs and observation wells within 1 foot of the surface.

Step 7. Moisten and spread 6-inch lifts of the appropriate clean, washed stone aggregate (usually No. 2 or No. 57 stone). Place at least 4 inches of additional aggregate above the underdrain, and then compact it using a vibratory roller in static mode until there is no visible movement of the aggregate. Do not crush the aggregate with the roller.

Step 8. Install the bedding layer. The thickness of the bedding layer is to be based on the block manufacturer's recommendation or that of a qualified professional.

Step 9. Paving materials shall be installed in accordance with manufacturer or industry specifications for the particular type of pavement.

9.3 CONSTRUCTION INSPECTION

Inspections before, during and after construction are needed to ensure that permeable pavement is built in accordance with these specifications. Use detailed inspection checklists that require sign-offs by qualified individuals at critical stages of construction, to ensure that the contractor's interpretation of the plan is consistent with the designer's intent.

Some common pitfalls can be avoided by careful construction supervision that focuses on the following key aspects of permeable pavement installation:

- Store materials in a protected area to keep them free from mud, dirt, and other foreign materials.
- The contributing drainage area should be stabilized prior to directing water to the permeable pavement area.
- Check the aggregate material to confirm that it is clean and washed, meets specifications and is installed to the correct depth.
- Check elevations (e.g., the invert of the underdrain, inverts for the inflow and outflow points, etc.) and the surface slope.
- Make sure the permeable pavement surface is even, runoff evenly spreads across it, and the storage bed drains within 48 hours.
- Inspect the structural integrity of the pavement surface, looking for signs of slumping, cracking, spalling or broken pavers. Replace or repair affected areas.
- Ensure that caps are placed on the upstream (but not the downstream) ends of the underdrains.
- Inspect the pretreatment structures (if applicable) to make sure they are properly installed and working effectively.
- The drawdown rate should be measured at the observation well for three (3) days following a storm event in excess of 0.5 inch in depth. If standing water is still observed in the well after three days, this is a clear sign that clogging is a problem.
- Once the final construction inspection has been completed, log the GPS coordinates for each facility and submit them to the City.

SECTION 10: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix as required components of the as-built differ from measure to measure.

SECTION 11: MAINTENANCE

11.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

11.2 MAINTENANCE TASKS

It is difficult to prescribe the specific types or frequency of maintenance tasks that are needed to maintain the hydrologic function of permeable pavement systems over time. Most installations work reasonably well year after year with little or no maintenance, whereas some have problems right from the start.

One preventative maintenance task involves vacuum sweeping on a frequency consistent with the use and loadings encountered in the parking lot. Vacuum sweeping should be performed once or twice a year. This frequency should be adjusted according to the intensity of use and deposition rate on the permeable pavement surface. More frequent blowing, with a handheld or backpack blower, may also help prevent organic material from impacting the pavement. The contract for sweeping should specify that after vacuum sweeping is completed any joint material shall be replaced in interlocking paver systems.

11.3 MAINTENANCE INSPECTIONS

It is highly recommended that a spring maintenance inspection and cleanup be conducted at each permeable pavement site, particularly at large-scale applications.

Maintenance of permeable pavement is driven by annual inspections that evaluate the condition and performance of the practice. The following are suggested (at minimum) annual maintenance inspection points for permeable pavements:

- The drawdown rate should be measured at the observation well for three (3) days following a storm event in excess of 0.5 inch in depth. If standing water is still observed in the well after three days, this is a clear sign that clogging is a problem.
- Inspect the surface of the permeable pavement for evidence of sediment deposition, organic debris, staining or ponding that may indicate surface clogging. If any signs of clogging are noted, schedule a vacuum sweeper (no brooms or water spray) to remove deposited material. Then, test sections by pouring water from a five gallon bucket to ensure they work.
- Inspect the structural integrity of the pavement surface, looking for signs of surface deterioration, such as slumping, cracking, spalling or broken pavers. Replace or repair affected areas, as necessary.
- Check inlets, pretreatment cells and any flow diversion structures for sediment buildup and structural damage. Note if any sediment needs to be removed.
- Inspect the condition of the observation well and make sure it is still capped.
- Inspect any contributing drainage area for any controllable sources of sediment or erosion.

SECTION 12: COMMUNITY & ENVIRONMENTAL CONCERNS

Compliance with the Americans with Disabilities Act (ADA). Porous concrete and porous asphalt are generally considered to be ADA compliant. Interlocking concrete pavers are ADA compliant, if designers ensure that surface openings between pavers do not exceed 0.5 inch. However, some forms of interlocking pavers may not be suitable for handicapped parking spaces. Interlocking concrete pavers interspersed with other hardscape features (e.g., concrete walkways) *can* be used in creative designs to address ADA issues.

Underground Injection Control Permits. The Safe Drinking Water Act regulates the infiltration of stormwater in certain situations pursuant to the Underground Injection Control (UIC) Program, which is administered either by the EPA or a delegated state groundwater protection agency. In general, the EPA (2008) has determined that permeable pavement installations are not classified as Class V injection wells, since they are always wider than they are deep.

Air and Runoff Temperature. Permeable pavement appears to have some value in reducing summer runoff temperatures, which can be important in watersheds with sensitive cold-water fish populations. The temperature reduction effect is greatest when runoff is infiltrated into the sub-base, but some cooling may also occur in the reservoir layer, when underdrains are used. ICPI (2008) notes that the use of certain reflective colors for interlocking concrete pavers can also help moderate surface parking lot temperatures.

Vehicle Safety. Permeable pavement is generally considered to be a safer surface than conventional pavement. Permeable pavement has less risk of hydroplaning, more rapid ice melt and better traction than conventional pavement.

Infiltration Trenches

Description: Excavated trench filled with stone aggregate used to capture and allow infiltration of stormwater runoff into the surrounding soils from the bottom and sides of the trench. Runoff from each rain event is captured and treated primarily through settling and filtration.

Components:
- Soil infiltration rate of greater than 0.5 in/hr required
- Excavated trench (3 to 8 foot depth) filled with stone media (1.5- to 2.5-inch diameter); pea gravel and sand filter layers
- A sediment forebay and grass channel, or equivalent upstream pretreatment, must be provided
- Observation well to monitor percolation

Advantages/Benefits:
- Provides for groundwater recharge
- Good for small sites with porous soils
- Cost effective
- High community acceptance when integrated into a development

Disadvantages/Limitations:
- Potential for groundwater contamination
- High clogging potential; should not be used on sites with fine-particle soils (clays or silts) in drainage area
- Cannot be used in karst soils
- Geotechnical testing required
- Community perceived concerns with mosquitoes and safety

Design considerations:
- 5 acres maximum drainage area
- Space Required – Varies depending on the depth of the facility
- Minimum Depth to Water Table – 2 feet between the bottom of the infiltration trench and the elevation of the seasonally high water table

Selection Criteria:

Level 1 – 50%

Level 2 – 90%

Land Use Considerations:

X	**Residential**
X	**Commercial**
X	**Industrial (with City approval)**

Maintenance:
- Inspect for clogging
- Remove sediment from forebay
- Replace pea gravel layer as needed
- Maintain side slopes/remove invasive vegetation

H	**Maintenance Burden** L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

Infiltration trenches are excavations typically filled with stone to create an underground reservoir for stormwater runoff (see **Figure 4.1**). The runoff volume gradually exfiltrates through the bottom and sides of the trench into the subsoil over a 2-day period and eventually reaches the water table. By diverting runoff into the soil, an infiltration trench not only treats the water quality volume, but also helps to preserve the natural water balance on a site and can recharge groundwater and preserve base flow. Due to this fact, infiltration systems are limited to areas with highly porous soils where the water table and/or bedrock are located well below the bottom of the trench.

In addition, infiltration trenches must be carefully sited to avoid the potential of groundwater contamination. Infiltration trenches are not intended to trap sediment and must always be designed with a sediment forebay and grass channel, filter strip or other appropriate pretreatment measures to prevent clogging and failure. Due to their high potential for failure, these facilities must only be considered for sites where upstream sediment control can be ensured.

Using the natural filtering properties of soil, infiltration trenches can remove a wide variety of pollutants from stormwater through sorption, precipitation, filtering, and bacterial and chemical degradation. Sediment load and other suspended solids should be removed from runoff by pretreatment measures on-site before they reach the trench surface.

SECTION 2: PERFORMANCE

When used appropriately, infiltration has a very high runoff volume reduction capability, as shown in **Table 4.1.**

Table 4.1. Summary of Runoff Reduction Provided by Infiltration[1]

Stormwater Function	Level 1 Design	Level 2 Design
Runoff Volume Reduction (RR)	50%	90%

SECTION 3: DESIGN TABLE

The major design goal for infiltration is to maximize runoff volume reduction. To this end, designers may choose to go with the baseline design (Level 1) or choose an enhanced design (Level 2) that maximizes runoff reduction. To qualify for Level 2, the infiltration practice must meet all the design criteria shown in the right hand column of **Table 4.2**.

Table 4.2. Level 1 and Level 2 Infiltration Design Guidelines	
Level 1 Design (RR:50)	**Level 2 Design (RR:90)**
Sizing: Tv = (1*Rv*A)/12	Sizing: Tv = (1.1*Rv*A)/12
At least two forms of pre-treatment (see **Table 4.4**)	At least three forms of pre-treatment (see **Table 4.4**)
Soil infiltration rate > 0.5 in/hr & <1 in/hr 1 test hole/50 linear ft, minimum of 2 (see Appendix **B**)	Soil infiltration rates of 1.0 to 4.0 in/hr 1 test hole/50 linear ft, minimum of 2 (see Appendix **B**)
Minimum of 2 feet between the bottom of the infiltration practice and the seasonal high water table or bedrock (**Section 4.1**)	
T_v infiltrates within 48 hours (**Section 4.3**)	
Setbacks – see suggested minimum setbacks **(Section 4.1)**	
All Designs are subject to hotspot runoff restrictions/prohibitions	

SECTION 4: TYPICAL DETAILS

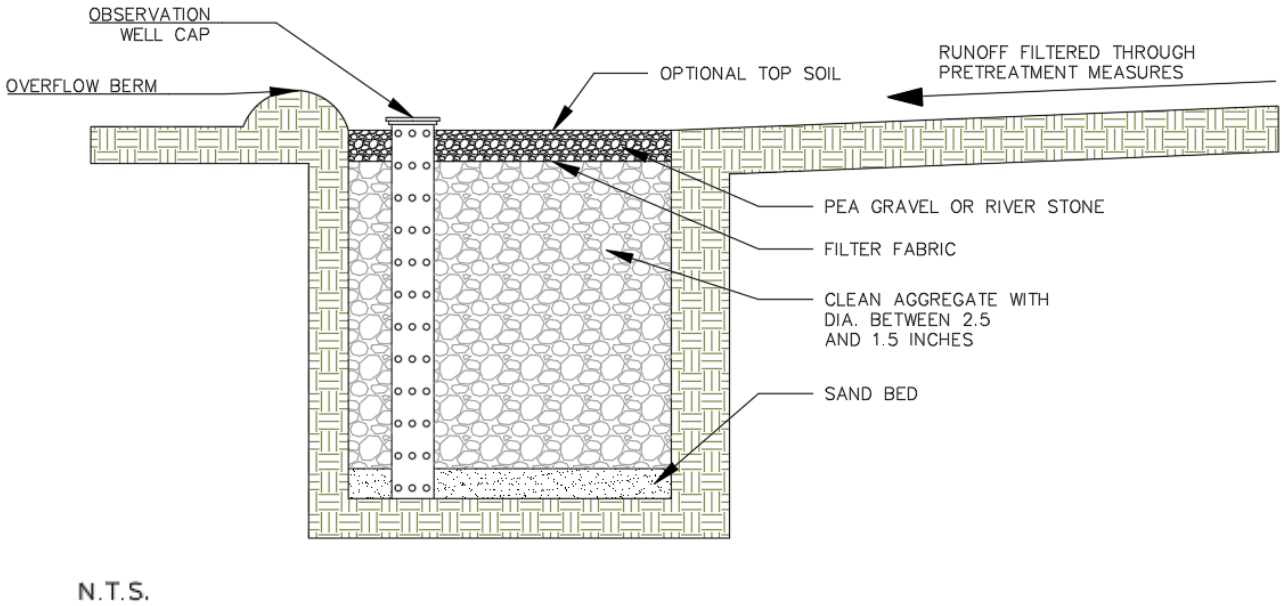


Figure 4.1. Typical Infiltration Trench Section

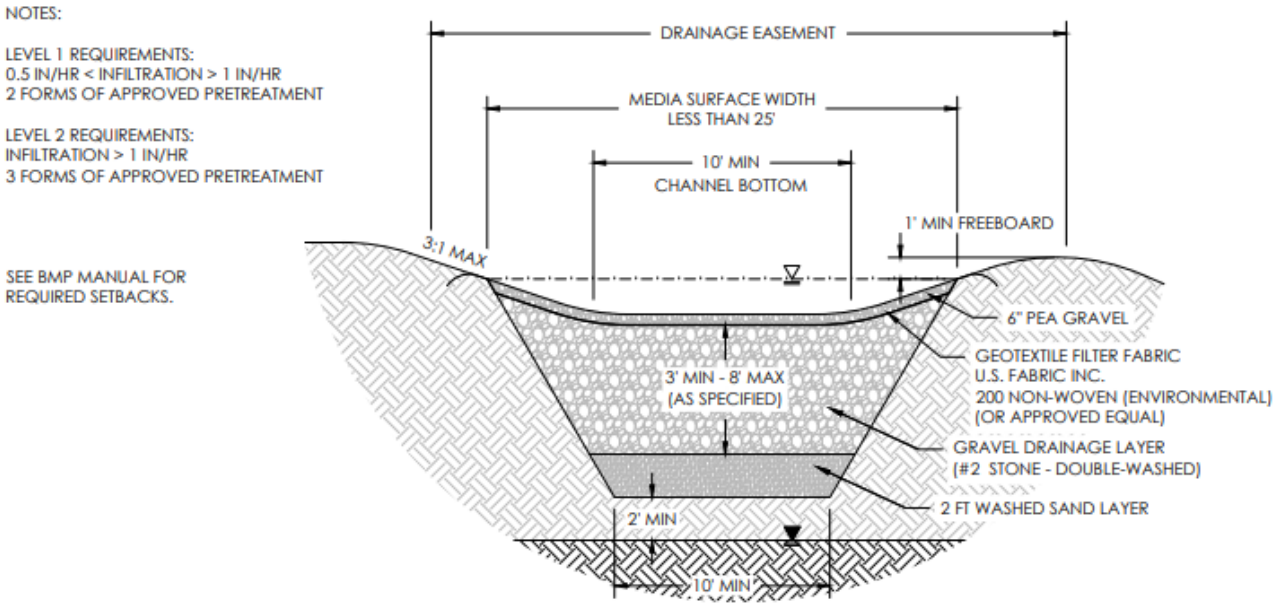


Figure 4.2. Typical Infiltration Trench Detail

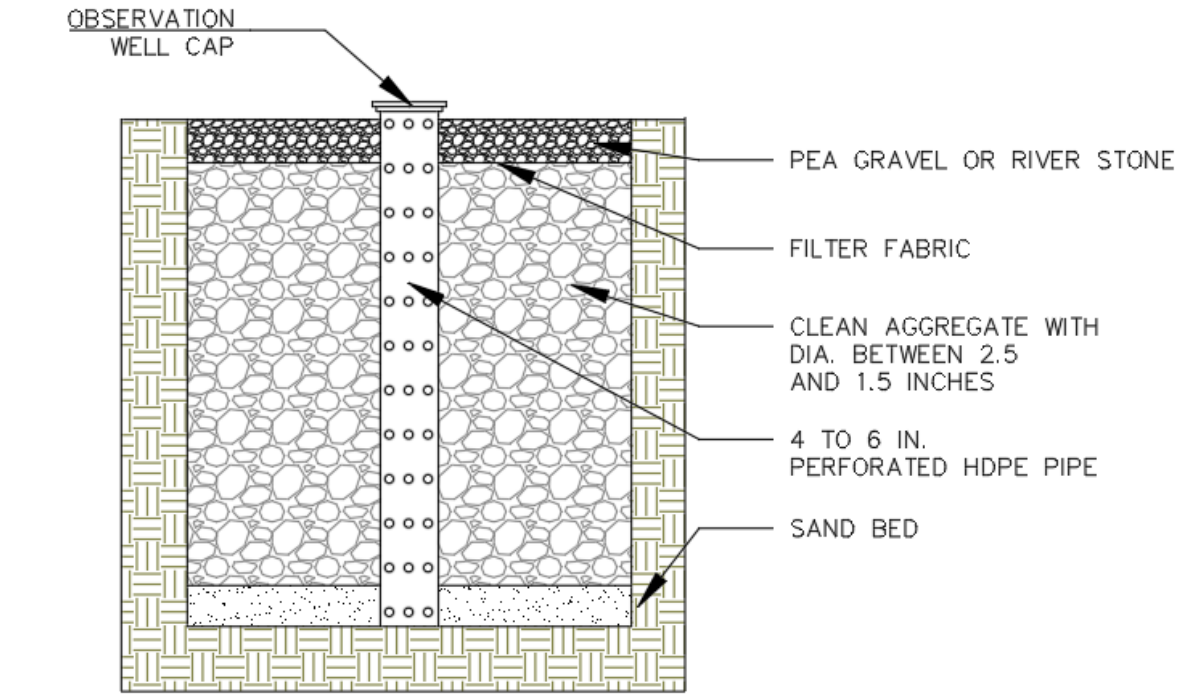


Figure 4.3. Observation Well Typical Section

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATION

Infiltration trenches are generally suited for medium-to-high density residential, commercial and institutional developments where the subsoil is sufficiently permeable to provide a reasonable infiltration rate and the water table is low enough to prevent groundwater contamination. They are applicable primarily for impervious areas where there are not high levels of fine particulates (clay/silt soils) in the runoff and should only be considered for sites where the sediment load is relatively low

Accessibility. Infiltration trenches require periodic maintenance and shall be accessible to various types of equipment. A path of travel for equipment no less than 12 feet in width shall be provided for the infiltration trench. Each infiltration trench shall have one point of vehicle access.

Applications. Infiltration trenches can either be used to capture sheet flow from a drainage area or function as an off-line device. Due to the relatively narrow shape, infiltration trenches can be adapted to many different types of sites and can be utilized in retrofit situations. Unlike some other structural stormwater controls, they can easily fit into the margin, perimeter, or other unused areas of developed sites. To reduce the potential for costly maintenance and/or system reconstruction, it is strongly recommended that the trench be located in an open or lawn area, with the top of the structure as close to the ground surface as possible. Infiltration trenches shall not be located beneath paved surfaces, such as parking lots

Contributing Drainage Area (CDA). Infiltration trenches work best with smaller contributing drainage areas, where it is easier to achieve flow distribution over the filter bed without experiencing erosive velocities and excessive ponding times. Infiltration trenches shall have a total contributing drainage area of 5 acres or less.

Curb Cuts. If curb cuts are to be used in the design of the infiltration trench, the designer shall provide calculation showing the curb cut can safely pass the 10 year storm event.

Floodplains. Infiltration trench should be constructed outside the limits of the 100-year floodplain. While not prohibited from use in floodplain areas, designers should be aware of the resulting increased maintenance burden for the property owner.

Irrigation. The planned infiltration trench should not receive baseflow, irrigation water, chlorinated wash-water or other such flows that are not stormwater runoff, except for irrigation as necessary for the survival of plantings within the infiltration trench. If irrigation is to be placed within the infiltration trench footprint, an irrigation plan shall be submitted to the City for review and approval. A soil moisture sensor shall be included in all irrigation plans submitted.

Setbacks. Suggested minimum setback requirements for infiltration trench facilities:

- From a property line – 10 feet
- From a building foundation – 25 feet
- From a private well – 100 feet
- From a public water supply well – 1,200 feet
- From a septic system tank/leach field – 100 feet
- From surface waters – 100 feet
- From surface drinking water sources – 400 feet (100 feet for a tributary)
- From adjacent hardscapes – 5 feet (minimum) or the depth of the infiltration trench

Subsurface Constraints. There shall be at least 2 feet between the bottom of the infiltration trench and the elevation of the seasonally high water table.

Utilities. Designers should ensure that future tree canopy growth in the infiltration trench will not interfere with existing overhead utility lines. Interference with underground utilities and any associated utility easements shall also be avoided, particularly water and sewer lines. No below-grade utilities are allowed within the footprint of infiltration trench, including pretreatment. No overhead utilities are allowed over the infiltration trenches incorporating tree plantings.

SECTION 6: DESIGN CRITERIA

6.1 SIZING OF INFILTRATION TRENCHES

The major design goal for infiltration is to maximize runoff volume reduction. To this end, designers may choose to go with the baseline design (Level 1) or choose an enhanced design (Level 2) that maximizes runoff reduction. To qualify for Level 2, the infiltration practice must meet all the design criteria shown in the right hand column of **Table 4.2**.

6.1.1 Stormwater Quality

Sizing of the surface area (SA) for the infiltration trench id based on the computed treatment volume (Tv) for the contributing drainage area and the storage provided in the facility. The required surface area (in square feet) is computed as the Treatment Volume (in cubic feet) divided by the equivalent storage depth (in feet). The equivalent storage depth is computed as the depth of gravel, media, and surface ponding (in feet) multiplied by the accepted porosity. See **Table 4.3** below for accepted porosities.

Table 4.3. Infiltration Trench Accepted Porosities

	Minimum Depth Required (inches)	Porosity Value (n)
Reservoir	36-96 inches	0.40

Use the following equation to calculate the required reservoir depth:

Equation 5.1. Required Depth of Reservoir Layer

$$D_{r-req} = \frac{T_{v-req}}{SA * n}$$

Where:

D_{r-req} = The required depth of the reservoir layer (ft); 36 inch minimum
T_{v-req} = The required treatment volume (cu. Ft.)
SA = The surface area of the infiltration trench (sq. ft.); 25- foot maximum width
n = The porosity of the reservoir layer

The maximum allowable depth of the reservoir layer is constrained by the allowable drain time, which is calculate using **Equation 4.2.**

Equation 4.2. Maximum Depth of Reservoir Layer

$$D_{r-max} = \frac{(\frac{i}{2} * t_d)}{n}$$

Where:

D_{r-max} = The maximum depth of the reservoir layer (ft.)
i = The field-verified infiltration rate for native soils (ft./day); slowest infiltration rate shall be used
t_d = The maximum allowable time to drain the reservoir layer; typically, 24 to 48 hours
n = The porosity of the reservoir layer

The required depth of the reservoir layer (D_{r-req}) must not exceed the maximum depth of the reservoir layer (D_{r-max}).

6.1.2 Stormwater Quantity

It is recommended that rain events larger than the 1 inch storm bypass infiltration trench to prevent additional maintenance burden. If designed with sufficient volume and appropriate outlet structures, designers can utilize the infiltration trench as both water quality and peak flow attenuation.

Surface Storage. The ponding depth for any infiltration trench within the any storm event shall be a maximum of 12 inches.

Subsurface Storage. Additional volume can be provided for peak flow attenuation by increasing the depth of the media or stone. Additional subsurface storage will not be allowed without sufficient infiltration rates. The maximum excavation depth is 10 feet.

Adjusted CN. The removal of volume by infiltration trench changes the runoff depth entering downstream flood control facilities. An approximate approach to accounting for this in reducing the size of peak flow detention facilities is to calculate an "effective SCS curve number" (CN_{adj}), which is less than the actual curve number (CN). CN_{adj} can then be used in hydrologic calculations and in routing. The method can also be used for other hydrologic methods in which a reduction in runoff volume is possible.

Hydraulic Modeling Requirements. Due to the variability of infiltration rates over time, specific rates of infiltration shall not to be utilized in hydraulic modeling for detention facilities. Where underdrains are utilized, they shall be included in hydraulic modeling, with only the "sump" portion below the underdrain being completely removed from the downstream runoff volume. Note that for design calculations and sizing of detention facilities to be accurate, infiltration must be confirmed by on-site infiltration testing. The infiltration trench shall be modeled using an equivalent volume based on the equivalent depth calculation. The underdrain shall be modeled as an equivalent orifice.

6.2 SOIL INFILTRATION RATE TESTING

To be suitable for infiltration, underlying soils shall have an infiltration rate of greater than 0.5 inches per hour, as initially determined from NRCS soil textural classification and subsequently confirmed by field geotechnical tests. The minimum geotechnical testing is one test hole per 50 linear feet, with a minimum of two borings per facility (taken within the proposed limits of the facility). Infiltration trenches cannot be used in fill soils. Clay lenses, bedrock or other restrictive layers below the bottom of the trench will reduce infiltration rates unless excavated.

On-site soil infiltration rate testing procedures are outlined in **Appendix B**. The number of soil tests varies base on the size of the infiltration trench:

- < 1,000 ft^2 = 2 tests
- 1,000 – 10,000 ft^2 = 4 tests
- >10,000 ft^2 = 4 tests + 1 test for every additional 5,000 ft^2

The bottom sump elevation of the infiltration trench must be at least two feet above bedrock and the seasonally high groundwater table. If, during construction, infiltration rates are suspected to have decreased due to machinery, material storage, or other causes of compaction of the underlying soils, additional infiltration testing may be required to verify pre-construction infiltration rates have not been reduced.

6.3 BMP GEOMETRY

Infiltration trenches are designed for intermittent flow and must be allowed to drain and allow aeration of the surrounding soil between rainfall events. They must not be used on sites with a continuous flow from groundwater, sump pumps, or other sources. Infiltration trenches shall fully dewater within 48 hours of the preceding rain event. The infiltration trench shall be designed to fully dewater the entire Tv within 24 to 48 hours after a rainfall event. The slowest infiltration rate obtained from tests performed at the site shall be used in the design calculations. Trench depths should be between 3 and 8 feet, to provide for easier maintenance. The width of a trench shall be less than 25 feet. The bottom slope of a trench shall be flat across its length and width to evenly distribute flows, encourage uniform infiltration through the bottom, and reduce the risk of clogging.

Broader, shallow trenches reduce the risk of clogging by spreading the flow over a larger area for infiltration. The surface area required is calculated based on the trench depth, soil infiltration rate, aggregate void space, and fill time (assume a fill time of 2 hours for most designs).

6.4 PRETREATMENT

Pretreatment facilities shall always be used in conjunction with an infiltration trench to prevent clogging and failure. Details and design criteria for pretreatment measures for infiltration trenches can be found in **Appendix A**.

Every infiltration practice must include multiple pretreatment techniques, although the nature of pretreatment practices depends on the scale at which infiltration is applied. The number, volume and type of acceptable pretreatment techniques needed for the two scales of infiltration are provided in **Table 4.4**.

Table 4.4. Required Pretreatment Elements for Infiltration Practices

Pretreatment[1]	**Level of Infiltration Trench**	
	Level 1 Infiltration	**Level 2 Infiltration**
Number and Volume of Pretreatment Techniques Employed	**2** techniques; **15%** minimum pretreatment volume required (exclusive).	**3** techniques; **25%** minimum pretreatment volume required (exclusive); at least **one** separate pre-treatment cell.
Acceptable Pretreatment Techniques	Grass filter strip Grass channel Gravel diaphragm	Sediment trap cell Sand filter cell Grass filter strip Gravel diaphragm

[1] A minimum of 50% of the runoff reduction volume must be pre-treated by a filtering or bioretention practice *prior* to infiltration *if* the site is a restricted stormwater hotspot

For a trench receiving sheet flow from an adjacent drainage area, the pretreatment system shall consist of a vegetated filter strip with a minimum 25-foot length. A vegetated buffer strip around the entire trench is required if the facility is receiving runoff from both directions. If the infiltration rate for the underlying soils is greater than 2 inches per hour, 50% of the Tv should be pretreated by another method prior to reaching the infiltration trench.

For an off-line configuration, or concentrated flow, pretreatment shall consist of a sediment forebay, vault, plunge pool, or similar sedimentation chamber (with energy dissipaters) sized to 25% of the storage volume (Tv). Exit velocities from the pretreatment chamber shall be nonerosive for the 2-year design storm.

6.5 CONVEYANCE AND OVERFLOW

Outlet structures are not required for infiltration trenches. If an outlet structure is utilized, the structure shall be placed outside the footprint of the infiltration trench. Typically for off-line designs, there is no need for an emergency spillway. However, a nonerosive overflow channel shall be provided to safely pass flows that exceed the storage capacity of the trench to a stabilized downstream area or watercourse.

On-line Infiltration Trench. An overflow structure shall always be incorporated into on-line designs to safely convey larger storms through the infiltration trench. The following criteria apply to overflow structures:

- The overflow associated with the 100-year design storms should be controlled so that velocities are non-erosive at the outlet point (i.e., to prevent downstream erosion).
- A common overflow system within infiltration practices consists of an outlet structure, which is scaled for the application, where the top of the structure is placed at the maximum water surface elevation of the infiltration trench (typically 6 inches above the surface of the filter bed).
- A trench shall be designed to fully dewater the entire Tv within 24 to 48 hours after a rainfall event. If used for both quality and quantity design, the infiltration trench shall fully dewater in 48 hours in the 100-year storm event. The slowest infiltration rate obtained from tests performed at the site should be used in the design calculations.

Off-line Infiltration Trench. Off-line designs are preferred. One common approach is to create an alternate flow path at the inflow point into the structure such that when the maximum ponding depth is reached, the incoming flow is diverted past the facility. In this case, the higher flows do not pass over the filter bed and through the facility, and additional flow is able to enter as the ponding water filtrates through the soil media.

Another option is to utilize a low-flow diversion or flow splitter at the inlet to allow only the Treatment Volume to enter the facility. This may be achieved with a weir or curb opening sized for the target flow, in combination with a bypass channel. Using a weir or curb opening helps minimize clogging and reduces the frequency of required maintenance. Using differing pipe elevations is not an approved method to achieve flow splitting.

6.6 OBSERVATION WELL

An observation well must be installed in every infiltration trench and should consist of a perforated PVC or HDPE pipe, 4 to 6 inches in diameter, extending to the bottom of the trench (see **Figure 4.2** for a schematic of an observation well). The observation well will show the rate of dewatering after a storm, as well as provide a means of determining sediment levels at the bottom and when the filter fabric at the top is clogged and maintenance is needed. It should be installed along the centerline of the structure, flush with the ground elevation of the trench. A visible floating marker should be provided to indicate the water level. The top of the well should be capped and locked to discourage vandalism and tampering.

6.7 MATERIAL SPECIFICATION

The stone aggregate used in the trench should be washed, bank-run gravel, 1.5 to 2.5 inches in diameter with a porosity of about 40%. Aggregate contaminated with soil shall not be used. A 6-inch layer of clean, washed sand is placed on the bottom of the trench to encourage drainage and prevent compaction of the native soil while the stone aggregate is added.

A top layer of filter fabric is located 2 to 6 inches from the top of the trench and serves to prevent sediment from passing into the stone aggregate. Since this top layer serves as a sediment barrier, it will need to be replaced more frequently and must be readily separated from the side sections. The top surface of the infiltration trench above the filter fabric is typically covered with pea gravel. The pea gravel layer improves

sediment filtering and maximizes the pollutant removal in the top of the trench. In addition, it can easily be removed and replaced should the device begin to clog. Alternatively, the trench can be covered with permeable topsoil and seeded with grass in a landscaped area. Vegetated filter strips and buffers should fit into and blend with surrounding area. Native grasses are preferable, if compatible. The trench may be covered with permeable topsoil and planted with grass in a landscaped area. If sod is to be used it shall be a sand based or washed sod product.

Table 4.5. Infiltration Trench Material Specifications

Material	Specification	Notes
Surface Layer	River Stone Turf (Seeded not sodded)	Lay a 3 inch layer on the surface of the filter bed to suppress weeds and prevent erosion
Filter Fabric	Use a non-woven geotextile fabric with a flow rate of >110 gal./min./ft^2	Apply to sides and below surface cover. Meet AASHTO M288-06, ASTM D4491 & D4751 standards
Gravel Drainage Layer	#57 or #2 clean washed stone	Meet TDOT Construction Specifications
Choker Layer	6-inch layer of clean, washed sand or # 8 or # 89 stone	Meet TDOT Construction Specifications
Observation Wells	6 inch PVC or HDPE pope with vented cap	Install one per 50 feet of length of the infiltration trench (minimum 1)

SECTION 7: SPECIAL CASE DESIGN APPLICATION

7.1 SHALLOW BEDROCK AND GROUNDWATER CONNECTIVITY

Many parts of Franklin have shallow bedrock, which can constrain the application of deeper infiltration trenches (particularly Level 2 designs). If bedrock is encountered during construction of the infiltration trench, the bottom sump elevation of the infiltration trench design shall be above the lowest bedrock / refusal elevation encountered in subsurface testing.

7.2 KARST

Karst regions are found in much of Middle Tennessee. Infiltrative practices, such as infiltration trenches, shall not be used in any areas with high risk of sinkhole formations or in areas of know sinkholes.

7.3 SITE SPECIFIC LIMITATIONS

Some sites may have areas identified as site specific limitations to infiltration of stormwater runoff. Site specific limitations shall be determined by the City engineer and approved through the Stormwater variance process. Sites with brownfield permits are an example of site specific limitations. Site specific limitations cannot be self-imposed or be caused by requirements within the City Ordinance. It should be noted that the site specific limitation may only occupy a portion of the entire proposed use, and that some "clean" areas (such as rooftops) can be diverted away to another infiltration or runoff reduction practice. Development proposals should be carefully reviewed to determine if any future operation, on all or part of the site, will be designated as a potential site specific limitation. Based on this designation, infiltration may be restricted or prohibited.

SECTION 8: CONSTRUCTION

The trench excavation should be limited to the width and depth specified in the design. Excavated material should be placed away from the open trench so as not to jeopardize the stability of the trench sidewalls. The bottom of the excavated trench shall not be loaded in a way that causes soil compaction and should be scarified prior to placement of sand. The sides of the trench shall be trimmed of all large roots. The sidewalls

shall be uniform with no voids and scarified prior to backfilling. All infiltration trench facilities shall be protected during site construction and should be constructed after upstream areas have been stabilized.

Unless otherwise approved by the City of Franklin Engineering Department the following installation steps shall be required of the person(s) installing the water quality BMPs located on this site. Failure to adhere to the following procedures may require reinstallation, reconstruction, or replacement of part or whole sections of the water quality BMP as well as denial of bond reductions and/or releases. Please contact the City's Engineering Department or your EPSC inspector for guidance if parts of this procedure are not applicable to a BMP that you are installing.

Step 1. Construction of the trench area may only begin after the entire contributing drainage area has been stabilized with vegetation. It may be necessary to block certain curbs or other inlets while the area is being constructed. The proposed site should be checked for existing utilities prior to any excavation.

Step 2. Contractor is to provide method of diverting runoff flow around the construction of the infiltration trench area during periods of rainfall to ensure sediment does not enter aruea. EPSC measures may need to be utilized during the installation. Construction materials that are contaminated by sediments must be removed and replaced with clean materials.

Step 3. Excavate infiltration trench area. Excavators or backhoes should work from the sides to excavate the area to the design depth and dimensions. Excavating equipment should have scoops with adequate reach so they do not sit inside the footprint of the area. If heavy rainfall occurs while the trench is open the soil shall be scarified/raked to ensure the surrounding soils have not been smeared.

Step 4. Scarify subgrade by ripping the bottom soils to a depth of 12" prior to stone placement.

Step 5. CALL CITY OF FRANKLIN INSPECTOR FOR INSPECTION 615-791-3218.

Step 6. Install washed stone layer. Install underdrain pipes and connect to the outlet structure. Install additional stone on the underdrain pipes as per the infiltration trench section detail. Contractor to flag the underdrain locations (3' each side) as the additional sections are being installed. A small loader is to be used for placement of additional sections and is to avoid accessing the areas of the underdrain pipe installation to prevent damage to the perforated pipe.

Step 7. CALL CITY OF FRANKLIN INSPECTOR FOR INSPECTION 615-791-3218.

Step 8. Install permeable geotextile fabric.

Step 9. Backfill with media that is specified.

Step 10. Contractor to flag limits of BMP for survey to locate and show on AS-BUILT plans.

SECTION 9: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D.** Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 10: OPERATION & MAINTENANCE

10.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the BMP operations and maintenance plan.

10.2 MAINTENANCE INSPECTIONS

It is highly recommended that spring maintenance inspections and a cleanup is conducted at the infiltration trench yearly. The following is a list of some key maintenance items to look for:

- Check to see if 75% to 90% cover (stone or vegetative cover) has been achieved in the bed and measure the depth of the remaining stone. If the stone layer is less than 3 inches, additional stone is required.
- Check for sediment buildup at inflow points, curb cuts, gravel diaphragms or pavement edges that prevents flow from reaching the filter bed, and check for other signs of bypassing. Remove accumulated sediment.
- Check for any winter- or salt-killed vegetation and replace.
- Note presence of accumulated sand, sediment and trash in the pretreatment cell or filter beds and remove it.
- Inspect infiltration trench side slopes and grass filter strips for evidence of any rill or gully erosion, and repair and stabilize any erosion issues found.
- Check the infiltration trench for evidence of excessive ponding or concentrated flows and take appropriate remedial action.
- Look for any bare soil or sediment sources in the contributing drainage area and stabilize them immediately.
- Check observation wells following 3 days of dry weather. Failure to percolate within this time period indicates clogging.
- Remove trees and other unwanted vegetation that starts to grow in the vicinity of the trench.
- Excavate trench walls to expose clean soil.

10.3 ROUTINE AND NON-ROUTINE MAINTENANCE TASKS

The most common non-routine maintenance problem involves standing water for longer than 24-48 hours. If water remains on the surface for longer than 24 hours after a preceding rain event, the infiltration trench is no longer functioning as designed. The following are several methods to remediate the ponding water.

- Replace pea gravel/topsoil and top surface filter fabric when clogged.
- Perform total rehabilitation of the trench to maintain design storage capacity.

Water Quality Swale

Description: Vegetated open channels designed to capture and infiltrate stormwater runoff within a dry storage layer beneath the base of the channel.

Components:
- Open trapezoidal or parabolic channel to store entire treatment volume, which is ultimately infiltrated
- Filter bed of permeable, engineered soils
- Underdrain system for impermeable soils
- Check dams every 50 feet, if length exceeds 100 feet

Advantages/Benefits:
- Stormwater treatment combined with conveyance
- Less expensive than curb and gutter
- Reduces runoff velocity
- Promotes infiltration

Disadvantages/Limitations:
- Higher maintenance than curb and gutter
- Cannot be used on steep slopes
- High land requirement
- Requires 3 feet of head

Design considerations:
- Longitudinal slopes ideally less than 2%
- Bottom channel width of 2 to 8 feet
- Underdrain required for subsoil infiltration rates less than 0.5 inches/hour
- Max 2.5 acres of impervious drainage area
- Side slopes of 3:1 or flatter; 4:1 recommended
- Must convey the 10-year storm event with a minimum of 6 inches of freeboard

Selection Criteria:

Level 1 – 40% Runoff Reduction Credit

Level 2 – 60% Runoff Reduction Credit

Land Use Considerations:

[X] **Residential**

[X] **Commercial**

[X] **Industrial** (with CITY approval)

Maintenance:
- Maintain grass height
- Remove sediment from forebay and channel
- Remove accumulated trash and debris
- Re-establish plants as needed

[M] **Maintenance Burden**
L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

Water quality swales are essentially bioretention cells that are shallow, linear channels covered with grasses or other surface material (other than mulch and ornamental plants). The water quality swale is a soil filter system that temporarily stores and then filters the desired Treatment Volume (T_v). Water quality swales rely on a pre-mixed soil media filter below the channel that is similar to that used for bioretention. If soils are extremely permeable, runoff infiltrates into underlying soils. Otherwise, the runoff treated by the soil media flows into an underdrain, which conveys treated runoff back to the conveyance system further downstream. The underdrain system consists of a perforated pipe within a gravel layer on the bottom of the swale, beneath the filter media. Water quality swales may appear as simple dense grass channels with the same shape and turf cover, while others may have more elaborate landscaping. Swales can be planted with medium to tall meadow grasses, decorative herbaceous cover or trees.

SECTION 2: PERFORMANCE

The primary pollutant removal mechanisms operating in swales are settling, filtering infiltration and plant uptake. The overall runoff reduction capabilities of water quality swales are summarized in **Table 5.1**.

Table 5.1. Runoff Volume Reduction Provided by Water Quality Swales

Stormwater Function	Level 1 Design	Level 2 Design
Runoff Volume Reduction (RR)	40%	60%

SECTION 3: DESIGN TABLE

Swales can be oriented to accept runoff from a single discharge point, or to accept runoff as lateral sheet flow along the swale's length.

Table 5.2. Water Quality Swale Design Criteria	
Level 1 Design (RR:40)	**Level 2 Design (RR:60)**
Sizing: See Section 6.1	**Sizing**: See Section 6.1
Surface Area (sq. ft.) = Tv/ Storage depth[1]	**Surface Area** (sq. ft.) = (1.1*Tv) / Storage Depth[1]
Effective swale slope: ≤ 2%	**Effective swale slope**: ≤ 1 %
Media Depth: minimum = 18 inches; recommended maximum = 36 inches	**Media Depth**: minimum = 24 inches; recommended maximum = 36 inches
Infiltration Testing (Section 6.2): one per 50 linear feet, 2 minimum; min. infiltration rate must be > 0.5 inch/hour to remove the underdrain requirement	
Underdrain (Section 6.7): Schedule 40 PVC or HDPE with clean-outs with 3/8 inch perforations on center	
Underground Storage Layer: (Section 6.7): a minimum 12-inch stone sump below the invert; OR none if the soil infiltration requirements are met (see **Section 6.2**)	
Filter Media (Section 6.6): 85% to 88%; 8% to 12% soil fines; 3% to 5% organic matter	
Inflow: sheet or concentrated flow with appropriate pretreatment	
Pretreatment: (Section 6.4): a pretreatment cell, level spreader, grass filter strip, gravel diaphragm, or gravel flow pretreatment structure.	
Planting Plan: medium to tall meadow grasses, decorative herbaceous cover, and trees are encouraged. Avoid sod or seeding overlain with straw.	

[1]The storage depth is the sum of the porosity (n) of the soil media and gravel layers multiplied by their respective depths, plus the surface ponding depth (Refer to Section 6.1)

SECTION 4: TYPICAL DETAILS

Figures 5.2 through 5.4 below provide typical schematics for water quality swales.

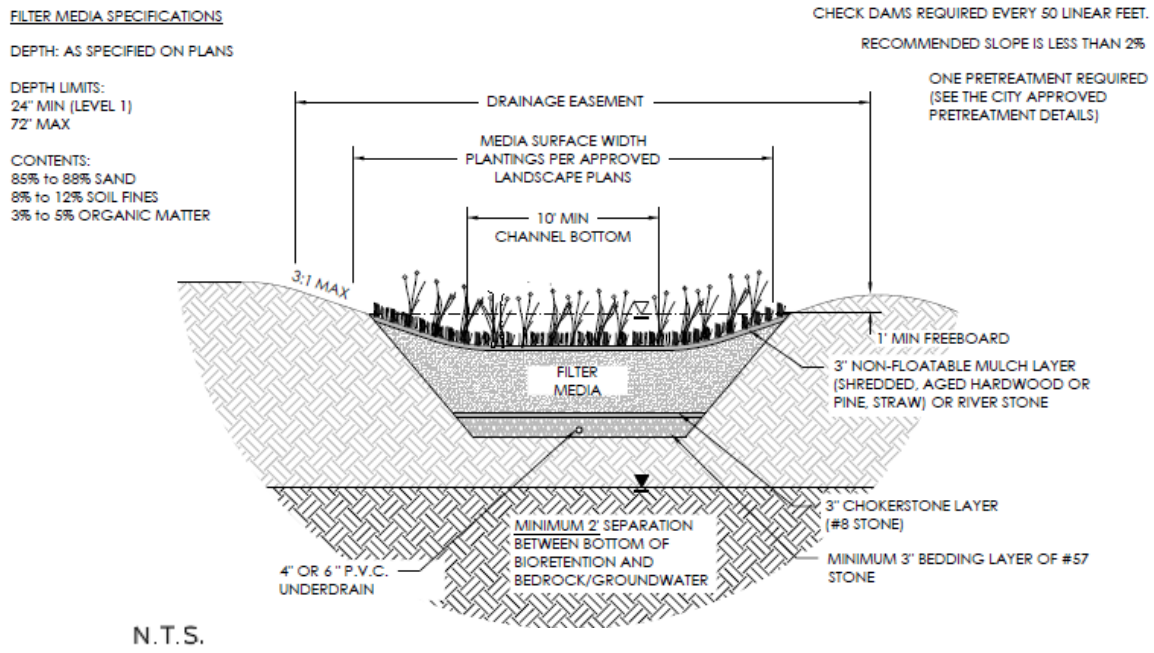


Figure 5.2. Typical Detail for Level 1 Water Quality Swale

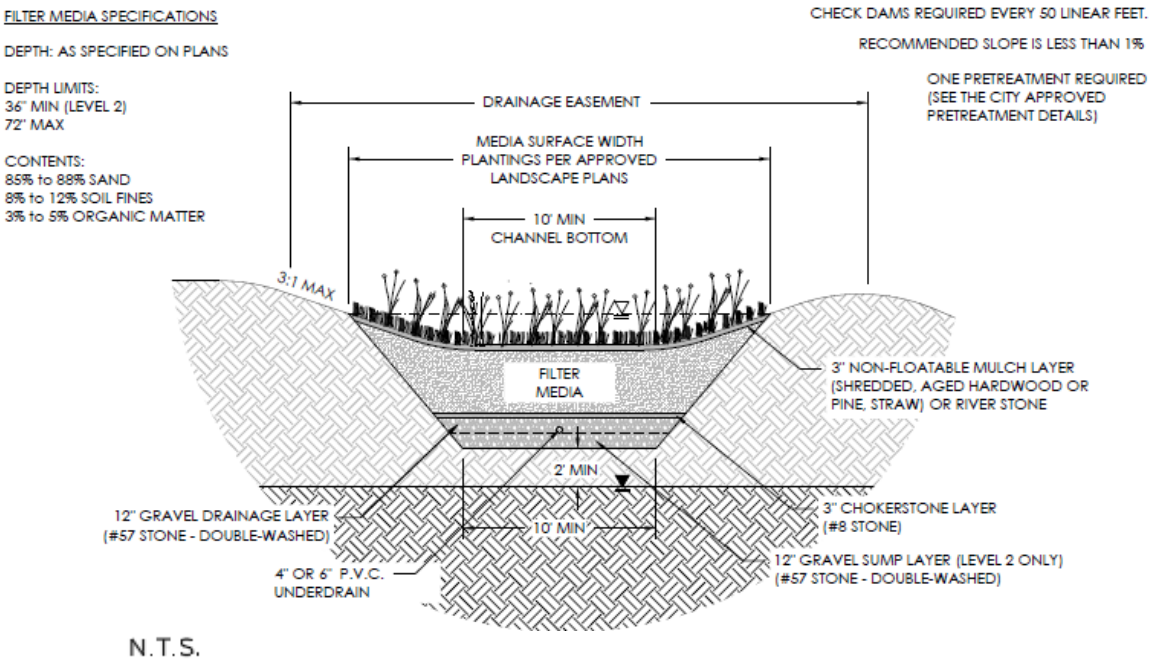


Figure 5.3. Typical Detail for Level 2 Water Quality Swale

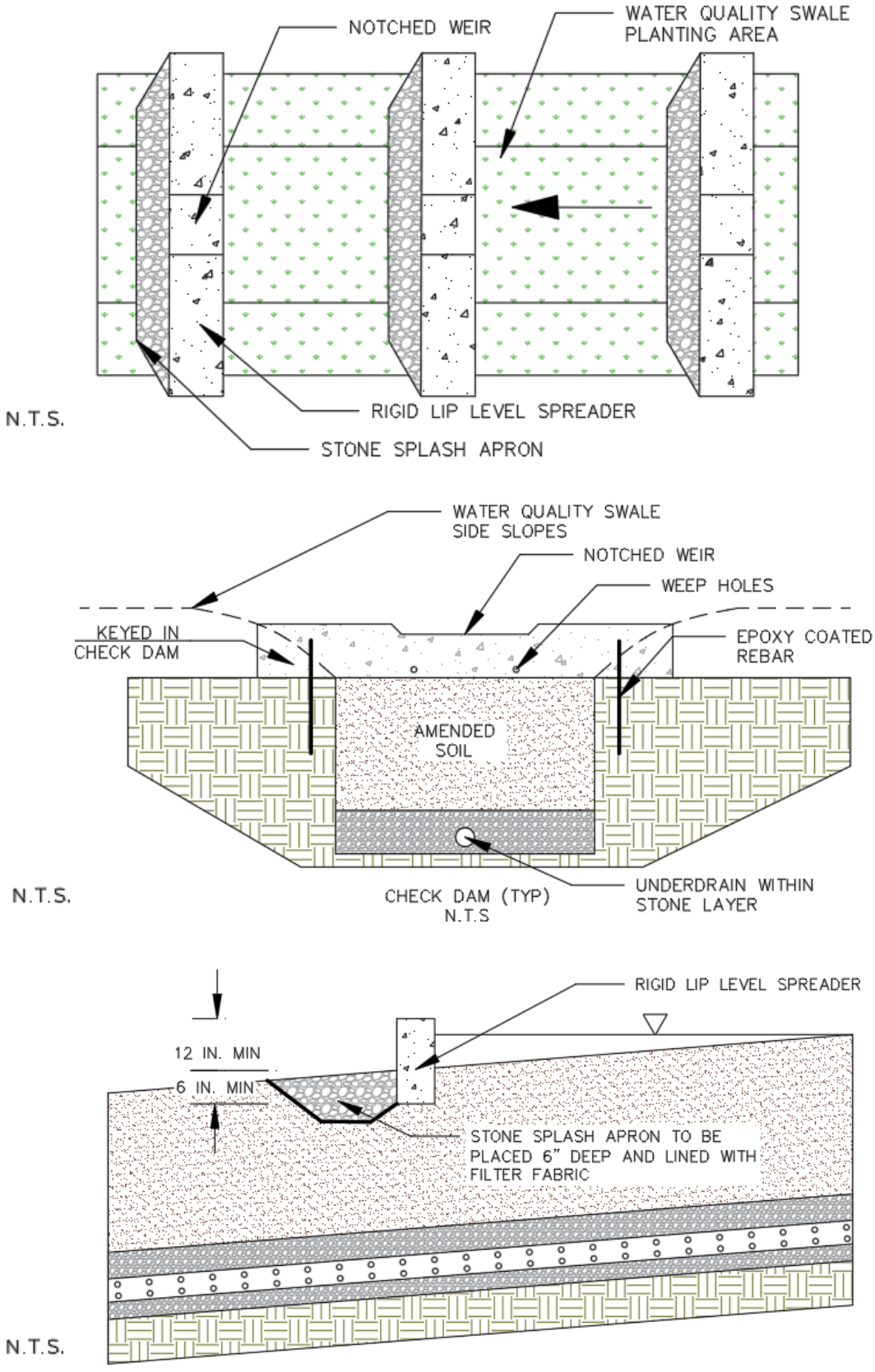


Figure 5.4. Typical Detail for Water Quality Swale Check Dam

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

Water quality swales can be implemented on a variety of development sites where density and topography permit their application. Some key feasibility issues for water quality swales include the following:

Accessibility. Water quality swales require periodic maintenance and shall be accessible to various types of equipment. A path of travel for equipment no less than 12 feet in width shall be provided for the water quality swale. Each water quality swale shall have one point of vehicle access.

Available Hydraulic Head. A minimum amount of hydraulic head is needed to implement water quality swales, measured as the difference in elevation between the inflow point and the downstream storm drain invert. Water quality swales typically require 3 feet of hydraulic head.

Available Space. Water quality swale footprints can fit into relatively narrow corridors between utilities, roads, parking areas, or other site constraints. Water quality swales shall at a minimum be 3% of the size of the contributing drainage area, depending on the amount of impervious cover.

Contributing Drainage Area. The maximum impervious contributing drainage area to a water quality swale should be 2.5 acres. When water quality swales treat larger drainage areas, the velocity of flow through the surface channel often becomes too great to treat runoff or prevent erosion in the channel. Similarly, the longitudinal flow of runoff through the soil, stone, and underdrain may cause hydraulic overloading at the downstream sections of the water quality swale. An alternative is to provide a series of inlets or diversions that convey the treated water to an outlet location.

Depth to Water Table. Designers should ensure that the bottom of the water quality swale is at least 2 feet above the seasonally high groundwater table, to ensure that groundwater does not intersect the filter bed, since this could lead to groundwater contamination or practice failure.

Hydraulic Capacity. Water quality swales that are an on-line practice must be designed with enough capacity to (1) convey runoff from the 100-year design storms at non-erosive velocities, and (2) contain the 10-year flow within the banks of the swale. This means that the swale's surface dimensions are more often determined by the need to pass the 10-year storm events, which can be a constraint in the siting of water quality swales within existing right of way (e.g., constrained by sidewalks).

Irrigation or Baseflow. Water quality swales should be located to avoid inputs of springs, irrigation systems, chlorinated wash-water, or other dry weather flows. Irrigation can be used to help vegetation growth within the first growing season and during droughts. A soil moisture sensor shall be installed. Irrigation plan shall be submitted for review.

Setbacks. It is not recommended to lace bioretention areas immediately adjacent to structures. to avoid the risk of seepage, a licensed PE should be consulted to determine the appropriate setbacks necessary to prevent bioretention infiltration from compromising structural foundations or pavement. At a minimum, bioretention basins should be located a horizontal distance of 100 feet from any water supply well and 50 feet from septic systems. Horizontal separation of 5 feet or the overall depth of the bioretention, whichever is greater, is required between the amended soils of the bioretention and any adjacent hardscape (i.e. parking lots or sidewalks). The bottom elevation of swales should be at least 1 foot below the invert of an adjacent roadbed.

Site Topography. Water quality swales should be used on sites with longitudinal slopes of less than 4%, but preferably less than 2%. Check dams can be used to reduce the effective slope of the swale and lengthen the contact time to enhance filtering and/or infiltration. Steeper slopes adjacent to the swale may generate rapid runoff velocities into the swale that may carry a high sediment loading (refer to pretreatment criteria in **Section 6.4**).

Utilities. Designers should consult local utility design guidance for the horizontal and vertical clearance between utilities and the swale configuration. No utility lines shall cross under water quality swales.

SECTION 6: DESIGN CRITERIA

6.1 SIZING OF WATER QUALITY CONVEYANCE AND WATER QUALITY TREATMENT SWALES

Sizing of the surface area (SA) for water quality swales is based on the computed Treatment Volume (T_v) of the contributing drainage area and the storage provided within the swale media and gravel layers and behind check dams. The required surface area (in square feet) is computed as the Treatment Volume (in cubic feet) divided by the equivalent storage depth (in feet). The equivalent storage depth is computed as the depth of the soil media, the gravel, and surface ponding (in feet) multiplied by the accepted porosity.

The accepted porosities are:

Table 5.3. Water Quality Swale Accepted Porosities

Material	Porosity Value (n)
Gravel (#57) Stone	0.40
Choker (#8) Stone Layer	0.40
Soil Media	0.25
Surface Layer	0.00
Surface Storage	1.00

The equivalent storage depth for a typical Level 1 design with a 4-inch gravel sump layer, 2 feet of media, and a 6-inch surface ponding depth is computed as:

Equation 5.1. Equivalent Storage Depth – Level 1

$$\text{Equivalent Storage Depth} = D_E = n_1(D_1) + n_2(D_2) + \cdots$$

$$D_E = (2 \text{ ft. x } 0.25) + (0.25 \text{ ft. x } 0.40) + (.5 \text{ ft. x } 1.00) = 1.7 \text{ft.}$$

The equivalent storage depth for a typical Level 2 design with a 12-inch gravel sump layer, 3 feet of media, and a 6-inch surface ponding depth is computed as:

Equation 5.2. Equivalent Storage Depth – Level 2

$$D_E = (3 \text{ ft. x } 0.25) + (1.0 \text{ ft. x } 0.40) + (.5 \text{ ft. x } 1.00) = 2.1 \text{ ft}$$

The effective storage depths will vary according to the actual design depths of the soil media and gravel layer.

Note: When using Equations 3 or 4 below to calculate the required surface area of a water quality swale that includes surface ponding (with check dams), the storage depth calculation (Equation 1 or 2) should be adjusted accordingly.

The Level 1 Water Quality Swale Surface Area (SA) is computed as:

Equation 5.3. Surface Area – Level 1

$$SA \text{ (sq. ft.)} = T_v/D_E \text{ ft.}$$

And the Level 2 Water Quality Swale SA is computed as:

Equation 5.4. Surface Area – Level 2

$$SA \text{ (sq. ft.)} = (1.1 * T_v)/D_E$$

NOTE: The volume reduced by upstream PTPs is supplemented with the anticipated volume of storage created by check dams along the swale length.

Where:
SA =Minimum surface area of Water Quality Swale (sq. ft.)
T_v =Treatment Volume (cu. ft.) = [(1 inch) (R_v)(A)]*3630,
A = Area in acres

The final water quality swale design geometry will be determined by dividing the SA by the swale length to compute the required width; or by dividing the SA by the desired width to compute the required length.

6.2 SOIL INFILTRATION RATE TESTING

The second key sizing decision is to measure the infiltration rate of subsoils below the water quality swale area to determine if an underdrain will be needed. The infiltration rate of the subsoil must exceed 0.5 inches per hour to avoid installation of an underdrain. The acceptable methods for on-site soil infiltration rate testing are outlined in **Appendix B**. A soil test shall be conducted for every 50 linear feet of water quality swale, with a minimum of two tests per swale.

6.3 WATER QUALITY SWALE GEOMETRY

Check dams. Check dams must be firmly anchored (keyed) into the side-slopes to prevent outflanking and be stable during the 10 year storm design event. The height of the check dam relative to the normal channel elevation should not exceed 12 inches. Each check dam should have a minimum of one weep hole or a similar drainage feature so it can dewater after storms. Armoring may be needed behind the check dam to prevent erosion. The check dam must be designed to spread runoff evenly over the water quality swale's filter bed surface, through a centrally located depression with a length equal to the filter bed width. In the center of the check dam, the depressed weir length should be checked for the depth of flow, sized for the appropriate design storm (see **Figure 5.3**). Check dams should be constructed of stone or concrete.

Drawdown. Water quality swales should be designed so that the desired Treatment Volume is completely filtered within 24 hours or less. This drawdown time can be achieved by using the soil media mix specified in **Section 6.6** and an underdrain along the bottom of the swale, or native soils with adequate permeability, as verified through testing (see **Section 6.2**).

Ponding Depth. Drop structures or check dams can be used to create ponding cells along the length of the swale. The maximum ponding depth in a swale should not exceed 12 inches at the most downstream point.

Shape. A parabolic shape is preferred for water quality swales for aesthetic, maintenance and hydraulic reasons. However, the design may be simplified with a trapezoidal cross-section, as long as the soil filter bed boundaries lay in the flat bottom areas.

Side Slopes. The side slopes of water quality swales shall be no steeper than 3H:1V for maintenance considerations. Flatter slopes are encouraged where adequate space is available, to enhance pretreatment of sheet

flows entering the swale. Swales should have a bottom width of from 2 to 8 feet to ensure that an adequate surface area exists along the bottom of the swale for filtering. If a swale will be wider than 8 feet, the designer should incorporate berms, check dams, level spreaders or multi-level cross-sections to prevent braiding and erosion of the swale bottom.

Swale Longitudinal Slope. The longitudinal slope of the swale should be moderately flat to permit the temporary ponding of the Treatment Volume within the channel. The recommended swale slope is less than or equal to 2% for a Level 1 design and less than or equal to 1% for a Level 2 design, though slopes up to 4% are acceptable if check dams are used. The minimum recommended slope for an on-line water quality swale is 0.5%. Refer to **Table 5.4** for check dam spacing based on the swale longitudinal slope.

Table 5.4. Typical Check Dam (CD) Spacing to Achieve Effective Swale Slope

Swale Longitudinal Slope	LEVEL 1	LEVEL 2
	Spacing[1] of 12-inch high (max.) Check Dams[2] to create an Effective Slope of 2%	Spacing[1] of 12-inch high (max.) Check Dams[2] to create an Effective Slope of 0 to 1%
0.5%	–	200 ft. to –
1.0%	–	100 ft. to –
1.5%	–	67 ft. to 200 ft.
2.0%	–	50 ft. to 100 ft.
2.5%	200 ft.	40 ft. to 67 ft.
3.0%	100 ft.	33 ft. to 50 ft.
3.5%	67 ft.	30 ft. to 40 ft.
4.0%	50 ft.	25 ft. to 33 ft.

[1] The spacing dimension is half of the above distances if a 6-inch check dam is used.
[2] Check dams require a stone energy dissipater at the downstream toe.

6.4 PRETREATMENT

Several pretreatment measures are feasible, depending on whether the specific location in the water quality swale system will be receiving sheet flow, shallow concentrated flow, or fully concentrated flow. See **Appendix A** for details.

6.5 CONVEYANCE AND OVERFLOW

The bottom width and slope of a water quality swale should be designed such that the velocity of flow from a 1-inch rainfall will not exceed 3 feet per second. Check dams may be used to achieve the needed runoff reduction volume, as well as to reduce the flow. Check dams should be spaced based on channel slope and ponding requirements, consistent with the criteria in **Table 5.5**.

The swale shall also convey the 2- and 10-year storms at non-erosive velocities with at least 6 inches of freeboard. The analysis should evaluate the flow profile through the channel at normal depth, as well as the flow depth over top of the check dams.

Water quality swales may be designed as off-line systems, with a flow splitter or diversion to divert runoff in excess of the design capacity to an adjacent conveyance system. Or, strategically placed overflow inlets may be placed along the length of the swale to periodically pick up water and reduce the hydraulic loading at the downstream limits.

6.6 FILTER MEDIA

The recommended bioretention soil mixture is generally classified as a loamy sand on the USDA Texture Triangle, with the following composition by volume: **85% to 88% sand; 8% to 12% soil fines; and 3% to 5% organic matter**. Sand shall consist of silica-based aggregate and shall meet the sieve sizes shown in **Table 5.5**. No substitutions for alternative materials such as "engineered sand" or recycled materials will be accepted.

Table 5.5. Sand sieve size requirements		
Sieve	**Size**	**% Passing**
3/8 in	9.50 mm	100
No. 4	4.75 mm	95 to 100
No. 8	2.36 mm	80 to 100
No. 16	1.18 mm	45 to 85
No. 30	0.60 mm	15 to 60
No. 50	0.30 mm	3 to 15
No. 100	0.15 mm	0 to 4
Effective Particle Size (D10) > 0.30 mm Uniformity Coefficient (D60/D10) < 0.40		

It may be advisable to start with an open-graded coarse silica sand material and proportionately mix in topsoil that will likely contain anywhere from 8% to 12% soil fines (sandy loam, loamy sand) to achieve the desired ratio of sand and fines. An additional 3% to 5% organic matter can then be added. (The exact composition of organic matter and topsoil material will vary, making particle size distribution and recipe for the total soil media mixture difficult to define in advance of evaluating the available material.)

6.7 UNDERDRAIN AND UNDERGROUND STORAGE LAYER

The underdrain should be constructed of 4 or 6-inch diameter perforated HDPE or PVC, which is placed on either a 3-inch layer of double-washed gravel (TDOT #57) for Level 1 or directly on a 12-inch sump layer of 1-inch stone for Level 2. The underdrain shall be encased in a gravel layer extending at least 3 inches above the surface of the pipe. This gravel layer should be covered with a 3-inch layer of choker stone (TDOT #8 or #89).

Some Level 2 water quality swale designs will not use an underdrain [(where soil infiltration rates meet minimum standards (see **Section 6.2**)]. For Level 2 designs with an underdrain, an underground storage layer, consisting of a minimum 12 inches of stone, shall be incorporated below the invert of the underdrain. The depth of the storage layer will depend on the target treatment and storage volumes needed to meet water quality criteria. The storage layer shall consist of clean, washed #57 stone.

If the underdrain is to daylight instead of tying into a storm structure, scour protection shall be provided based of the velocity, in feet per second, exiting the underdrain during the 10 year storm event.

All water quality swales shall include observation wells. The observation wells should be tied into any T's or Y's in the underdrain system, and should extend upwards to be above the surface, with a vented cap. In addition, cleanout pipes shall be provided.

6.8 LANDSCAPING AND PLANTING PLAN

Designers should choose grasses, herbaceous plants or trees that can withstand both wet and dry periods and relatively high velocity flows for planting within the channel. Salt tolerant grass species should be chosen for water quality swales receiving drainage from areas treated for ice in winter. Taller and denser grasses are preferable, although the species is less important than good stabilization and dense vegetative cover. Grass species should have the following characteristics: a deep root system to resist scouring; a high stem density with well-branched top growth; water-tolerance; resistance to being flattened by runoff; and an ability to recover growth following

inundation. A qualified landscape designer should be consulted for selection of appropriate plantings. See **Appendix C** for landscape plan requirements and all native plant lists.

6.9 WATER QUALITY SWALE MATERIAL SPECIFICATIONS

Table 5.6 outlines the standard material specifications for constructing water quality swales**.**

Table 5.6. Water Quality Swale Material Specifications		
Material	**Specification**	**Notes**
Surface Layer	• Shredded hardwood mulch • River stone • Native grasses	Lay a 3-inch layer on the surface of the filter bed to suppress weed growth and prevent erosion
Filter Media Composition	Filter Media to contain (by volume): • 85% to 88% sand • 8% to 12% soil fines • 3% to 5% organic matter	The volume of filter media is based on 110% of the product of the surface area and the media depth, to account for settling.
Choking Layer	A 3- inch layer of choker stone (typically #8 or # 89 washed gravel) laid above the underdrain stone.	
Stone and/or Storage Layer	A 12 to 18 inch layer (depending on the desired depth of the storage layer) of #57 stone should be double-washed and clean and free of all soil and fines.	
Underdrains, Cleanouts, and Observation Wells	6-inch PVC or HDPE pipe, with 3/8-inch perforations.	If needed, install perforated pipe for the full length of the water quality swale. Use non-perforated pipe, as needed, to connect with the storm drain system.
Check Dams	Use non-erosive material such as wood, gabions, riprap, or concrete. All check dams should be underlain with filter fabric and include weep holes. Wood used for check dams should consist of pressure-treated logs or timbers, or water-resistant tree species such as cedar, hemlock, swamp oak or locust.	
Erosion Control Fabric	Where flow velocities dictate, use woven biodegradable erosion control fabric or mats that are durable enough to last at least 2 growing seasons.	

SECTION 7: SPECIAL CASE DESIGN ADAPTATIONS

7.1 SHALLOW BEDROCK AND GROUNDWATER CONNECTIVITY

Many parts of Franklin have shallow bedrock and groundwater, which can constrain the application of deeper bioretention areas (particularly Level 2 designs). If bedrock or groundwater is encountered during subsurface testing for the construction of the water quality swale, the bottom sump elevation of the design shall be above the lowest bedrock/refusal or groundwater elevation encountered in subsurface testing. Bedrock removal should be limited to unexpected outcroppings and rises not encountered in subsurface testing. Note that this is not a desirable design and should be utilized only when all other possibilities have been exhausted.

7.2 STEEP TERRAIN

In areas of steep terrain, water quality swales can be implemented with contributing slopes of up to 20% gradient, if a multiple cell design is used to dissipate erosive energy prior to filtering. This can be accomplished by terracing a series of water quality swale cells to manage runoff across or down a slope. The drop in elevation between cells should be limited to 1 foot and armored with river stone or a suitable equivalent. A greater emphasis on properly

engineered energy dissipaters and/or drop structures is warranted.

7.3 SITE SPECIFIC LIMITATIONS

Some sites may have areas identified as site specific limitations to infiltration of stormwater runoff. Site specific limitations shall be determined by the City engineer and approved through the Stormwater variance process. Sites with brownfield permits are an example of site specific limitations. Site specific limitations cannot be self-imposed or be caused by requirements within the City Ordinance. It should be noted that the site specific limitation may only occupy a portion of the entire proposed use, and that some "clean" areas (such as rooftops) can be diverted away to another infiltration or runoff reduction practice. Development proposals should be carefully reviewed to determine if any future operation, on all or part of the site, will be designated as a potential site specific limitation. Based on this designation, infiltration may be restricted or prohibited.

SECTION 8: CONSTRUCTION

8.1 CONSTRUCTION EROSION PREVENTION AND SEDIMENT CONTROL

Construction Stage EPSC Controls. Water quality swales should be fully protected by silt fence or construction fencing, particularly if they will provide an infiltration function (i.e., have no underdrains). Ideally, water quality swale areas should remain *outside* the limits of disturbance during construction to prevent soil compaction by heavy equipment.

Water quality swale locations may be used for small sediment traps or basins during construction. However, these must be accompanied by notes and graphic details on the EPSC plan specifying that the maximum excavation depth of the sediment trap/basin at the construction stage must (1) be at least 1 foot above the depth of the post-construction water quality swale installation, (2) contain an underdrain, and (3) specify the use of proper procedures for conversion from a temporary practice to a permanent one, including de-watering, cleanout and stabilization.

8.2 CONSTRUCTION SEQUENCE

The following is a typical construction sequence to properly install a water quality swale, although the steps may be modified to adapt to different site conditions.

Step 1. Protection during Site Construction. As noted above, water quality swales should remain outside the limit of disturbance during construction to prevent soil compaction by heavy equipment. However, this is seldom practical given that swales are a key part of the drainage system at most sites. In these cases, temporary EPSC such as dikes, silt fences and other similar measures should be integrated into the swale design throughout the construction sequence. Specifically, barriers should be installed at key check dam locations, erosion control fabric should be used to protect the channel, and excavation should be no deeper than 2 feet above the proposed invert of the bottom of the planned underdrain. Water quality swales that lack underdrains (and rely on filtration) must be fully protected by silt fence or construction fencing to prevent compaction by heavy equipment during construction.

Step 2. Installation should begin after the entire contributing drainage area has been stabilized by vegetation. The designer should check the boundaries of the contributing drainage area to ensure it conforms to original design. Additional EPSC may be needed during swale construction, particularly to divert stormwater from the water quality swale until the filter bed and side slopes are fully stabilized. Pretreatment cells should be excavated first to trap sediments before they reach the planned filter beds.

Step 3. Excavators or backhoes should work from the sides to excavate the water quality swale area to the appropriate design depth and dimensions. Excavating equipment should have scoops with adequate reach so they

do not have to sit inside the footprint of the water quality swale area.

Step 4. The bottom of the water quality swale should be ripped, roto-tilled or otherwise scarified at a depth of 12 inches to promote greater infiltration.

Step 5. Place the stone needed for storage layer over the filter bed. Perforate the underdrain pipe and check its slope. Add the remaining stone jacket, and then pack #57 stone to 3 inches above the top of the underdrain, and then add 3 inches of choker stone as a filter layer.

Step 6. Add the soil media in 12-inch lifts until the desired top elevation of the water quality swale is achieved. Wait a few days to check for settlement, and add additional media as needed.

Step 7. Install check dams and internal pretreatment features, as specified in the plan.

Step 8. Prepare planting holes for specified trees, shrubs, and grasses install erosion control fabric where needed, and install any temporary irrigation.

Step 9. Plant landscaping materials as shown in the landscaping plan, and water them weekly during the first 2 months. The construction contract should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction.

Step 10. Conduct a final construction inspection and develop a punch list for facility acceptance.

8.3 CONSTRUCTION INSPECTION

Inspections are needed during construction to ensure that the water quality swale is built in accordance with these specifications. Detailed inspection checklists should be used that include sign-offs by qualified individuals at critical stages of construction, to ensure that the contractor's interpretation of the plan is consistent with the designer's intent. Some common pitfalls can be avoided by careful construction supervision that focuses on the following key aspects of water quality swale installation.

- Check the filter media to confirm that it meets specifications and is installed to the correct depth.
- Check elevations such as the invert of the underdrain, inverts for the inflow and outflow points, and the ponding depth provided between the surface of the filter bed and the overflow structure.
- Ensure that caps are placed on the upstream (but not the downstream) ends of the underdrains.
- Inspect check dams and pretreatment structures to make sure they are properly installed and working effectively.
- Check that outfall protection/energy dissipation measures at concentrated inflow and outflow points are stable.

The real test of a water quality swale occurs after its first big storm. The post-storm inspection should focus on whether the desired sheet flow, shallow concentrated flows or fully concentrated flows assumed in the plan actually occur in the field. Also, inspectors should check that the water quality swale drains completely within 24 hour drawdown period. Minor adjustments are normally needed as a result of this post-storm inspection (e.g., spot reseeding, gully repair, added armoring at inlets or outfalls, and check dam realignment.

SECTION 9: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 10: MAINTENANCE

10.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

10.2. MAINTENANCE INSPECTIONS

Annual inspections are used to trigger maintenance operations such as sediment removal, spot revegetation and inlet stabilization. The following is a list of several key maintenance inspection points:

- Add reinforcement planting to maintain 95% turf cover or vegetation density. Reseed or replant any dead vegetation.
- Remove any accumulated sand or sediment deposits on the filter bed surface or in pretreatment cells.
- Inspect upstream and downstream of check dams for evidence of undercutting or erosion and remove trash or blockages at weepholes.
- Examine filter beds for evidence of braiding, erosion, excessive ponding or dead grass.
- Check inflow points for clogging and remove any sediment.
- Inspect side slopes and grass filter strips for evidence of any erosion, and repair as needed.
- Look for any bare soil or sediment sources in the contributing drainage area and stabilize immediately.

Ideally, yearly inspections should be conducted in the spring of each year and yearly inspection reports submitted to the City by July 1.

10.3 ROUTINE MAINTENANCE AND OPERATION

Once established, water quality swales have minimal maintenance needs outside of the spring clean-up, regular mowing of pretreatment areas only if needed, and pruning and management of trees and shrubs. The surface of the filter bed can become clogged with fine sediment over time, but this can be alleviated through core aeration or deep tilling of the filter bed. Additional effort may be needed to repair check dams, stabilize inlet points and remove deposited sediment from pretreatment cells.

Extended Detention

Description: Constructed stormwater detention basin that has a permanent pool (or micropool). Runoff from each rain event is captured and treated primarily through settling and biological uptake mechanisms.

Variations: Wet extended detention, micropool extended detention, multiple pond system

Components:
- Permanent pool / micropool – prevents re-suspension of solids
- Live storage above permanent pool – sized for a percentage of water quality volume and flow attenuation.
- Forebay – settles out larger sediments in an area where sediment removal will be easier
- Spillway system – spillway system(s) provides outlet for stormwater runoff when large storm events occur and maintains the permanent pool

Advantages/Benefits:
- Can be designed as a multi-functional BMP
- Cost effective
- Can be designed as an amenity within a development
- Wildlife habitat potential
- High community acceptance when integrated into a development

Disadvantages/Limitations:
- Potential for thermal impacts downstream
- Not recommended in karst terrain
- Community perceived concerns with mosquitoes and safety

Design considerations:
- Minimum contributing drainage area of 25 acres; 10 acres for micropool extended detention (Unless water balance calculations show support of permanent pool by a smaller drainage area)
- Sediment forebay or equivalent pretreatment must be provided
- Minimum length to width ratio = 3:1
- Maximum depth of permanent pool = 4’
- 3:1 side slopes or flatter around pond perimeter

Runoff Reduction Credit:

15% for design specified
0% if lined

Land Use Considerations:

X	**Residential**
X	**Commercial**
X	**Industrial**

Maintenance:
- Remove debris from inlet and outlet structures
- Maintain side slopes/remove invasive vegetation
- Monitor sediment accumulation and remove periodically

M	**Maintenance Burden** L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

An Extended Detention (ED) Pond relies on 24 to 48 hour detention of stormwater runoff after each rain event. Elevations and design shall allow the entire feature to drain within 72 hours. An under-sized outlet structure restricts stormwater flow so it backs up and is stored within the basin. The temporary ponding enables particulate pollutants to settle out and reduces the maximum peak discharge to the downstream channel, thereby reducing the effective shear stress on banks of the receiving stream. ED differs from stormwater detention, since it is designed to achieve a minimum drawdown time, rather than a maximum peak rate of flow (which is commonly used to design for peak discharge or flood control purposes and often detains flows for just a few minutes or hours). ED ponds rely on gravitational settling as their primary pollutant removal mechanism. Consequently, they generally provide fair-to-good removal for particulate pollutants, but low or negligible removal for soluble pollutants, such as nitrate and soluble phosphorus. The use of ED alone generally results in a low overall pollutant removal. As a result, ED is normally combined with other practices to maximize pollutant removal rates.

SECTION 2: PERFORMANCE

Table 6.1. Runoff Volume Reduction Provided by ED Ponds	
Stormwater Function	**Specified Design**
Runoff Volume Reduction (RR)	15%

SECTION 3: DESIGN TABLE

ED ponds must be designed with a Storage Volume, T_V. **Table 6.2** lists the criteria for qualifying designs. See Section 6 for more detailed design guidelines.

Table 6.2. Extended Detention (ED) Pond Criteria
Specified Design (RR:15)
$Tv^1 = 1.25*Rv*A*3630$
A minimum of 40% of Tv in the permanent pool (forebay, micropool, deep pool, or wetlands)
Length/Width ratio *OR* flow path = 3:1 or more
Length of the shortest flow path / overall length = 0.7 or more
Minimum T_v ED time = 24 hours
Maximum vertical Tv ED limit of 4 feet
Trees and wetlands in the planting plan
Includes additional cells or features (deep pools, wetlands, etc.) Refer to Section 5
CDA is greater than 10 acres unless water balance supports smaller contributing drainage area (CDA)

[1] A= Area in Acres

SECTION 4: TYPICAL DETAILS

Figure 6.1 portrays a typical schematic for an ED pond.

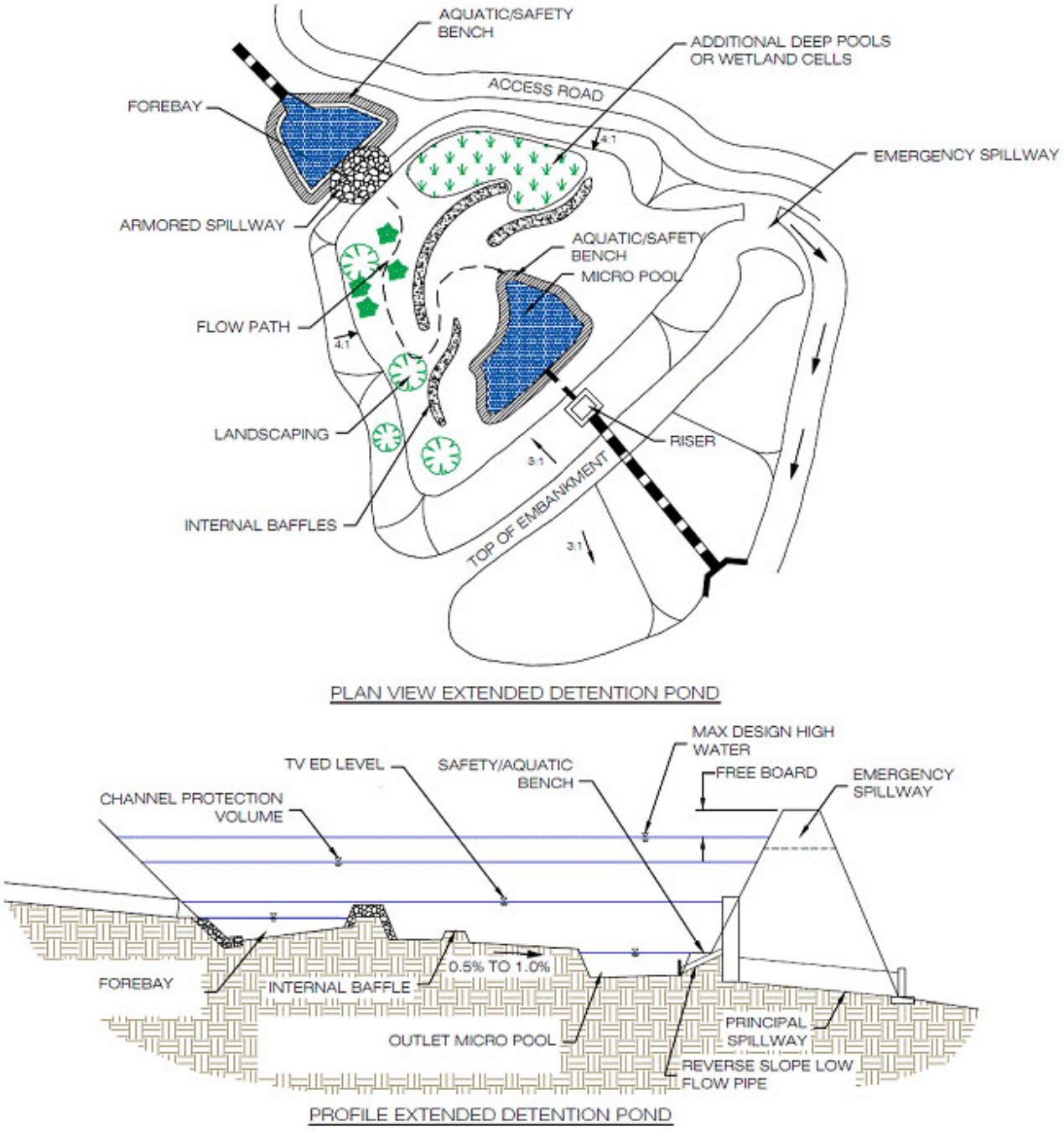


Figure 6.1. Typical Extended Detention Pond Details

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

The following feasibility issues need to be evaluated when ED ponds are considered as the final practice in a treatment train. Many of these issues will be influenced by the type of ED Pond being considered (refer to Design Applications at the end of this section).

Available Hydraulic Head. The depth of an ED pond is usually determined by the amount of hydraulic head available at the site. The bottom elevation is normally the invert of the existing downstream conveyance system to which the ED pond discharges. Typically, a minimum of 6 to 10 feet of head is needed for an ED pond to function.

Contributing Drainage Area. A minimum contributing drainage area of 10 acres is recommended for ED ponds in order to sustain a permanent micropool to protect against clogging. Extended detention may still work with drainage areas less than 10 acres, but designers should be aware that these "pocket" ponds will typically (1) have very small orifices that will be prone to clogging, (2) experience fluctuating water levels, and (3) generate more significant maintenance problems. Water balance calculations should also support a CDA less than 10 acres.

Depth-to-Water Table and Bedrock. If less than 3 feet of vertical separation exists between the bottom of the ED pond and the underlying soil-bedrock interface, ED ponds should not be used unless they have an acceptable liner.

Design Applications. Extended Detention is normally combined with other stormwater treatment options within the stormwater facility (e.g., wet ponds, and constructed wetlands) to enhance its performance and appearance.

Minimum Setbacks. ED ponds should be set back at least 10 feet from property lines, 25 feet from building foundations, 50 feet from septic system fields, and 100 feet from private wells.

Soils. The permeability of soils is seldom a design constraint for micropool ED ponds. Soil infiltration tests need to be conducted at proposed pond sites to estimate infiltration rates, which can be significant in Hydrologic Soil Group (HSG) A soils and some group B soils. Infiltration through the bottom of the pond is encouraged unless it will impair the integrity of the embankment. Geotechnical tests should be conducted to determine the infiltration rates and other subsurface properties of the soils underlying the proposed ED pond. If the site is on karst topography, an alternative practice or combination of practices should be employed at the site, if possible. The Extended Detention Basin should be the option of last resort and, if used in karst, must have an impermeable clay or (preferably) geosynthetic liner.

Space Required. A typical ED pond requires a footprint of 1% to 3% of its contributing drainage area, depending on the depth of the pond (i.e., the deeper the pond, the smaller footprint needed).

While ED ponds can provide for flood protection, they will rarely provide adequate runoff volume reduction and pollutant removal to serve as a stand-alone compliance strategy. Therefore, designers should always maximize the use of upland runoff reduction practices, (e.g., rooftop disconnections, small-scale infiltration, bioretention, and water quality swales) that reduce runoff at its source. Upland runoff reduction practices can be used to satisfy most or all of the runoff reduction requirements at most sites. Upland runoff reduction practices will greatly reduce the size, footprint and cost of the downstream ED pond.

SECTION 6: DESIGN CRITERIA

6.1 OVERALL SIZING

Designers can use a site-adjusted R_v (see **Section 1 Chapter 3** for appropriate equations), which reflects the use of upland runoff reduction practices, to compute the remaining treatment and flood protection volumes that must be

treated by the ED pond. ED ponds should then be designed to capture and treat the remaining runoff volume as necessary. Runoff treatment (T_v) credit may be taken for the entire water volume below the permanent pool elevation of any micropools, forebays and wetland areas, as well as, the temporary extended detention above the normal pool. A minimum of 40% of the T_v must be designed into the permanent pool.

Equation 6.1. ED Treatment Volume

$$T_v \text{ (cu. ft.)} = (\text{Original } T_v - \text{the volume reduced by an upstream BMP})$$

After calculating T_V, the forebay should be sized using guidance in **Section 6.4**.

The outlets must then be sized for appropriate storm events. If the pond is additionally going to address peak flow attenuation, the downstream impacts must be considered for the 2-through 100-year events. Refer to **Section 5 TSS-01** for instruction on design of outlet orifices and weirs.

6.2 TREATMENT VOLUME DRAWDOWN AND DETENTION DESIGN

Low flow orifices can be sized using the following equation, as provided in **Section 5 PTP-05**. If different equation is used or different type of low flow orifice is used, provide supporting calculations.

Equation 6.2. Area of Low Flow Orifice

$$a = \frac{2A(H - H_o)^{0.5}}{3600CT(2g)^{0.5}}$$

Where:

a	=	Area of orifice (ft^2)
A	=	Average surface area of the pond (ft^2)
C	=	Orifice coefficient, 0.66 for thin, 0.80 for materials thicker than orifice diameter
T	=	Drawdown time of pond (hrs), must be greater than 24 hours
g	=	Gravity (32.2 ft/sec^2)
H	=	Elevation when pond is full to storage height (ft)
Ho	=	Final elevation when pond is empty (ft)

Table 6.2 provides maximum ponding depths and other criteria for providing runoff volume reduction.

Once the low flow orifice has been sized, design embankments and emergency spillways, investigate potential dam hazard classifications, and finally design inlets, sediment forebays, outlet structures, maintenance access, and safety features. These items are detailed in both Section 6.5 and below.

6.3 REQUIRED GEOTECHNICAL TESTING

Soil borings should be taken below the proposed embankment, in the vicinity of the proposed outlet area, and in at least two locations within the proposed ED pond treatment area. Soil boring data is needed to (1) determine the physical characteristics of the excavated material, (2) determine its adequacy for use as structural fill or spoil, (3) provide data for structural designs of the outlet works (e.g., bearing capacity and buoyancy), (4) determine compaction/composition needs for the embankment, (5) determine the depth to groundwater and bedrock and (6) evaluate potential infiltration losses (and the potential need for a liner).

6.4 PRETREATMENT FOREBAY

Sediment forebays are considered to be an integral design feature to maintain the longevity of ED ponds. A forebay must be located at each major inlet to trap sediment and preserve the capacity of the main treatment cell. Other forms of pre-treatment for sheet flow and concentrated flow for minor inflow points should be designed consistent with pretreatment criteria found in **Appendix A**. The following criteria apply to forebay design:

- A major inlet is defined as an individual storm drain inlet pipe or open channel serving at least 10% of the ED pond's contributing drainage area.
- The forebay consists of a separate cell, formed by an acceptable barrier. (e.g., an earthen berm, concrete weir, gabion baskets, etc.).
- The forebay should be at least 4 feet deep and must be equipped with a variable width aquatic bench for safety purposes. The aquatic benches should be 4 to 6 feet wide at a depth of 18 inches below the water surface.
- The total volume of all forebays should be at least 15% of the total Treatment Volume. The relative size of individual forebays should be proportional to the percentage of the total inflow to the pond. Similarly, any outlet protection associated with the end section or end wall should be designed according to state or local design standards.
- The forebay should be designed in such a manner that it acts as a level spreader to distribute runoff evenly across the entire bottom surface area of the main treatment cell.
- The bottom of the forebay may be hardened (e.g., concrete, asphalt, or grouted riprap) in order to make sediment removal easier.

6.5 CONVEYANCE AND OVERFLOW

No Pilot Channels. Micropool ED ponds shall not have a low flow pilot channel, but instead must be constructed in a manner whereby flows are evenly distributed across the pond bottom, to promote the maximum infiltration possible.

Internal Slope. The maximum longitudinal slope through the pond should be approximately 0.5% to 1% to promote positive flow through the ED pond.

Primary Spillway. The primary spillway shall be designed with acceptable anti-flotation, anti-vortex, and trash rack devices. The spillway must generally be accessible from dry land.

Non-Clogging Low Flow Orifice. ED Ponds with drainage areas of 10 acres or less, where small diameter pipes are typical, are prone to chronic clogging by organic debris and sediment. Orifices less than 3 inches in diameter may require extra attention during design to minimize the potential for clogging. Designers should always look at upstream conditions to assess the potential for higher sediment and woody debris loads. The risk of clogging in outlet pipes with small orifices can be reduced by:

- Providing a micropool at the outlet structure:
  - Use a reverse-sloped pipe that extends to a mid-depth of the permanent pool or micropool.
  - Install a downturned elbow or half-round pipe over a riser orifice (circular, rectangular, V-notch, etc.) to pull water from below the micropool surface.
  - The depth of the micropool should be at least 4 feet deep, and the depth may not draw down by more than 2 feet during 30 consecutive days of dry weather in the summer.
- Providing an over-sized forebay to trap sediment, trash and debris before it reaches the ED pond's low-flow orifice.
- Installing a trash rack to screen the low-flow orifice.
- Using a perforated pipe under a gravel blanket with an orifice control at the end in the riser structure to supplement the primary outlet.

Emergency Spillway. ED ponds must be constructed with overflow capacity to pass the 100-year design storm event through either the Primary Spillway or a vegetated or armored Emergency Spillway.

Adequate Outfall Protection. The design must specify an outfall that will be stable for the 10- year design storm event. The channel immediately below the pond outfall must be modified to prevent erosion and conform to natural dimensions in the shortest possible distance. This is typically done by placing appropriately sized riprap, over filter fabric, which can reduce flow velocities from the principal spillway to non-erosive levels (3.5 to 5.0 fps depending on the channel lining material). Flared pipe sections that discharge at or near the stream invert or into a step pool arrangement should be used at the spillway outlet.

Inlet Protection. Inlet areas should be stabilized to ensure that non-erosive conditions exist during storm events up to the overbank flood event (i.e., the 10-year storm event). Inlet pipe inverts should generally be located at or slightly below the forebay pool elevation.

On-Line ED Ponds must be designed to detain the required T_v and either manage or be capable of safely passing larger storm events conveyed to the pond (e.g., 10-year flood protection, and/or the 100-year design storm event).

6.6. INTERNAL DESIGN FEATURES

Side Slopes. Side slopes leading to the ED pond should generally have a gradient of 4H:1V to 5H:1V. The mild slopes promote better establishment and growth of vegetation and provide for easier maintenance and a more natural appearance.

Long Flow Path. ED pond designs should have an irregular shape and a long flow path from inlet to outlet to increase water residence time, treatment pathways, and pond performance. In terms of flow path geometry, there are two design considerations: (1) the overall flow path through the pond, and (2) the length of the shortest flow path (Hirschman et al., 2009):

- The overall flow path can be represented as the length-to-width ratio *OR* the flow path. These ratios must be at least 3L:1W. Internal berms, baffles, or topography can be used to extend flow paths and/or create multiple pond cells.
- The shortest flow path represents the distance from the closest inlet to the outlet. The ratio of the shortest flow to the overall length must be at least 0.7. In some cases – due to site geometry, storm sewer infrastructure, or other factors – some inlets may not be able to meet these ratios. However, the drainage area served by these "closer" inlets should constitute no more than 20% of the total contributing drainage area.

Treatment Volume Storage. The total T_v storage may be provided by a combination of the permanent pool (in the form of forebays, deep pools, and/or wetland area) and extended detention storage.

Vertical Extended Detention Limits. The maximum T_v ED water surface elevation may not extend more than 4 feet above the basin floor or normal pool elevation. The maximum vertical elevation for ED detention over shallow wetlands is 1 foot. Frequent fluctuations in water elevations, or bounce effect, are not as critical for larger flood control storms (e.g., the 10-year design storm), and these events can exceed the 4 foot vertical limit if they are managed by a multi-stage outlet structure.

Safety Features.

- The principal spillway opening must be designed and constructed to prevent access by small children.
- End walls above pipe outfalls greater than 48 inches in diameter must be fenced to prevent a hazard.
- An emergency spillway and associated freeboard must be provided in accordance with applicable local or state dam safety requirements. The emergency spillway must be located so that downstream structures will not be impacted by spillway discharges.

- Both the safety bench and the aquatic bench should be landscaped with vegetation that hinders or prevents access to the pool.

6.7 LANDSCAPING AND PLANTING PLAN

A landscaping plan must be provided that indicates the methods used to establish and maintain vegetative coverage within the ED pond. Minimum elements of a plan include the following:

- Delineation of pond-scaping zones within the pond
- Selection of corresponding plant species
- The planting plan
- The sequence for preparing the wetland bed, if one is incorporated with the ED pond (including soil amendments, if needed)
- Sources of plant material
- The planting plan should allow the pond to mature into a native forest in the right places, yet keep mowable turf along the embankment and all access areas. The wooded wetland concept proposed by Cappiella *et al.*, (2005) may be a good option for many ED ponds.
- Woody vegetation may not be planted or allowed to grow within 15 feet of the toe of the embankment nor within 25 feet from the principal spillway structure.
- Avoid species that require full shade, or are prone to wind damage. Extra mulching around the base of trees and shrubs is strongly recommended as a means of conserving moisture and suppressing weeds.

6.8 MAINTENANCE REDUCTION FEATURES

Good maintenance access is needed so crews can remove sediments from the forebay, alleviate clogging and make riser repairs. The following ED pond maintenance issues can be addressed during design, in order to make on-going maintenance easier:

- Adequate maintenance access must extend to the forebay, micropool, any safety benches, riser, and outlet structure and must have sufficient area to allow vehicles to turn around.
- The riser should be located within the embankment for maintenance access, safety and aesthetics.
- Access roads must (1) be constructed of load-bearing materials or be built to withstand the expected frequency of use, (2) have a minimum width of 12 feet, and (3) have a profile grade that does not exceed 15%. Steeper grades are allowable if appropriate stabilization techniques are used, such as a gravel road.
- A maintenance right-of-way or easement must extend to the ED pond from a public or private road.

6.9 ED POND MATERIAL SPECIFICATIONS

ED ponds are generally constructed with materials obtained on-site, except for the plant materials, inflow and outflow devices (e.g., piping and riser materials), possibly stone for inlet and outlet stabilization, and filter fabric for lining banks or berms.

The basic material specifications for earthen embankments, principal spillways, vegetated emergency spillways and sediment forebays shall be as specified in Tennessee state guidelines and TSS-05, Dry Ponds in within this manual.

6.10 DAM SAFETY

Tennessee Safe Dams Act may apply to ponds with storage volumes and embankment heights large enough to fall under the regulation for dam safety, as applicable. Size emergency spillway for any overtopping of pond in case of rain event in excess of 100-year storm and for instances of malfunction or clogging of primary outlet structure.

SECTION 7: SPECIAL CASE DESIGN ADAPTATIONS

7.1 STEEP TERRAIN

The use of ED ponds is highly constrained at development sites with steep terrain.

7.2 KARST TERRAIN

Karst is found in some areas of the City. The presence of karst complicates both land development in general and stormwater design. Designers should always conduct geotechnical investigations in karst terrain to assess this risk during the project planning stage. Because of the risk of sinkhole formation and groundwater contamination in karst regions, *use of ED ponds is highly restricted* (see CSN Technical Bulletin No. 1, 2009). If these studies indicate that less than 3 feet of vertical separation exists between the bottom of the ED pond and the underlying soil-bedrock interface, ED ponds should not be used unless they have an acceptable liner.

7.3 MULTI-FUNCTIONAL USES

Recreational and other uses may be provided between storm runoff events, as shown in **Figure 6.2**.

Figure 6.2. Multi-Use Dry Detention Doubling as Sports Fields Englewood, CO

SECTION 8: CONSTRUCTION

8.1 CONSTRUCTION SEQUENCE

The following is a typical construction sequence to properly install an ED pond. The steps may be modified to reflect different dry ED pond designs, site conditions, and the size, complexity and configuration of the proposed facility.

Step 1: Use of ED pond as an EPSC. An ED pond may serve as a sediment basin during project construction. If this is done, the volume should be based on the more stringent sizing rule (erosion and sediment control requirement vs. water quality treatment requirement). Installation of the permanent riser should be initiated during the construction phase, and design elevations should be set with final cleanout of the sediment basin and conversion to the post-construction ED pond in mind. The bottom elevation of the ED pond should be lower than the bottom elevation of the temporary sediment basin. Appropriate procedures should be implemented to prevent discharge of turbid waters when the basin is being converted into an ED pond.

Step 2: Stabilize the Drainage Area. ED ponds should only be constructed after the contributing drainage area to

the pond is completely stabilized or if water is routed around them during construction. If the proposed pond site will be used as a sediment trap or basin during the construction phase, the construction notes should clearly indicate that the facility will be dewatered, dredged and re-graded to design dimensions after the original site construction is complete.

Step 3: Assemble Construction Materials on-site, make sure they meet design specifications, and prepare any staging areas.

Step 4: Clear and Strip the project area to the desired sub-grade.

Step 5: Install EPSC Controls prior to construction, including temporary de-watering devices and stormwater diversion practices. All areas surrounding the pond that are graded or denuded during construction must be planted with turf grass, native plantings, or other approved methods of soil stabilization.

Step 6: Excavate the Core Trench and Install the Spillway Pipe.

Step 7: Install the Riser or Outflow Structure and ensure the top invert of the overflow weir is constructed level at the design elevation.

Step 8: Construct the Embankment and any Internal Berms in 8 to 12-inch lifts and compact the lifts with appropriate equipment.

Step 9: Excavate/Grade until the appropriate elevation and desired contours are achieved for the bottom and side slopes of the ED pond.

Step 10: Construct the Emergency Spillway in cut or structurally stabilized soils.

Step 11: Install Outlet Pipe**s**, including downstream rip-rap apron protection and/or channel armor, as necessary.

Step 12: Stabilize Exposed Soils with temporary seed mixtures appropriate for the pond. All areas above the normal pool elevation should be permanently stabilized by hydroseeding or seeding over straw.

Step 13: Plant the Pond Area, following the pond-scaping plan (see **Section 6.7**).

8.2 CONSTRUCTION INSPECTION

Multiple inspections are critical to ensure that stormwater ponds are properly constructed. Inspections are recommended during the following stages of construction:

- Pre-construction meeting
- Initial site preparation (including installation of EPSC controls)
- Excavation/Grading (interim and final elevations)
- Installation of the embankment, the riser/primary spillway, and the outlet structure
- Implementation of the pond-scaping plan and vegetative stabilization
- Final inspection (develop a punch list for facility acceptance)

If the ED pond has a permanent pool, then to facilitate maintenance the contractor should measure the actual constructed pond depth at three areas within the permanent pool (forebay, mid-pond and at the riser), and they should mark and geo-reference them on an as-built drawing. This simple data set will enable maintenance inspectors to determine pond sediment deposition rates in order to schedule sediment cleanouts.

SECTION 9: MAINTENANCE

9.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

9.2 MAINTENANCE INSPECTIONS

Maintenance of ED ponds is driven by annual inspections that evaluate the condition and performance of the pond, including the following:

- Measure sediment accumulation levels in forebay.
- Monitor the growth of wetlands, trees and shrubs planted, and note the presence of any invasive plant species.
- Inspect the condition of stormwater inlets to the pond for material damage, erosion or undercutting.
- Inspect the banks of upstream and downstream channels for evidence of sloughing, animal burrows, boggy areas, woody growth, or gully erosion that may undermine embankment integrity.
- Inspect pond outfall channel for erosion, undercutting, rip-rap displacement, woody growth, etc.
- Inspect condition of principal spillway and riser for evidence of spalling, joint failure, leakage, corrosion, etc.
- Inspect condition of all trash racks, reverse sloped pipes or flashboard risers for evidence of clogging, leakage, debris accumulation, etc.
- Inspect maintenance access to ensure it is free of woody vegetation, and check to see whether valves, manholes and locks can be opened and operated.
- Inspect internal and external side slopes of the pond for evidence of sparse vegetative cover, erosion, or slumping, and make needed repairs immediately.

9.3 COMMON ONGOING MAINTENANCE ISSUES

ED ponds are prone to a high clogging risk at the ED low-flow orifice. This component of the pond's plumbing should be inspected at least twice a year after initial construction. The constantly changing water levels in ED ponds make it difficult to mow or manage vegetative growth. The bottom of ED ponds often become soggy, and water-loving trees such as willows may take over. The maintenance plan should clearly outline how vegetation in the pond will be managed or harvested in the future.

The maintenance plan should schedule a cleanup at least once a year to remove trash and floatables that tend to accumulate in the forebay, micropool, and on the bottom of ED ponds.

Frequent sediment removal from the forebay is essential to maintain the function and performance of an ED pond. Maintenance plans should schedule cleanouts every 5 to 7 years, or when inspections indicate that 50% of the forebay capacity has been filled. Sediments excavated from ED ponds are not usually considered toxic or hazardous and can be safely disposed by either land application or land filling.

SECTION 10: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in Appendix D. Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 11: COMMUNITY AND ENVIRONMENTAL CONCERNS

Extended Detention Ponds can generate the following community and environmental concerns that need to be addressed during design.

Aesthetics. ED ponds tend to accumulate sediment and trash, which residents are likely to perceive as unsightly and creating nuisance conditions. Fluctuating water levels in ED ponds also create a difficult landscaping environment. In general, designers should avoid designs that rely solely on *dry* ED ponds.

Existing Wetlands. ED ponds should never be constructed within existing *natural* wetlands, nor should they inundate or otherwise change the hydroperiod of existing wetlands.

Existing Forests. Designers can expect a great deal of neighborhood opposition if they do not make a concerted effort to save mature trees during design and pond construction. Designers should also be aware that even modest changes in inundation frequency can kill upstream trees (Cappiella *et al.,* 2007).

Safety Risk. ED ponds are generally considered to be safer than other pond options, since they have few deep pools. Steep side-slopes and unfenced headwalls, however, can still create some safety risks. Gentle side slopes should be provided to avoid potentially dangerous drop-offs, especially where ED ponds are located near residential areas.

Mosquito Risk. The fluctuating water levels within ED ponds have potential to create conditions that lead to mosquito breeding. Mosquitoes tend to be more prevalent in irregularly flooded ponds than in ponds with a permanent pool (Santana *et al*., 1994). Designers can minimize the risk by combining ED with a wet pond or wetland.

Sheet Flow

Description: Impervious areas are disconnected, and runoff is routed over a level spreader to sheet flow over adjacent vegetated areas. This slows runoff velocities, promotes infiltration, and allows sediment and attached pollutants to settle and/or be filtered by the vegetation. Disconnection is the process of redirecting flow from rooftop downspouts or impervious areas that are directly connected to the public stormwater system and directing flow to a storage facility, or in this case, an infiltration area through sheet flow.

Variations:
1) Disconnection to vegetated filter strips
2) Disconnection to conserved open space

Components:
- Level spreader – creates sheet flow
- Vegetated filter strip or open space with minimal slope

Advantages/Benefits:
- Cost effective
- Wildlife habitat potential
- High community acceptance

Disadvantages/Limitations:
- Small drainage area
- Sheet flow must be maintained to achieve design goals
- Often requires additional BMPs to achieve runoff reduction goals

Design considerations:
- Must have slopes between 2% and 6%
- Filter strips and conservation areas may be adjacent to and discharge to water quality buffers. Pre-approval by the City Engineer or his designee is required if any part of the filter strip is within the water quality buffer.

Selection Criteria:

50%-75% Runoff Reduction Credits

See Table 7.1

Land Use Considerations:

X	**Residential**
X	**Commercial**
X	**Industrial (with City approval)**

Maintenance:
- Maintain dense, healthy vegetation to ensure sheet flow
- Inspect regularly for signs of erosion

M	**Maintenance Burden** L = Low M = Moderate H = High

SECTION 1. DESCRIPTION

Filter strips are vegetated areas that treat sheet flow delivered from adjacent impervious areas by slowing runoff velocities and allowing sediment and attached pollutants to settle and/or be filtered by the vegetation. The two design variants of filter strips are (1) *Conserved Open Space* and (2) designed *Vegetated Filter Strips*. The design, installation, and management of these design variants are quite different, as outlined in this specification.

In both instances, stormwater must enter the filter strip or conserved open space as sheet flow. If the inflow is from a pipe or channel, an engineered level spreader must be designed in accordance with the criteria contained herein to convert the concentrated flow to sheet flow.

SECTION 2. PERFORMANCE

With proper design and maintenance, these practices can provide relatively high runoff reduction as shown in **Table 7.1**.

Table 7.1: Runoff Volume Reduction Provided by Filter Strips

Stormwater Function	Conservation Area		Vegetated Filter Strip	
	HSG Soils A and B	HSG Soils C and D	HSG Soils A	HSG Soils B [1], C and D
	Assume no CA[2] in Conservation Area		No CA[3]	With CA[2]
Runoff Vol. Reduction (RR)	75%	50%	50%	50%

[1] CSN (2008); CWP (2007)
[2] CA = Compost Amended Soils
[3] Compost amendments are generally not applicable for undisturbed A soils, although it may be advisable to incorporate them on mass-graded A or B soils and/or filter strips on B soils, in order to maintain runoff reduction rates.

SECTION 3. DESIGN TABLE

Conserved Open Space and Vegetated Filter Strips do not have two levels of design. Instead, each must meet the appropriate minimum criteria outlined in **Table 7.2** and **Section 6** to qualify for the indicated level of runoff reduction. In addition, designers must conduct a site visit prior to design to confirm topography and soil conditions.

Table 7.2. Filter Strip Design Criteria

Design Issue	Conserved Open Space	Vegetated Filter Strip
Soil and Vegetative Cover (Sections 6.1 and 6.2)	Undisturbed soils and native vegetation	Amended soils and dense turf cover or landscaped with herbaceous cover, shrubs, and trees
Overall Slope and Width (perpendicular to the flow) (Section 5)	0.5% to 3% Slope – Minimum 35 ft width 3% to 6% Slope – Minimum 50 ft width The first 10 ft. of filter must be 2% or less in all cases [2]	1% [1] to 4% Slope – Minimum 35 ft. width 4% to 6% Slope – Minimum 50 ft. width The first 10 ft. of filter must be 2% or less in all cases
Sheet Flow (Section 5)	Maximum flow length of 150 ft. from adjacent pervious areas; Maximum flow length of 75 ft. from adjacent impervious areas	
Concentrated Flow (Section 6.3)	Length of ELS[6] Lip = 13 lin. ft. per each 1 cfs of inflow if area has 90% Cover[3] Length = 40 lin. ft. per 1 cfs for[4] forested or re-forested areas (ELS[6] length = 13 lin.ft. min; 130 lin.ft. max.)	Length of ELS[6] Lip = 13 lin.ft. per each 1 cfs of inflow (13 lin.ft. min; 130 lin.ft. max.)
Construction Stage (Section 7)	Located outside the limits of disturbance and protected by ESC controls	Prevent soil compaction by heavy equipment
Typical Applications	Adjacent to stream or wetland buffer or forest conservation area	Treat small areas of Impervious Cover (e.g., 5,000 sf) close to source
Compost Amendments (Section 6.1)	No	Yes (B, C, and D soils)[5]
Boundary Spreader (Section 6.3)	GD [6] at top of filter	GD[6] at top of filter

[1] A minimum of 1 % is recommended to ensure positive drainage.

[2] For Conservation Areas with a varying slope, a pro-rated length may be computed only if the first 10 ft. is 2% or less.

[3] Vegetative Cover is described in **Section 6.2**.

[4] Where the Conserved Open Space is a mixture of native grasses, herbaceous cover and forest (or re-forested area), the length of the ELS [6] Lip can be established by computing a weighted average of the lengths required for each vegetation type. Refer to **Section 6.3** for design criteria

[5] The City may waive the requirement for compost amended soils for filter strips on B soils under certain conditions (see **Section 6.1**).

[6] ELS = Engineered Level Spreader; GD = Gravel Diaphragm; PB = Permeable Berm.

SECTION 4. TYPICAL DETAILS

Figure 7.1 shows a typical approach for sheet flow to a conserved open space (Cappiella *et al.*, 2006). **Figures 7.2 and 7.3** provide standard details for an engineered level spreader modeled off those developed by North Carolina State University (Hathaway and Hunt, 2006).

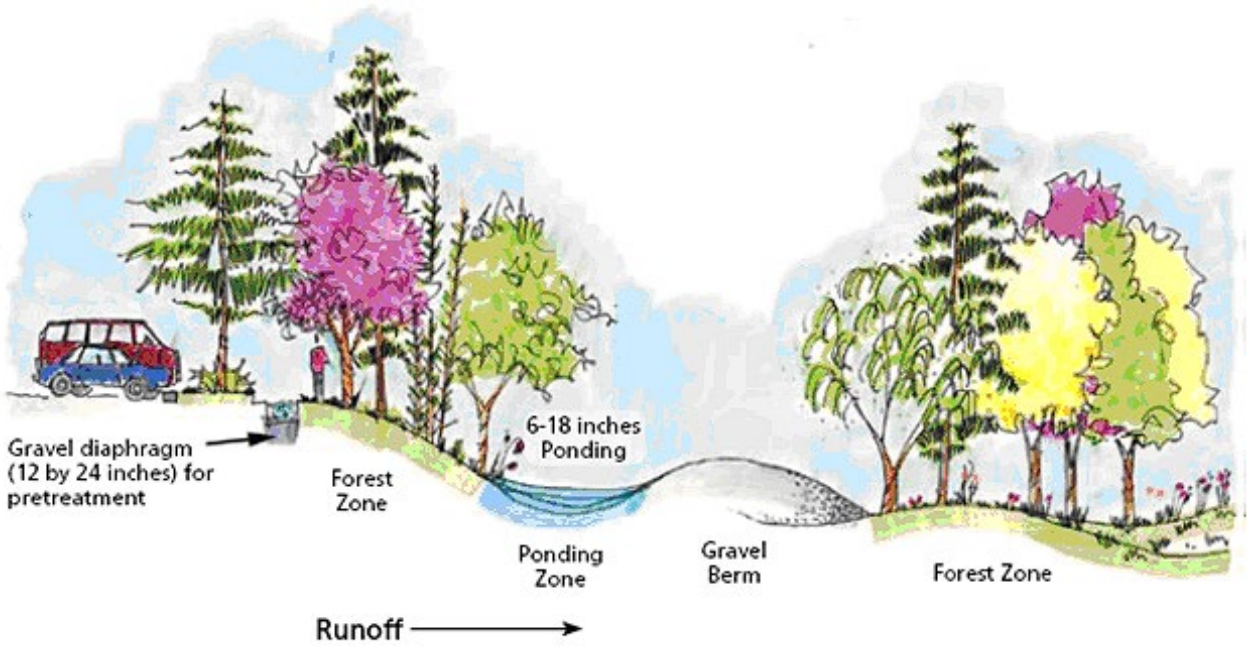


Figure 7.1. Typical Sheet flow to Conserved Open Space (Hathaway and Hunt 2006)

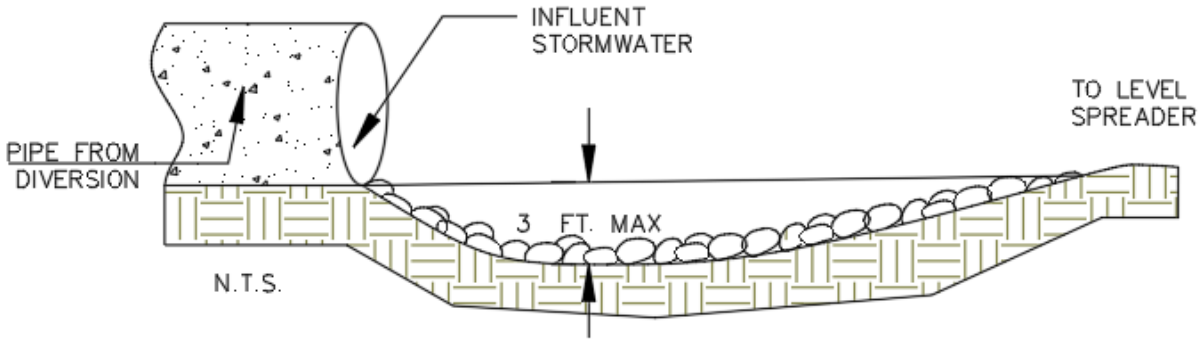


Figure 7.2. Level Spreader Forebay

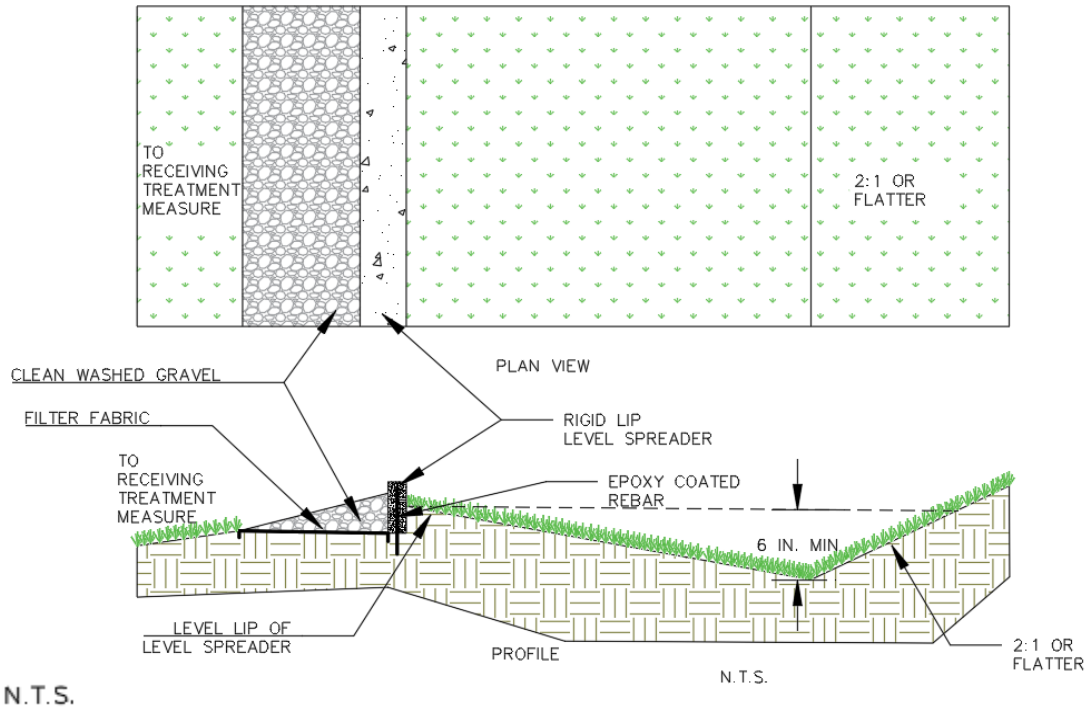


Figure 7.3: Section - Level Spreader with Rigid Lip

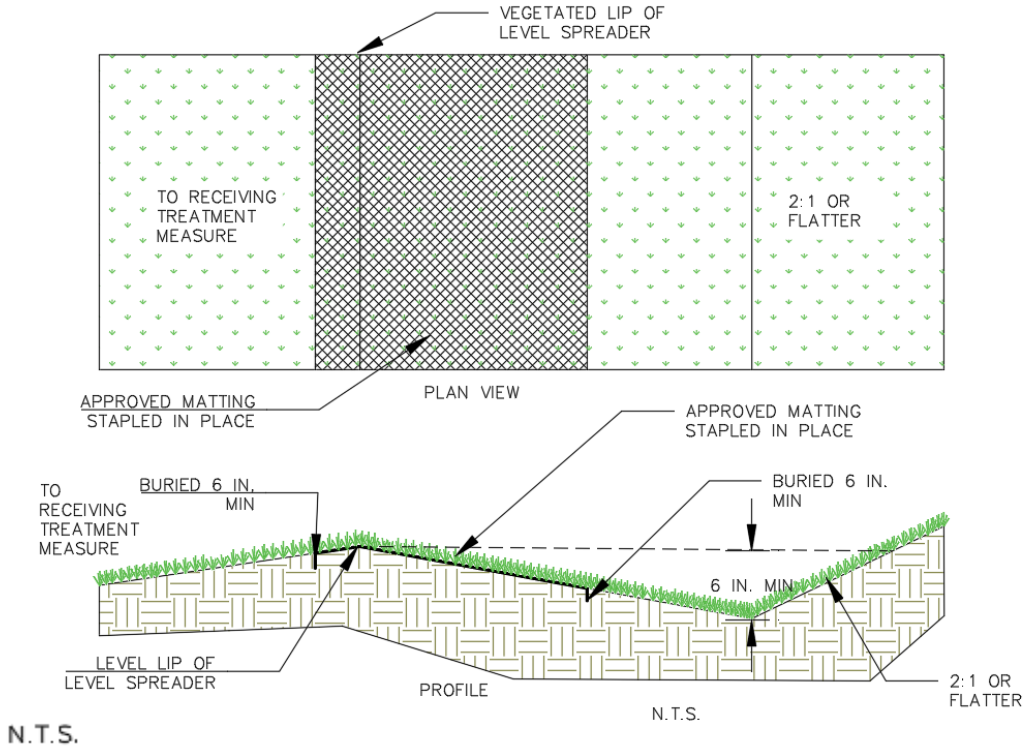


Figure 7.5: Section - Alternative Level Spreader with Vegetated Lip

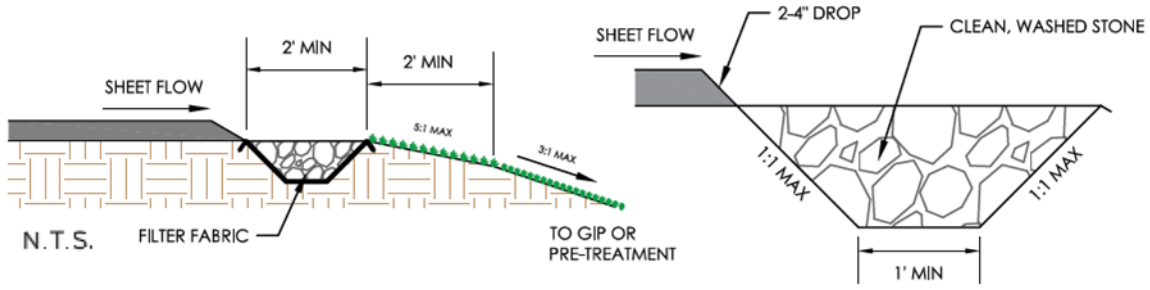


Figure 7.6 – Gravel Diaphragm – Sheet Flow Pre-treatment

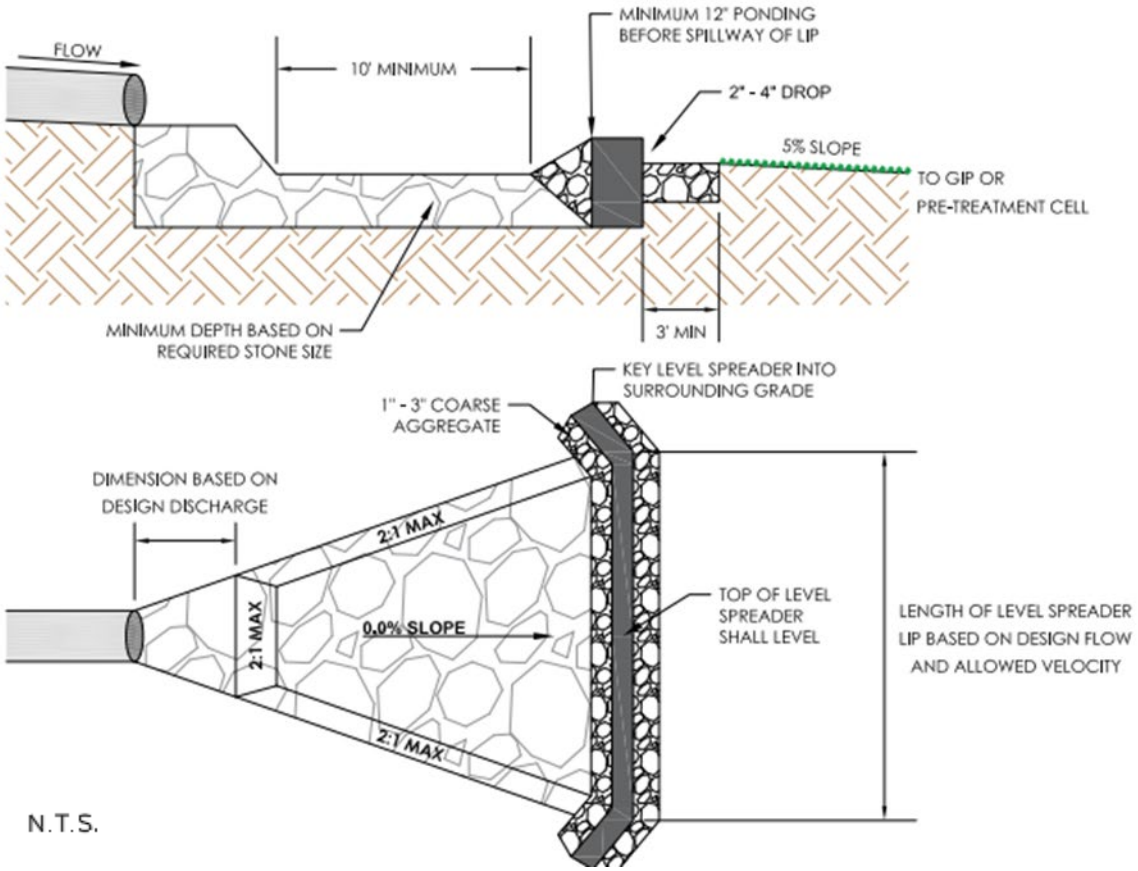


Figure 7.7: Level Spreader: Pipe or Channel Flow to Filter Strip or Preserved Open Space

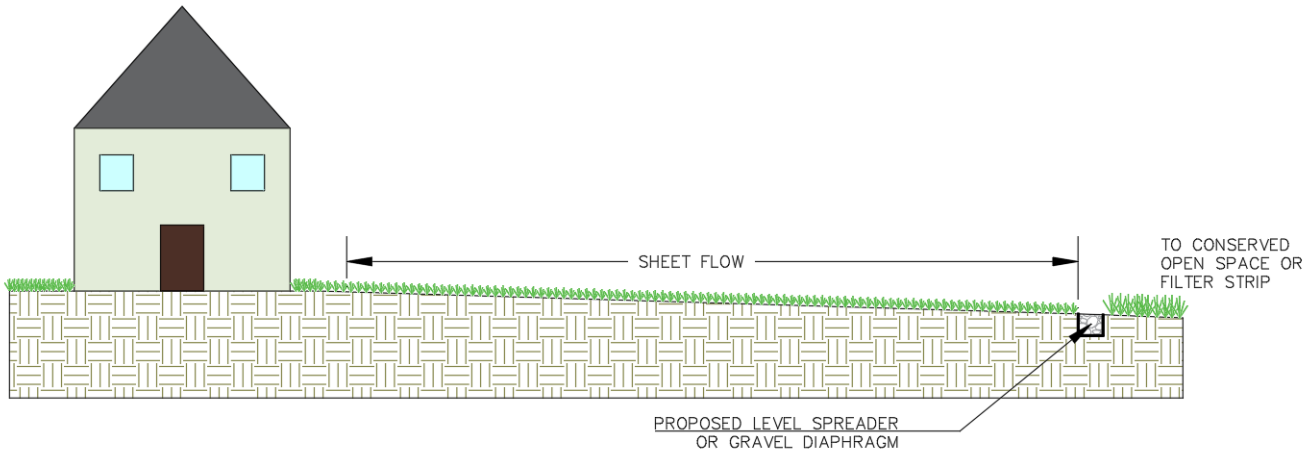


Figure 7.8: Simple Disconnection of a roof drain to downstream Preserved Open Space or Vegetated Filter Strip

SECTION 5. PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

5.1 CONSERVED OPEN SPACE

Designers may apply a runoff reduction credit to any impervious that is hydrologically connected and effectively treated by a protected conserved open space that meets the following eligibility criteria:

- No major disturbance shall occur within the conserved open space during or after construction (i.e., no clearing or grading is allowed except temporary disturbances associated with incidental utility construction, restoration operations, or management of nuisance vegetation). The conserved open space area shall not be stripped of topsoil. Some light grading may be needed at the boundary using tracked vehicles to prevent compaction.
- The limits of disturbance shall be clearly shown on all construction drawings and protected by acceptable signage and erosion control measures. The conserved open space shall not be included within the limits of disturbance.
- A long term vegetation management plan shall be prepared to maintain the conserved open space in a natural vegetative condition. Generally, conserved open space management plans do not allow any active management. However, a specific plan should be developed to manage the unintended consequences of passive recreation, control invasive species, provide for tree and understory maintenance.
- The conserved open space shall be protected by a green infrastructure easement that assigns the responsible party to ensure that no future development, disturbance, or clearing may occur within the area.
- The practice does **not apply** to jurisdictional wetlands or riparian buffers that are sensitive to increased inputs of stormwater runoff.

5.2 VEGETATED FILTER STRIPS

Vegetated filter strips are best suited to treat runoff from small segments of impervious cover (usually less than 5,000 sq. ft) adjacent to road shoulders, small parking lots and rooftops. Vegetated filter strips may also be used as pretreatment for another stormwater practice such as a water quality swale, bioretention, or infiltration areas. If enough pervious area is available at the site, larger areas of impervious cover can be treated by vegetated filter strips, using an engineered level spreader to recreate sheet flow.

Conserved open space and vegetated filter strips can be used in a variety of situations; however, there are several constraints to their use:

Filter Slopes and Widths. Maximum slope for both conserved open space and vegetated filter strips is 6%, in order to maintain sheet flow through the practice. In addition, the overall contributing drainage area must likewise be relatively flat to ensure sheet flow draining into the filter. Where this is not possible, alternative measures, such as an engineered level spreader, can be used. Minimum widths (flow path) for conserved open space and vegetated filter strips are dependent on slope, as specified in **Table 7.2**.

Soils. Vegetated filter strips are appropriate for all soil types, except fill soils. The runoff reduction rate, however, is dependent on the underlying Hydrologic Soil Groups (see **Table 7.1**) and whether soils receive compost amendments.

Contributing Flow Path to Filter. Vegetated filter strips are used to treat very small drainage areas of a few acres or less. The limiting design factor is the length of flow directed to the filter. As a rule, flow tends to concentrate after 75 feet of flow length for impervious surfaces, and 150 feet for pervious surfaces when flow concentrates, it moves too rapidly to be effectively treated by a vegetated filter strip, unless an engineered level spreader is used. When the existing flow at a site is concentrated, other green infrastructure practices shall be used instead of a vegetated filter strip.

Proximity of Underground Utilities. Underground pipes and conduits that cross the vegetated filter strip are not allowed.

Use with Riparian Buffers. Zone 1 riparian buffers can be used as a vegetated filter strip with pre-approval by the City Engineer or his designee. Any level spreader or gravel diaphragm shall be located outside of the riparian buffer limits. All vegetated filter strips located within the zone 1 buffer shall have a green infrastructure easement. No utilities shall cross the vegetated filter strip. All requirements for slopes and widths shall be met.

SECTION 6. DESIGN CRITERIA

6.1 COMPOST SOIL AMENDMENTS

Compost soil amendments will enhance the runoff reduction capability of a vegetated filter strip when located on hydrologic soil groups B, C, and D, subject to the following design requirements:

- The compost amendments should extend over the full length and width of the filter strip.
- The amount of approved compost material and the depth to which it must be incorporated is outlined in **Appendix 7-A**.
- The amended area will be raked to achieve the most level slope possible without using heavy construction equipment, and it will be stabilized rapidly with perennial grass and/or herbaceous species. It shall be seeded, not sodded.
- If slopes exceed 3%, a protective biodegradable fabric or matting shall be installed to stabilize the site prior to runoff discharge.
- Compost amendments shall not be incorporated until the gravel diaphragm and/or engineered level spreader are installed (see **Section 6.3**).
- The City may waive the requirement for compost amendments on HSG-B soils in order to receive credit as a filter strip if (1) the designer can provide verification of the adequacy of the on-site soil type, texture, and profile to function as a filter strip, and (2) the area designated for the filter strip will not be disturbed during construction.

6.2 PLANTING AND VEGETATION MANAGEMENT

Conserved Open Space. No grading or clearing of native vegetation is allowed within the conserved open space.

Reforested Conserved Open Space. At some sites, the conserved open space may be in turf or meadow cover or overrun with invasive plants and vines. In these situations, a landscape architect should prepare a reforestation plan for the conserved open space utilizing the reforestation specifications as described under **GIP-08, Reforestation**, with any credits and associated plans receiving approval by the City.

Vegetated Filter Strips. Vegetated filter strips should be planted at such a density to achieve a 90% grass/herbaceous cover after the second growing season. Performance has been shown to fall rapidly as vegetative cover falls below 80%. Filter strips shall be seeded, not sodded, whenever possible. Seeding establishes deeper roots, and sod may have muck soil that is not conducive to infiltration. The filter strip vegetation may consist of turf grasses, meadow grasses, other herbaceous plants, shrubs, and trees, as long as the primary goal of at least 90% coverage with grasses and/or other herbaceous plants is achieved. Designers should choose vegetation that stabilizes the soil and is salt tolerant. Vegetation at the toe of the filter, where temporary ponding may occur behind the permeable berm, shall be able to withstand both wet, with approximately 6 inches of ponding, and dry periods. The planting areas can be divided into zones to account for differences in inundation and slope.

6.3 GRAVEL DIAPHRAGMS, BERMS AND LEVEL SPREADERS

Gravel Diaphragms. A gravel diaphragm at the top of the slope is required for both conserved open space and vegetated filter strips that receive sheet flow. The gravel diaphragm is created by excavating a 2-foot wide and 1-foot deep trench that runs on the same contour at the top of the filter strip or conserved open space. The diaphragm serves two purposes. First, it acts as a pretreatment device, settling out sediment particles before they reach the practice. Second, it acts as a level spreader, maintaining sheet flow as runoff flows over the filter strip. Stone shall be sized based on the flows received. Refer to **Figure 7.6.**

- The flow should travel over the impervious area and to the practice as sheet flow and then drop 2 to 4 inches onto the gravel diaphragm. The drop helps to prevent runoff from running laterally along the pavement edge, where grit and debris tend to build up (thus allowing by-pass of the filter strip).
- A layer of filter fabric shall be placed between the gravel and the underlying soil trench.

Permeable Berm. Vegetated filter strips should be designed with a permeable berm at the toe of the filter strip to create a shallow ponding area. Runoff ponds behind the berm and gradually flows through outlet pipes in the berm or through a gravel lens in the berm with a perforated pipe. During larger storms, runoff may overtop the berm. The permeable berm shall have the following properties:

- A wide and shallow trench, 6 to 12 inches deep, shall be excavated at the upstream toe of the berm, parallel with the contours.
- The berm 6 to 12 inches high should be located down gradient of the excavated depression and should have gentle side slopes to promote easy mowing.
- Stone may be needed to armor the top of berm to handle extreme storm events.
- A permeable berm is not needed when vegetated filter strips are used as pretreatment to another stormwater practice.

Engineered Level Spreaders. The design of engineered level spreaders should conform to the following design criteria in order to ensure non-erosive sheet flow into the vegetated area.

The flow is directed through a stilling basin energy dissipater and then a level spreader such that the entire design storm for the conveyance system (typically a 10-year frequency storm) is discharged as sheet flow.

Key design elements of the engineered level spreader, as provided in **Figures 7.2 and 7.3**, include the following:

- High flow bypass provides safe passage for larger design storms through the filter strip. The bypass channel should accommodate all peak flows greater than the water quality design flow.

- A forebay should have a maximum depth of 3 feet (**Figure 7.2**). A permeable berm shall be used to prevent extended ponding within the forebayThe forebay is sized such that the surface area is 0.2% of the contributing impervious area. A forebay is not necessary if the concentrated flow is from the outlet of an extended detention basin or similar practice.
- The length of the level spreader shall be determined by the type of filter area and the design flow:
  - 13 feet of level spreader length per every 1 cubic foot per second (cfs) of inflow for discharges to a vegetated filter strip or conserved open space consisting of native grasses or thick ground cover;
  - 40 feet of level spreader length per every 1 cfs of inflow when the spreader discharges to a conserved open space consisting of forested or reforested area (Hathaway and Hunt, 2006).
  - Where the conserved open space is a mix of grass and forest (or re-forested), establish the level spreader length by computing a weighted average of the lengths required for each vegetation type.
  - The minimum level spreader length is 13 feet and the maximum is 130 feet.
  - For the purposes of determining the level spreader length, the peak discharge shall be determined using the rational equation with an intensity of 1-inch/hour.
- The level spreader lip shall be concrete, with a well-anchored footer, or other accepted rigid, non-erodible material.
- The ends of the level spreader section should be tied back into the slope to avoid scouring around the ends of the level spreader; otherwise, short-circuiting of the facility could create erosion.
- The width of the level spreader channel on the up-stream side of the level lip should be three times the diameter of the inflow pipe, and the depth should be 9 inches or one-half the culvert diameter, whichever is greater.
- The level spreader shall be placed 3 to 6 inches above the downstream natural grade elevation to avoid turf buildup. In order to prevent grade drops that re-concentrate the flows, a section of course aggregate, underlain by filter fabric, shall be installed just below the spreader to transition from the level spreader to natural grade.

Vegetated receiving areas down-gradient from the level spreader must be able to withstand the force of the flow coming over the lip of the device. It may be necessary to stabilize this area with temporary or permanent materials in accordance with the calculated velocity (on-line system peak, or diverted off-line peak) and material specifications, along with seeding and stabilization in conformance with the Tennessee Erosion and Sediment Control Handbook.

6.4 FILTER DESIGN MATERIAL SPECIFICATIONS

Table 7.3 describes materials specifications for the primary treatment within filter strips.

Table 7.3. Vegetated Filter Strip Materials Specifications

Material	Specification	Quantity
Gravel Diaphragm	Size of the stone used shall be sized based on the flow at a 10-year storm event.	Diaphragm should be 2 feet wide, 1 foot deep, and at least 3 inches below the edge of pavement.
Permeable Berm	40% excavated soil, 40% sand, and 20% gravel to serve as the media for the berm.	
Geotextile	Needled, non-woven, polypropylene geotextile meeting the following specifications: Grab Tensile Strength (ASTM D4632): > 120 lbs. Mullen Burst Strength (ASTM D3786): > 225 lbs./sq. in. Flow Rate (ASTM D4491): > 125 gpm/sq. ft. Apparent Opening Size (ASTM D4751): US #70 or #80 sieve	
Engineered Level Spreader	Level Spreader lip should be concrete, metal, or other rigid material; Reinforced channel on upstream of lip.	

Erosion Control Fabric or Matting	Where flow velocities dictate, use woven biodegradable erosion control fabric or mats that are durable enough to last at least 2 growing seasons.
Topsoil	If existing topsoil is inadequate to support dense turf growth, imported top soil (loamy sand or sandy loam texture), with less than 5% clay content, corrected pH at 6 to 7, a soluble salt content not exceeding 500 ppm, and an organic matter content of at least 2% shall be used. Topsoil shall be uniformly distributed and lightly compacted to a minimum depth of 6 to 8 inches
Compost	Compost shall be derived from plant material and provided by a member of the U.S. Composting Seal of Testing Assurance (STA) program, as outlined in **Appendix 7-A**.

SECTION 7: CONSTRUCTION

7.1 CONSTRUCTION SEQUENCE FOR CONSERVED OPEN SPACE AREAS

The conserved open space must be fully protected during the construction stage of development and kept outside the limits of disturbance on the Erosion Prevention and Sediment Control (EPSC) Plan.

- No clearing, grading or heavy equipment access is allowed except temporary disturbances associated with incidental utility construction, restoration operations or management of nuisance vegetation.
- The perimeter of the conserved open space shall be protected by a silt fence, chain link fence, orange safety fence, or other measures in order to meet stormwater pollution prevention sediment discharge requirements.
- The limits of disturbance should be clearly shown on site development plans, grading permit applications and/or concept plans and identified and shall be clearly marked in the field.
- Construction of the gravel diaphragm or engineered level spreader shall not commence until the contributing drainage area has been stabilized and perimeter EPSC has been removed and cleaned out.
- Some light grading may be needed at the filter strip boundary; this should be done with tracked vehicles to prevent compaction.
- Stormwater should not be diverted into the vegetated filter strip until the gravel diaphragm and/or level spreader are installed and stabilized.

7.2 CONSTRUCTION SEQUENCE FOR VEGETATED FILTER STRIPS

Vegetated filter strips can be within the limits of disturbance during construction. The following procedures should be followed during construction:

- Before site work begins, vegetated filter strip boundaries should be clearly marked.
- Only vehicular traffic used for filter strip construction should be allowed within 10 feet of the filter strip boundary.
- If existing topsoil is stripped during grading, it shall be stockpiled for later use.
- Construction runoff should be directed away from the proposed filter strip site, using perimeter silt fence, or, preferably, a diversion dike.
- Construction of the gravel diaphragm or engineered level spreader shall not commence until the contributing drainage area has been stabilized and perimeter EPSC has been removed and cleaned out.
- Vegetated filter strips require light grading to achieve desired elevations and slopes. This should be done with tracked vehicles to prevent compaction. Topsoil and or compost amendments should be incorporated evenly across the filter strip area, stabilized with seed, and protected by biodegradable erosion control matting or blankets.
- Stormwater should not be diverted into the filter strip until the turf cover is dense and well established.

7.3 CONSTRUCTION INSPECTION

Construction inspection is critical to obtain adequate spot elevations, to ensure the gravel diaphragm or engineered level spreader is completely level, on the same contour and constructed to the correct design elevation. As-built certification is required to ensure compliance with design standards. Inspectors should evaluate the performance of the Filter Strip after the first big storm to look for evidence of gullies, outflanking, undercutting or sparse vegetative cover. Spot repairs should be made, as needed.

SECTION 8. AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 9. MAINTENANCE

9.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

Any sheet flow GIP shall be covered by a green infrastructure easement to allow inspection and maintenance and be included in the site's LTMP to ensure that no future development, disturbance or clearing may occur within the area, except as stipulated in the vegetation maintenance plan.

9.2 MAINTENANCE INSPECTIONS

Annual inspections are used to trigger maintenance operations such as sediment removal, spot re-vegetation and level spreader repair. Ideally, inspections should be conducted in the non-growing season when it easier to see the flow path.

Inspectors should check to ensure that:

- Flows through the filter strip do not short-circuit the overflow control section;
- Debris and sediment does not build up at the top of the filter strip;
- Foot or vehicular traffic does not compromise the gravel diaphragm;
- Scour and erosion do not occur within the filter strip;
- Sediments are cleaned out of level spreader forebays and flow splitters; and
- Vegetative density exceeds a 90% cover in the boundary zone or grass filter.

9.3 ONGOING MAINTENANCE

Once established, vegetated filter strips have minimal maintenance needs outside of the spring clean-up, regular mowing, repair of check dams and other measures to maintain the hydraulic efficiency of the strip and a dense, healthy grass cover. Vegetated filter strips that consist of grass/turf cover should be mowed at least twice a year to prevent woody growth. Vegetated filter strips within the riparian buffer are no touch, no disturb. No vegetation maintenance activities shall be performed within the riparian buffer.

APPENDIX 7-A

DESIGN CRITERIA FOR AMENDING SOILS WITH COMPOST

SECTION 1: DESCRIPTION

Soil restoration is a practice applied after construction, to deeply till compacted soils and restore their porosity by amending them with compost. These soil amendments can reduce the generation of runoff from compacted urban lawns and may also be used to enhance the runoff reduction performance of filter strips.

SECTION 2: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

Compost amended soils are suitable for any pervious area where soils have been or will be compacted by the grading and construction process. They are particularly well suited when existing soils have low infiltration rates (HSG C and D) and when the pervious area will be used to filter runoff. The area or strip of amended soils should be hydraulically connected to the stormwater conveyance system. Soil restoration is recommended for sites that will experience mass grading of more than a foot of cut and fill across the site.

Compost amendments are not recommended where:

- Existing soils have high infiltration rates (e.g., HSG A and B), although compost amendments may be needed at mass-graded B soils in order to maintain runoff reduction rates.
- The water table or bedrock is located within 1.5 feet of the soil surface.
- Slopes exceed 10%.
- Existing soils are saturated or seasonally wet.
- They would harm roots of existing trees (keep amendments outside the tree drip line).
- The downhill slope runs toward an existing or proposed building foundation.
- The contributing impervious surface area exceeds the surface area of the amended soils.

Compost amendments can be applied to the entire pervious area of a development or be applied only to select areas of the site to enhance the performance of runoff reduction practices. Some common design applications include:

- Reduce runoff from compacted lawns.
- Increase runoff reduction within a vegetated filter strip.
- Increase the runoff reduction function of a tree cluster or reforested area of the site.

SECTION 3: DESIGN CRITERIA

3.1 SOIL TESTING

Soil tests are required during two stages of the compost amendment process. The first testing is done to ascertain pre-construction soil properties at proposed amendment areas. The initial testing is used to determine soil properties to a depth 1 foot below the proposed amendment area, with respect to bulk density, pH, salts, and soil nutrients. These tests should be conducted every 5,000 square feet, and are used to characterize potential drainage problems and determine what, if any, further soil amendments are needed.

The second soil test is taken at least one week after the compost has been incorporated into the soils. This soil analysis should be conducted by a reputable laboratory to determine whether any further nutritional requirements,

pH adjustment, and organic matter adjustments are necessary for plant growth. This soil analysis should be done in conjunction with the final construction inspection to ensure tilling or subsoiling has achieved design depths.

3.2 DETERMINING DEPTH OF COMPOST INCORPORATION

The depth of compost amendment is based on the relationship of the surface area of the soil amendment to the contributing area of impervious cover that it receives. **Table 7-A.1** presents some general guidance derived from soil modeling by Holman-Dodds (2004) that evaluates the required depth to which compost must be incorporated. Some adjustments to the recommended incorporation depth were made to reflect alternative recommendations of Roa Espinosa (2006), Balousek (2003), Chollak and Rosenfeld (1998) and others.

Table 7-A.1. Short-Cut Method to Determine Compost and Incorporation Depths

	Contributing Impervious Cover to Soil Amendment Area Ratio [1]			
	IC/SA = 0 [2]	IC/SA = 0.5	IC/SA = 0.75	IC/SA = 1.0 [3]
Compost (in) [4]	2 to 4 [5]	3 to 6 [5]	4 to 8 [5]	6 to 10 [5]
Incorporation Depth (in)	6 to 10 [5]	8 to 12 [5]	15 to 18 [5]	18 to 24 [5]
Incorporation Method	Rototiller	Tiller	Subsoiler	Subsoiler

Notes:

[1] IC = contrib. impervious cover (sq. ft.) and SA = surface area of compost amendment (sq. ft.)

[2] For amendment of compacted lawns that do not receive off-site runoff

[3] In general, IC/SA ratios greater than 1 should be avoided

[4] Average depth of compost added

[5] Lower end for B soils, higher end for C/D soils

Once the area and depth of the compost amendments are known, the designer can estimate the total amount of compost needed using the following estimator:

Equation 7.1. Compost Quantity Estimation

$$C = A * D * 0.0031$$

Where:

C	=	compost needed (cu. yds.)
A	=	area of soil amended (sq. ft.)
D	=	depth of compost added (in.)

3.3 COMPOST SPECIFICATIONS

The basic material specifications for compost amendments are outlined below:

- The compost shall be the result of the biological degradation and transformation of plant-derived materials under conditions that promote anaerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have a moisture content that has no visible free water or dust produced when handling the material. It shall meet the following criteria:

  a. 100% of the material must pass through a half inch screen
  b. The pH of the material shall be between 6 and 8
  c. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight
  d. The organic matter content shall be between 35% and 65%
  e. Soluble salt content shall be less than 6.0 mmhos/cm
  f. Maturity should be greater than 80%
  g. Stability shall be 7 or less
  h. Carbon/nitrogen ratio shall be less than 25:1
  i. Trace metal test result = "pass"
  j. The compost must have a dry bulk density ranging from 40 to 50 lbs./cu.ft.

SECTION 4: CONSTRUCTION

4.1 CONSTRUCTION SEQUENCE

The construction sequence for compost amendments differs depending whether the practice will be applied to a large area or a narrow filter strip. For larger areas, a typical construction sequence is as follows:

Step 1. Prior to building, the proposed area should be deep tilled to a depth of 2 to 3 feet using a tractor and sub-soiler with two deep shanks (curved metal bars) to create rips perpendicular to the direction of flow. (This step is usually omitted when compost is used for narrower filter strips.)

Step 2. A second deep tilling to a depth of 12 to 18 inches is needed after final building lots have been graded.

Step 3. It is important to have dry conditions at the site prior to incorporating compost.

Step 4. An acceptable compost mix is then incorporated into the soil using a roto-tiller or similar equipment at the volumetric rate of 1 part compost to 2 parts soil.

Step 5. The site should be leveled and seeds or sod used to establish a vigorous grass cover. Lime or irrigation may initially be needed to help the grass grow quickly.

Step 6. Areas of compost amendments exceeding 2500 square feet should employ simple erosion control measures, such as silt fence, to reduce the potential for erosion and trap sediment.

Reforestation

Description: Reforestation refers to trees planted in groups in urban areas such as: parking lots, right of ways (ROW), parks, schools, public lands, vacant land, and neighborhood open spaces, to provide shade and stormwater retention and to add aesthetic value.

Advantages/Benefits:

- Reduces effective impervious cover
- Reduces stormwater runoff
- Provides aesthetic value
- Provides rainfall interception
- Shade provides cooling and energy savings
- Provides habitat
- Provides pollutant removal
- Provides flow attenuation

Disadvantages/Limitations:

- Poor quality urban soils may require soil amendments or remediation
- Long-term maintenance is required for high tree survival rates
- Must be implemented over large areas to see significant reduction in stormwater runoff
- Time required for trees to mature
- Poor soils, improper planting methods, conflicts with paved areas and utilities, inputs from road salt, lack of water, or disease can lead to low survival rate
- Reforestation not allowed in riparian buffers

Design Considerations:

- Stormwater trees are limited to areas where there is enough space for fully grown trees as well as utilities and a separation distance from structures.
- Tree species with desirable stormwater control characteristics should be utilized. For trees receiving runoff, tree species must have a high tolerance for common urban pollutants. This includes salt tolerance if receiving runoff from areas treated for snow and ice. References for appropriate tree selection are included in **Table 8.2**.
- Soils play a significant role in pollutant removal and tree health. Selection of soils intended to improve stormwater controls should allow water to infiltrate into the soil, with planting soil characteristics and volume tailored to meet the needs of a healthy tree.
- Credit is subject to City approval.

Selection Criteria:

Twice the forest Rv factor for the corresponding soil type.

Equal to the forest Rv factor if amended soils are used in conjunction with reforestation.

***This GIP is subject to City approval**

Land Use Considerations:

X	**Residential**
X	**Commercial**
X	**Industrial**

Maintenance:

- Trees may require irrigation in dry periods

L	**Maintenance Burden** L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

Site reforestation involves planting trees at a development site with the explicit goal of establishing a natural forest canopy that will intercept rainfall, increase evapotranspiration rates, and enhance soil infiltration rates. Reforestation is subject to approval from the City Engineer.

SECTION 2: PERFORMANCE

The overall runoff reduction credits for reforestation through lower runoff coefficients are summarized in **Table 8.1**.

Table 8.1. Reforestation Runoff Coefficient Credit

Level 1 Design				**Level 2 Design**			
Twice the forest Rv factor for the corresponding soil type.				Equal to forest Rv factor if Amended Soils (See **GIP-07 A-7**) are used in conjunction.			
A	B	C	D	A	B	C	D
0.04	0.06	0.08	0.10	0.02	0.03	0.04	0.05
Impervious area may be routed to the reforestation area following the guidance and applying the Runoff Coefficient Credits detailed in **GIP-07**. The reforestation area should be treated as a vegetated filter strip for the application of this GIP.							

SECTION 3: DESIGN TABLE

The overall runoff reduction credits for reforestation through lower runoff coefficients are summarized in **Table 8.2.**

Table 8.2. Design Specifications for Reforestation	
Item	**Specifications for Level 1 and Level 2**
Area	Minimum contiguous area of 5,000 sq. ft.
Tree Type	No more than 20% of any single tree species. Consider composition of local forests in planting design. 2/3 of trees must be large canopy. See the USGS landfire map for delineation of forest type and the 2006 Descriptions of Ecological Systems for Modeling of LANDFIRE Biophysical Settings Ecological Systems of location US State TN. PFD for description of species within each forest type. Links: http://landfire.cr.usgs.gov/viewer/ http://www.tn.gov/environment/na/pdf/tn_eco_systems.pdf http://www.se-eppc.org/pubs/middle.pdf
Density	• 300 large canopy trees – species that normally achieve an overall height at maturity of thirty feet or more per acre • 10 shrubs substitute for 1 large canopy tree • 2 small canopy trees substitute for 1 large canopy tree Note: Adjustments to densities may be possible with CITY approval.
Canopy Rate	Achieve 75% forest canopy within first 10 years
Size	Tree - Minimum tree size 6-8 ft in height Shrub – 18-24 inches or 3 gallon size
Ground Cover	Entire area should be covered with 2-4 inches of organic mulch or a native seed mix

Reforestation areas are eligible under the following qualifying conditions:

- The minimum contiguous area of reforestation must be greater than 5,000 square feet, with no more than 20% of the area in any single tree species. The basic density of plantings is 300 large canopy trees per acre, approximately 12 feet on center. When shrubs are substituted for trees, there must be 10 shrubs per one large canopy tree. Two small canopy trees, such as Dogwoods or Red Buds, may be substituted for one large canopy tree. Adjustments can be made to these densities for areas of urban reforestation with the approval of the City. Reforestation should consider the composition of area forests, and two thirds of selected trees must be large canopy. Reforestation methods should achieve 75% forest canopy within ten years.
- The minimum size requirement for reforestation is saplings 6-8 feet in height. The minimum size requirement for shrubs is 18-24 inches, or 3 gallon size. In addition, the entire reforestation should be covered with 2-4 inches of organic mulch or with a native seed mix in order to help retain moisture and provide a beneficial environment for the reforestation.
- A long-term vegetation management plan must be prepared and filed with the City in order to demonstrate the ability to maintain the reforestation area in an appropriate forest canopy condition. The plan should include a scale drawing showing the area to be planted, along with a plant list which includes species, size, number, and packaging. In addition, the reforestation area shall be clearly identified on all construction drawings and EPSC plans during construction.
- The reforestation area must be protected by a perpetual stormwater easement or deed restriction which stipulates that no future development or disturbance may occur within the area.
- The planting plan must be approved by the City, including any special site preparation needs.
- The construction contract should contain a care and replacement warranty extending at least two growing seasons, to ensure adequate growth and survival of the plant community.

- The final size of the trees should be considered when designing the planting plan. Tennessee One-Call (811) must be contacted prior to the submission of the planting plan to ensure that no utilities will be impacted by the tree planting. The planting plan must also avoid placing trees under overhead utilities.
- If using the reforestation area as a vegetated filter strip to receive additional credit under **GIP-07**, follow all GIP design criteria and ensure that additional routed runoff does not cause erosion or degrade the quality of ground cover.

SECTION 4: DESIGN CONSIDERATIONS

Trees are often one of the most economical stormwater BMPs that can be introduced into urban ROWs. Tree canopies intercept rainfall before it becomes stormwater and the tree boxes into which trees are planted can be used to capture and treat runoff. Trees also reduce the urban heat island effect, improve the urban aesthetic and improve air quality. Data and modeling show that urban trees can remove over 50% of the moisture in the soil beneath their canopy. Refer to **Table 8.2** for native tree species. A list of native trees is also provided in **Appendix C**.

Tree plantings within the ROW must receive approval from Public Works. Vacant residential lots also provide reforestation opportunities. These lots can become an urban forest and an amenity to a neighborhood. Vegetation management plans must account for City rules, regulations, and codes regarding overgrown lots and safety concerns of the residents. Special criteria for reforesting empty residential lots include:

- The area between curb and sidewalk and a 10 foot wide buffer adjacent to the sidewalk (away from the street) shall be kept mowed and clear.
- While the trees are being established, mowing is permitted between the trees. Eventually, the canopy should shade out the grass and forest undergrowth will be established. Vegetation management plans should consider if residents would prefer the site mowed in perpetuity.

SECTION 5: DESIGN CRITERIA

5.1 RUNOFF REDUCTION CALCULATIONS

Level 1 Reforestation involves using soil types currently on a site, without soil amendments. Current soil should be preserved from compaction and disturbance during construction and should be clearly identified on all construction drawings and EPSC plans. Trees should be planted following tree selection criteria in **Table 8.2**. Use **Table 8.1** to find Rv factors for Level 1 which equal twice the forested area Rv factors.

Level 2 Reforestation requires the use of amended soils. Soil Amendment guidance is located in **GIP-07 7-A**. This area is then treated as original forested area for calculation purposes. Level 2 design allows for use of Forested Rv factors as shown in **Table 8.1**.

For both levels, once the forest area R_V is determined continue through the design process with weighted R_V calculations located in **Section 1 Chapter 3** of the Manual.

SECTION 6: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix, as required components of the as-built differ from measure to measure.

SECTION 7: MAINTENANCE

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the long term maintenance plan and agreement.

Mowing is not permitted in reforestation areas. The credit is based on a natural successional forest ecosystem undisturbed by man.

Additional maintenance activities include:

- Watering the trees as needed during dry periods
- Repairing areas of erosion or reseeding areas that are bare
- Removing trash and debris from area
- Replanting any trees that die throughout the year. (The construction contract should contain a care and replacement warranty extending at least two growing seasons, to ensure adequate growth and survival of the plant community.)

Green Roof

Description: A green roof is a layer of vegetation installed on top of a conventional flat or slightly sloped roof that consists of waterproofing material, root permeable filter fabric, growing media, and specially-selected plants.

Variations:

- Extensive green roofs have a thin layer of growing medium and are usually composed of sedums.
- Intensive green roofs have a thicker layer of growing medium and contain shrubs, trees and other vegetation.

Advantages/Benefits:

- Runoff volume reduction
- Provides flow attenuation
- Extends the life of a conventional roof by up to 20 yrs.
- Provides increased insulation and energy savings
- Reduces air pollution
- Provides habitat for wildlife
- Increases aesthetic value
- Provides sound insulation
- Provides water quality treatment
- Reduces urban heat island effect

Disadvantages/Limitations:

- Cost may be greater than a conventional roof, and feasibility is limited by load-bearing capacity of roof
- Must obtain necessary permits and comply with local building codes
- Requires more maintenance than a conventional roof
- Plant survival and waterproofing are potential issues
- May require irrigation

Selection Criteria:

LEVEL 1 – 80% Runoff Reduction Credit

LEVEL 2 – 90% Runoff Reduction Credit

Land Use Considerations:

[X] **Residential**

[X] **Commercial**

[X] **Industrial**

Maintenance:

- May include watering, fertilizing, and weeding, typically greatest in the first two years when plants are becoming established.
- Maintenance largely depends on the type of green roof system installed and the type of vegetation planted.

[M] **Maintenance Burden**
L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

Vegetated roofs (also known as *green roofs, living roofs* or *ecoroofs*) are alternative roof surfaces that typically consist of waterproofing, drainage materials and an engineered growing media that is designed to support plant growth. Vegetated roofs capture and temporarily store stormwater runoff in the growing media before it is conveyed into the storm drain system. A portion of the captured stormwater evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates and pollutant loads on development sites.

There are two different types of vegetated roof systems: *intensive* vegetated roofs and *extensive* vegetated roofs. Intensive systems have a deeper growing media layer that ranges from 6 inches to 4 feet thick, which is planted with a wider variety of plants, including trees. By contrast, extensive systems typically have much shallower growing media (under 6 inches), which is planted with carefully selected drought tolerant vegetation. Extensive vegetated roofs are much lighter and less expensive than intensive vegetated roofs and are recommended for use on most development and redevelopment sites.

NOTE: This specification is intended for situations where the primary design objective of the vegetated roof is stormwater management and, unless specified otherwise, addresses extensive roof systems.

Designers may wish to pursue other design objectives for vegetated roofs, such as energy efficiency, green building or LEED points, architectural considerations, visual amenities and landscaping features, which are often maximized with intensive vegetated roof systems. However, these design objectives are beyond the scope of this specification.

Vegetated roofs typically contain a layered system of roofing, which is designed to support plant growth and retain water for plant uptake while preventing ponding on the roof surface. The roofs are designed so that water drains vertically through the media and then horizontally along a waterproofing layer toward the outlet. Extensive vegetated roofs are designed to minimize maintenance requirements. Plant species are selected so that the roof does not need supplemental irrigation or fertilization after vegetation is initially established. Tray systems are also available with removable dividers which allow the media to meld together, creating a seamless appearance but reducing difficulty in construction.

SECTION 2: PERFORMANCE

The overall stormwater functions of vegetated roofs are summarized in **Table 9.1**.

Table 9.1: Runoff Volume Reduction Provided by Vegetated Roofs

Stormwater Function	Level 1 Design	Level 2 Design
Runoff Volume Reduction (RR)	80%	90%

SECTION 3: DESIGN TABLE

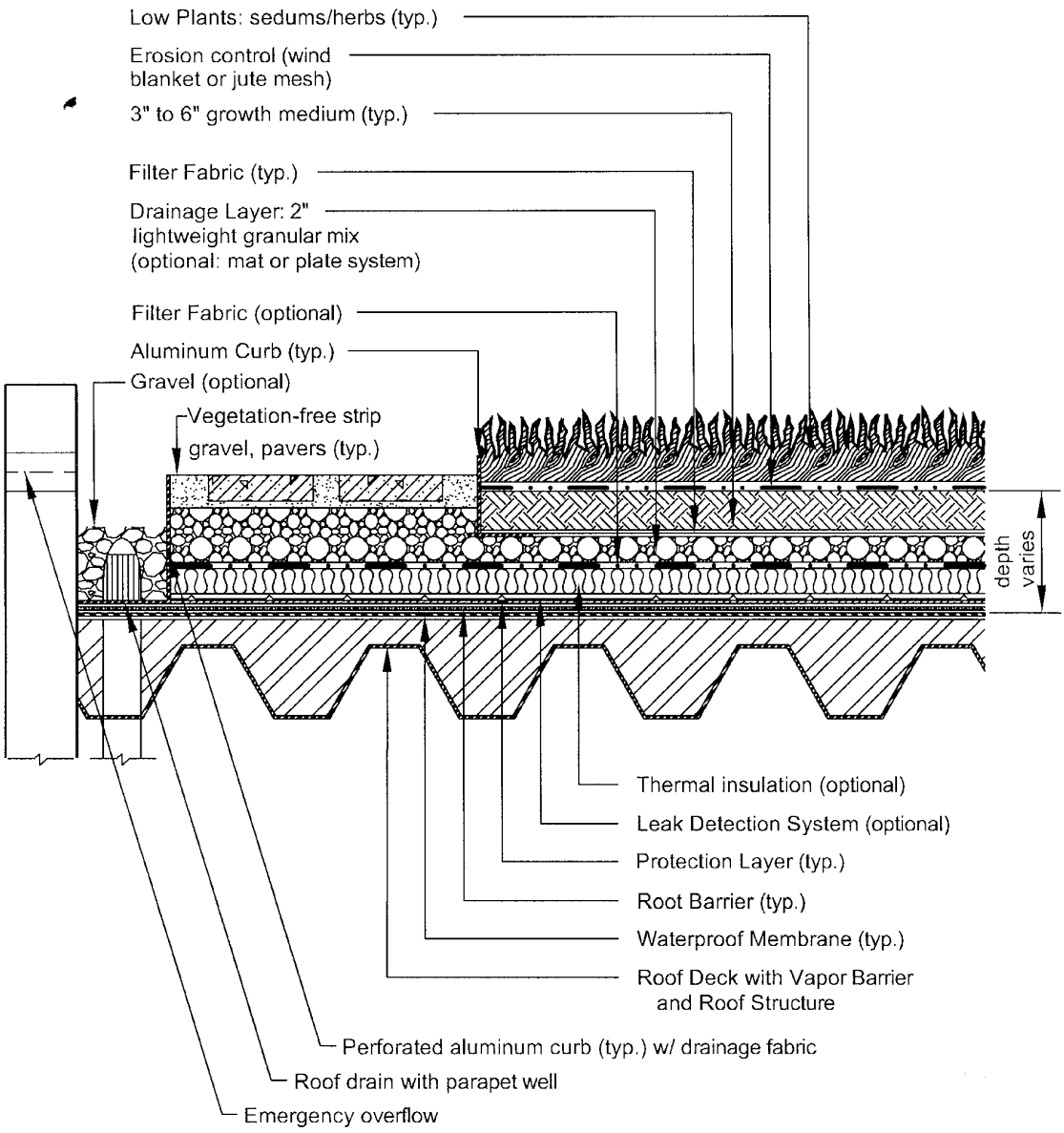
The major design goal for vegetated roofs is to maximize runoff volume reduction. The rooftops have little TSS loading or loading removal. Designers may choose the baseline design (Level 1) or choose an enhanced (Level 2) design that maximizes nutrient and runoff reduction. In general, most intensive vegetated roof designs will automatically qualify as being Level 2. **Table 9.2** lists the design criteria for Level 1 and 2 designs.

Table 9.2: Green Roof Design Guidance	
Level 1 Design (RR:80)	**Level 2 Design (RR: 90)**
Tv = 1.0 (Rv)[1] (A)/12	Tv = 1.1 (Rv) [1] (A)/12
Depth of media up to 6 inches	Media depth > 6 inches
No more than 15% organic matter in media	No more than 15% organic matter in media
All Designs: Must be in conformance to ASTM (2005) International Green (Vegetated) Roof Standards.	

[1]Rv represents the runoff coefficient for a conventional roof, which will usually be 0.95. The runoff reduction rate applied to the vegetated roof is for "capturing" the Treatment Volume (Tv) compared to what a conventional roof would produce as runoff.

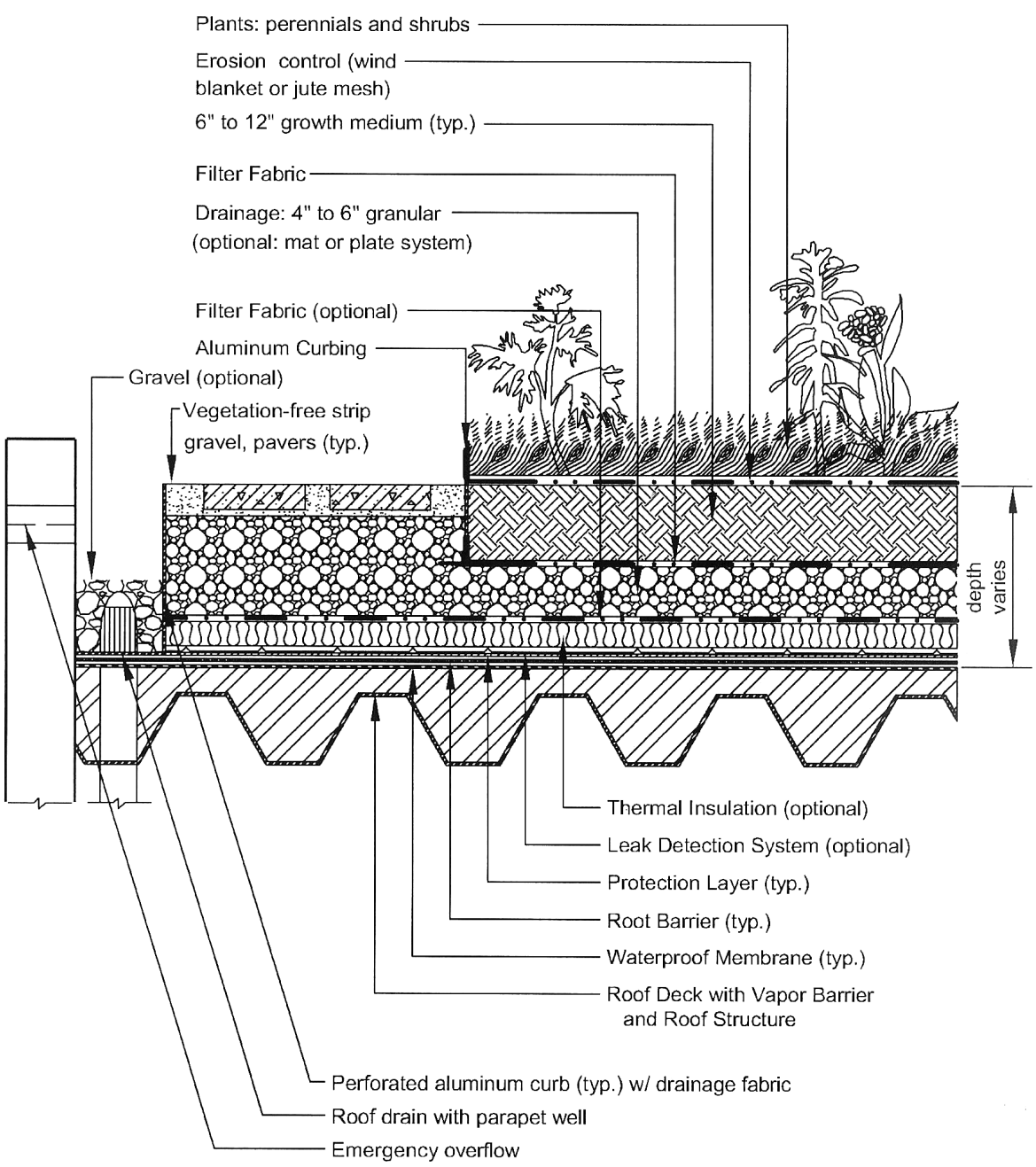
SECTION 4: TYPICAL DETAILS

Figure 9.1. Photos of Vegetated Roof Cross-Sections (source: B. Hunt, NCSU)



CROSS SECTION VIEW (NTS)

Figure 9.2. Typical Section – Extensive Vegetated Roof (Source: Northern VA Regional Commission)



CROSS SECTION (NTS)

Figure 9.3. Typical Section – Intensive Vegetated Roof (Source: Northern VA Regional Commission)

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

5.1 TYPICAL APPLICATIONS

Vegetated roofs are ideal for use on commercial, institutional, municipal and multi-family residential buildings. They are particularly well suited for use on ultra-urban development and redevelopment sites. Vegetated roofs can be used on a variety of rooftops, including the following:

- Non-residential buildings (e.g. commercial, industrial, institutional and transportation uses)
- Multi-family residential buildings (e.g. condominiums or apartments)
- Mixed-use buildings

5.2 COMMON SITE CONSTRAINTS

Building Codes. The vegetated roof design should comply with the City Building Codes with respect to roof drains and emergency overflow devices. If the green roof is designed to be accessible, the access must not only be convenient for installation and maintenance purposes, but also must adhere to City Building Codes and other regulations for access and safety.

Non-Vegetated Areas. Roof access paths, mechanical equipment, photovoltaic panels, and skylights are counted as part of the green roof for calculation purposes. These areas should not exceed 20% of the roof area counted as green roof.

Retrofitting Green Roofs. Key feasibility factors to consider when evaluating a retrofit include the area, age and accessibility of the existing roof, and the capability of the building's owners to maintain it. Options for green roof retrofits are described in Profile Sheet RR-3 of Schueler et al (2007). The structural capacity of the existing rooftop can be a major constraint to a green roof retrofit.

Risks of Leaky Roofs. Although well-designed and installed green roofs have less problems with roof leaks than traditional roofs, there is a perception among property managers, insurers and product fabricators that this emerging technology could have a greater risk of problems. For an excellent discussion on how to properly manage risk in vegetated roof installations, see Chapter 9 in Weiler and Scholz-Barth (2009).

Roof Access. Adequate access to the roof must be available to deliver construction materials and perform routine maintenance. Roof access can be achieved either by an interior stairway, through a penthouse or by an alternating tread device with a roof hatch or trap door not less than 16 square feet in area and with a minimum dimension of 24 inches. Designers should also consider how they will get construction materials up to the roof (e.g., by elevator or crane), and how construction materials will be stockpiled in the confined space.

Roof Pitch. Treatment volume (Tv) is maximized on relatively flat roofs (a pitch of 1 to 2%). Some pitch is needed to promote positive drainage and prevent ponding and/or saturation of the growing media. Vegetated roofs can be installed on rooftops with slopes up to 25% if baffles, grids, or strips are used to prevent slippage of the media. The effective Tv, however, diminishes on rooftops with steep pitches.

Roof Type. Vegetated roofs can be applied to most roof surfaces, although concrete roof decks are preferred. Certain roof materials, such as exposed treated wood and uncoated galvanized metal, may not be appropriate for vegetated rooftops due to pollutant leaching through the media.

Structural Capacity of the Roof. When designing a vegetated roof, designers must not only consider the stormwater storage capacity of the vegetated roof, but also its structural capacity to support the weight of the additional water. A conventional rooftop typically must be designed to support an additional 15 to 30 pounds per square foot for an extensive vegetated roof. As a result, a structural engineer, architect or other qualified professional shall be involved with all vegetated roof designs to ensure that the building is structurally sound.

SECTION 6: DESIGN CRITERIA

6.1 OVERALL SIZING

Vegetated roof areas should be sized to capture a portion of the Treatment Volume (Tv). The required size of a vegetated roof will depend on several factors, including the porosity and hydraulic conductivity of the growing media and the underlying drainage materials. Site designers and planners should consult with vegetated roof manufacturers and material suppliers for specific sizing guidelines. As a general sizing rule, the following equation can be used to determine the water quality treatment storage volume retained by a vegetated roof:

Equation 9.1. Treatment Volume for Green Roof

$$T_v = (RA * D * n)/12$$

Where,

T_v = storage volume (cu. ft.)
RA = vegetated roof area (sq. ft.)
D = media depth (in.)
n = media porosity (usually 0.3, but consult manufacturer specifications)

The resulting Tv can then be compared to the required Tv for the entire rooftop area (including all non-vegetated areas) to determine if it meets or exceeds the required Tv for Level 1 or Level 2 design, as shown in **Table 9.2**.

6.2 STRUCTURAL CAPACITY OF THE ROOF

Vegetated roofs can be limited by the additional weight of the fully saturated growing medium and plants, in terms of the physical capacity of the roof to bear structural loads. The designer should consult with a licensed structural engineer or architect to ensure that the building will be able to support the additional live and dead structural load and determine the maximum depth of the vegetated roof system and any needed structural reinforcement.

In most cases, fully-saturated extensive vegetated roofs have a maximum load of about 30 psf, which is fairly similar to traditional new rooftops (12 to 15 psf.) that have a waterproofing layer anchored with stone ballast. For an excellent discussion of vegetated roof structural design issues, consult Chapter 9 in Weiler and Scholz-Barth (2009) and ASTM E2397, *Standard Practice for Determination of Dead Loads and Live Loads Associated with Green (Vegetated) Roof Systems*.

6.3 FUNCTIONAL ELEMENTS OF A VEGETATED ROOF SYSTEM

A vegetated roof is composed of up to eight different systems or layers, from bottom to top, that are combined together to protect the roof and maintain a vigorous cover. Designers can employ a wide range of materials for each layer, which can differ in cost, performance, and structural load. The entire system as a whole must be assessed to meet design requirements. Some manufacturers offer proprietary vegetated roofing systems, whereas in other cases, the designer or architect must assemble their own system, in which case they are advised to consult Weiler and Scholz-Barth (2009), Snodgrass and Snodgrass (2006) and Dunnett and Kingsbury (2004).

1. ***Deck Layer.*** The roof deck layer is the foundation of a vegetated roof. It and may be composed of concrete, wood, metal, plastic, gypsum or a composite material. The type of deck material determines the

strength, load bearing capacity, longevity and potential need for insulation in the vegetated roof system. In general, concrete decks are preferred for vegetated roofs, although other materials can be used as long as the appropriate system components are matched to them.

2. *Waterproofing Layer.* All vegetated roof systems must include an effective and reliable waterproofing layer to prevent water damage through the deck layer. A wide range of waterproofing materials can be used, including built up roofs, modified bitumen, single-ply, and liquid-applied methods. The waterproofing layer must be 100% waterproof and have an expected lifespan as long as any other element of the vegetated roof system.

3. *Insulation Layer.* Many vegetated rooftops contain an insulation layer, usually located above, but sometimes below, the waterproofing layer. The insulation increases the energy efficiency of the building and/or protects the roof deck (particularly for metal roofs).

4. *Root Barrier (Optional).* The next layer of a vegetated roof system is an optional root barrier that protects the waterproofing membrane from root penetration.. Chemical root barriers or physical root barriers that have been impregnated with pesticides, metals or other chemicals that could leach into stormwater runoff should be avoided.

5. *Drainage Layer and Drainage System.* A drainage layer is then placed between the optional root barrier and the growing media to quickly remove excess water from the vegetation root zone. The drainage layer should consist of synthetic or inorganic materials that can retain water and provide efficient drainage. A wide range of prefabricated water cups or plastic modules can be used, as well as a traditional system of protected roof drains, conductors and roof leaders. The required depth of the drainage layer is governed by both the required stormwater storage capacity and the structural capacity of the rooftop. ASTM E2396 and E2398 can be used to evaluate alternative material specifications.

6. *Root-Permeable Filter Fabric.* A semi-permeable polypropylene filter fabric is normally placed between the drainage layer and the growing media to prevent the media from migrating into the drainage layer and clogging it.

7. *Growing Media.* The next layer in an extensive vegetated roof is the growing media, which is typically 4 to 6 inches deep for extensive roofs and 6 inches or more for intensive roofs. The depth and composition of the media is described in **Section 6.5**.

8. *Plant Cover.* The top layer of a vegetated roof typically consists of slow-growing, shallow-rooted, perennial, succulent plants that can withstand harsh conditions at the roof surface. An experienced design professional should be consulted to select the plant species best suited to a given installation. Guidance on selecting the appropriate vegetated roof plants for hardiness zones in Franklin can be found in Snodgrass and Snodgrass (2006). A mix of base ground covers (usually *Sedum* species) and accent plants can be used to enhance the visual amenity value of a green roof.

6.4 PRETREATMENT

Pretreatment is not needed for green roofs.

6.5 FILTER MEDIA COMPOSITION

The recommended growing media for extensive vegetated roofs is composed of approximately 80% to 90% lightweight inorganic materials, such as expanded slates, shales or clays, pumice, scoria or other similar materials. The remaining media should contain no more than 15% organic matter, normally well-aged

compost. The percentage of organic matter should be limited, since it can leach nutrients into the runoff from the roof and clog the permeable filter fabric. The growing media should have a maximum water retention capacity of around 30%. It is advisable to mix the media in a batch facility prior to delivery to the roof. More information on growing media can be found in Weiler and Scholz-Barth (2009) and Snodgrass and Snodgrass (2006).

The composition of growing media for intensive vegetated roofs may be different, and it is often much greater in depth (e.g., 6 inches to 4 feet). If trees are included in the vegetated roof planting plan, the growing media must provide enough volume for the root structure of mature trees.

6.6 CONVEYANCE AND OVERFLOW

The drainage layer below the growth media should be designed to convey the 10-year storm without backing water up to into the growing media. The drainage layer should convey flow to an outlet or overflow system such as a traditional rooftop drainage system with inlets set slightly above the elevation of the vegetated roof surface. Roof drains immediately adjacent to the growing media should be boxed and protected by flashing extending at least 3 inches above the growing media to prevent clogging.

6.7 VEGETATION AND SURFACE COVER

A planting plan must be prepared for a vegetated roof by a landscape architect, botanist or other professional experienced with vegetated roofs, and it must be reviewed and approved by the City.

Plant selection for vegetated rooftops is an integral design consideration, which is governed by local climate and design objectives. The primary ground cover for most vegetated roof installations is a hardy, low-growing succulent, such as *Sedum, Delosperma, Talinum, Semperivum* or *Hieracium* that is matched to the local climate conditions and can tolerate the difficult growing conditions found on building rooftops (Snodgrass and Snodgrass, 2006). Franklin lies in the transition zone between USDA Plant Hardiness Zones 6 and 7.

Other vegetation considerations:

- Plant choices can be much more diverse for deeper intensive vegetated roof systems. Herbs, forbs, grasses, shrubs and even trees can be used, but designers should understand they have higher watering, weeding and landscape maintenance requirements.
- The species and layout of the planting plan should reflect the location of building, in terms of its height, exposure to wind, snow loading, heat stress, orientation to the sun, and shading by surrounding buildings. In addition, plants should be selected that are fire resistant and able to withstand heat, cold and high winds.
- Designers should also match species to the expected rooting depth of the growing media, which can also provide enough lateral growth to stabilize the growing media surface. The planting plan should usually include several accent plants to provide diversity and seasonal color. For a comprehensive resource on vegetated roof plant selection, consult Snodgrass and Snodgrass (2006).
- It is also important to note that most vegetated roof plant species will *not* be native to the Southeast (which is in contrast to *native* plant recommendations for other stormwater practices, such as bioretention and constructed wetlands).
- Given the limited number of vegetated roof plant nurseries in the region, designers should order plants 6 to 12 months prior to the expected planting date. It is also advisable to have plant materials contract-grown.
- When appropriate species are selected, most vegetated roofs will not require supplemental irrigation, except during the first year that the vegetated roof is being established, or during periods of drought. Irrigation should thus be provided as needed for full establishment and during drought periods. The

planting window extends from the spring to early fall, although it is important to allow plants to root thoroughly before the first killing frost.

- Plants can be established using cuttings, plugs, mats, and, more rarely, seeding or containers. Several vendors also sell mats, rolls, or proprietary vegetated roof planting modules. For the pros and cons of each method, see Snodgrass and Snodgrass (2006).
- The goal for vegetated roof systems designed for stormwater management is to establish a full and vigorous cover of low-maintenance vegetation that is self-sustaining and requires minimal mowing, trimming or weeding.
- The vegetated roof design should include non-vegetated walkways (e.g., permeable paver blocks) to allow for easy access to the roof for weeding and making spot repairs.

6.8 MATERIAL SPECIFICATIONS

Standard specifications for North American vegetated roofs continue to evolve, and no universal material specifications exist that cover the wide range of roof types and system components currently available. The American Society for Testing and Materials (ASTM) has recently issued several overarching vegetated roof standards, which are described and referenced in **Table 9.3**.

Designers and reviewers should also fully understand manufacturer specifications for each system component listed in **Section 6.3**, particularly if they choose to install proprietary "complete" vegetated roof systems or modules.

Table 9.3. Extensive Vegetated Roof Material Specifications

Material	Specification
Roof	Structural Capacity should conform to ASTM E2397-05, *Practice for Determination of Live Loads and Dead Loads Associated with Green (Vegetated) Roof Systems*. In addition, use standard test methods ASTM E2398-05 for *Water Capture and Media Retention of Geocomposite Drain Layers for Green (Vegetated) Roof Systems*, and ASTME 2399-05 for *Maximum Media Density for Dead Load Analysis*.
Waterproof Membrane	See Chapter 6 of Weiler and Scholz-Barth (2009) for waterproofing options that are designed to convey water horizontally across the roof surface to drains or gutter. This layer may sometimes act as a root barrier.
Root Barrier (Optional)	Impermeable liner that impedes root penetration of the membrane.
Drainage Layer	1 to 2 inch layer of clean, washed granular material, such as ASTM D 448 size No. 8 stone. Roof drains and emergency overflow should be designed in accordance with City Codes.
Filter Fabric	Needled, non-woven, polypropylene geotextile. Density (ASTM D3776) > 16 oz./sq. yd., or approved equivalent. Puncture resistance (ASTM D4833) > 220 lbs., or approved equivalent.
Growth Media	85% lightweight inorganic materials and 15% organic matter (e.g. well-aged compost). Media should have a maximum water retention capacity of around 30%. Media should provide sufficient nutrients and water holding capacity to support the proposed plant materials. Determine acceptable saturated water permeability using ASTM E2396-05.
Plant Materials	Low plants such as sedum, herbaceous plants, and perennial grasses that are shallow-rooted, self-sustaining, and tolerant of direct sunlight, drought, wind, and frost. See ASTM E2400-06, *Guide for Selection, Installation and Maintenance of Plants for Green (Vegetated) Roof Systems*.

SECTION 7: CONSTRUCTION

7.1 CONSTRUCTION SEQUENCE

Given the diversity of extensive vegetated roof designs, there is no typical step-by-step construction sequence for proper installation. The following general construction considerations are noted:

- Construct the roof deck with the appropriate slope and material.
- Install the waterproofing method, according to manufacturer's specifications.
- Conduct a flood test to ensure the system is watertight by placing at least 2 inches of water over the membrane for 48 hours to confirm the integrity of the waterproofing system.
- Add additional system components (e.g., insulation, optional root barrier, drainage layer and interior drainage system, and filter fabric), taking care not to damage the waterproofing. Drain collars and protective flashing should be installed to ensure free flow of excess stormwater.
- The growing media should be mixed prior to delivery to the site. Media should be spread evenly over the filter fabric surface. The growing media should be covered until planting to prevent weeds from growing. Sheets of exterior grade plywood can also be laid over the growing media to accommodate foot or wheelbarrow traffic. Foot traffic and equipment traffic should be limited over the growing media to reduce compaction.
- The growing media should be moistened prior to planting, and then planted with the ground cover and other plant materials, per the planting plan, or in accordance with ASTM E2400. Plants should be watered immediately after installation and routinely during establishment.

- It generally takes 12 to 18 months to fully establish the vegetated roof. An initial fertilization using slow release fertilizer (e.g., 14-14-14) with adequate minerals is often needed to support growth. Watering is needed during the first summer. Hand weeding is also critical in the first two years (see Table 10.1 of Weiler and Scholz-Barth, 2009, for a photo guide of common rooftop weeds).
- Most construction contracts should contain a Care and Replacement Warranty that specifies a 75% minimum survival after the first growing season of species planted and a minimum effective vegetative ground cover of 75% for flat roofs and 90% for pitched roofs.

7.2 CONSTRUCTION INSPECTION

Inspections during construction are needed to ensure that the vegetated roof is built in accordance with these specifications. Detailed inspection checklists should be used that include sign-offs by qualified individuals at critical stages of construction and confirm that the contractor's interpretation of the plan is consistent with the intent of the designer and/or manufacturer.

An experienced installer should be retained to construct the vegetated roof system. The vegetated roof should be constructed in sections for easier inspection and maintenance access to the membrane and roof drains. Careful construction supervision is needed during several steps of vegetated roof installation, as follows:

- During placement of the waterproofing layer, to ensure that it is properly installed and watertight;
- During placement of the drainage layer and drainage system;
- During placement of the growing media, to confirm that it meets the specifications and is applied to the correct depth;
- Upon installation of plants, to ensure they conform to the planting plan;
- Before issuing use and occupancy approvals.

SECTION 8: AS-BUILT REQUIREMENTS

As-built and certification requirements can be found in **Appendix D**. Please reference the appendix, as required components of the as-built differ from measure to measure

SECTION 9: MAINTENANCE

9.1 MAINTENANCE DOCUMENT

Each BMP must have a City of Franklin Long Term Maintenance Plan (LTMP) Agreement submitted for approval and maintained and updated by the BMP owner. The LTMP Agreement must be completed and submitted to the City with the grading permit application. The LTMP Agreement is for the use of the BMP owner in performing routine inspections. The developer/owner is responsible for the cost of maintenance and annual inspections. The BMP owner must maintain and update the LTMP Agreement.

9.2 MAINTENANCE INSPECTIONS

A vegetated roof should be inspected twice a year during the growing season to assess vegetative cover, and to look for leaks, drainage problems and any rooftop structural concerns (see **Table 9.4**). In addition, the vegetated roof should be hand-weeded to remove invasive or volunteer plants, and plants/media should be added to repair bare areas (refer to ASTM E2400). Many practitioners also recommend an annual application of slow-release fertilizer in the first few years after the vegetated roof is installed.

9.3 ROUTINE AND NON-ROUTINE MAINTENANCE TASKS

If a roof leak is suspected, it is advisable to perform an electric leak survey (i.e., Electrical Field Vector Mapping) to pinpoint the exact location, make localized repairs, and then reestablish system components and ground cover.

The use of herbicides, insecticides, and fungicides should be avoided, since their presence could hasten degradation of the waterproof membrane. Also, power-washing and other exterior maintenance operations should be avoided so that cleaning agents and other chemicals do not harm the vegetated roof plant communities.

Table 9.4. Typical Maintenance Activities Associated with Green Roofs

Activity	Schedule
Water to promote plant growth and survival.	As needed
Inspect the vegetated roof and replace any dead or dying vegetation.	Following Construction
Inspect the waterproof membrane for leaking or cracks.	Semi-annually
Annual fertilization.	As needed
Weeding to remove invasive plants.	As needed
Inspect roof drains, scuppers and gutters to ensure they are not overgrown or have organic matter deposits. Remove any accumulated organic matter or debris.	Semi-annually
Inspect the green roof for dead, dying or invasive vegetation. Plant replacement vegetation as needed.	As needed

Appendix A

Pretreatment Measures Design Standards

A.1 Pretreatment Forebay

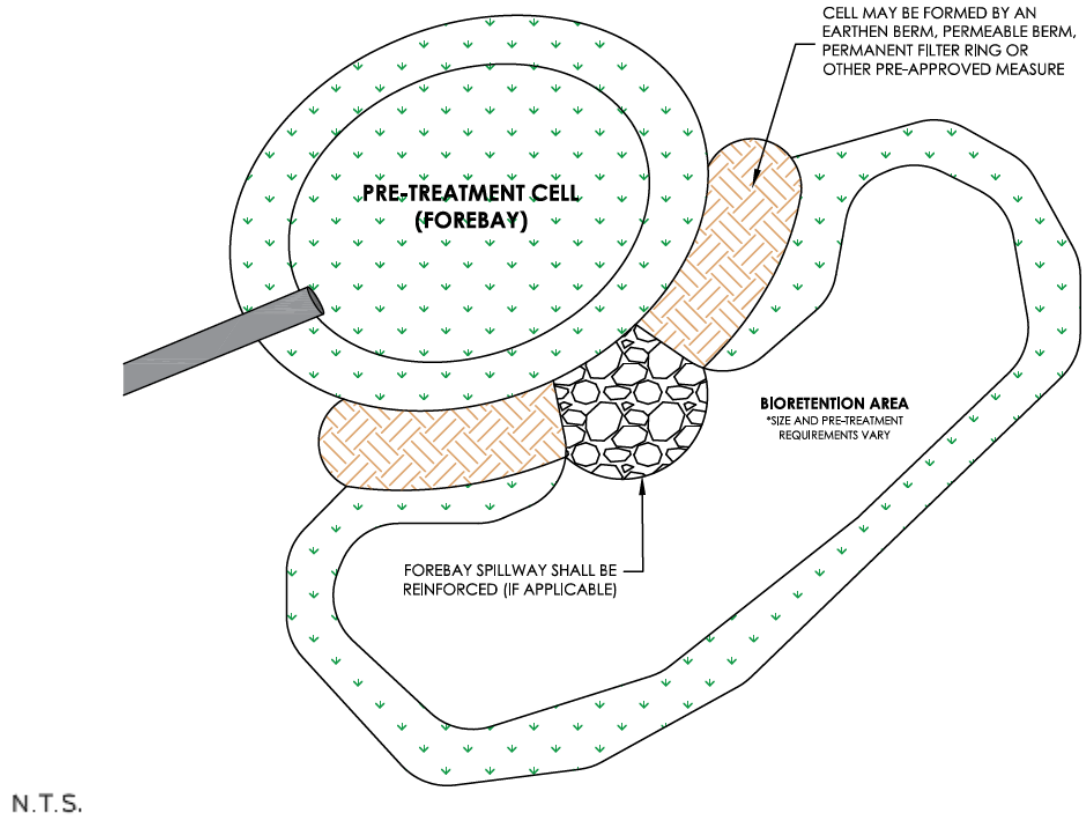


Figure A.1. Pretreatment Forebay Standard Detail

Used in concentrated flow conditions, forebays are located at piped inlets or curb cuts leading to the bioretention area and includes an energy dissipater sized for the expected rates of discharge. Forebays can be hard-lined, with concrete or grouted rip rap, to ease removal of accumulated material. Note that concrete-lined forebays may increase flow velocity without additional energy dissipation measures being incorporated. The forebay shall have a 2:1 length-to-width ratio. The forebay may be formed by a stone check dam or an earthen or rock berm. Pre-treatment forebays should not have underlying engineered soil media, in contrast to the main BMP. The ground surface of the pretreatment forebay should slope 1% towards the BMP to provide positive drainage to the surface of the BMP. Velocities entering the forebay shall be evaluated and additional measures provided as necessary to provide scour protection and energy dissipation through the forebay for the 10-year storm event. Exit velocities from the pretreatment forebay must be non-erosive for the 2-year design storm.

Table A.1. Sizing Requirements based on GIP	
GIP	**Sizing Requirement**
Level 1 Bioretention (GIP-01)	15% of Tv (exclusive)
Level 2 Bioretention (GIP-01)	15% of Tv (exclusive)
Level 1 Infiltration Trench (GIP-04)	15% of Tv (exclusive)
Level 2 Infiltration Trench (GIP-04)	15% of Tv (exclusive)
Water Quality Swale (GIP-05)	15% of Tv (exclusive)

The forebay pre-treatment volume required for concentrated flow entering a bioretention area is not included within the total treatment volume (Tv) required (see Equation A.1). Riprap used for energy dissipation within the forebay shall be sized per TDOT specifications. The treatment volume required for the forebay is computed as follows:

Equation A.1. Example Pretreatment Forebay Treatment Volume Sizing

$$Tv_{Forebay} = Total\ Tv * 0.15\ (level\ 1\ bioretention)$$

Where:

Total Tv = Total required Treatment Volume (cu. ft.)

$Tv_{Forebay}$ = Treatment Volume required for the forebay (see table A.1) (cu. ft.)

A.2 Gravel Flow Spreaders

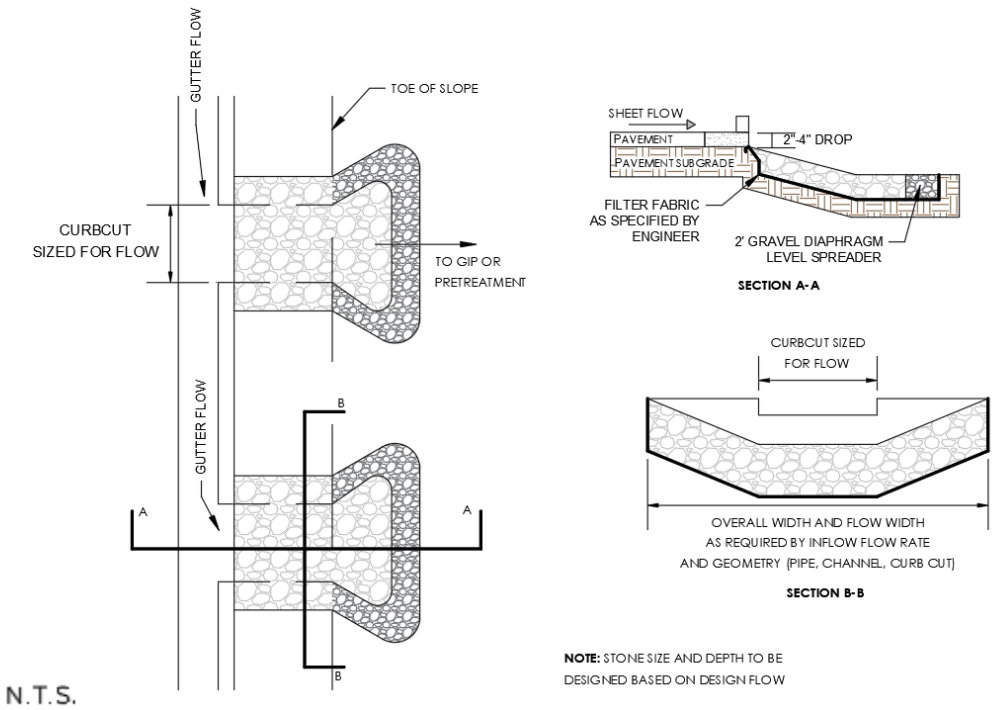


Figure A.2. Gravel Flow Spreader Standard Detail

Used in concentrated flow conditions, the gravel flow spreader is located at curb cuts, downspouts, or other small-scale concentrated inflow points, and should have a 2 to 4-inch elevation drop from a hard-edged surface into a gravel or stone diaphragm. The gravel should extend the entire width of the opening and create a level stone weir at the bottom or treatment elevation of the basin. Exit velocities from the gravel flow spreader must be non-erosive for the 2-year design storm. Gravel flow spreaders can be utilized as a pretreatment measure for the following:

- Bioretention Areas (GIP-01)
- Infiltration Trenches (GIP-04)
- Water Quality Swales (GIP-05)

A.3 Grass Filter Strips

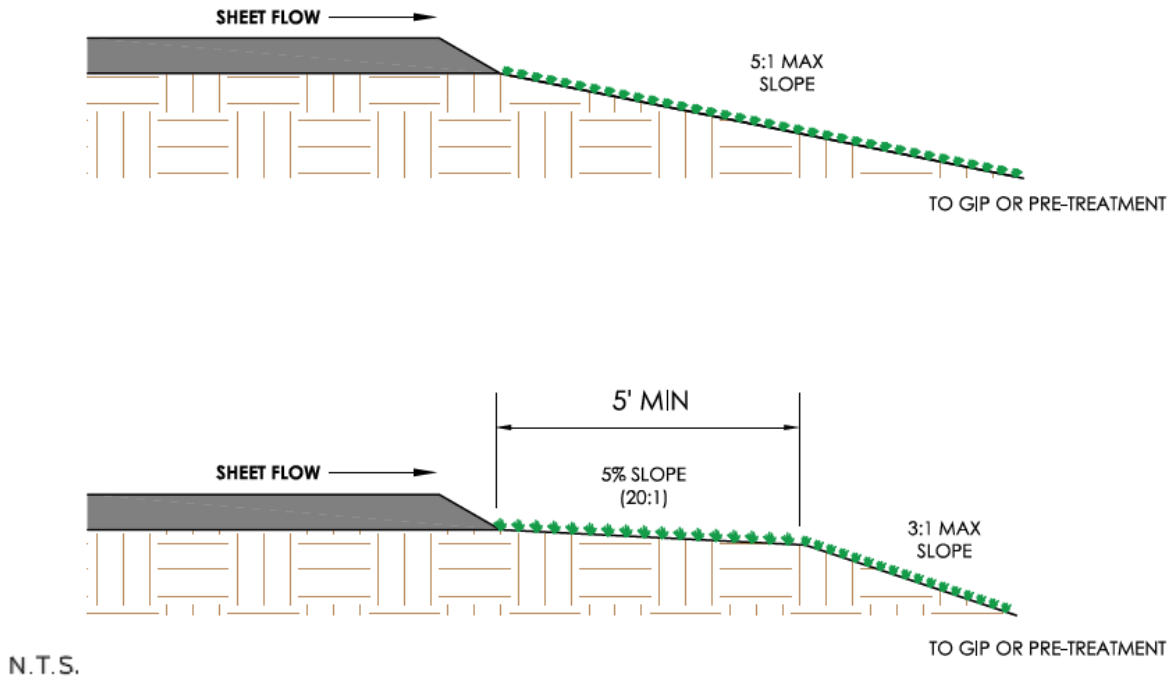


Figure A.3. Grass Filter Strip Standard Detail

Grass filter strips, or vegetated filter strips, can be utilized in sheet flow conditions only. Grass filter strips extend from the edge of pavement to the surface of the BMP at a 5:1 slope or flatter. Alternatively, provide a combined 5 feet of grass filter strip at a maximum 5% (20:1) slope and 3:1 or flatter side slopes on the bioretention basin or water quality swale.

For an infiltration trench receiving sheet flow from an adjacent drainage area, a grass filter strip with a minimum 25-foot length, as measured in the direction of flow, shall be implemented. A grass filter strip around the entire BMP is required if the facility is receiving runoff from both directions.

Grass filter strips are best suited to treat runoff from small catchment areas (less than 5,000 sq. ft. of impervious area.) Filter strips should be seeded, not sodded. If sod is to be used, sod shall be staked.

A.4 Gravel Diaphragm

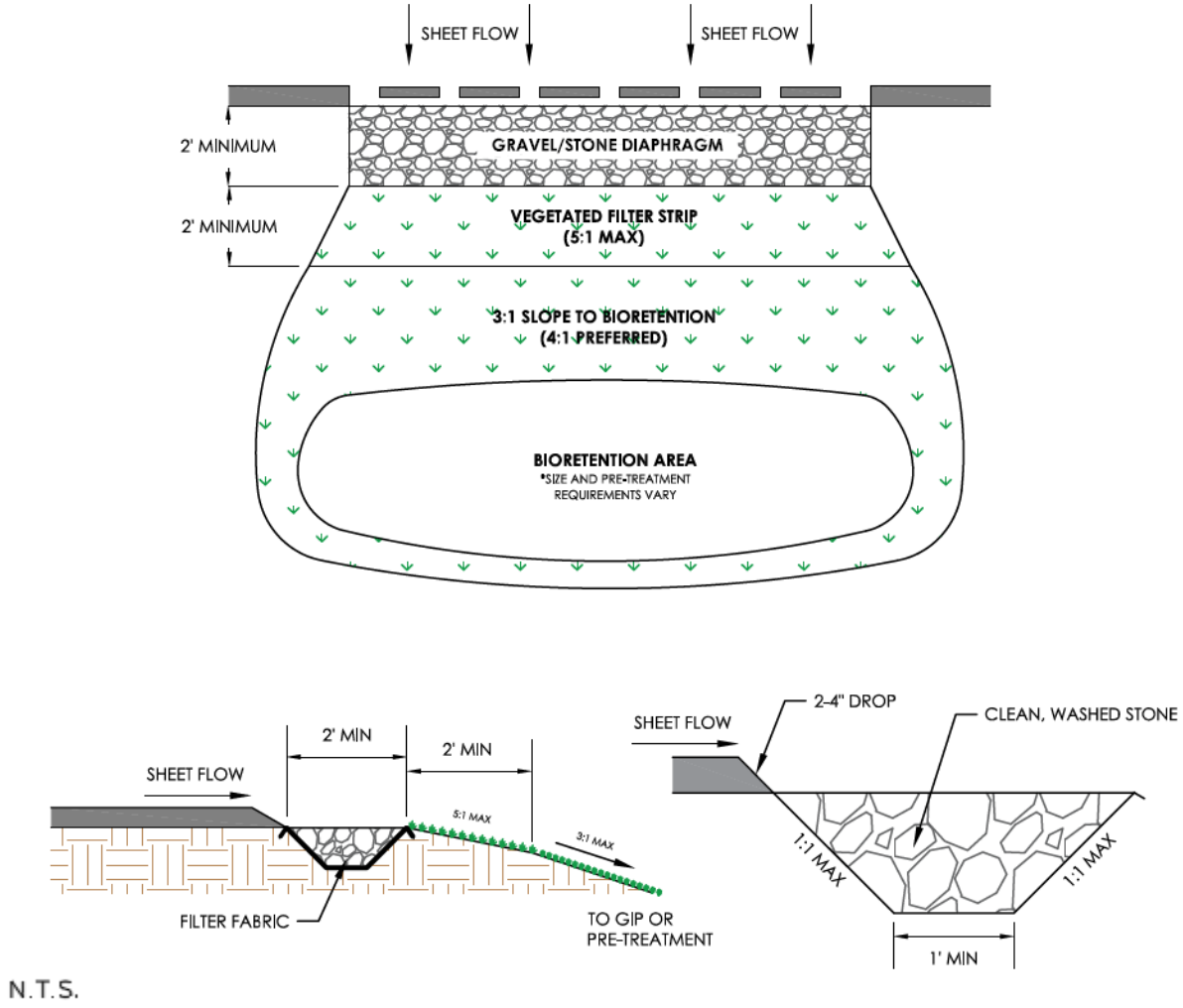


Figure A.4. Gravel Diaphragm Standard Detail

A gravel diaphragm located at the edge of the pavement should be oriented perpendicular to the flow path to pretreat lateral runoff and shall have a 2 to 4 inch drop from the edge of pavement. A layer of filter fabric shall be placed between the gravel and the underlying soils. The stone must be sized according to the calculated velocity of discharge in the 2 year storm event.

A.5 Level Spreaders

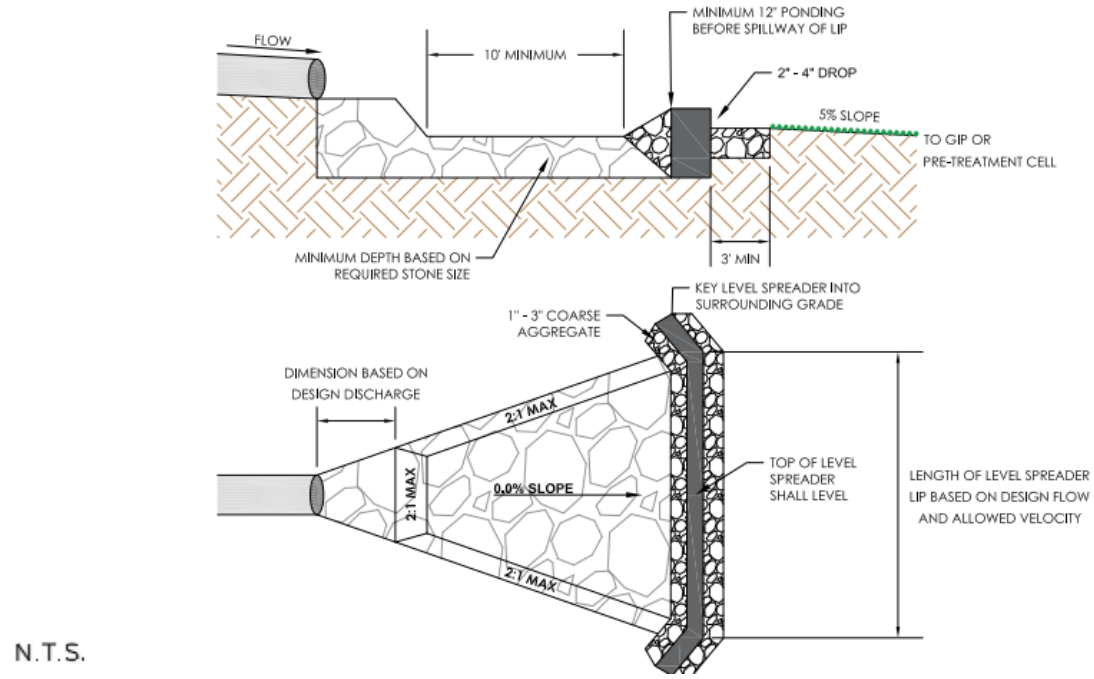


Figure A.5. Engineered Level Spreader Detail

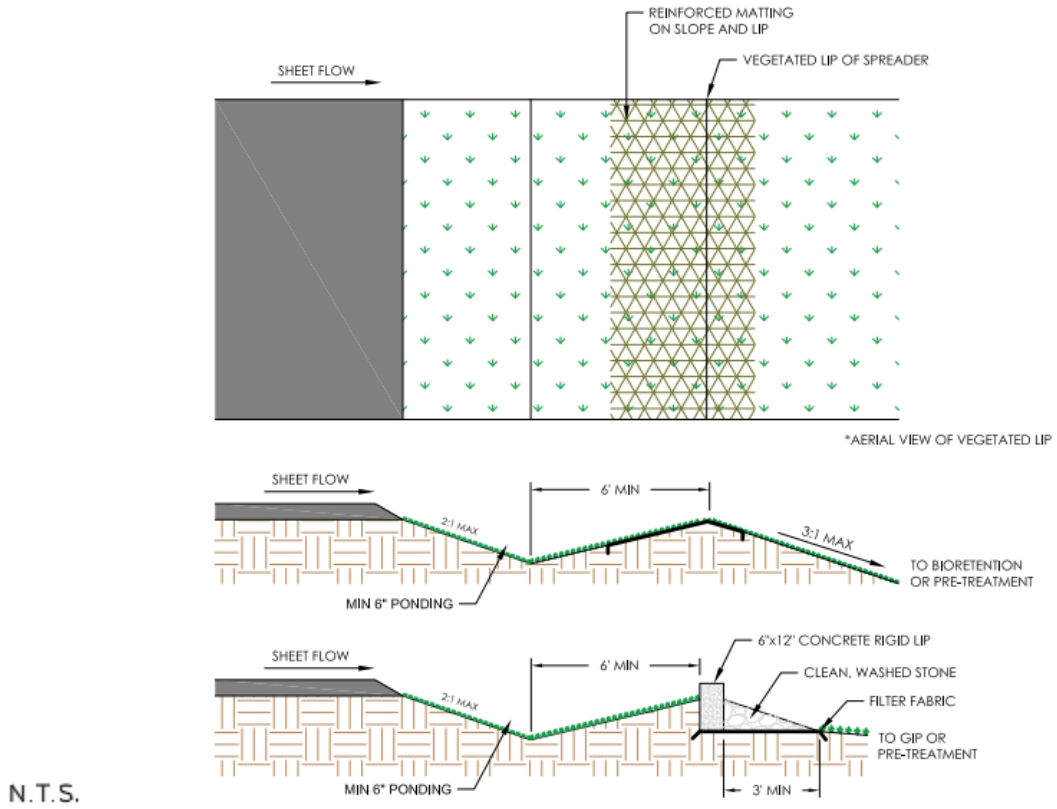


Figure A.6. Vegetated and Rigid Lip Level Spreader Detail

The design of engineered level spreaders should conform to the following design criteria in order to ensure non-erosive sheet flow into the green infrastructure practice.

Key design elements of the engineered level spreader, as provided in **Figures A.5 and A.6**, include the following:

- A forebay should have a maximum depth of 3 feet and gradually transition to a depth of 1 foot at the level spreader lip (**Figure A.5**). The forebay is sized such that the surface area is 0.2% of the contributing impervious area. (A forebay is not necessary if the concentrated flow is from the outlet of an extended detention basin or similar practice).
- The length of the level spreader should be determined by the design flow:
  - The minimum level spreader length is 13 feet and the maximum is 130 feet.
  - For the purposes of determining the level spreader length, the peak discharge shall be determined using the rational equation with an intensity of 1-inch/hour.
- The level spreader lip shall be concrete, with a well-anchored footer, or other accepted rigid, non-erodible material.
- The ends of the level spreader section should be tied back into the slope to avoid scouring around the ends of the level spreader; otherwise, short-circuiting of the facility could create erosion.
- The level spreader should be placed 3 to 6 inches above the downstream natural grade elevation to avoid turf buildup. In order to prevent grade drops that re-concentrate the flows, a 3-foot long section of coarse aggregate, underlain by filter fabric, should be installed just below the spreader to transition from the level spreader to natural grade.

The flow is directed through a stilling basin energy dissipater and then a level spreader such that the entire design storm for the conveyance system (typically a 10-year frequency storm) is discharged as sheet flow through the floodplain.

A.6 Proprietary Structures

An approved proprietary structure, such as a water quality unit, with demonstrated capability of reducing sediment and hydrocarbons may be used as a required pretreatment measure but shall not be credited toward meeting runoff reduction requirements.

APPENDIX B

B.1 INFILTRATION SOIL TESTING PROCEDURES

I. Test Pit/Boring Procedures

1. Number of test pits or standard borings:
    a. Bioretention and permeable pavement: Provide a minimum of 2 test pits or standard borings for each facility plus 1 additional test pit or boring per 5000 sf of surface area. (ex. 10,000 sf facility = 4 test pits)
    b. Infiltration trench and water quality swale: Provide one test pit or standard soil boring for every 50 linear feet of the proposed infiltration area, with a minimum of two per facility. (ex. 150 lf facility = 3 test pits)
2. The location of each test pit or standard soil boring should correspond to the location of the proposed infiltration area.
3. Excavate each test pit or penetrate each standard soil boring to a depth at least 2 feet below the bottom of the proposed infiltration area.
4. If the groundwater table is located within 2 feet of the bottom of the proposed facility, determine the depth to the groundwater table immediately upon excavation and again 24 hours after excavation is completed.
5. Determine the USDA or Unified Soil Classification system textures at the bottom of the proposed infiltration area and at a depth that is 2 feet below the bottom. All soil horizons should be classified and described.
6. If bedrock is located within 2 feet below the bottom of the proposed infiltration area, determine the depth to the bedrock layer.
7. Test pit/soil boring stakes should be left in the field to identify where soil investigations were performed.

II. Infiltration Testing Procedures

1. Number of infiltration tests:
    a. Bioretention and permeable pavement: Provide a minimum of 2 infiltration tests for each facility plus 1 additional test per 5000 sf of surface area. (ex. 10,000 sf facility = 4 infiltration tests)
    b. Infiltration trench and water quality swale: Provide one infiltration test for every 50 linear feet of the proposed infiltration area, with a minimum of two per facility. (ex. 150 lf facility = 3 infiltration tests)
2. The location of each infiltration test should correspond to the location of the proposed infiltration area.
3. Install a test casing (e.g., a rigid, 4 to 6 inch diameter pipe) to a depth 2 feet below the bottom of the proposed infiltration area.
4. Remove all loose material from the sides of the test casing and any smeared soil material from the bottom of the test casing to provide a natural soil interface into which water may percolate. If desired, a 2-inch layer of coarse sand or fine gravel may be placed at the bottom of the test casing to prevent clogging and scouring of the underlying soils. Fill the test casing with clean water to a depth of 2 feet, and allow the underlying soils to presoak for 24 hours.

5. After 24 hours, refill the test casing with another 2 feet of clean water and measure the drop in water level within the test casing after one hour. Repeat the procedure three (3) additional times by filling the test casing with clean water and measuring the drop in water level after one hour. A total of four (4) observations must be completed. The infiltration rate of the underlying soils may be reported either as the average of all four observations or the value of the last observation. The infiltration rate should be reported in terms of inches per hour.
6. Infiltration testing may be performed within an open test pit or a standard soil boring. After infiltration testing is completed, the test casing should be removed and the test pit or soil boring should be backfilled and restored.

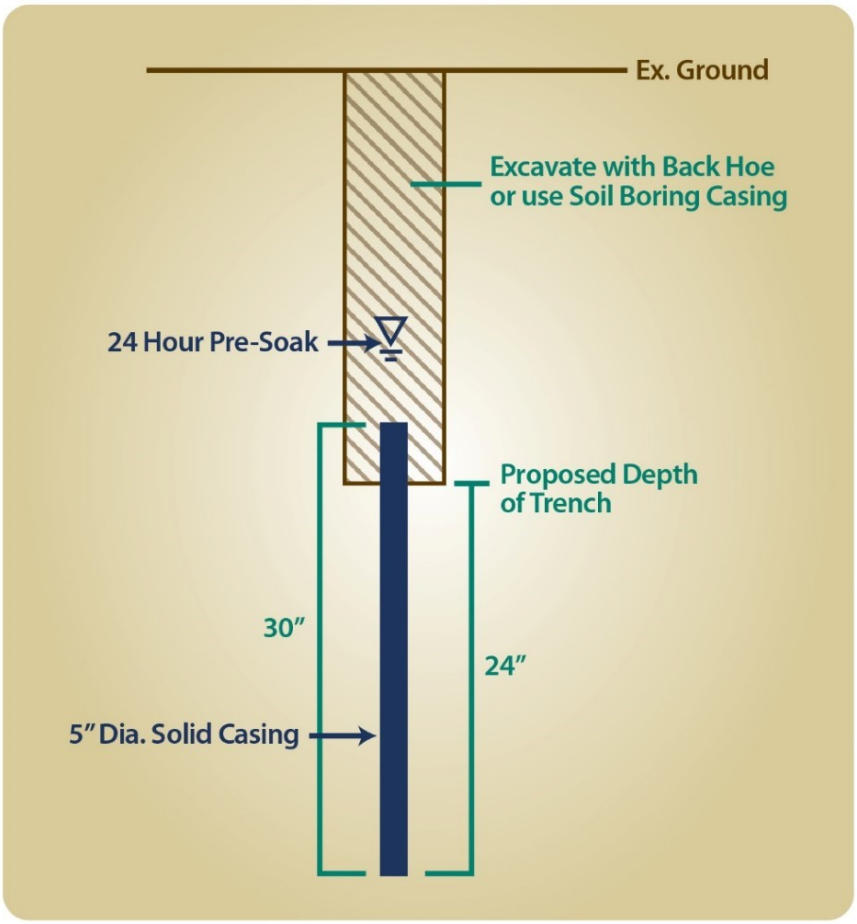


Figure 4-A. 1. Infiltration Test Schematic

B.2 SOIL INFILTRATION RATE TESTING

Table B.2 Required Number of Tests for Each GIP	
GIP	**Number of Tests**
Bioretention (GIP-01) **Urban Bioretention (GIP-02)** **Permeable Pavement (GIP-03)**	2 tests + 1 test per 5,000 ft^2 surface area
Infiltration Trench (GIP-04) **Water Quality Swale (GIP-05)**	1 test per 50 linear feet, 2 minimum

Appendix C

Landscape Plan Requirements for Biofiltration Practices and Native Plant Lists

All native plant lists are in Section 9 of this Appendix in **Tables C.3-C.7**.

SECTION 1: GENERAL GIP PLANTING REQUIREMENTS

**These general requirements apply to all GIP biofiltration practices (any area containing amended soils in the filter bed). Additional specific requirements or exceptions for each practice are denoted in their specific subsequent section.*

1.1 Planting Plans

A landscaping plan must be provided for each biofiltration (any area containing amended soils) area. Minimum plan elements shall include the proposed delineation of planting areas, the planting plan, including the size, the list of planting stock, sources of plant species, and the planting sequence, including post-nursery care and initial maintenance requirements. The planting area is defined as the area where amended soils are to be located, which does not include any pretreatment measures. The planting plan must address 100% of the planting area. The planting plan be shall be prepared by a qualified landscape architect, to tailor the planting plan to the site-specific conditions.

Native plant species are required for biofiltration as they are typically best acclimated for our region's climate. Ornamental species may be used for landscaping effect if they are not aggressive or invasive but must be first approved by the City's Stormwater Coordinator. **Tables C.3 – C.7** list native plant species suitable for use in biofiltration practices. Milkweed shall be required in all biofiltration practices and shall equal 5% or greater of overall planting schedule.

Irrigation can be utilized around biofiltration areas to encourage growth of the plants through the first growing season and any subsequent droughts. If irrigation is to be utilized, an irrigation plan shall be submitted to the City's Stormwater Coordinator for review and then subsequently included in the Long Term Maintenance Plan for the site. A soil moisture probe shall be shown as installed within the footprint of the bioretention area to prevent overwatering or baseflow from occurring.

The planting template refers to the form and combination of native trees, shrubs, and perennial ground covers that maintain the appearance and function of the biofiltration practice areas.

1.2 Plant Spacing

Table C.1 is for use only when plants are spaced equidistant from each other as shown in **Figure C.1**, below.

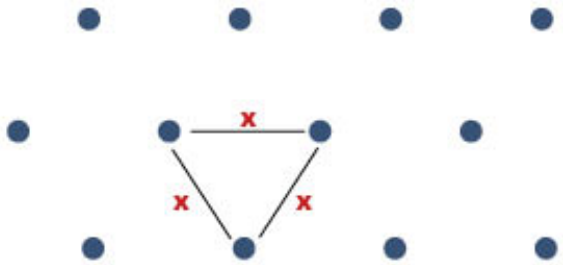


Figure C.1 Typical plant spacing where x equals distance on center (O.C.) of plant species.

Table C.1 Plant Spacing for Perennials, Grasses, Sedges and Shrubs	
Spacing (O.C.)	**Plants per 100 sq.ft.**
18" o.c.	51.2
24" o.c.	29
28" o.c.	22
30" o.c.	18.5
36" o.c.	12.8
42" o.c.	10
4' o.c.	7.23
5' o.c.	4.61
6' o.c.	3.2
8' o.c.	1.8

1.3 Soil Amendments for Tree Holes

Biofiltration practices that require trees in the planting schedule shall require tree holes in the filter bed that must be at least 4 feet deep (or as much as design allows) to provide enough soil volume for the root structure of mature trees. In addition, a more organic filter media is required within the planting holes for trees, with ratio of 50% sand, 30% topsoil and 20% acceptable leaf compost (or other as approved).

1.4 Groundcover

Groundcover for biofiltration practices shall either be a triple shredded hardwood mulch, river rock, or pine straw. In some situations, the City may consider alternative ground covers to mulch, river rock, and pine straw such as native groundcover, turf, and pea gravel. This alternative must be proposed, justified, and approved by the City's Stormwater Coordinator during the plan review process and will be dependent on location, use and maintenance of the proposed areas. If seeding of the area is specified, then hydroseeding shall be the method detailed on the landscape sheets for seed application and establishment in these areas. This is due to the high failure rate of conventional seeding methods that is experienced due to frequent and high water flow these features experience.

The following design consideration should be evaluated when choosing groundcovers.

- ***Mulch.*** A 3-inch layer of mulch on the surface of the filter bed enhances plant survival, suppresses weed

growth, and pretreats runoff before it reaches the filter media. Triple shredded, aged hardwood, especially cypress, makes a very good surface cover, as it retains a significant amount of nitrogen and typically will not float away. Shredded hardwood mulch will typically require annual replacement as a part of regular maintenance.

- *Pine Straw.* A 3-inch layer of pine straw on the surface of the filter bed provides many of the same benefits as mulch. In some biofiltration designs pine straw will resistant to floating and washing in frequent flow events. Pine straw still requires annual replacement and/or refreshing as part of a regular maintenance schedule.

- *River Rock.* River rock is often the preferred groundcover selected for biofiltration practices. This is due to its heavier weight which keeps it in place and provides a velocity dissipation effect which reduces filter bed erosion. River rock typically doesn't require annual replacement and provides for longer term stabilization solution. Higher upfront cost is typically offset when compared to annual replacement cost of mulch and pine straw as they compile annually. However, river rock does present its own challenges. During summer months river rock can absorb heat and create a heat island effect that can be detriment to the vegetation planted within the biofiltration practice. Lastly river rock size can vary, and when larger (>4") river rock is used compaction of the filter bed can occur. Care should be taken during installation and placement as to prevent soil compaction when using larger river rock. Plant material selected should be chosen to withstand the heat the river rock can produce.

SECTION 2: BIORETENTION

2.1 Landscape and Planting Plan

Bioretention areas shall be planted in accordance with a planting template. The choice of which planting template to use depends on the scale of bioretention, the context of the site in the urban environment, the filter depth, the desired landscape amenities, and the future owner's capability to maintain the landscape. In general, the vegetative goal is to achieve a surface area coverage of at least 75% in the first two years. For a bioretention area to qualify for Level 2 Design, a minimum of one tree must be planted for every 400 square feet. All bioretention areas shall include at least 5% of native milkweed vegetation within the planting plan.

The planting template refers to the form and combination of native trees, shrubs, and perennial ground covers that maintain the appearance and function of the bioretention area. Planting templates may be of the following types:

- *Ornamental planting.* This option includes perennials, sedges, grasses, shrubs and/or trees in a mass bed planting. This template is recommended for commercial sites where visibility is important. This template requires maintenance much like traditional landscape beds.

- *Meadow.* This is a lower maintenance approach that focuses on the herbaceous layer and may resemble a wildflower meadow or prairie. The goal is to establish a more natural look that may be appropriate if the facility is in a lower maintenance area (e.g., further from buildings and parking lots). Shrubs and trees may be incorporated.

- *Reforestation.* This option plants a variety of tree seedlings and saplings in which the species distribution is modeled on characteristics of existing local forest ecosystems. Trees are planted in groups with the goal of establishing a mature forest canopy. This template is appropriate for large bioretention areas located at wooded edges or where a wooded buffer is desired.

SECTION 3: GIP-02 URBAN BIORETENTION

3.1 Landscape and Planting Plan

The degree of landscape maintenance that can be provided will determine some of the planting choices for urban bioretention areas. The planting cells can be formal gardens or naturalized landscapes. Landscaping in the ROW should be designed to limit visual obstructions for pedestrian and vehicular traffic. **Tables C.8 - C.12** detail plants suitable for tree planters.

In areas where less maintenance will be provided and trash accumulation in shrubbery or herbaceous plants is a concern, consider a "turf and trees" landscaping model. Spaces for herbaceous flowering plants can be included. This may be attractive at a community entrance location.

Native trees or shrubs shall be used for urban bioretention areas. As with regular bioretention, selected perennials, shrubs, and trees must be tolerant of drought, and inundation. The landscape designer should also take into account that de-icing materials may accumulate in the bioretention areas in winter and could kill vegetation. Additionally, tree species selected shall meet the City of Franklin street tree requirements within the Zoning Ordinance.

SECTION 4: GIP-04 INFILTRATION TRENCH

4.1 Landscape and Planting Plan

The trench may be covered with permeable topsoil and planted with grass in a landscaped area. If sod is to be used it shall be a sand based or washed sod product.

SECTION 5: GIP-05 WATER QUALITY SWALE

5.1 Landscape and Planting Plan

Designers should choose grasses, herbaceous plants or trees that can withstand both wet and dry periods and relatively high velocity flows for planting within the channel. Salt tolerant grass species should be chosen for water quality swales receiving drainage from areas treated for ice in winter. Taller and denser grasses are preferable, although the species is less important than good stabilization and dense vegetative cover. Grass species should have the following characteristics: a deep root system to resist scouring; a high stem density with well-branched top growth; water-tolerance; resistance to being flattened by runoff; and an ability to recover growth following inundation. A qualified landscape designer should be consulted for selection of appropriate plantings. A nonfloatable mulch, such as river rock, should be used to prevent clogging of the check dams.

SECTION 6: GIP-07 SHEET FLOW

6.1 Landscape and Planting Plan

6.1.1 Conserved Open Space. No grading or clearing of native vegetation is allowed within the Conserved Open Space.

6.1.2 Reforested Conserved Open Space. At some sites, the Conserved Open Space may be in turf or meadow cover or overrun with invasive plants and vines. In these situations, a landscape architect shall prepare a reforestation plan for the Conserved Open Space utilizing the reforestation specifications as described under **GIP-08, Reforestation**, with any credits and associated plans receiving approval by the City Engineer.

6.1.3 Vegetated Filter Strips. Vegetated Filter Strips shall be planted at such a density to achieve a 90% grass/herbaceous cover after the second growing season. Performance has been shown to fall rapidly as vegetative cover falls below 80%. Filter strips shall be seeded, not sodded, whenever possible. Seeding establishes deeper roots, and sod may have muck soil that is not conducive to infiltration. The filter strip vegetation may consist of turf grasses, meadow grasses, other herbaceous plants, shrubs, and trees, as long as the primary goal of at least 90% coverage with grasses and/or other herbaceous plants is achieved. Designers should choose vegetation that stabilizes the soil and is salt tolerant. Vegetation at the toe of the filter, where temporary ponding may occur behind the permeable berm, shall be able to withstand both wet, with approximately 6 inches of ponding, and dry periods. The planting areas can be divided into zones to account for differences in inundation and slope.

SECTION 7: GIP-08 REFORESTATION

7.1 Landscape and Planting Plan

The credit given for the reforestation GIP is based on conditions representative of a natural forested area. The intent of these areas is to create a mature native successional undisturbed forest. There shall be no mowing, clearing, grading, construction, storage, or disturbance of vegetation in reforestation areas except as permitted by the City's Stormwater Coordinator. Reforestation areas are eligible under the following qualifying conditions:

- The minimum contiguous area of reforestation must be greater than 5,000 square feet, with no more than 20% of the area in any single tree species. The basic density of plantings is 300 large canopy trees per acre, approximately 12 feet on center. When shrubs are substituted for trees, there must be 10 shrubs per one large canopy tree. Two small canopy trees or understory trees, such as Dogwoods or Red Buds, may be substituted for one large canopy tree. Adjustments can be made to these densities for areas of urban reforestation with the approval of the City's Stormwater Coordinator. Reforestation should consider the composition of area forests, and two thirds of selected trees must be large canopy. Reforestation methods should achieve 75% forest canopy within ten years.
- The minimum size requirement for reforestation is saplings 6-8 feet in height. The minimum size requirement for shrubs is 18-24 inches, or 3 gallon size. or with a native seed mix in order to help retain moisture and provide a beneficial environment for the reforestation.
- A reforestation management plan shall be included in the Long Term Maintenance Plan and Agreement outlining long term management and maintenance objectives that will perpetuate a

mature native successional forested ecosystem. The plan shall address but be not limited to; irrigation needs, tree removal and replacement methods, ground cover goals for stabilization, yearly health surveys, and any other requirements set forth in this section or GIP 08. The plan shall have a scale drawing showing the area to be planted, along with a plant list which includes species, size, number, and packaging. In addition, the reforestation area shall be clearly identified on all construction drawings and EPSC plans during construction. Reference the GIP-08 section for further Long Term Maintenance Requirements.

- The reforestation area must be protected by a green infrastructure easement which stipulates that no future development or disturbance may occur within the area.
- The planting plan shall be approved by the City, including any special site preparation needs.
- The construction contract should contain a care and replacement warranty extending at least two growing seasons, to ensure adequate growth and survival of the plant community.
- The final size of the trees should be considered when designing the planting plan. Tennessee One-Call (811) must be contacted prior to the submission of the planting plan to ensure that no utilities will be impacted by the tree planting. The planting plan must also avoid placing trees under overhead utilities.
- If using the reforestation area as a vegetated filter strip to receive additional credit under **GIP-07**, follow all GIP design criteria and ensure that additional routed runoff does not cause erosion or degrade the quality of ground cover.

The overall runoff reduction credits for reforestation through lower runoff coefficients are summarized in **Table C.2.**

Table C.2. Design Specifications for Reforestation

Item	Specifications for Level 1 and Level 2
Area	Minimum contiguous area of 5,000 sq. ft.
Tree Type	No more than 20% of any single tree species. Consider composition of local forests in planting design. 2/3 of trees must be large canopy. See the USGS landfire map for delineation of forest type and the 2006 Descriptions of Ecological Systems for Modeling of LANDFIRE Biophysical Settings Ecological Systems of location US State TN .PFD for description of species within each forest type. Links: http://landfire.cr.usgs.gov/viewer/ http://www.tn.gov/environment/na/pdf/tn_eco_systems.pdf http://www.se-eppc.org/pubs/middle.pdf
Density	• 300 large canopy trees – species that normally achieve an overall height at maturity of thirty feet or more per acre • 10 shrubs substitute for 1 large canopy tree • 2 small canopy trees substitute for 1 large canopy tree Note: Adjustments to densities may be possible with CITY approval.
Canopy Rate	Achieve 75% forest canopy within first 10 years
Size	Tree - Minimum tree size 6-8 ft in height Shrub – 18-24 inches or 3 gallon size
Ground Cover	Entire area should be covered with 2-4 inches of organic mulch or a native seed mix

SECTION 8: GIP-09 GREEN ROOF

8.1 Landscape and Planting Plan

A planting plan must be prepared for a vegetated roof by a landscape architect and it must be reviewed and approved by the City.

Plant selection for vegetated rooftops is an integral design consideration, which is governed by local climate and design objectives. The primary ground cover for most vegetated roof installations is a hardy, low-growing succulent, such as *Sedum, Delosperma, Talinum, Semperivum* or *Hieracium* that is matched to the local climate conditions and can tolerate the difficult growing conditions found on building rooftops (Snodgrass and Snodgrass, 2006). Franklin lies in the transition zone between USDA Plant Hardiness Zones 6 and 7.

Other vegetation considerations:

- Plant choices can be much more diverse for deeper intensive vegetated roof systems. Herbs, forbs, grasses, shrubs and even trees can be used, but designers should understand they have higher watering, weeding and landscape maintenance requirements.
- The species and layout of the planting plan should reflect the location of building, in terms of its height, exposure to wind, snow loading, heat stress, orientation to the sun, and shading by surrounding buildings. In addition, plants should be selected that are fire resistant and able to withstand heat, cold and high winds.
- Designers should also match species to the expected rooting depth of the growing media, which can also provide enough lateral growth to stabilize the growing media surface. The planting plan should usually include several accent plants to provide diversity and seasonal color. For a comprehensive resource on vegetated roof plant selection, consult Snodgrass and Snodgrass (2006).
- It is also important to note that most vegetated roof plant species will not be native to the Southeast (which is in contrast to native plant recommendations for other stormwater biofiltration practices).
- Given the limited number of vegetated roof plant nurseries in the region, designers should order plants 6 to 12 months prior to the expected planting date. It is also advisable to have plant materials contract-grown.
- When appropriate species are selected, most vegetated roofs will not require supplemental irrigation, except during the first year that the vegetated roof is being established or during periods of drought. Irrigation should thus be provided as needed for full establishment and during drought periods. The planting window extends from the spring to early fall, although it is important to allow plants to root thoroughly before the first killing frost.
- Plants can be established using cuttings, plugs, mats, and, more rarely, seeding or containers. Several vendors also sell mats, rolls, or proprietary vegetated roof planting modules. For the pros and cons of each method, see Snodgrass and Snodgrass (2006).
- The goal for vegetated roof systems designed for stormwater management is to establish a full and vigorous cover of low-maintenance vegetation that is self-sustaining and requires minimal mowing, trimming or weeding.
- The vegetated roof design should include non-vegetated walkways (e.g., permeable paver blocks) to allow for easy access to the roof for weeding and making spot repairs.

SECTION 9: NATIVE PLANT LISTS

Table C.3. Popular Native Perennials for Bioretention – Full Sun						
Latin Name	**Common Name**	**Size**	**Spacing**	**Moisture**	**Color**	**Height**
Asclepias incarnate	Marsh milkweed	Plugs – 1 gal.	1 plant/24" o.c.	Wet	Pink	3-4'
Asclepias	Purple milkweed	Plugs – 1 gal.	1 plant/18" o.c.	Moist	Purple	3'
Asclepias syriaca	Common milkweed	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Orange	2-5'
Asclepias tuberosa	Butterfly milkweed	Plugs – 1 gal.	1 plant/18" o.c.	Dry-moist	Orange	2'
Asclepias verdis	Green milkweed	Plugs – 1 gal.	1 plant/18" o.c.	Moist	Green	2'
Asclepias verdicillata	Whorled milkweed	Plugs – 1 gal.	1 plant/18" o.c.	Moist	White	2.5'
Aster laevis	Smooth aster	Plugs – 1 gal.	1 plant/18" o.c.	Moist	Blue	2-4'
Aster novae-angliae	New England aster	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Blue	2-5'
Aster sericeus	Silky aster	Plugs – 1 gal.	1 plant/18" o.c.	Dry	Purple	1-2'
Chamaecrista	Partridge pea	Plugs – 1 gal.	1 plant/18" o.c.	Dry	Yellow	1-2'
Conoclinium	Mist flower	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Blue	1-2'
Coreopsis lanceolata	Lance-leaf coreopsis	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Yellow	6-8'
Echinacea pallida	Pale purple coneflower	Plugs – 1 gal.	1 plant/18" o.c.	Dry	Purple	2-3'
Echinacea purpurea	Purple coneflower	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	3-4'
Eupatorium	Boneset	Plugs – 1 gal.	1 plant/24" o.c.	Wet	White	3-5'
Eupatorium	Sweet Joe-Pye Weed	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Purple	3-6'
Iris virginica	Flag Iris	Plugs – 1 gal.	1 plant/18" o.c.	Moist-Wet	Blue	2'
Liatris aspera	Rough blazingstar	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	2-5'
Liatris microcephalla	Small-headed	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	3'
Liatris spicata	Dense blazingstar	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Purple	1.5'
Liatris squarrulosa	Southern blazingstar	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	2-6'
Lobelia cardinalis	Cardinal flower	Plugs – 1 gal.	1 plant/18" o.c.	Wet-moist	Red	2-4'
Monarda didyma	Bee balm	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Red	3'
Monarda fistulosa	Wild bergamot	Plugs – 1 gal	1 plant/18" o.c.	Moist	Purple	1-3'
Oenethera fruticosa	Sundrops	Plugs – 1 gal	1 plant/18" o.c.	Moist-dry	Yellow	
Penstemon digitalis	Smooth white	Plugs – 1 gal	1 plant/24" o.c.	Wet	White	2-3'
Penstemon hirsutus	Hairy beardtongue	Plugs – 1 gal	1 plant/18" o.c.	Dry	White	1-3'
Penstemon smallii	Beardtongue	Plugs – 1 gal	1 plant/18" o.c.	Moist	Purple	1-2'
Pycanthemum	Slender mountain mint	Plugs – 1 gal	1 plant/18" o.c.	Moist	White	1.5-2.5'
Ratibida piñata	Gray-headed	Plugs – 1 gal	1 plant/18" o.c.	Moist	Yellow	2-5'
Rudbeckia hirta	Black-eyed Susan	Plugs – 1 gal	1 plant/18" o.c.	Moist-dry	Yellow	3'
Salvia lyrata	Lyre-leaf sage	Plugs – 1 gal	1 plant/18" o.c.	Moist	Purple	1-2'
Solidago nemoralis	Gray goldenrod	Plugs – 1 gal.	1 plant/18" o.c.	Dry	Yellow	2'
Solidago rugosa	Rough-leaved	Plugs – 1 gal.	1 plant/18" o.c.	Wet	Yellow	1-6'
Veronacastrum	Culver's root	Plugs – 1 gal.	1 plant/24" o.c.	Dry	White	3-6'
Veronia veboracensis	Tall ironweed	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Purple	3-4'

Plant material size and grade to conform to "American Standards for Nursery Stock" American Association of Nurserymen, Inc. latest approved revision, ANSI Z-60-1

Table C.4. Popular Native Perennials for Bioretention – Shade						
Latin Name	**Common Name**	**Size**	**Spacing**	**Moisture**	**Color**	**Height**
Aquilegia canadensis	Wild columbine	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Pink	1-2.5'
Athyrium filix-femina	Lady Fern	1 gal.	1 plant/18" o.c.	Moist	Green	3'
Arisaema triphyllum	Jack-in-the-pulpit	Plugs – 1 gal.	1 plant/18" o.c.	Moist	Green	1.5-2.5'
Arisaema dricontium	Green dragon	Plugs – 1 gal.	1 plant/18" o.c.	Wet-moist	Green	3'
Asarum canadense	Wild ginger	Plugs – 1 gal.	1 plant/18" o.c.	Wet-moist	Red-brown	0.5-1'
Aster cardifolius	Blue wood aster	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Blue	1-3'
Aster novae-angliae	New England aster	Plugs – 1 gal.	1 plant/24" o.c.	Moist-dry	Blue/ purple	3-4'
Aster oblongifolius	Aromatic Aster	Plugs – 1 gal.	1 plant/24" o.c.	Moist-dry	Blue/ purple	1.5-3'
Coreopsis major	Tickseed coreopsis	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Yellow	3'
Dryopteris marginalis	Shield Fern	1 gal.	1 plant/18" o.c.	Moist	Green	2-3'
Geranium maculatum	Wild geranium	Plugs – 1 gal.	1 plant/18" o.c.	Moist	Pink	2'
Heuchera americana	Alumroot	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	1'
Iris cristata	Dwarf crested iris	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	4"
Lobelia siphilicata	Great blue lobelia	Plugs – 1 gal.	1 plant/18" o.c.	Wet-moist	Blue	1.5-3'
Lobelia cardinalis	Cardinal flower	Plugs – 1 gal.	1 plant/18" o.c.	Wet-moist	Red	2-4'
Mertensia virginica	Virginia bluebells	Plugs – 1 gal.	1 plant/18" o.c.	Moist	Blue	1.5'
Osmunda cinnamomea	Cinnamon Fern	1 gal.	1 plant/24" o.c.	Wet-moist	Green	3-4'
Phlox divericata	Blue phlox	Plugs – 1 gal.	1 plant/18" o.c.	moist	Blue	0.5-2'
Polemonium reptans	Jacob's ladder	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Blue	15"
Polystichum acrostichoides	Christmas fern	Plugs – 1 gal.	1 plant/24" o.c.	Moist-dry	Evergreen	2'
Stylophoru diphyllum	Wood poppy	Plugs – 1 gal.	1 plant/18" o.c.	Wet -moist	Yellow	1.5'

Plant material size and grade to conform to "American Standards for Nursery Stock" American Association of Nurserymen, Inc. latest approved revision, ANSI Z-60-1.

Table C.5. Popular Native Grasses and Sedges for Bioretention						
Latin Name	**Common Name**	**Size**	**Spacing**	**Moisture**	**Color**	**Height**
Carex grayi	Gray's Sedge	1 gal.	1 plant/24" o.c.	Moist	Green	3'
Carex muskingumensis	Palm Sedge	1 gal.	1 plant/24" o.c.	Moist	Green	3'
Carex stricta	Tussock Sedge	1 gal.	1 plant/24" o.c.	Moist	Green	3-4'
Chasmanthium latifolium	Upland Sea Oats	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Green	4'
Equisetum hyemale	Horsetail	Plugs – 1 gal.	1 plant/18" o.c.	Wet	Green	3'
Juncus effesus	Soft Rush	Plugs – 1 gal.	1 plant/24" o.c.	Wet-dry	Green	4-6'
Muhlenbergia capallaris	Muhly Grass	1 gal.	1 plant/24" o.c.	Moist	Pink	3'
Panicum virgatum	Switchgrass	1-3 gal.	1 plant/48" o.c.	Moist-dry	Yellow	5-7'
Schizachyrium scoparium	Little Blue Stem	1 gal.	1 plant/24" o.c.	Moist-dry	Yellow	3'
Sporobolus heterolepsis	Prairie Dropseed	1 gal.	1 plant/24" o.c.	Moist-dry	Green	2-3'

Plant material size and grade to conform to "American Standards for Nursery Stock" American Association of Nurserymen, Inc. latest approved revision, ANSI Z-60-1.

Table C.6. Popular Native Trees for Bioretention							
Latin Name	**Common Name**	**DT-FT**	**Light**	**Moisture**	**Notes**	**Flower Color**	**Height**
Acer rubrum	Red Maple	DT-FT	Sun-shade	Dry-wet	Fall color		50-70’
Acer saccharum	Sugar Maple		Sun-pt shade	Moist	Fall color		50-75’
Ameleanchier Canadensis	Serviceberry		Sun-pt shade	Moist-wet	Eatable berries	White	15-25’
Asimina triloba	Paw Paw		Sun-pt shade	Moist	Eatable fruits	Maroon	15-30’
Betula nigra	River Birch	FT	Sun-pt shade	Moist-wet	Exfoliating bark		40-70’
Carpinus caroliniana	Ironwood		Sun-pt shade	Moist		White	40-60’
Carya aquatica	Water Hickory	FT-DT	Sun	Moist	Fall color		35-50’
Cercus Canadensis	Redbud	DT	Sun-shade	Moist	Pea-like flowers, seed	Purple	20-30’
Chionanthus virginicus	Fringetree		Sun-pt shade	Moist	Panicled, fragrant	White	12-20’
Cladratis lutea	Yellowwood	DT	Sun	Dry-moist	Fall color	White	30-45’
Cornus florida	Flowering Dogwood		Part shade	Moist	Red fruit, wildlife	White	15-30’
Ilex opaca	American Holly	DT	Sun-pt shade	Moist	Evergreen	White	30-50’
Liquidambar styraciflua	Sweetgum	DT-FT	Sun-pt shade	Dry-moist	Spiny fruit		60-100’
Magnolia virginiana	Sweetbay Magnolia		Sun-pt shade	Moist-wet	Evergreen	White	10-60’
Nyssa sylvatica	Black Gum		Sun-Shade	Moist	Fall color		35-50’
Oxydendrum arboretum	Sourwood		Sun-pt shade	Dry-moist	Wildlife	White	20-40’
Platanus occidentalis	Sycamore	FT	Sun-pt shade	Moist	White mottled bark		70-100’
Quercus bicolor	Swamp White Oak	DT	Sun-pt shade	Moist-wet	Acorns		50-60’
Quercus nuttalli	Nuttall Oak	DT	Sun	Dry-moist	Acorns		40-60’
Quercus lyrata	Overcup Oak	FT	Sun	Moist	Acorns		40-60’
Quercus shumardii	Shumard Oak	DT	Sun	Moist	Acorns		40-60’
Rhamnus caroliniana	Carolina Buckthorn		Sun	Moist	Black fruit		15-30’
Salix nigra	Black Willow	FT	Sun-pt shade	Moist-wet	White catkins	Yellow	40-60’
Ulmus americana	American Elm	DT-FT	Sun-pt shade	Moist			
Salix nigra	Black Willow	FT	Pt shade	Moist-	White catkins	Yellow	40-60’

Size: min. 2” caliper if not reforestation. DT: Drought Tolerant FT: Flood Tolerant
Plant material size and grade to conform to “American Standards for Nursery Stock” American Association of Nurserymen, Inc. latest approved revision, ANSI Z-60-1.

Table C.7. Popular Native Shrubs for Bioretention								
Latin Name	**Common Name**	**DT FT**	**Light**	**Moisture**	**Spacing (0 C)**	**Notes**	**Flower Color**	**Height**
Aronia arbutifolia	Red Chokeberry	FT	Sun-pt shade	Dry-wet	4’	Red berries, wildlife	White	6-12’
Buddleia davidii	Butterfly Bush	DT	Sun-pt shade	Dry-moist	4’	Non-native	Blue	5’
Callicarpa Americana	American Beautyberry	DT	Sun-pt shade	Dry-wet	5’	Showy purple fruit	Lilac	4-6’
Cephalanthus occidentalis	Button Bush	FT	Sun-shade	Moist-wet	5’	Attracts wildlife	White	6-12’
Clethra alnifolia	Sweet Pepper Bush		Sun-pt shade	Dry-moist	3’	Hummingbird	White	5-8’
Cornus amomum	Silky Dogwood		Sun-shade	Moist-wet	6’	Blue berries, wildlife	White	6-12’
Corylus americana	American Hazelnut		Sun-pt shade	Dry-moist	8’	Eatable nuts, wildlife	Yellow	8-15’
Hamemelis virginiana	Witch-hazel		Sun-pt shade	Dry-moist	8’	Winter bloom	Yellow	10’
Hibiscus moscheutos	Swamp Mallow	FT	Sun	Moist-wet	30”	Cold-hardy	White – red	4-7’
Hydrangea quercifolia	Oakleaf Hydrangea	DT	Pt shade – shade	Moist	4’	Winter texture	White	3-6’
Hypericum frondosum	Golden St. John’s Wort	DT	Sun-pt shade	Dry-moist	30”	Semi-evergreen	Yellow	2-3’
Hypericum prolificum	Shrubby St. John’s Wort	DT	Sun-pt shade	Dry-moist	3’	Semi-evergreen	Yellow	3’
Ilex decidua (dwarf var.)	Possumhaw Viburnum	DT	Sun-pt shade	Moist	4-6’	Red berries		6-14’
Ilex glabra	Inkberry	DT	Sun-pt shade	Moist-wet	3’	Evergreen		4-8’
Ilex verticillata	Winterberry Holly	FT	Sun-pt shade	Moist-wet	3’	Red berries		10’
Itea virginica	Virginia Sweetspire	DT FT	Sun-shade	Moist-wet	4’	Fall color	White	4-8’
Lindera benzoin	Spicebush	DT	Pt shade – shade	Moist-wet	8’	Butterflies, wildlife	Yellow	6-12’
Viburnum dentatum	Arrowwood Viburnum		Sun-shade	Dry-wet	6’	Wildlife	White	6-8’

Size: minimum 3 gal. container or equivalent. DT: Drought Tolerant FT: Flood Tolerant

This list provides plant species; there are multiple varieties within each species.

Plant material size and grade to conform to “American Standards for Nursery Stock” American Association of Nurserymen, Inc. latest approved revision, ANSI Z-60-1.

Table C.8. Popular Native Perennials Suitable for Tree Planters – Full Sun						
Latin Name	**Common Name**	**Size**	**Spacing**	**Moisture**	**Color**	**Height**
Asclepias tuberosa	Butterfly milkweed	Plugs – 1 gal.	1 plant/18" o.c.	Dry-moist	Orange	2'
Aster novae-angliae	New England aster	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Blue	2-5'
Coreopsis lanceolata	Lance-leaf coreopsis	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Yellow	6-8'
Eupatorium purpureum	Sweet Joe-Pye Weed (Dwarf)	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Purple	3-6'
Iris virginica	Flag Iris	Plugs – 1 gal.	1 plant/18" o.c.	Moist-Wet	Blue	2'
Liatris spicata	Dense blazingstar	Plugs – 1 gal.	1 plant/24" o.c.	Wet-moist	Purple	1.5'
Penstemon digitalis	Smooth white beardtongue	Plugs – 1 gal	1 plant/24" o.c.	Wet	White	2-3'
Salvia lyrata	Lyre-leaf sage	Plugs – 1 gal	1 plant/18" o.c.	Moist	Purple	1-2'

C.9. Popular Native Perennials Suitable for Tree Planters – Shade						
Latin Name	**Common Name**	**Size**	**Spacing**	**Moisture**	**Color**	**Height**
Aquilegia canadensis	Wild columbine	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Pink	1-2.5'
Aster novae-angliae	New England aster	Plugs – 1 gal.	1 plant/24" o.c.	Moist-dry	Blue/ purple	3-4'
Aster oblongifolius	Aromatic Aster	Plugs – 1 gal.	1 plant/24" o.c.	Moist-dry	Blue/ purple	1.5-3'
Coreopsis lanceolata	Tickseed coreopsis	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Yellow	3'
Heuchera americana	Alumroot	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Purple	1'

DT: Drought Tolerant
FT: Flood Tolerant

Table C.10. Popular Native Grasses and Sedges Suitable for Tree Planters						
Latin Name	**Common Name**	**Size**	**Spacing**	**Moisture**	**Color**	**Height**
Carex muskingumensis	Palm Sedge	1 gal.	1 plant/24" o.c.	Moist	Green	3'
Chasmanthium latifolium	Upland Sea Oats	Plugs – 1 gal.	1 plant/18" o.c.	Moist-dry	Green	4'
Equisetum hyemale	Horsetail	Plugs – 1 gal.	1 plant/18" o.c.	Wet	Green	3'
Juncus effesus	Soft Rush	Plugs – 1 gal.	1 plant/24" o.c.	Wet-dry	Green	4-6'
Muhlenbergia capallaris	Muhly Grass	1 gal.	1 plant/24" o.c.	Moist	Pink	3'
Panicum virgatum	Switchgrass	1-3 gal.	1 plant/48" o.c.	Moist - dry	Yellow	5-7'
Schizachyrium scoparium	Little Blue Stem	1 gal.	1 plant/24" o.c.	Moist-dry	Yellow	3'
Sporobolus heterolepsis	Prairie Dropseed	1 gal.	1 plant/24" o.c.	Moist-dry	Green	2-3'

Table C.11. Popular Native Trees Suitable for Tree Planters							
Latin Name	**Common Name**	**DT-FT**	**Light**	**Moisture**	**Notes**	**Flower Color**	**Height**
Acer rubrum	Red Maple	DT-FT	Sun-shade	Dry-wet	Fall color		50-70'
Betula nigra	River Birch	FT	Sun-pt shade	Moist-wet	Exfoliating bark		40-70'
Carpinus caroliniana	Ironwood		Sun-pt shade	Moist		White	40-60'
Carya aquatica	Water Hickory	FT-DT	Sun	Moist	Fall color		35-50'
Cercus Canadensis	Redbud	DT	Sun-shade	Moist	Pea-like flowers, seed pods	Purple	20-30'
Liquidambar styraciflua	Sweetgum (fruitless)	DT-FT	Sun-pt shade	Dry-moist			60-100'
Nyssa sylvatica	Black Gum		Sun-Shade	Moist	Fall color		35-50'
Platanus occidentalis	Sycamore	FT	Sun-pt shade	Moist	White mottled bark		70-100'
Quercus nuttalli	Nuttall Oak	DT	Sun	Dry-moist	Acorns		40-60'
Quercus lyrata	Overcup Oak	FT	Sun	Moist	Acorns		40-60'
Quercus shumardii	Shumard Oak	DT	Sun	Moist	Acorns		40-60'
Ulmus americana	American Elm	DT-FT	Sun-pt shade	Moist			

DT: Drought Tolerant
FT: Flood Tolerant

Table C.12. Popular Native Shrubs Suitable for Tree Planters							
Latin Name	**Common Name**	**DT-FT**	**Light**	**Moisture**	**Notes**	**Flower Color**	**Height**
Clethra alnifolia	Sweet Pepper Bush (Dwarf)		Sun-pt shade	Dry-moist	Hummingbirds	White	5-8’
Hydrangea quercifolia	Oakleaf Hydrangea	DT	Pt shade – shade	Moist		White	3-6’
Hypericum frondosum	Golden St. John’s Wort	DT	Sun-pt shade	Dry-moist	Semi-evergreen	Yellow	2-3’
Ilex glabra	Inkberry (Dwarf)	DT	Sun-pt shade	Moist-wet	Evergreen		4-8’

DT: Drought Tolerant
FT: Flood Tolerant

Appendix D

As-built Requirements for Green Infrastructure Practices and TSS Removal Practices

After the SCMs are installed, an as-built survey shall be performed. The as-built may be performed by a Registered Land Surveyor (RLS) or Professional Engineer (PE) registered with the State of Tennessee; however, the survey shall be reviewed by a PE, who shall provide a stamped certification letter stating that the site has been inspected and that the stormwater management system and stormwater control measures (both structural and non-structural) are complete and functional in accordance with the plans approved by the City and the overall design intent has been met. Coordinate data shall be presented in the State of Tennessee Plane System with the North American Datum 1983 (NAD83) and North American Vertical Datum (NAVD) of 1988. Submittals without a certification letter from a PE will be considered incomplete.

The City of Franklin Planning and Sustainability Department has requirements and a checklist for drainage as-builts which can be found at: https://www.franklintn.gov/government/departments-k-z/planning-and-sustainability/performance-agreements-sureties. Please ensure this document is reviewed prior to performing the survey and all items are addressed.

In addition to the abovementioned requirements set by the Planning and Sustainability Department, each SCM has specific information that needs to be provided as part of the as-built and PE certification letter. Below you will find each SCM with details of components that need to be documented.

GIP-01 Bioretention

1. Elevations shall be provided for inverts of the underdrain and outlet control structure and top of casting (overflow).
2. Elevations shall be provided for top of soil and top of surrounding berm.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
4. Curb cut location and width shall be verified, if applicable.

GIP-02 Urban Bioretention

1. Elevations shall be provided for inverts of the underdrain and outlet control structure and top of casting (overflow)
2. Elevations shall be provided for top of soil and top of surrounding area, berm, or wall.
3. Pretreatment measures shall be verified.
4. Surface area of the feature shall be provided.
5. Curb cut location and width shall be verified, if applicable.

GIP-03 Permeable Pavement

1. Underdrain inverts, if utilized, shall be verified.
2. Surface area of the permeable pavement shall be verified.
3. Curb cut location and width shall be verified, if applicable.

GIP-04 Infiltration Trench

1. Elevations shall be provided for invert of the underdrain and outlet control structure and top of casting (overflow)
2. Elevations shall be provided for top of trench and top of surrounding berm.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
4. Surface area of the feature shall be provided.
5. Curb cut location and width shall be verified, if applicable.

GIP-05 WQ Swale

1. Elevations shall be provided for inverts of the underdrain, check dams/check dam weirs, outlet control structure, and top of casting (overflow)
2. Elevations shall be provided for top of soil and top of surrounding berm.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
4. Surface area of the feature shall be provided.
5. Curb cut location and width shall be verified, if applicable.

GIP-06 Extended Detention

1. Elevations shall be provided for inverts of the outlet control structure, low flow orifice, top of casting (overflow), and all applicable features: forebay, micro pool, deep pool, wetland, dewatering device, etc.
2. Elevations shall be provided for top of surrounding berm and emergency spillway.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
4. Note the type of outlet structure (i.e. v-notch weir, riser, low flow orifice, etc.)

GIP-07 Sheet Flow

1. Elevations shall be provided for the top of any level spreader. Provide shots at each end and every 7 feet along the level lip.
2. Verify level spreader is properly installed to create sheet flow.
3. Verify vegetated filter strip or open space that receives sheet flow has minimal slope.
4. Verify paved area drains toward level spreader and pervious area.
5. Verify the proper vegetation has been established or protected.
6. If using amended soils, ensure proper installation by digging a test pit to verify the depth of mulch, amended soil and scarification.

GIP-08 Reforestation

This SCM requires certification from a Landscape Architect registered in the State of Tennessee to certify that the plantings have been installed per the approved plan and, if applicable, that the soil has been properly amended.

1. Provide the location, size, and species of the plantings.
2. Verify ground cover; organic mulch or establishment/germination native seed mix.

GIP-09 Green Roof

1. Profile view of facility including typical cross-sections with dimensions;
2. Growing medium elevations.
3. Stormwater piping associated with the site, including pipe materials, sizes, slopes, invert elevations at bends and connections.
4. Elevations of all overflow devices.
5. Planting and irrigation plan.

TSS-01 Stormwater Wet Pond

1. Elevations shall be provided for permanent pool, inverts of the outlet control structure, and top of casting (overflow).
2. Elevations shall be provided for top of surrounding berm and emergency spillway.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
4. Note the type of outlet structure (i.e. – v notch weir, riser, low flow orifice., etc)

TSS-02 Constructed Wetland

If components of the stormwater wetland constructed in the field differ from the design approved by the City, the as-built certification must: (1) Note the differences between the measure in the field and the design approved by the City; (2) Demonstrate that the design meets the requirements of the City's stormwater program and, if applicable, the City's floodplain management program; and/or (3) Propose additional measures to be included on the site to mitigate the differences.

1. Elevations shall be provided for the different areas of the wetland (i.e. deep water, low marsh, high marsh, etc.) permanent pool, inverts of the outlet control structure, low flow orifice, top of casting (overflow), and all applicable features: forebay, micro pool, deep pool, wetland, dewatering device, etc.
2. Elevations shall be provided for top of surrounding berm and emergency spillway.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.

TSS-03 Surface Sand Filter

1. Elevations shall be provided for inverts of the underdrain, bottom of forebay, top of sand bed, standpipe in forebay or berm separating forebay/sand bed, and overflow
2. Pretreatment measures shall be verified.
3. Forebay surface area and depth shall be provided.
4. Surface area of sand bed shall be provided.

TSS-04 Water Quality Swale

1. Elevations shall be provided for inverts of the underdrain, check dams/check dam weirs, outlet control structure, and top of casting (overflow)
2. Elevations shall be provided for top of soil and top of surrounding berm.
3. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
4. Surface area of the feature shall be provided.
5. Curb cut location and width shall be verified, if applicable.

TSS-05 Dry Pond

1. Elevations shall be provided for bottom of pond, inverts of the outlet control structure, low flow orifice, top of casting (overflow), and all applicable features: forebay, micro pool, deep pool, wetland, dewatering device, etc.
2. Elevations shall be provided for top of surrounding berm and emergency spillway.
3. Elevations shall be provided for the top of any level spreader. Provide shots at each end and every 7 feet along the level lip.
4. Pretreatment measures shall be verified. Forebay surface area and depth shall be provided.
5. Note the type of the outlet structure (i.e. – v notch weir, riser, low flow orifice, etc.)

TSS-06 Filter Strip

1. Ensure design flows spread evenly across filter strip.
2. Verify slope is between 2% and 6%.
3. Verify dimensions of filter strip.
4. Elevations shall be provided for the top of any level spreader. Provide shots at each end and every 7 feet along the level lip.

TSS-07 Grass Channel

1. Verify shape of the channel
2. Provide the length, average depth, average slope of each side of the channel, average width of the bottom of the channel, and average slope throughout the channel.

TSS-08 Underground Sand Filter

1. Verify the manufacturer and model information of the vault, if manufactured.
2. Provide location of cleanouts/manholes.
3. Provide elevations for inlet/outlet/underdrain inverts, top of filter bed (sand), and overflow weir.
4. Verify the vault is free of sediment and construction trash/debris.

TSS-09 Perimeter Sand Filter

1. Provide elevations for the center of each grate (inlet), bottom of forebay, weir, top of filter bed (sand), underdrain invert, and any overflow/spillway.
2. Forebay surface area and depth shall be provided.
3. Surface area of sand bed shall be provided.

TSS-10 Organic Filter

1. Elevations shall be provided for inverts of the underdrain, bottom of forebay, top of filter bed, standpipe in forebay or berm separating forebay/filter bed, and overflow
2. Pretreatment measures shall be verified.
3. Forebay surface area and depth shall be provided.
4. Surface area of filter bed shall be provided.

TSS-11 Gravity Oil Grit Separator

1. Verify the manufacturer and model information of the separator which has been installed.
2. Provide location of cleanouts/manholes.
3. Provide all applicable invert elevations.
4. Verify the separator is free of sediment and construction trash/debris

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01870

DATE: March 23, 2021

TO: Board of Mayor and Aldermen

FROM: Eric Stuckey, City Administrator
Paul Holzen, Director of Engineering
Jonathan Marston, Asst. Director of Engineering
Jimmy Wiseman, Asst. Director of Engineering
Adam Moser, Traffic Engineer

SUBJECT:

Presentation And Acknowledge Receipt Of The Final Report For The Cool Springs Transportation Study.

PURPOSE:

The purpose of this memorandum is to provide information to the Franklin Board of Mayor and Aldermen (BOMA) concerning the Final Report of the Cool Springs Transportation Study. The Study has been completed by the Consultant, KCI, with incorporation of City staff and BOMA comments. The final recommendations and incorporation of recommendations will be presented.

BACKGROUND/STAFF COMMENTS:

On November 26, 2019, the BOMA approved a Professional Services Agreement (COF Contract No. 2019-0321) to KCI Technologies Inc for the Cool Springs Transportation Study. This comprehensive study reviews the Cool Springs area's existing traffic conditions, along with approved and ongoing development and its expected future affects on the transportation infrastructure in this area. The study has been finalized with recommendations and improvements. This presentation will summarize the final report and recommendations, and staff will discuss implementation of the recommendations.

FINANCIAL IMPACT:

There is no financial impact of the Final Report, however, future recommendations in the report, such as infrastructure improvements, will likely require funding.

RECOMMENDATION:

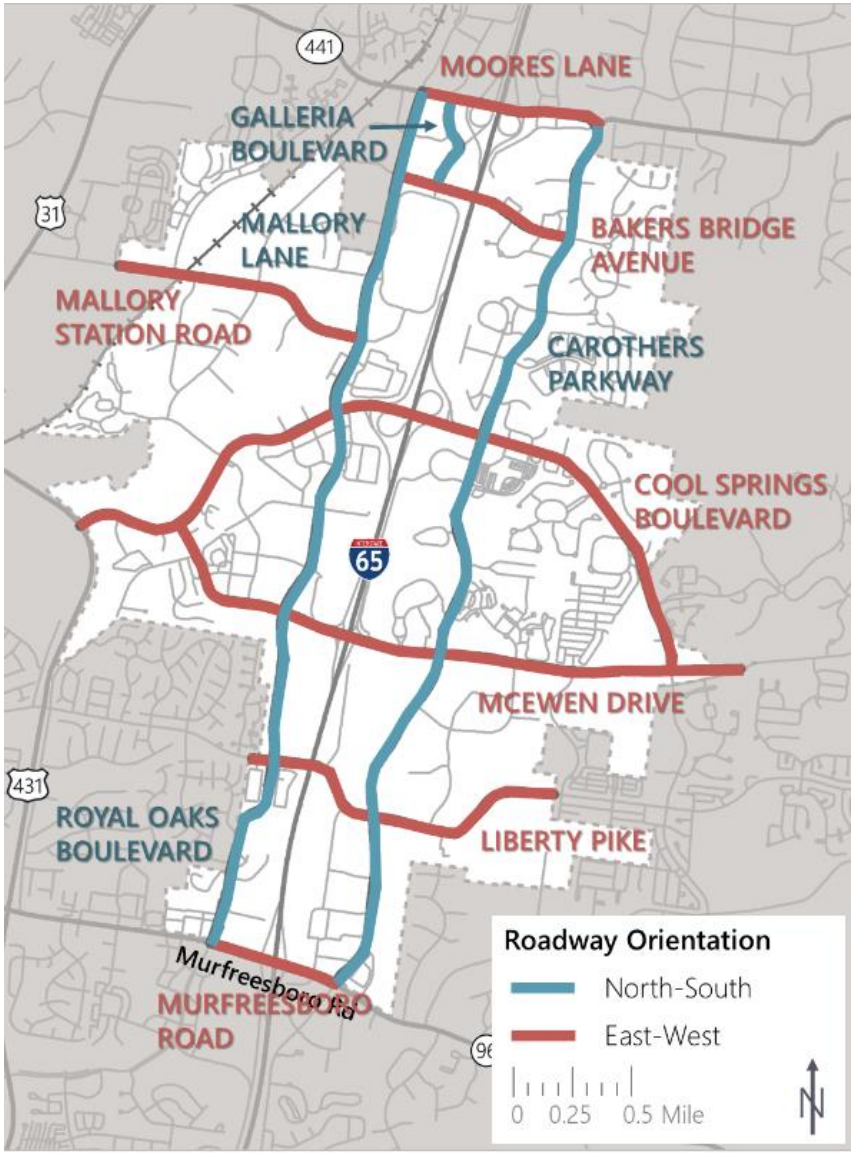
Staff recommends that the Board of Mayor and Aldermen acknowledge the Final Report of the Cool Springs Transportation Study.

HISTORIC FRANKLIN TENNESSEE

CITY OF FRANKLIN

COOL SPRINGS
Transportation Network Study

Study Area


441
MOORES LANE
GALLERIA BOULEVARD
31
MALLORY LANE
BAKERS BRIDGE AVENUE
MALLORY STATION ROAD
CAROTHERS PARKWAY
COOL SPRINGS BOULEVARD
65
MCEWEN DRIVE
431
ROYAL OAKS BOULEVARD
LIBERTY PIKE
Murfreesboro Rd
MURFREESBORO ROAD
Roadway Orientation
North-South
East-West
0 0.25 0.5 Mile
N

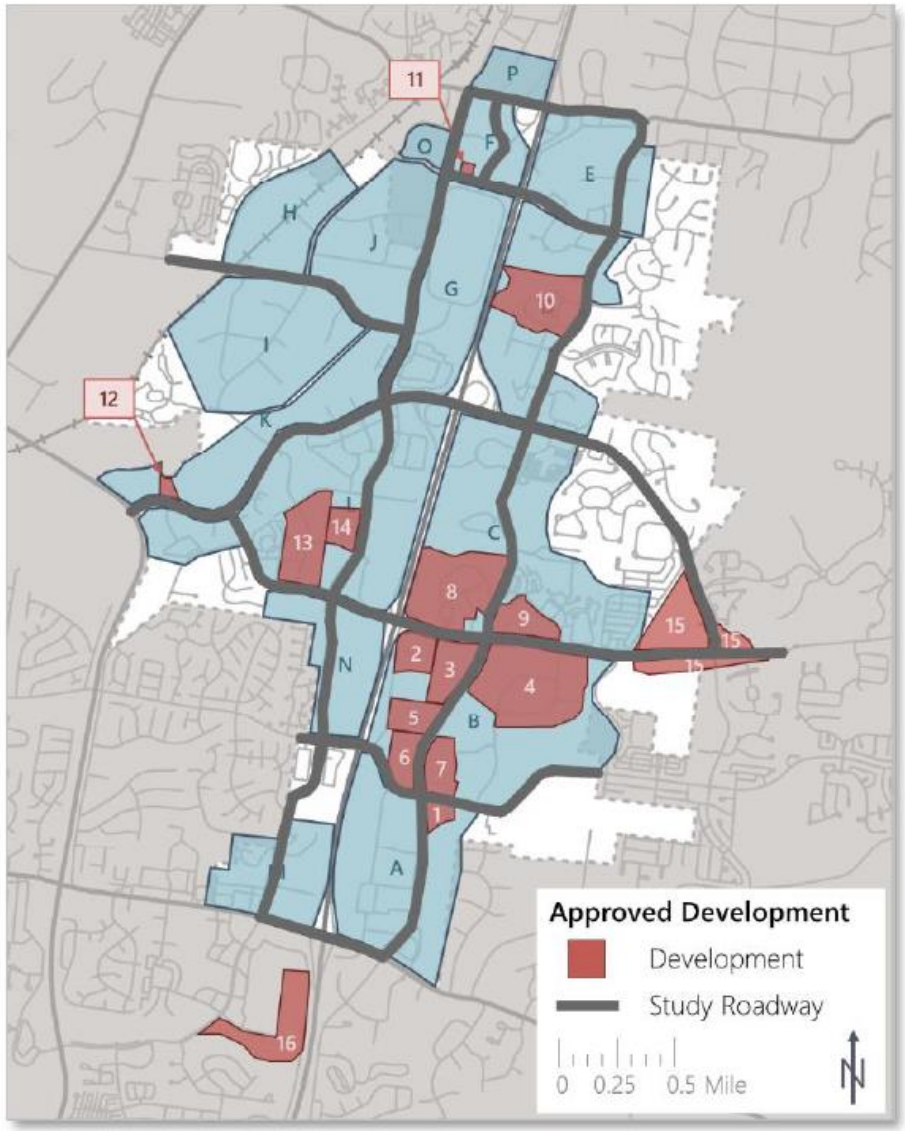
Level Of Service (LOS) Analysis

Scenarios:

- **Existing**
- 1: 50% Approved Development Buildout
- 2: 100% Approved Development Buildout
- 3: 25% Future Growth (Infill, Redevelopment, Available Land)
- 4: 50% Future Growth (Infill, Redevelopment, Available Land)

Scenario 4: % Intersections LOS E or better:

AM Peak	33%
Midday Peak	8%
PM Peak	9%



Proposed Recommendation Areas

INFRASTRUCTURE

Development Approval Practices

Trip Reduction Strategies

More Multimodal Options

Recommended Implementation Timeline

Short-Term Recommendations

- Revise LOS D Requirements
- Revise Standard Cross Sections

Mid-Term Recommendations

- Develop TDM Toolbox
- Begin Utilization of VMT
- Conduct Micromobility Pilot

Long-Term Recommendations

- Explore Multimodal Funding Options

INFRASTRUCTURE

What Have We Implemented?

Current Practice

Development impacts are assessed based on intersection Level of Service (LOS) and must be mitigated when LOS D is not maintained.

Current Issue

LOS D is already unachievable in many areas with existing and approved development.

What Have We Implemented?

Revised COF Traffic Impact Study Guidelines to include wording to recognized already failed intersections and acceptable mitigation measures for development. For Example:

- If already LOS E, maintain LOS E with infrastructure improvements
- Reduce development trips

Thank you

CITY OF FRANKLIN

COOL SPRINGS
Transportation Network Study

FINAL REPORT

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Future Conditions ii
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EXECUTIVE SUMMARY

Introduction

Existing Conditions

Future Conditions

Recommendations

The principal purpose of the Transportation Network Study is to provide the City of Franklin with a coordinated plan of transportation improvements to be made as development occurs in the Cool Springs area. These improvements will improve safety of all roadway users, improve traffic flow, and preserve roadway capacity. The study objectives were to:

1. Inventory and analyze existing conditions;
2. Evaluate potential impacts to the transportation system from currently approved and future development scenarios;
3. Recommend infrastructure and operational improvements; and
4. Recommend policy strategies for achieving desired transportation outcomes.

Introduction

Part 1 of this study, the Introduction, presents the project objectives listed above as well as the study area and study intersections.

The city of Franklin is located within Williamson County in the Middle Tennessee region. The Cool Springs area is located in the northeastern part of Franklin near the southern boundary of Brentwood.

This study focuses on the operations of fifty-six signalized and eight unsignalized intersections. The fifty-eight intersections in Franklin and six intersections in Brentwood make up the majority of the Cool Springs transportation network.

Existing Conditions

Part 2 of this study, The Existing Conditions Report, includes a discussion of the existing conditions of the Cool Springs roadway network and a review of the existing development policies for the City of Franklin.

In order to evaluate the existing conditions in the study area, PTV Vistro, a traffic simulation software, was used to create a model of the transportation network that evaluated traffic operations for the study intersections.

Extensive field observations and intersection inventories were conducted for each of the study intersections to ensure that the traffic simulation model accurately reflected the existing conditions. Part 2 of this report details this process and includes the following information:

- Study Intersections
- Roadway Infrastructure
- Data Collection
- VISTRO Modeling
- Capacity Analysis
- Policy Review

Under existing conditions, the results of the capacity analysis indicate that percent of intersections operate at LOS E or better in the AM, Midday, and PM peak is as follows:

AM Peak	100%
Midday Peak	98%
PM Peak	95%

Future Conditions

Part 3 of this study, the Future Conditions Report, presents the conditions of the roadway network in Cool Springs after accounting for traffic impacts of approved and potential developments within the study area.

The Cool Springs area has experienced significant growth over the past 20 years, and this trend is expected to continue. The Future Conditions Report presents general growth projections, projections due to approved development, and projections based on future

development potential within the Cool Springs area. In order to understand the implications of future growth on the transportation network, the following four growth scenarios were tested using the Vistro model:

1. Approved Development – 50%
2. Approved Development – 100%
3. Maximized Development – 25%
4. Maximized Development – 50%

'Approved Development' represents the developments that are approved to be built within the study area, as of April 2020, for which traffic studies were completed as part of the approval process. These approved developments also include a list of recommended improvements that corresponds with each approved development.

'Maximized Development' represents potential development, redevelopment, and infill opportunities of parcels within the study area. Using a combination of land use, zoning, and property assessment data, these future development opportunities were quantified in coordination with the City of Franklin Planning Department.

Results of each scenario determined the future operations of the Cool Springs transportation network, which were then evaluated to create a coordinated plan of transportation improvements.

Under Scenario 1, the results of the capacity analysis indicate that percent of intersections operate at LOS E or better in the AM, Midday, and PM peak is as follows:

AM Peak	94%
Midday Peak	94%
PM Peak	86%

Under Scenario 2, the results of the capacity analysis indicate that percent of intersections operate at LOS E or better in the AM, Midday, and PM peak is as follows:

AM Peak	80%
Midday Peak	83%
PM Peak	63%

Under Scenario 3, the results of the capacity analysis indicate that percent of intersections operate at LOS E or better in the AM, Midday, and PM peak is as follows:

AM Peak	33%
Midday Peak	8%
PM Peak	9%

Under Scenario 4, the results of the capacity analysis indicate that percent of intersections operate at LOS E or better in the AM, Midday, and PM peak is as follows:

AM Peak	16%
Midday Peak	3%
PM Peak	3%

Recommendations

The Recommendations Report, Part 4, presents the proposed immediate, short-term, mid-term, and long-term roadway infrastructure recommendations for the study area. Additionally, policy recommendations are also presented.

Field inventories were collected for each study intersection in December 2019 and January 2020. From those inventories, an initial set of recommendations was determined for immediate roadway improvements. These improvements include refreshing striping, sidewalk repairs, sign repair/replacement, and additional observations. Recommendations for forty-seven of the study intersections are presented under immediate recommendations.

Short-term recommendations indicate improvements that could occur within the next

five years. This study presents **three short-term recommendations**. These recommendations include the addition of right-turn lanes and roadway restriping where right-of-way acquisition is minimal.

Under both Future Conditions – Scenario 1 and Future Conditions – Scenario 2 with the implementation of the short-term recommended improvements, the three study intersections are expected to operate at LOS E or better in the AM, Midday, and PM peak hour.

Mid-term recommendations indicate improvements that could occur in the next five to ten years. This report presents **seventeen mid-term recommendations**. These recommendations include the addition of turn lanes and through lanes and roadway restriping where right-of-way acquisition will be required.

Under both Future Conditions – Scenario 1 and Future Conditions – Scenario 2 with the implementation of the mid-term recommended improvements, the majority of the seventeen study intersections are expected to operate at LOS E or better in the AM, Midday, and PM peak hour.

Due to high levels of congestion from maximized development, it was determined that Future Conditions – Scenario 3 and Future Conditions – Scenario 4 would benefit more from policy improvements rather than further infrastructure improvements. Therefore, no infrastructure improvements are recommended for Future Conditions – Scenario 3 and Future Conditions – Scenario 4 under short-term and mid-term recommendations.

Long-term recommendations indicate improvements that could occur after ten years. Recommendations for corridor wide improvements and alternative intersections are presented under long-term improvements.

Functional plans for each of the proposed short-term and mid-term roadway improvements are provided in Appendix R of this report.

Recommendations for policy changes are presented in Part 4 of this report. Policy recommendations focus on three core areas. The first centers around the City's development approval practices, specifically the need to reevaluate them to find alternative ways to measure and address development impacts. The second set of recommendations focuses on strategies for reducing vehicular trips on the roadway network by incentivizing alternative modes such as walking, biking, or taking transit, or changing other travel behaviors. The final set of policy recommendations focuses on the funding, design, and implementation of multimodal infrastructure to accommodate current and future modes of travel in Cool Springs. Combined, these recommendations complement the infrastructure improvements to preserve the quality of life for Franklin residents and the economic vitality of the study area long term.

Part 1

INTRODUCTION

Project Description

Study Area

PROJECT DESCRIPTION

A properly planned transportation system plays a critical role in a community's sustainability and livability. The Cool Springs Transportation Network Study is a strategic effort to evaluate the existing and future conditions of the Cool Springs transportation network, including roadways, sidewalks, and various multimodal facilities. This document serves as a guide for community decision-makers as they respond to and anticipate future growth while guiding the smart evolution of the Cool Springs area of the City of Franklin.

This Transportation Network Study specifically:

1. Inventories and analyzes existing conditions
2. Evaluates potential impacts to the transportation system from future development scenarios
3. Recommends infrastructure and operation improvements
4. Recommends policy strategies for achieving desired transportation outcomes.

The principal purpose of the Transportation Network Study is to provide the City of Franklin with a coordinated plan of transportation improvements to be made as development occurs and to improve safety of all roadway users, improve traffic flow, and preserve roadway capacity.

Study Area

The City of Franklin is located within Williamson County in the Middle Tennessee region (Tennessee Department of Transportation (TDOT) Region 3), as illustrated in Figure 1-1. According to the U.S. Census, in 2017, Franklin was named the 8th fastest growing city in the nation. Franklin's location within the region and its proximity to the Nashville area draws new residents, industries, and visitors alike.

The Cool Springs area, outlined in red in Figure 1-1, is a mixed-use, with residential, commercial, and retail development located along the northeastern boundary of Franklin and the southwestern boundary of Brentwood. Due to its location along I-65, Cool Springs is expected to continue to see growth and development.

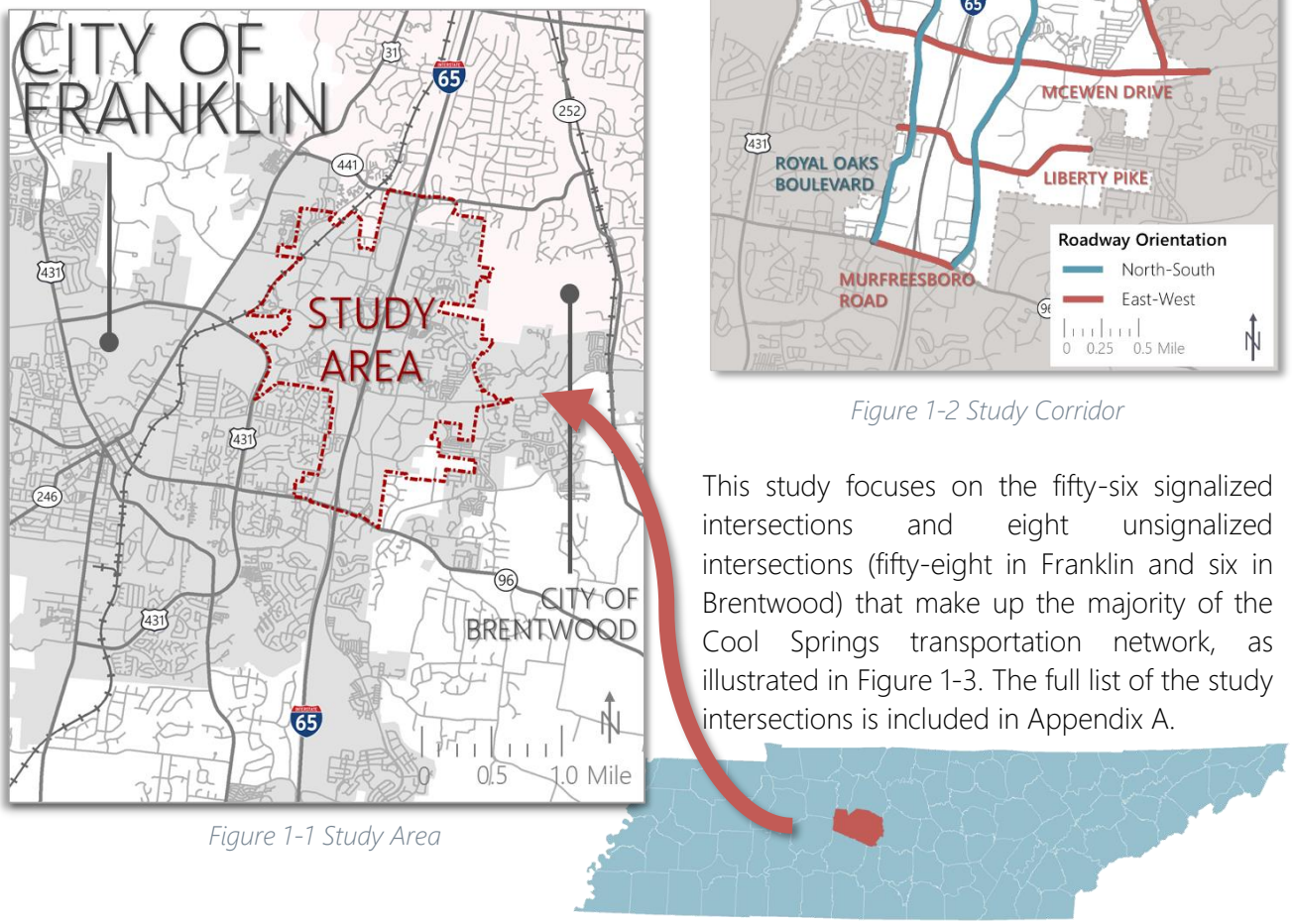


Figure 1-1 Study Area

The study area includes 19.02 miles of roadway along ten focus corridors, illustrated in Figure 1-2. Mallory Lane/Royal Oaks Boulevard, Carothers Parkway, and Galleria Boulevard are typically oriented in the north-south direction; while Moores Lane, Bakers Bridge Avenue, Mallory Station Road, Cool Springs Boulevard, McEwen Drive, Liberty Pike, and Murfreesboro Road are typically oriented in the east-west direction.

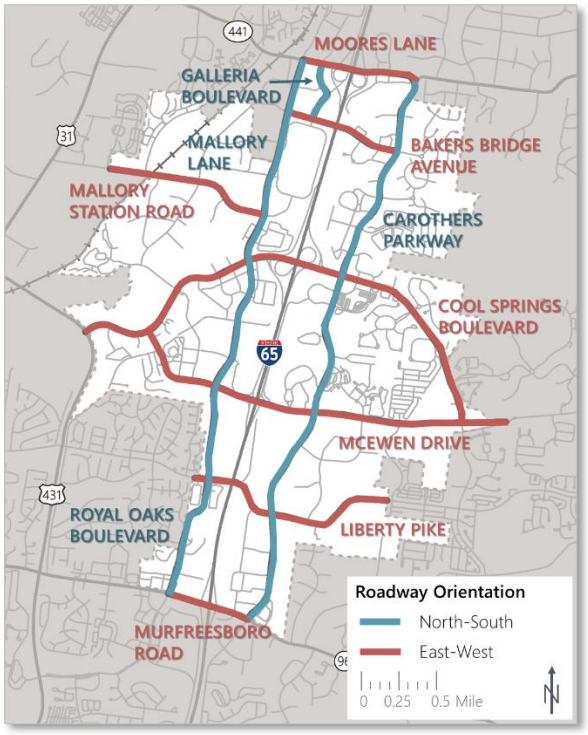


Figure 1-2 Study Corridor

This study focuses on the fifty-six signalized intersections and eight unsignalized intersections (fifty-eight in Franklin and six in Brentwood) that make up the majority of the Cool Springs transportation network, as illustrated in Figure 1-3. The full list of the study intersections is included in Appendix A.

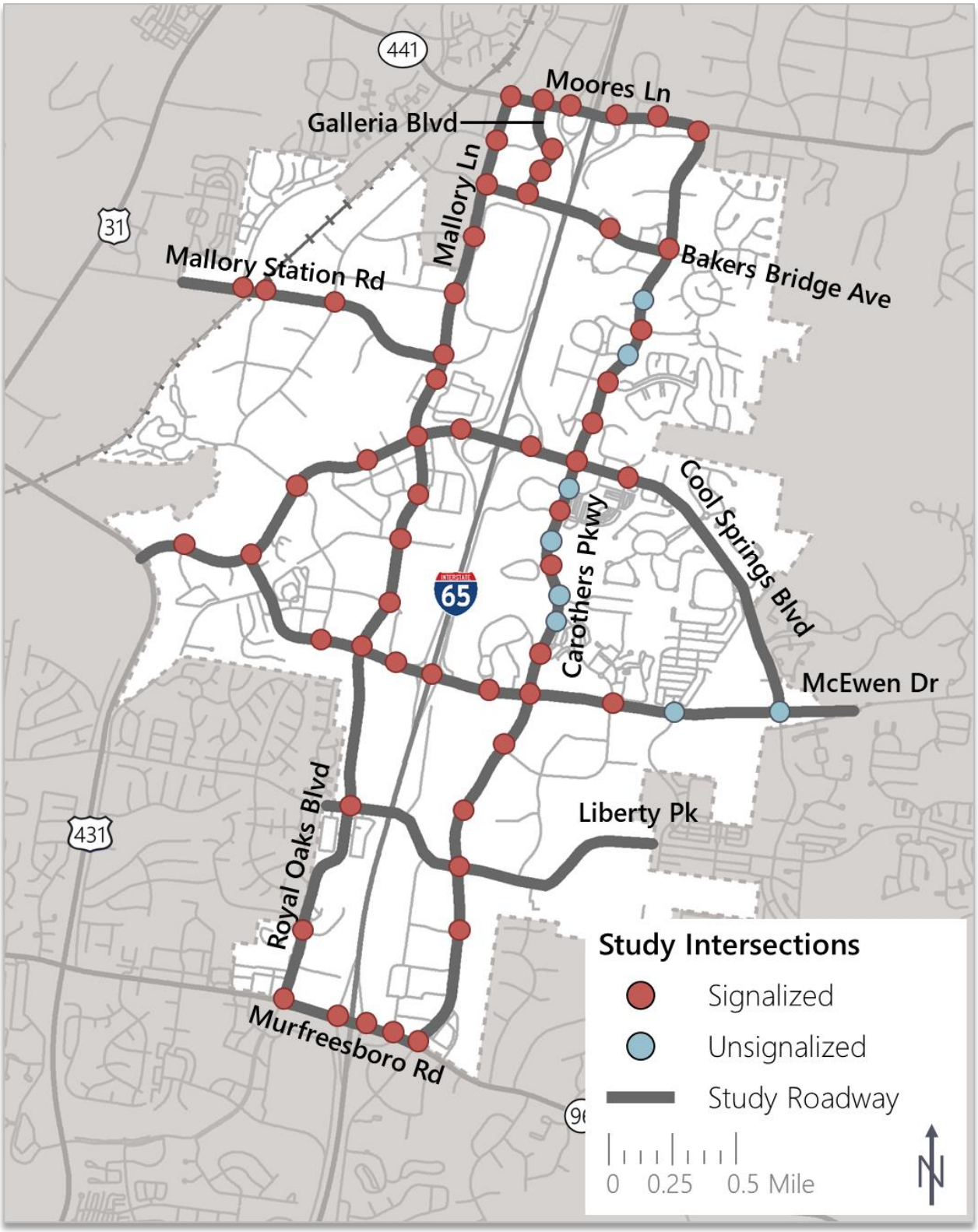


Figure 1-3 Study Intersections

Part 2

EXISTING CONDITIONS

Roadway Infrastructure

Data Collection

VISTRO Modeling

Capacity Analysis

Policy Review

Chapter 1

ROADWAY NETWORK

Due to its geographical proximity to the Nashville region, the city of Franklin has seen significant growth and development over the past couple decades. Development patterns within the city of Franklin have had a strong influence over the transportation network and how it operates today. Understanding the implications of continual growth on the transportation system is vital to the sustainability of the city of Franklin, and specifically for this study, in the Cool Springs area.

This chapter sets the stage for looking at future growth by first documenting the existing conditions in the study area. To accomplish this, the following were taken into consideration:

- Roadway Infrastructure
- Existing Traffic Patterns
- Data Collection
- Model Development
- Capacity Analysis

To evaluate the existing traffic operations within Cool Springs, a model of the network was created using the traffic simulation software PTV Vistro. To ensure that the traffic simulation model accurately reflects existing conditions, extensive field observations and intersection inventories were conducted for all sixty-three of the study intersections.

Roadway Infrastructure

Functional Classification

Roadways are assigned a functional classification based on a roadway's design function to provide regional mobility, local accessibility, or both. The Federal Highway Administration (FHWA) establishes four main classes. A description of each of these functional classifications are displayed below. Figure 2-2 illustrates the classifications of the Cool Springs roadway network.

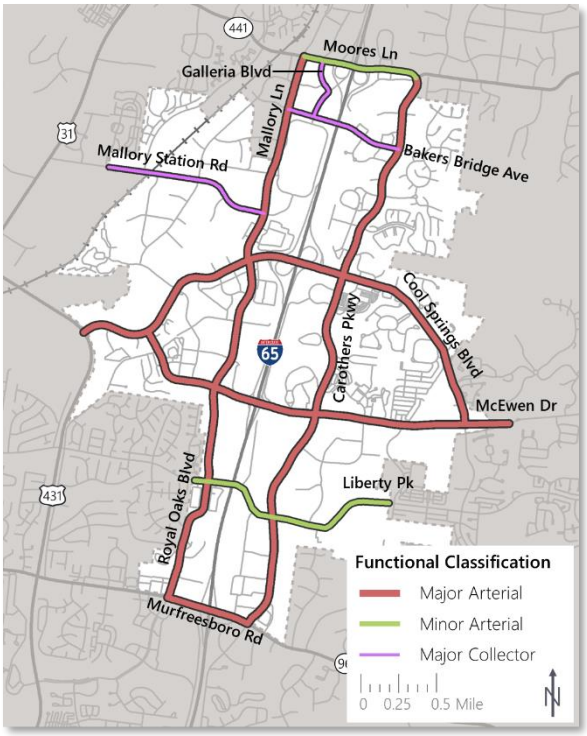


Figure 2-2 Functional Classification

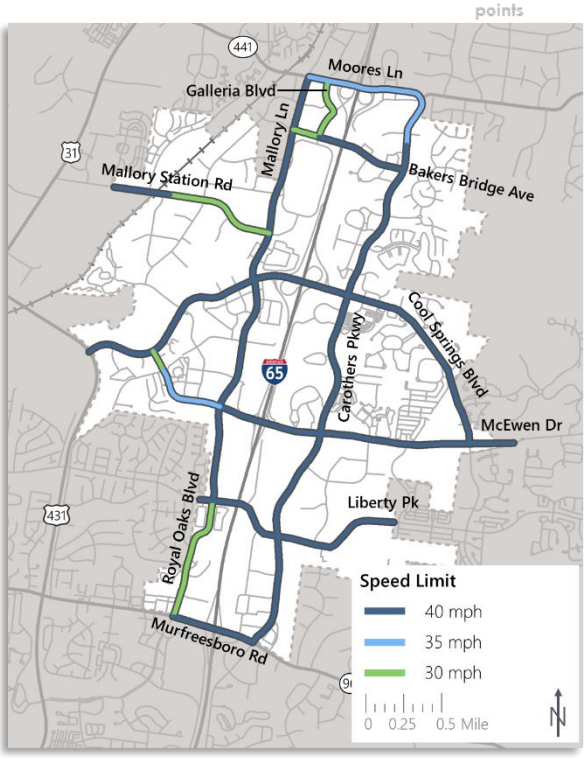


Figure 2-1 Posted Speed Limit

Speed Limits

The posted speed limits for the study corridors are presented in Figure 2-1. Detailed approach speeds for each study intersection are presented in Appendix C. According to Franklin's Code of Ordinances, where speed limits are not posted, the speed limits should be as follows:

- Highways & Non-Local Roads: 30 mph
- Alleys: 15 mph
- Residential & Local Roads: 25 mph

Data Collection

In order to develop a calibrated Vistro model of the Cool Springs area, a detailed inventory of the signal system was performed using data obtained from the City of Franklin, the City of Brentwood and field observations performed by the project team. This section details the components of the data collection.

Turning Movement Count (TMC)

In order to provide data for the study, vehicle, pedestrian, and bicycle count data was collected for the study area. Manual turning movement counts were collected at the study area intersections for a typical weekday while schools were in session from 6:00 – 9:00 AM, 11:00 AM – 1:00 PM, and 4:00 – 6:00 PM. From the turning movement counts, AM, Midday, and PM peak hour traffic volumes were determined. Detailed peak hour turning movement counts and a figure depicting the turning movement counts can be found in Appendix B. The majority of the turning movements counts were completed in January 2020, however, counts conducted within the past two years were utilized for some intersections. Counts conducted before 2020 were factored up to represent 2020 volumes.

Field Inventory

A detailed inventory of each intersection was conducted between December 2019 and January 2020. The following information was included in the field inventory of each intersection:

- Approach Speed
- Intersection Geometry and Laneage
- Storage/Taper Lengths
- Turn Lane Treatments
- Pedestrian Treatments
- Pertinent Signing/Markings
- Approach Grade
- Queue Observations
- Vehicle Detection
- Signal Heads and Phasing

Detailed field inventory sheets for each study intersection are included in Appendix C.

Peak Hour Observations

On Wednesday, January 29, 2020, peak hour observations of the Cool Springs area network were conducted. In the AM, Midday, and PM peak hours, multiple teams traversed the network recording the following observations:

- Queue Lengths
- Queue Clearance
- Lane Utilization
- General Patterns and Observations

One example observation includes:

- McEwen Drive and Carothers Parkway
    - 7:24 AM – ~100% of northbound left-turns were using the right-most left-lane.
    - 8:07 AM – Eastbound left-turn queue was 20+ cars. Two cars failed to clear.

Detailed peak hour observations are included in Appendix D.

Signal Timing Data

Existing signal timing plans were obtained from the City of Franklin and the City of Brentwood. Signal timing plans typically include the following information:

- Minimum Green, Yellow, and Red Time
- Pedestrian Timings
- Time of Day (TOD) Plans
- Coordination Information

Detailed signal timing plans for each of the signalized study intersections are presented in Appendix E.

Drone Footage

The project team captured drone footage of the study area to provide a high-quality aerial view of how study intersections operate. Video was collected on February 2, 2020 between 7:30 AM and 4:30 PM. The drone footage was used to aid in the validation of the results from the existing conditions Vistro model. Figure 2-3 presents captures from the drone footage. The drone footage was electronically provided to the City for their future reference.

Figure 2-3 Stills from Drone Footage

Multimodal Accommodations

Sidewalks are provided throughout the study area. Figure 2-4 depicts the existing sidewalk infrastructure within the study area, and Table 2-1 presents the miles of sidewalk on at least one side of the roadway in relation to the total roadway mileage. It should be noted that, within the study area, there are a low number of pedestrian trips for utilitarian trip purposes; therefore, pedestrian counts were not taken into account for this study. Most observed pedestrian trips were for presumedly recreational purposes.

Table 2-1 Existing Roadway with Sidewalk

Roadway with Sidewalk	16.34 mi
Total Roadway	19.02 mi

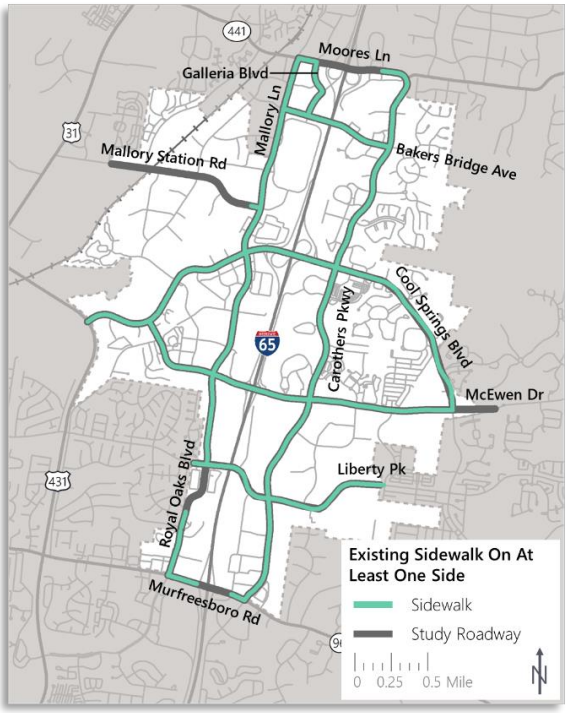


Figure 2-4 Existing Sidewalk

In addition to sidewalks, fifty-two of the sixty-four intersections have pedestrian infrastructure (i.e. pedestrian signals crossing the major and/or minor roadway, crosswalks crossing the major and/or minor roadway). The pedestrian infrastructure for each study intersections is shown in Figure 2-5 with a symbol. The symbol is divided into four sections which when filled in with color indicate a pedestrian facility provided at the intersection. For example, the intersection of Cool Springs Boulevard and Carothers Parkway, indicated by in Figure 2-5, includes the following pedestrian facilities:

- Signals – To Cross the Major Road
  - Indicated By:
- Signals – To Cross the Minor Road
  - Indicated By:
- Crosswalk – To Cross the Major Road
  - Indicated By:
- Crosswalk – To Cross the Minor Road
  - Indicated By:

Symbols which are only partially filled in with color, , indicate study intersections with limited pedestrian facilities. Symbols which are blank indicate that no pedestrian infrastructure is currently provided at the study intersection.

Table 2-2 details the number of intersections that utilize each type of pedestrian infrastructure. It should be noted that the table and figure both indicate pedestrian infrastructure on at least one side of the roadway.

Table 2-2 Tally of Pedestrian Infrastructure

Major Road - Signal	39
Minor Road - Signal	43
Major Road - Crosswalk	44
Minor Road - Crosswalk	47
No Infrastructure	12

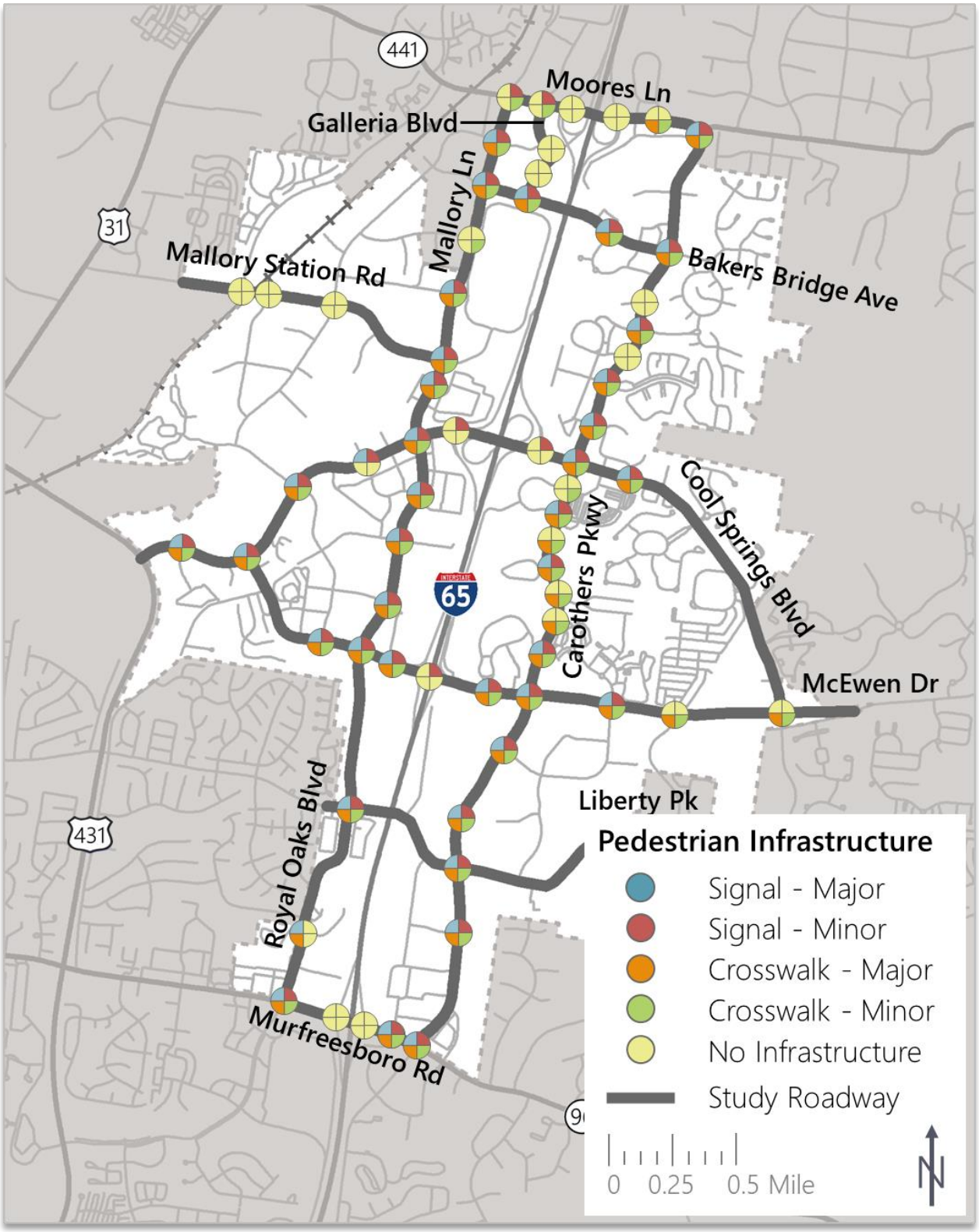


Figure 2-5 Pedestrian Infrastructure

Within the project area, there are bicycle facilities along McEwen Drive, Carothers Parkway, and Liberty Pike. West of Mallory Lane, McEwen Drive is categorized as a signed shared roadway, and east of Mallory Lane, McEwen Drive has bike lanes in each direction. Carothers Parkway is categorized as a multi-use path to the south of Cool Springs Boulevard. Liberty Pike has bike lanes in each direction. These facilities are illustrated in Figure 2-6, and Table 2-3 describes the associated mileage. It should be noted that Figure 2-6 and Table 2-3 includes multi-use paths that are within the study area, but not on the study roadways. Additionally, within the study area, there are a low number of bicycle trips for utilitarian trip purposes. Most observed bicycle trips were for recreational purposes.

Table 2-3 Bicycle Facilities Mileage

Bike Lane	3.52 mi
Multi-Use Path	5.26 mi

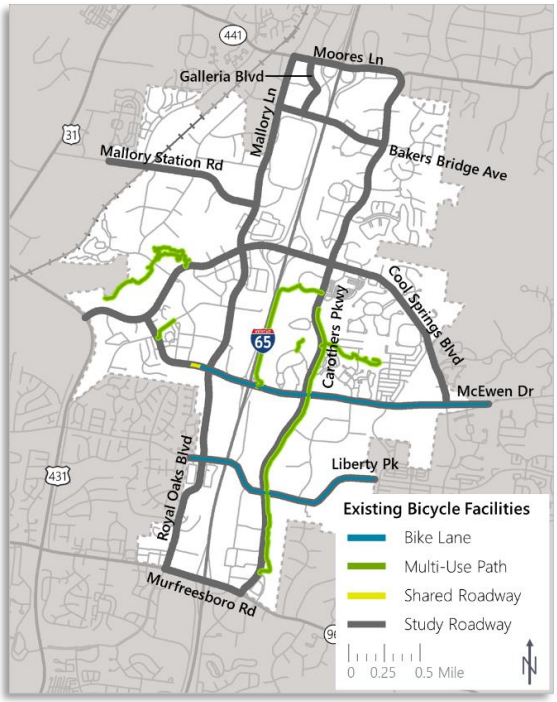


Figure 2-6 Bicycle Facilities

The Franklin Transit Authority (FTA) offers two transit lines within the city of Franklin; Red Route and Blue Route. The Blue Route and the Blue Route 2 run through the Cool Springs area along Mallory Lane and Carothers Parkway, respectively. Figure 2-7shows the bus stops and transit route that travel through the study area. Table 2-4 details the number of bus stops for each route within the study area. For both routes, stops occur every thirty minutes on weekdays. For the Blue Route only, stops occur every sixty minutes on Saturdays. No service is provided on Sundays for either route.

Table 2-4 Public Transit Stops within Study Area

Blue Route	8
Blue Route 2	14

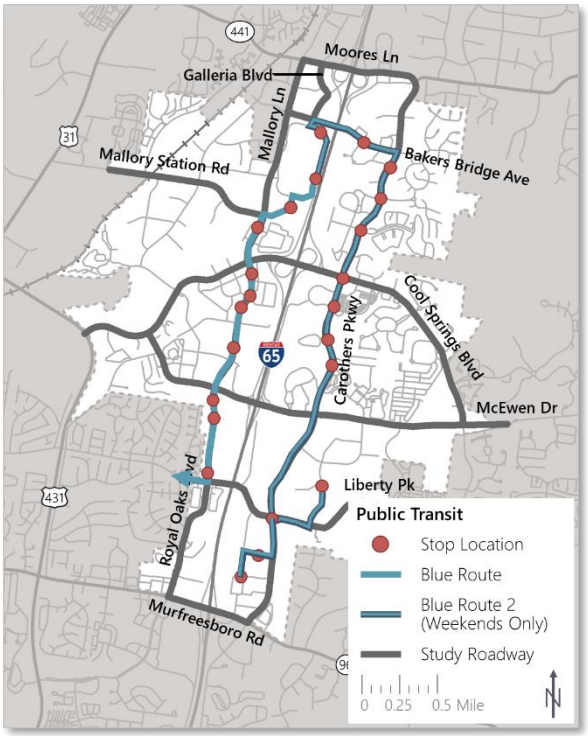


Figure 2-7 Public Transit

VISTRO Modeling

Studying roadway networks in the field can often be difficult and time consuming, especially when considering future developments within an area. Therefore, simulation software is typically used to model roadway networks for traffic studies. This study specifically utilized PTV Vistro to model the Cool Springs area.

According to PTV Group, "PTV Vistro is an all-in-one solution for conducting traffic analyses, evaluating new development impact, and optimizing signal timing." Roadways can be drawn to mimic existing facilities, and new developments can be incorporated into the model. Vistro is an excellent tool for analyzing the impacts of future developments within an area. In addition to having capacity analysis capabilities, Vistro can be used to analyze the cumulative impacts of development over time.

The lane geometry, speed limits, turning movement counts, and signal timing data described above were used to develop the Vistro model, shown in Figure 2-8. The drone footage and field observations were used to aid in the calibration and validation of the Vistro model based on the comparison between observed queuing and delay and the reported Vistro queuing and delay.

In addition to the above information, the following inputs were also considered:

- Peak Hour Factors
- Heavy Vehicle Factors
- Lost Time
- Turn Bay Lengths

These inputs are described in greater detail in Appendix F.

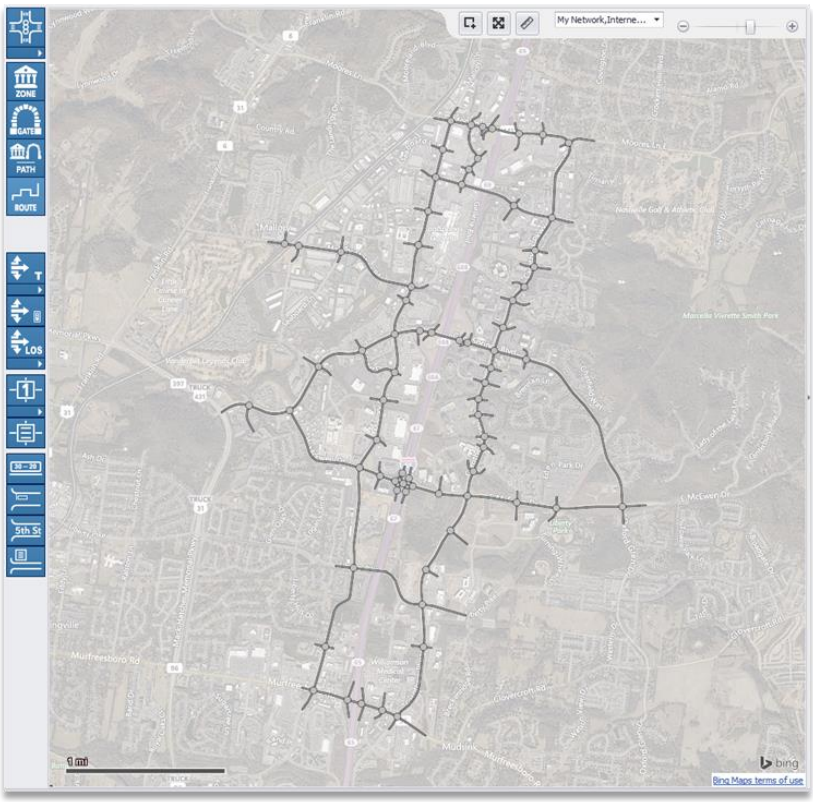


Figure 2-8 Cool Springs Vistro Model

Capacity Analysis

Operations

Capacity describes the maximum number of vehicles that can utilize a roadway segment or intersection under a given set of conditions. This measurement is typically expressed as number of vehicles per unit of time (i.e. vehicles per hour).

Vehicle Level of Service (LOS) is a measurement used to identify how well a roadway segment or intersection is able to accommodate traffic volumes with the roadway's capacity. This measurement is generally expressed as a function of vehicular delay, or how much time a driver spends at that location. Pedestrian and Bicycle Level of Service (PLOS and BLOS, respectively) express the degree of satisfaction of sidewalk or bicycle facilities offered to the pedestrian or cyclist with respect to safety, comfort, and convenience.

Based on the amount of delay experienced, LOS is assigned a "grade" between LOS A and LOS F. LOS A is the highest condition rating with vehicles experiencing minimal delay, while LOS F is considered the worst with vehicles experiencing excessive delay.

Figure 2-10, Figure 2-11, and Figure 2-12 depict the vehicle LOS for each of the study intersections in the AM, Midday, and PM peaks, respectively. Table 2-5 details the number of intersections for each vehicle LOS grade for each respective peak.

Figure 2-13 depicts the PLOS provided by the Nashville MPO. The BLOS for the study are is not included within this report; however, detailed BLOS for the study area can be found on the Nashville MPO website.

Table 2-5 Intersection Tally by Existing LOS

LOS	A	B	C	D	E	F
AM	23	19	11	8	3	0
Mid	14	18	21	8	2	1
PM	9	18	22	7	5	3

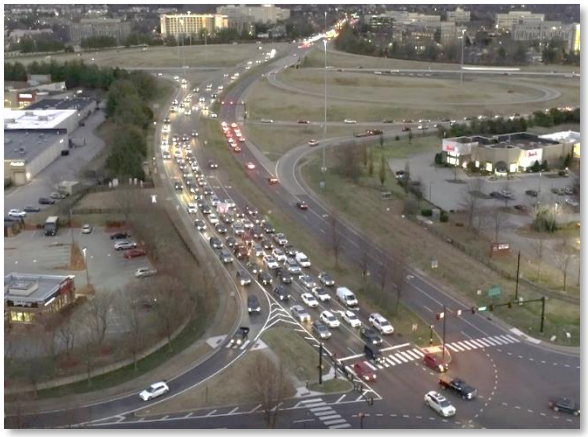


Figure 2 - 9 Mallory Lane and Cool Springs Boulevard

Figure 2-10 Existing Vehicle LOS - AM Peak

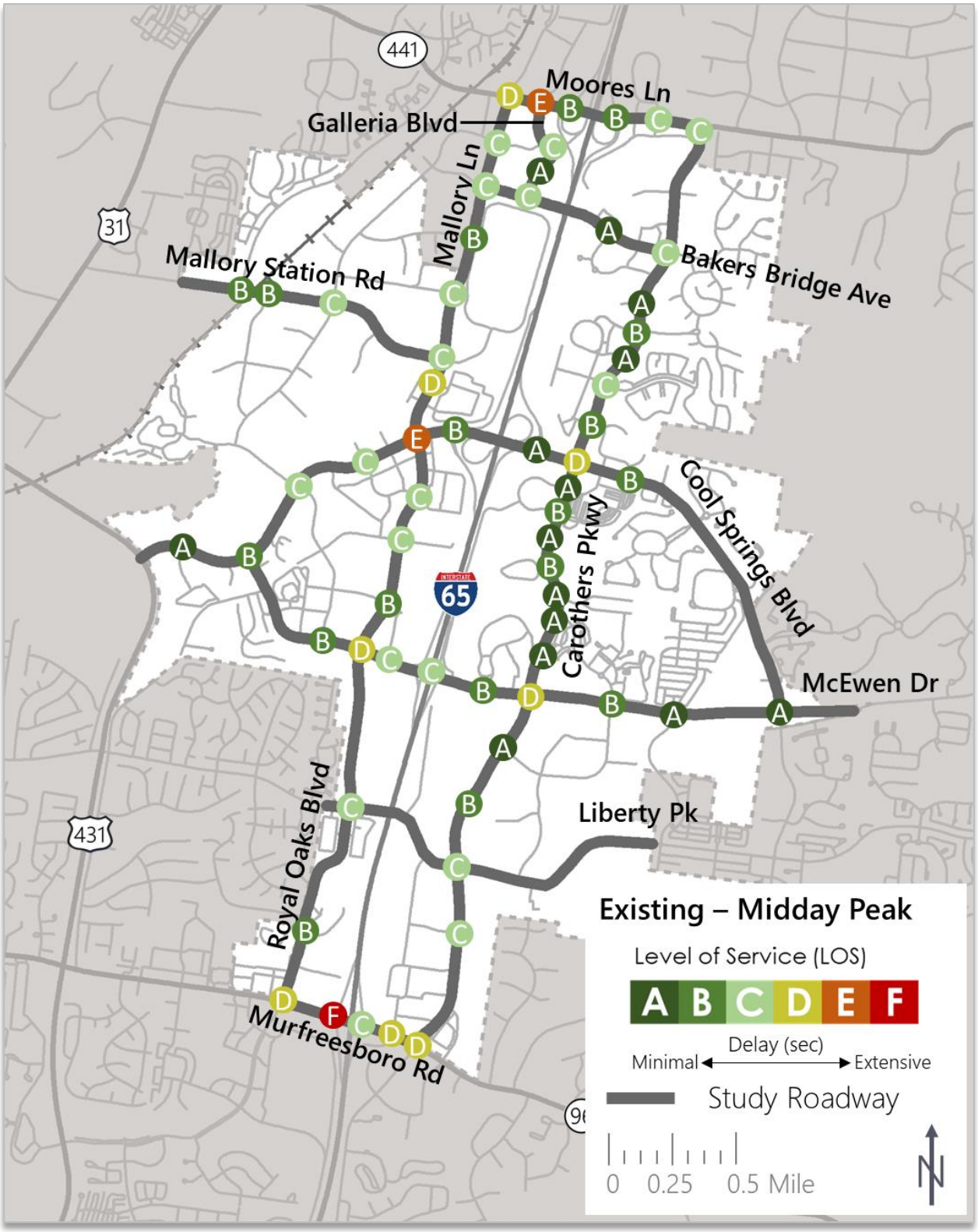


Figure 2-11 Existing Vehicle LOS - Midday Peak

Figure 2-12 Existing Vehicle LOS - PM Peak

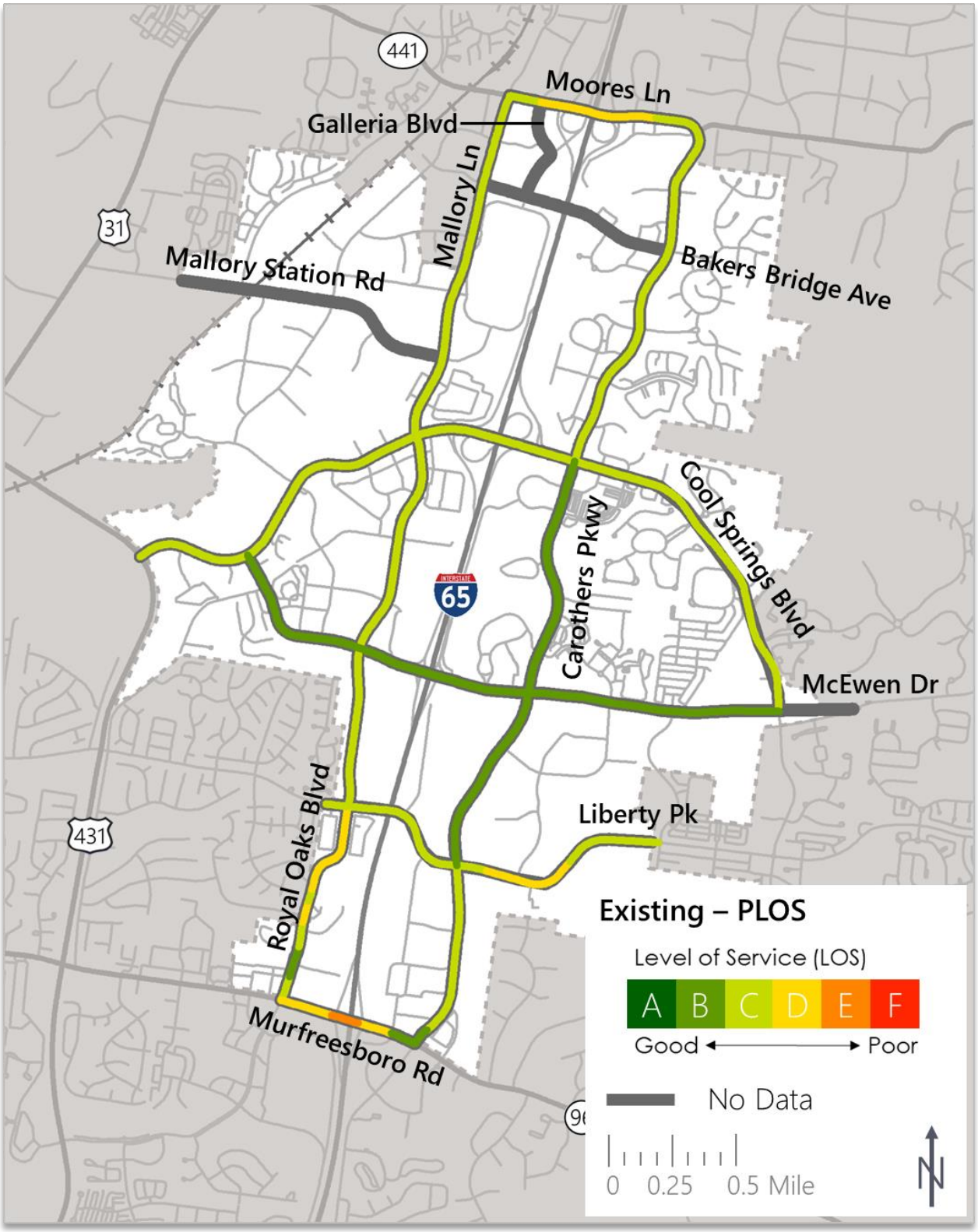


Figure 2-13 Existing Pedestrian LOS, Nashville MPO

Volume-to-capacity ratio (v/c ratio) is a measurement used to indicate how an intersection is operating in terms of capacity, where capacity is defined as the maximum number of vehicles that can utilize an intersection per hour. According to the *Highway Capacity Manual* (HCM), an intersection with a v/c ratio less than 0.85 is operating under capacity, an intersection with a v/c ratio at 1.0 is operating at capacity, and an intersection with a v/c ratio greater than 1.0 is operating over capacity. Figure 2-14, Figure 2-15, and Figure 2-16 depict the Vistro model results for the v/c ratio of each study intersection in the AM, Midday, and PM peaks, respectively.

In addition to LOS and v/c ratio, this study considered the queue lengths for each study intersection. Tables detailing the LOS and v/c ratio and queue lengths for each study intersection are included in Appendix K and Appendix L, respectively. The detailed Vistro model outputs from this operations analysis is included in Appendix M.

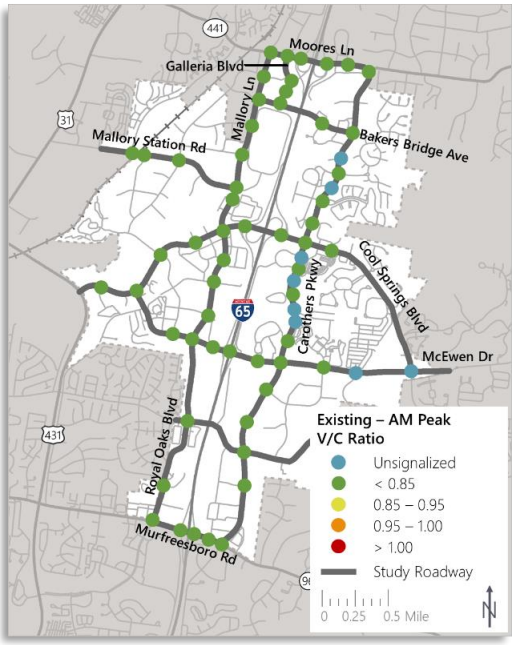


Figure 2-14 Existing V/C Ratio - AM Peak

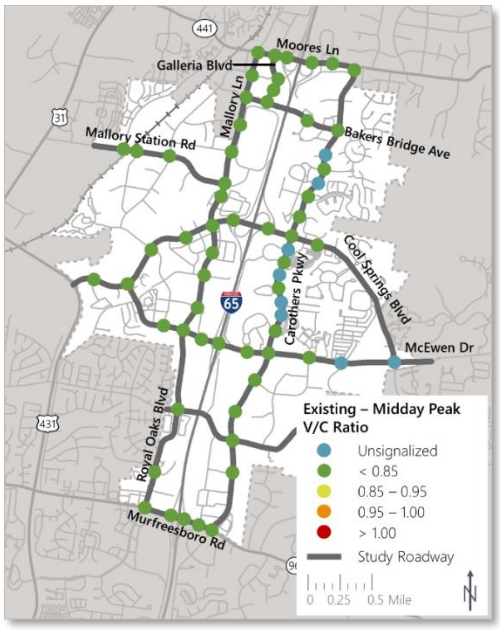


Figure 2-15 Existing V/C Ratio - Midday Peak

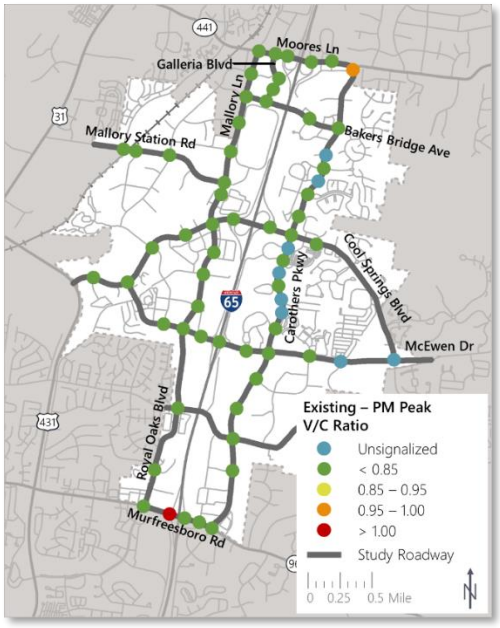


Figure 2-16 Existing V/C Ratio - PM Peak

Under existing conditions, the results of the capacity analysis indicate that at least 95% of intersections operate at LOS E or better in the AM, Midday, and PM peaks. Additionally, the results of the capacity analysis indicate that at least 97% of intersections operate below capacity in the AM, Midday, and PM peaks.

Chapter 2

POLICY REVIEW

Knowing that land use and development patterns directly impact the transportation system, the City of Franklin has undertaken the following recent planning efforts that impact the Cool Springs area:

- Envision Franklin
- Connect Franklin Comprehensive Transportation Network Plan
- Cool Springs Multimodal Transportation Network Study
- Franklin's Greenway and Open Space Master Plan
- Integrated Growth Plan

These plans, as well as the regulatory frameworks they institute and investment priorities they identify, set the stage for the future character, purpose, and operation of the study area.

To complement the technical analysis of the transportation system, this section provides a high-level review of the existing plans that drive growth and development, the policies that guide how that growth is to occur, and the projects identified for addressing the anticipated growth within the Cool Springs area.

This chapter details the previously completed planning efforts including land use plans, growth plans and policies, transportation plans, and presents the responsiveness to growth potential.

Previously Completed Planning Efforts

The City of Franklin has undertaken a number of recent planning efforts related to growth and development, spanning from 2010 to more recent efforts completed in 2019. These efforts can be broken into three primary categories – land use plans, growth plans and policies, and multimodal transportation plans. Each relevant study is documented along with the intentions, outcomes, and the impact on the Cool Springs area.

Land Use Plans

Envision Franklin reflects the most recent update to land use policy. Adopted in 2017, this document seeks to balance the historical preservation of Franklin's natural and community assets with the ability to address impending growth pressures stemming from its desirability as a place to live, work and play. Envision Franklin seeks to align the long-term vision of Franklin with the character, development, and transportation needs throughout its unique areas. Envision Franklin concludes by laying out the steps for implementing this land use vision through regulatory tools, existing and new partnerships, and policy decision-making frameworks.

Specific to the Cool Springs area, perhaps one of the most notable impacts of Envision Franklin is the designation of much of the study area for the Cool Springs Transportation Study as centers for 'Regional Commerce'. Defined as high-intensity activity centers, Regional Commerce areas are those that are intended to

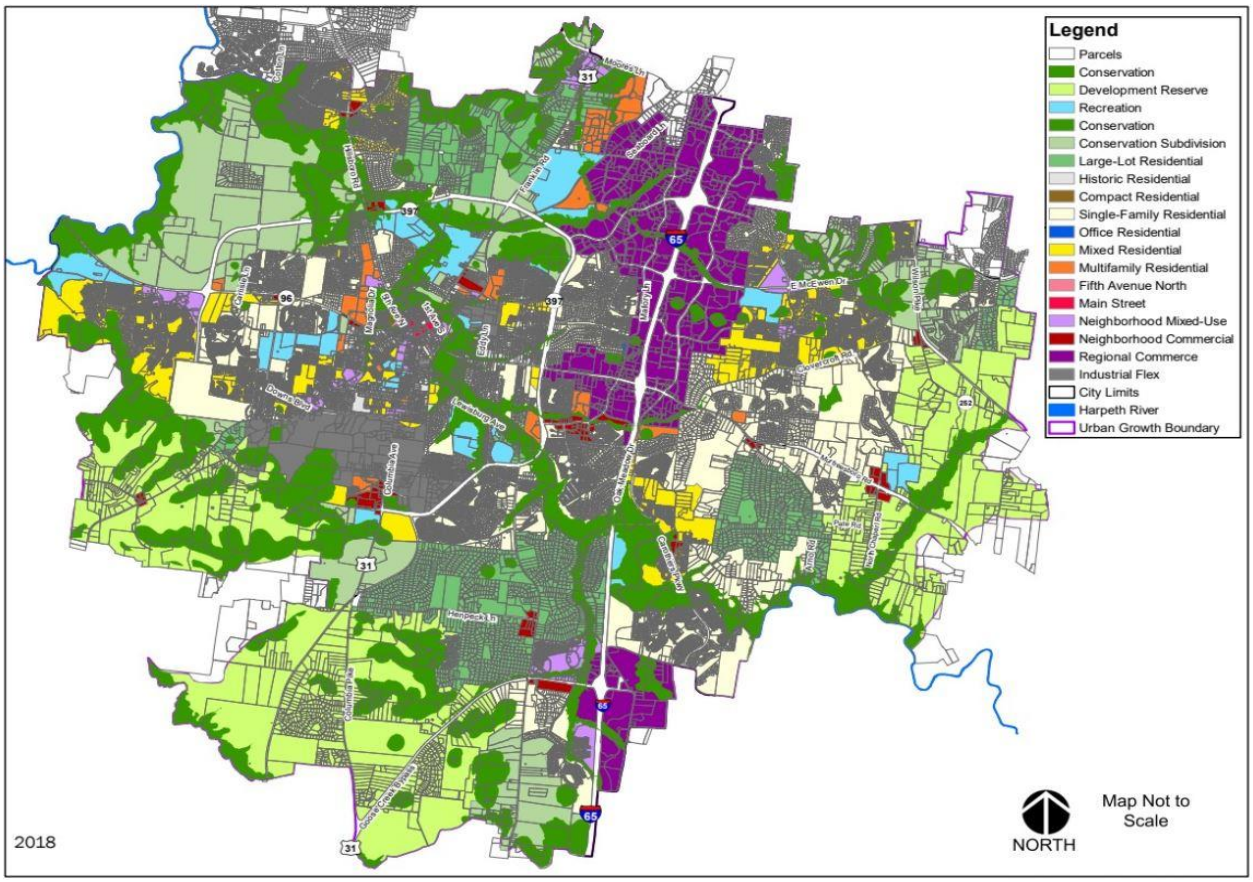


Figure 2 - 17 Design Concepts Map from Envision Franklin

attract a significant number of visitors and employers, either with current development patterns or with future development design. The main focus of land use in these areas is economically driven; in the Cool Springs area, the intention is to take advantage of the proximity to the I-65 corridor and its interchanges, which provide a high level of accessibility to draw a larger regional population. As such, the primary land uses are employment-based and include office, research and development, and commercial, all of which are designed to be high-density developments.

Noting that land use and transportation are directly related, Envision Franklin also lays out the character to be imposed on major roadway facilities based on the functional classification, the types of surrounding land uses, and geometric attributes of the roadways. Within the study area, Carothers Road, Mallory Lane, Highway 96/Murfreesboro Road, McEwen Drive, Cool Springs Boulevard, and Moores Lane are all identified as 'Mixed-Use' corridor areas. Within this designation, all of these corridors are envisioned to have multimodal accommodations including provisions for pedestrians, cyclists, and transit users to varying degrees based on the roadway classification.

In short, the Envision Franklin planning document identifies the Cool Springs area as an area for more growth, specifically in employment-related land uses, and at much higher densities than those that currently exist. Coupled with those land use visions are high-level desires for transportation options and accommodations along major corridors

Growth Plans and Policies

To enact the vision set forth by Envision Franklin, the City revised to its zoning ordinance, an effort that concluded in late 2019 after significant engagement of stakeholders and residents. As a result of this process, much of the Cool Springs area lies within a few specific zoning districts, namely the Regional Commerce 6 (RC6), Regional Commerce 12 (RC12), Planned District (PD), General Office (GO), Civic Institutional (CI), Residential 2 (R2), and Light Industrial (LI) districts. The breakout of acreage in the study area by these zoning classifications is shown in Table 2-6. Consistent with the Envision Franklin plan, the newly adopted zoning ordinance allows for higher density development patterns in the Cool Springs area.

Table 2-6 Zoning Classification by Acreage

Zoning Classification	Acreage (%)
Regional Commerce 6	847 (24%)
Regional Commerce 12	732 (21%)
Planned District	923 (27%)
General Office	87 (2%)
Civic Institutional	251 (7%)
Residential 2	235 (7%)
Light Industrial	414 (12%)
Total	**3,489**

Transportation Plans

There are a number of transportation plans that have been completed in recent years by the City of Franklin. Some of these take a long-term look at transportation needs across the city while others focus on the short-term programming of local dollars to fund capital roadway projects.

The Connect Franklin Comprehensive Transportation Network Plan, completed in 2016, served as a major update to the City's previous Major Thoroughfare Plan of 2010. Encompassed within this effort was a comprehensive approach to the entire multimodal transportation system that identifies priority transportation investments needed to maintain acceptable levels of service and

protect the livability of Franklin. Technical analysis as well as a public engagement process were used to determine where existing issues in the network needed to be addressed, including:

- Roadway capacity deficiencies,
- Improvements to bicycle and pedestrian network connectivity,
- Safety,
- Land use compatibility with multimodal options, and
- Shortcomings in transit capital and operations funding.

In addition, policy recommendations were put forth to guide future development reviews, the update to the previous zoning ordinance, and access management requests. For each recommended improvement project, planning level costs were developed, and projects were prioritized into short-, medium-, and long-term implementation horizons. Within the study area, the projects presented in Table 2-7 are recommended as part of the Connect Franklin plan and account for a significant amount of capital funds to allocated to multimodal improvements in the study area over the next 20 years.

Table 2-7 Connect Franklin Recommendations within Cool Springs Study Area

SHORT-TERM RECOMMENDATIONS
North Royal Oaks Boulevard Widening from Lakeview Drive to Liberty Pike
Murfreesboro Road (SR-96) Widening from Western I-65 Ramp to Eastern I-65 Ramp
Jordan Road Widening from Aspen Grove Drive to Mallory Lane
Liberty Pike Widening from Carothers Parkway to Columbia State Community College
Carothers Pkwy Multi-Use Path from Northern Nissan Access to Northern City Limits
Mallory Lane Multi-Use Path from Liberty Pike to Moores Lane
Cool Springs Boulevard Multi-Use Path from Mack Hatcher Parkway (SR-397) to I-65
MEDIUM-TERM RECOMMENDATIONS
Mallory Lane Widening from Mallory Station Road to Moores Lane (SR-441)
Cool Springs Blvd Widening from Mack Hatcher Parkway (SR-397) to Mallory Lane
Mallory Lane Widening from Liberty Pike to West McEwen Drive
Mallory Station Road Widening from Seaboard Lane to Mallory Lane
Seaboard Lane Upgrade from Mallory Station Road to Crossroads Boulevard
North Royal Oaks Blvd Multi-Use Path from Murfreesboro Rd (SR-96) to Lakeview Dr
LONG-TERM RECOMMENDATIONS
Cool Springs Boulevard Widening from Mallory Lane to Carothers Parkway
Carothers Parkway Widening from McEwen Drive to Bakers Bridge Avenue
Seaboard Lane and Aspen Grove Drive Sidewalk and Multi-Use Path from Cool Springs Boulevard to Mallory Station Road
Bakers Bridge Avenue Multi-Use Path from Mallory Lane to Carothers Parkway

Feeding the Connect Franklin plan were two separate multimodal transportation efforts. The first, the Cool Springs Multimodal Transportation Network Study (CSMTNS), was a transit-focused effort completed by the Franklin Transit Authority (FTA) in 2015. Interestingly, the study area for the CSMTNS aligns well with the Cool Springs Transportation Network Study, making its recommendations very much applicable to this study. The intention of the CSMTNS was to address the growing congestion issue in the Cool Springs area using investments in alternative modes and transportation demand management (TDM) strategies in order to preserve the quality of life that residents and employees within the area are drawn to.

The recommendations resulting from the CSMTNS are grouped into short-, medium-, and long-term improvements, similar to many other planning efforts. However, the overall recommendations for the study area include the following with a focus on first addressing local service, then regional connections, and finally, service enhancements:

- Reconfiguring the existing transit routes through Cool Springs and providing a lunch time shuttle service to create greater flexibility for potential transit users
- Improving multimodal connections between transit, pedestrian, and bicycle modes to reduce the need for vehicles in short-distance trips
- Working with area employers on TDM strategies
- Adding more and different transit vehicles to better meet anticipated demand
- Working with the Nashville Regional Transit Authority (RTA) on addressing commuter traffic through park and ride lots, connecting FTA service, and a new transit center off I-65
- Infrastructure and operational improvements to make transit a more competitive mode by improving service levels and supportive accommodations (e.g., transit signal priority, express bus service, pedestrian access, etc.)

The existing FTA Blue Route and Blue Route 2, shown graphically in Part 2 – Chapter 1, currently run on Mallory Lane and Carothers Road, respectively, and directly reflect the locally focused recommendations from this study.

The second multimodal study is Franklin's Greenway and Open Space Master Plan, completed in 2010. With the goal of focusing on sustainability in the city, the Greenway and Open Space Master Plan is intended to guide the implementation and funding of alternative mode facilities as development occurs in the urban growth boundary. In short, this document proposes a variety of capital investments in bike routes, bike lanes, sidewalks, and multi-use paths that would create a comprehensive and connected network throughout the city. Within the Cool Springs study area, this plan identifies the following investments:

- Proposed bike lanes on Carothers Parkway and Liberty Pike
- Proposed multi-use paths on Cool Springs Boulevard and McEwen Drive

Finally, the Integrated Growth Plan (IGP) was a transportation planning effort most recently updated in 2013 that examined the Carothers Parkway and East McEwen Drive area as it relates to growth potential and transportation improvements. Embedded within this study was a detailed analysis of the trips to be generated by likely land uses along the Carothers Parkway

corridor, near McEwen Drive, and the improvements needed to sustain that growth.

This study included turning movement counts and projections to support existing and future capacity analyses of many intersections throughout the study area. This analysis led to the development of needed improvements for key intersections in the area, complete with conceptual designs and cost estimates. This document has been used to primarily guide infrastructure improvements as development occurs near the intersection of Carothers Parkway and East McEwen Drive and has been influential in the proactive build out of intersections along Carothers Parkway in advance of growth.

In addition to infrastructure improvements, the existing plans in place for the City of Franklin also make a variety of recommendations related to policies and strategies that could be useful in managing growth. Many of these relate to expansion of the sidewalk and bikeway network to promote transit accessibility, access management policies, demand management strategies, more frequent transit service in the Cool Springs area, connectivity between developments, and traffic calming measures. These various strategies have been evaluated for inclusion within the final recommendations of the Cool Springs Transportation Study.

Responsiveness to Growth Potential

Existing Priorities

Ultimately, the investments identified in the aforementioned planning documents feed the development of specific projects to be funneled into the design, right-of-way, and construction phases. The City of Franklin's Capital Improvement Plan (CIP) programs the dollars for making such progression in the project development process. The current CIP allocates funding for the fiscal years of 2019 – 2028; within this time frame, the following projects are funded within the study area:

- Jordan Road Reconstruction (ST16006)
- East McEwen Drive Roundabout – Right Turn Bypass Lane (ST16008)
- Mallory Lane/Royal Oaks Boulevard and Liberty Pike Roundabout (ST16011)
- Aspen Grove and Seaboard Lane Intersection Improvements (ST16013)
- North Royal Oaks Boulevard Widening (ST1619)
- McEwen Drive Interchange Improvements (ST19004)

The projects listed above have been selected by Franklin's Board of Mayor and Alderman (BOMA) to reflect the priorities for infrastructure investments in the Cool Springs area. However, the development potential afforded by the new zoning allowances within the study area presents challenges to the City in adequately responding to growth in traffic volumes generated by future development on vacant land and redevelopment of existing parcels. As such, the next section includes a high-level review of tools at the City's disposal for addressing the many impacts of growth.

Existing Tools

There are three primary tools that the City can use to influence the development of land and how it impacts the collective transportation network – the Traffic Impact Analysis (TIA) Guidelines, the Transportation and Street Technical Standards, and the City's Road Impact Fee.

The TIA Guidelines are currently located within the City's Transportation and Street Technical Standards and outline the conditions that necessitate a TIA for new developments. Of

note is that it is intended for these guidelines to become a standalone document in 2021. The standards establish requirements for TIAs based on daily and PM peak hour trip generation thresholds, proximity to existing or planned traffic signals, and the potential for negative impacts to traffic flow or safety. These criteria, as well as the items that must be included in a TIA, are similar to what can be found in TIA guidelines from other municipalities. The primary outcome from TIAs is the identification of infrastructure improvements needed to mitigate the traffic impacts of development. The cost of these improvements is often born by the developer of the site or in some cases, shared with the municipality. Due to the additive nature of traffic, this process makes it so that small scale improvements are typically assigned to developers while larger scale capital improvements tend to become the responsibility of the City.

As a means of implementing these necessary improvements, the City of Franklin was given authority from the State Legislature in 1987 to collect road impact fees, which were first established in 2000 with subsequent adjustments throughout the years. The intention of the road impact fee is to collect monetary compensation from developers to ensure the provision of adequate collector and arterial road improvements. In step with TIA principles, the code requires that the fees collected are directly proportional to the needs generated by new development and cannot be legally used to address existing deficiencies.

Worth noting is that the TIA process tends to focus heavily on the vehicle with some consideration given to alternative modes and how they can mitigate impacts of development. In areas where congestion cannot be addressed by roadway improvements, either due to physical or fiscal feasibility, investments in alternative modes such as walking, biking, and transit can be utilized as a means of providing mobility options to reduce the number of vehicular trips on a network. All multimodal improvements to the transportation system, must be consistent with the City's Transportation and Street Technical Standards, which lay out the desired cross section elements of streets based on their primary function, mobility, access, or a combination. The functional classification is linked to the City's Major Thoroughfare Plan, which is the Connect Franklin plan mentioned previously in this report. These classifications directly relate to the design criteria and principles used to build out the street network as development occurs, including sidewalk widths, types of bicycle facilities, and multi-use path considerations for all roadway types.

Knowing that there are challenges and limitations with the traditional growth management tools mentioned above, recommendations for this Cool Springs Transportation Study will include alternative strategies for further evaluation and consideration by the City of Franklin.

Part 3

FUTURE CONDITIONS

Background Growth

Approved Development

Future Conditions: Scenario 1 and Scenario 2

Maximized Development

Future Conditions: Scenario 3 and Scenario 4

Scenario Comparison

Chapter 1

BACKGROUND GROWTH

Within the Cool Springs area, development trends play an essential role in the transportation network and how it operates. Understanding the effect of continual growth on the transportation system is vital to the sustainability of the Cool Springs area. This chapter sets the stage for analyzing future growth by first documenting the background growth in the study area.

To accomplish this, the following historic traffic data sets were taken into consideration:

- TDOT AADT Growth Data
- StreetLight Growth Data
- Turning Movement Count Growth Data

Growth trends determined from the historic traffic data were then used to estimate the potential background growth within the study area.

This chapter details the methodology used to determine an appropriate background growth rate for each of the study intersections by analyzing historical growth trends and development potential for individual zones within the study area.

Growth Rates

TDOT AADT Growth Rates

TDOT collects information on daily traffic volumes for major roadway corridors across the state. Reported as Annual Average Daily Traffic (AADT) volumes, this data represents the number of vehicles that are on a particular roadway every day of the year on average.

There are seventeen locations within the Cool Springs area where this data is collected. The TDOT data for 2018 was compared to the TDOT data for 2014 to determine the approximate growth per year for four years. This data is presented in Appendix G, and the count stations and corresponding growth rates within the study area are presented in Figure 3-1.

For example, TDOT Count Location 2, located along Moores Lane, has experienced a decrease in traffic of less than 2% per year for four years. In contrast, TDOT Count Location 12, located along Liberty Pike, has experienced an increase in vehicle traffic of between 2% and 5% per year for four years.

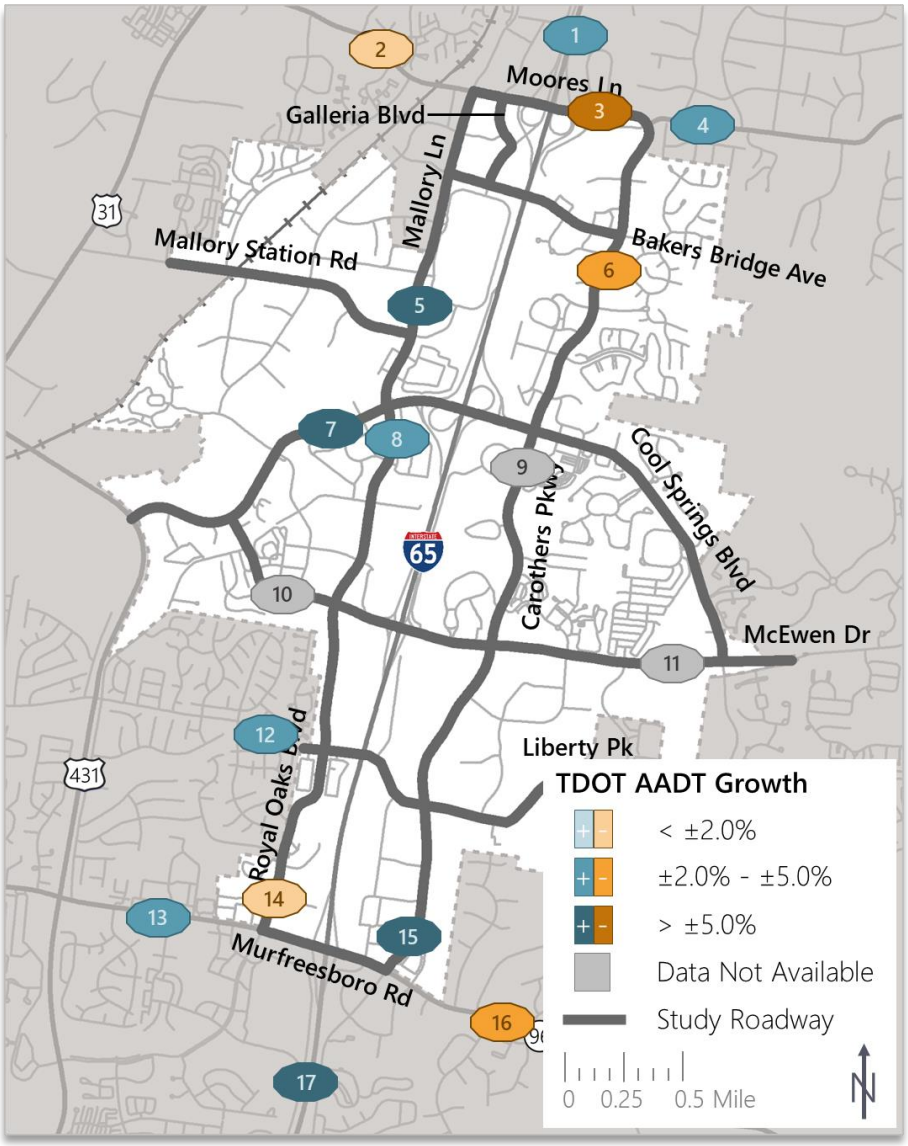


Figure 3-1 TDOT AADT Growth

StreetLight Growth Rates

StreetLight Data, Inc. is a private data firm that collects third party location and crowd source data such as automated vehicle location devices. Once the data is collected, it is then converted into traffic volumes broken down by hour. The data can then be used to determine the year to year growth on their streets.

There are twenty-five locations within the Cool Springs area where this data is collected. These locations correspond with the entry/exit points of the study area. The StreetLight data for 2020 was compared to the StreetLight data for 2016 to determine the approximate growth per year for four years. The growth rates from this data is shown in Figure 3-2 and additional information is included in Appendix G.

Compared to TDOT Count Location 2, StreetLight Location B, located along Moores Lane, has experienced an increase in traffic of less than 2% per year for four years. Compared to TDOT Location 12, StreetLight Location Q, located along Liberty Pike, has also experienced an increase in vehicle traffic; however, this increase is less than 2% per year for four years.

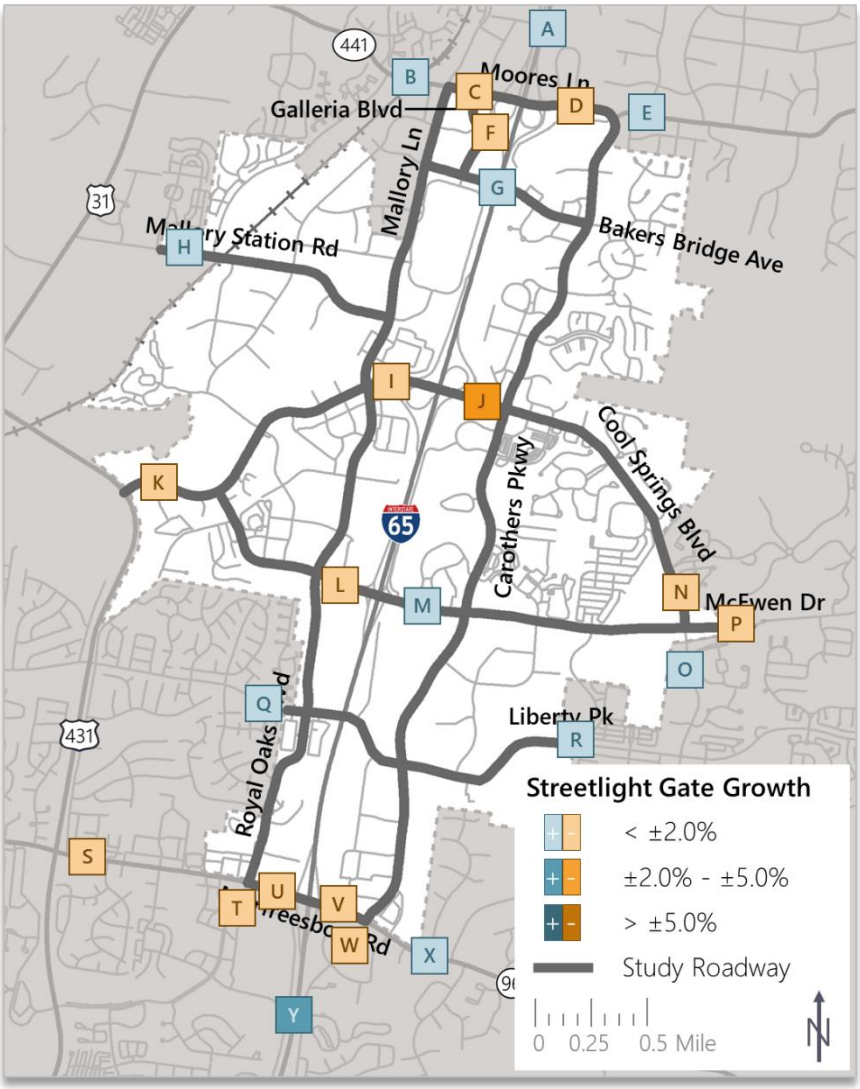


Figure 3-2 StreetLight Annual Growth

Turning Movement Count Growth Rates by Intersection

As traffic studies are conducted within the area, turning movement counts are required for study intersections. The City of Franklin has collected these historical turning movement counts at various intersections across multiple years.

These counts were compiled and the annual growth rates per year for the individual intersections were determined. The results of the calculated growth rates are presented in Figure 3-3. This historical growth data for each intersection is included in Appendix G.

It should be noted that the study intersections along Moores Lane are located within Brentwood, and historical turning movement counts for these study intersections were not available. Additionally, the majority of the available historical counts are for signalized intersections; therefore, the growth rates for unsignalized intersections were not calculated.

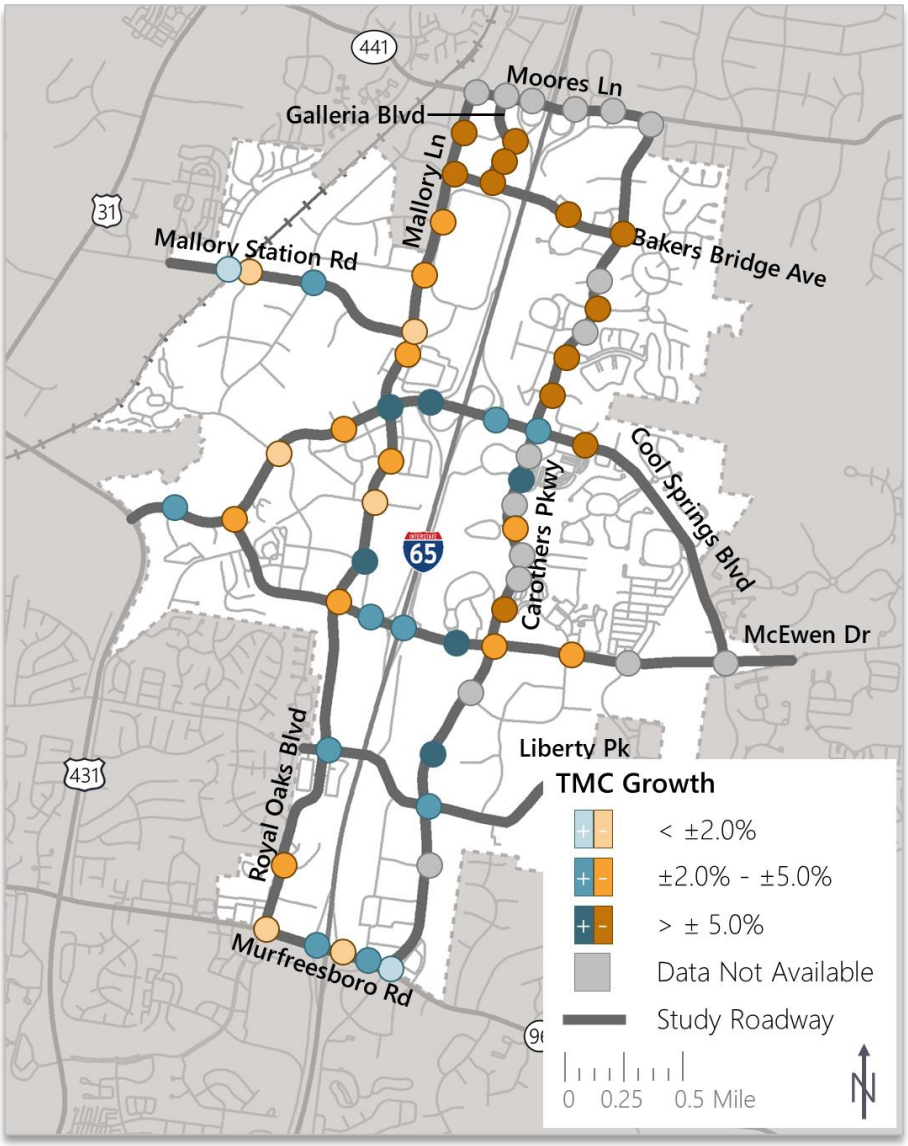


Figure 3-3 TMC Growth

Growth Regions

Cool Springs encompasses a large area of diverse land uses and travel patterns, and different areas/regions within the Cool Springs area are expected to grow at different rates.

Therefore, the study area was subdivided into sixteen growth regions to allow for different growth rates based on individual regions. The subdivided regions are shown in Figure 3-4.

Regional Growth Rates

Based on the TDOT, StreetLight, and TMC historical growth rates and the existing land uses within each region, a background growth rate for each region was determined using the following considerations:

- A minimum of 1.0% per year growth
- The percentage of growth based on TDOT, StreetLight, and TMC historic data.
- The amount of "free" land within each region where potential or planned development could occur.

The growth rate for each region is presented in Table 3-1 and shown in Figure 3-4.

Table 3-1 Background Growth Rate by Region

Region	Growth Rate	Region	Growth Rate
A	2.0%	I	1.5%
B	1.5%	J	1.5%
C	1.5%	K	1.5%
D	1.0%	L	1.5%
E	1.0%	M	1.5%
F	1.0%	N	1.0%
G	1.0%	O	1.0%
H	1.5%	P	1.0%

Intersection Growth Rates

Utilizing the regional background growths presented in Table 3-1 and Figure 3-4, background growths for each approach of each study intersection were determined. The following assumptions were used to determine these growth rates:

- Approaches with limited connectivity were assumed to have 0% growth.
    - Forty-one study intersections include at least one approach with an assumed 0% growth.
    - For example, the eastbound and westbound approaches of Carothers Parkway and Corporate Centre Drive have limited connectivity and/or potential growth; therefore, both approaches were assumed to have a 0% growth.
- Approaches that bridge two regions were assumed to be an average of those two regions.
    - For example, the intersection of Carothers Parkway and Cool Springs Boulevard is located between Region C (1.5% growth) and Region D (1.0% growth). Therefore, the eastbound and westbound approaches were assumed to have a growth rate of 1.25% while the northbound approach was assumed to be 1.5% and the southbound approach was assumed to be 1.0%.

The growth rates for each study intersection approach are presented in Appendix G. These growth rates represent the annual average growth rate expected to occur at each of study intersections.

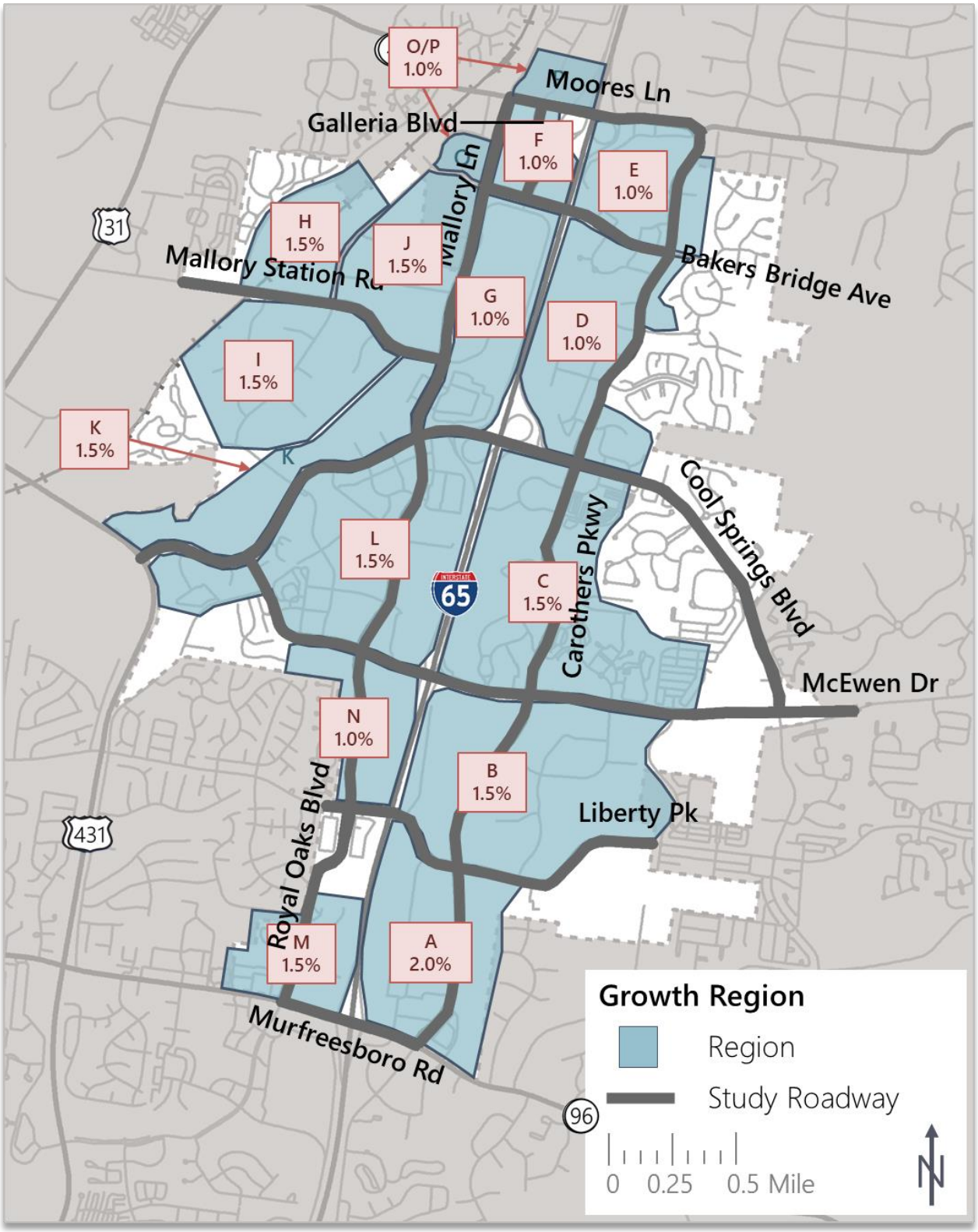


Figure 3-4 Growth Regions

Chapter 2

APPROVED DEVELOPMENT

When developments are planned within the city limits, the proposed land uses are evaluated by city staff to estimate the number of trips expected to be generated by the project site. If the estimated daily trips exceed 1,000 vehicles per day, then developers are required to complete a Traffic Impact Study (TIS) /Traffic Impact Analysis (TIA) that details the proposed development and the effects the development will have on the surrounding roadway network.

This chapter presents the approved developments within the study area, as of April 2020, for which traffic studies were completed as part of the approval process. In addition to detailing the effects of the proposed development on the existing roadway network, traffic studies also provide recommendations for roadway improvements to mitigate the impacts that these developments have on the surrounding roadway network. This chapter details those recommendations, as well as, funded or planned roadway improvements planned by the City of Franklin.

This chapter details the approved land developments and their associated current occupancy, expected daily trips, and recommended roadway infrastructure improvements. Also included in this chapter are additional roadway infrastructure improvements currently funded or planned by the City of Franklin.

Land Development

There are sixteen approved developments within or near the Cool Springs area that were identified for this study. The locations of the approved land developments, indicated in red, are presented in Figure 3-5.

The traffic analysis, presented in the TIS/TIA for each development, used factors taken from ITE's *Trip Generation* to estimate the amount of traffic expected to be generated by the project site. The combined daily trips for the approved developments are 222,270 trips.

Additional information, such as name, percent of development occupied as of January 2020 (when data was collected), and expected daily trips, is included in Table 3-2. The land use breakdown, expected peak hour trips, and infrastructure related recommendations for each development are included in Appendix H.

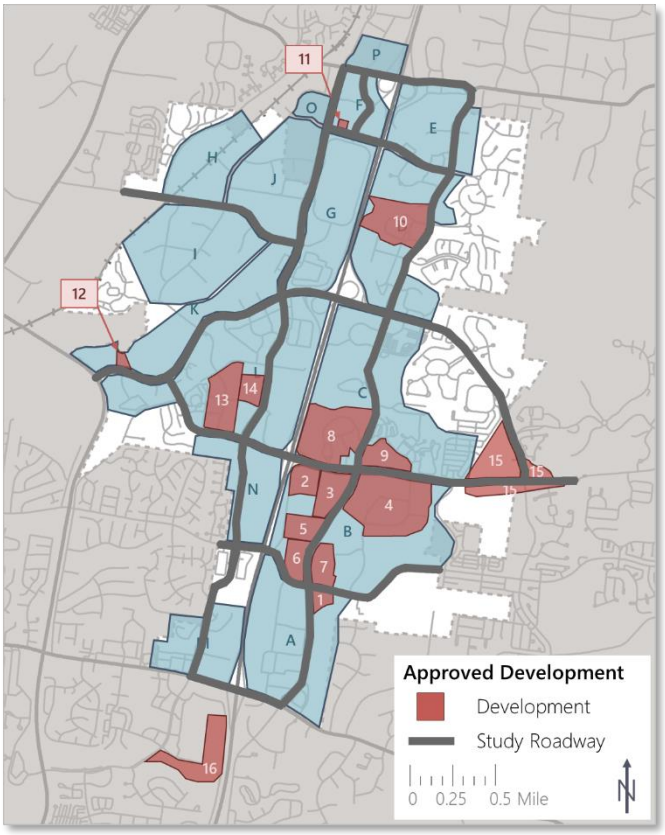


Figure 3-5 Approved Land Development

Table 3-2 Approved Land Development

Zone	Development No.	Development Name	Percent Occupancy	Daily Trips (vpd)
A	1	Liberty Station	0%	1,403
B	2	Franklin Summit	0%	6,354
	3	Aureum	0%	20,715
	4	Ovation	0%	32,058
	5	Huffines Ridge	0%	5,365
	6	Carothers Crossing West	0%	4,061
	7	Carothers Crossing East	70%	19,646
C	8	Apex Village	0%	12,796
	9	Franklin Park	40%	23,765
D	10	East Works	0%	30,309
F	11	7086 Bakers Bridge Avenue	0%	1,560
K	12	The Franklin at Legends	40%	1,102
L	13	Mallory Green	33%	3,963
	14	McEwen Town Center	5%	26,976
No Zone	15	Avalon Square	0%	27,502
	16	Vintage Franklin	0%	4,695

Roadway Development

Approved Land Development Improvements

One of the by-products of traffic studies/analyses is a list of recommended improvements to mitigate the impacts of the proposed development on the existing roadway network. The recommended study intersection improvements, as determined by the studies conducted for the approved developments, are presented in Table 3-3. It should be noted Table 3-3 only includes approved developments where recommendations for the study intersections were provided. Additionally, unless otherwise noted, these improvements have not been completed to date. Additional recommended improvement details are presented in Appendix H.

Table 3-3 Recommendations from Approved Development Studies

Dev No.	Intersection	Recommendations
3	East McEwen Drive and Tower Circle	An eastbound right-turn lane with 300 feet of storage and 200 feet of taper should be provided.
		Two westbound left-turn lanes with 225 feet of storage and 200 feet of taper should be provided.
		The northbound approach should be designed to include two ingress lanes and four egress lanes. The egress lanes should include two left-turn lanes with 200 feet of storage, one through lane, and one right-turn lane with 200 feet of storage.
		Pedestrian facilities should be provided.
	East McEwen Drive and Carothers Parkway	Widen the eastbound approach to provide two right-turn lanes. These lanes should operate as signalized.
		Pedestrian facilities and signal control should be modified/updated to incorporate the additional laneage.
	Carothers Parkway and Ovation Parkway	A southbound right-turn lane with 250 feet of storage and 160 feet of taper should be provided.
		Two northbound left-turn lanes with 300 feet of storage and 150 feet of taper should be provided.
		The eastbound approach should be designed to include two ingress lanes and four egress lanes. The egress lanes should include two left-turn lanes with 100 feet of storage, one through lane, and one right-turn lane with 100 feet of storage.
		Pedestrian facilities should be provided.
6	Carothers Parkway and Liberty Pike	A 2nd northbound left-turn lane should be constructed. (NOTE: This improvement was constructed in May/June 2020)
	Carothers Parkway and Southstar Drive	A northbound left-turn lane with 200 feet of storage should be provided.
		A southbound right-turn lane with 125 feet of storage should be provided.
		A westbound through lane should be provided.

Dev No.	Intersection	Recommendations
6	Carothers Parkway and Southstar Drive	The eastbound approach should be designed to include one ingress lane and three egress lanes. The egress lanes include one left-turn lane, one through lane, and one right-turn lane.
		The existing traffic signal should be modified to include the addition of the eastbound approach.
8	Carothers Parkway and East McEwen Drive	Two southbound right-turn lanes with 600 feet of storage should be provided.
10	Carothers Parkway and Bakers Bridge	Two eastbound left-turn lanes with 250 feet of storage should be provided.
		Pull back the medians on the north and south approaches to allow eastbound and westbound left-turns to operate simultaneously (remove split phasing).
		A southbound right-turn lane with 200 feet of storage should be provided.
	Carothers Parkway and Mayfield Drive	The eastbound approach should be widened and restriped to include two left-turn lanes and one through/right-turn lane.
		Two northbound left-turn lanes with 200 feet of storage and 125 feet of taper should be provided.
		The existing southbound right-turn channelization should be removed.
		The traffic signal should be modified to remove the split phasing.
	Cool Springs Boulevard and Carothers Parkway	Triple northbound left-turn lanes with 250 feet of storage should be provided. The outside lane will be dedicated for I-65 northbound on ramp, the middle lane will be for both Cool Springs Boulevard westbound and I-65 northbound on ramp, the inside lane will be dedicated for Cool Springs Boulevard westbound only.
		A northbound right-turn lane with 150 feet of storage should be provided.
		A westbound right-turn lane with 250 feet of storage should be provided. The existing right-turn lane should be restriped as a shared through/right-turn lane.
		Two eastbound right-turn lanes with 300 feet of storage should be provided. The existing shared through/right-turn lane should be restriped as an exclusive through lane.
	Carothers Parkway and Private Drive North of Mayfield Drive	The north/south median along Carothers Parkway shall be modified to only allow a northbound left-turn movement.
	Carothers Parkway and Private Drive South of Mayfield Drive	The north/south median along Carothers Parkway shall be modified to only allow a northbound left-turn movement.

Dev No.	Intersection	Recommendations
10	Cool Springs Boulevard and I-65 Northbound On-Ramp	Add an additional dedicated westbound right-turn lane. This lane will begin as an additional westbound through lane from Carothers Parkway.
		The westbound right-turn lanes should be signalized.
		The I-65 On Ramps will be moved to the west approximately 150 feet to the west. The existing 300 feet of storage for the eastbound left-turn lanes should be maintained.
	Cool Springs Boulevard and I-65 Southbound On-Ramp	Two westbound left-turn lanes with 500 feet of storage should be provided.
12	Cool Springs Boulevard and Windcross Court	The southbound approach should be designed to include one ingress lane and two egress lanes. The egress lanes should include one left-turn lane and one through/right-turn lane.
		The northbound approach should be restriped to include one shared through/left-turn lane and one right-turn lane. The northbound left-turn should operate under permissive-only phasing. A protected right-turn arrow interval concurrent with the westbound left-turn phase is recommended.
		An eastbound left-turn lane with 175 feet of storage should be provided. The left-turn should operate under protected-permissive signal phasing.
13 14	McEwen Drive and Spring Creek Drive	Two southbound left-turn lanes should be provided.
16	Murfreesboro Road and Royal Oaks Boulevard	The northbound approach should be restriped to include one left-turn lane, two through lanes, and three right-turn lanes. (NOTE: This improve was removed after completion of the analysis for this study)

Planned City Improvements

In addition to the recommendations from the traffic studies for each of the approved developments, the City of Franklin has three planned roadway improvements within the study area. Those improvements are as follows:

- The intersection of Liberty Pike and Mallory Lane/Royal Oaks Boulevard is planned to be reconstructed as a multi-lane roundabout.
- The McEwen Drive at I-65 interchange is planned to be modified to include additional laneage. The modifications will require the southbound on-ramp to be widened or restriped to include the additional lanes.
- The roundabout at the intersection of McEwen Drive and Cool Springs Boulevard is planned to be modified to include additional laneage. These improvements were completed in the summer 2020.

Chapter 3

FUTURE CONDITIONS:
SCENARIO 1 AND SCENARIO 2

A principal purpose of the Cool Springs Transportation Network Study is to provide the City of Franklin with an outlook on future development potential and the resulting traffic operations in the study area.

To achieve this, traffic projections were determined based on future conditions with the general background growth, as well as, the approved development presented in the previous chapter of this report.

For the future plus approved developments conditions, two scenarios were developed to determine potential infrastructure improvements needed to accommodate the additional growth resulting from the approved developments located within the study area:

- Scenario 1 – 50% completion of approved development
- Scenario 2 – 100% completion of approved development

This section details the incorporation of these two scenarios into the Vistro model.

To evaluate the future traffic operations within Cool Springs, the existing Vistro model of the network was updated to include the background growths and approved developments. Two scenarios were tested to determine the effects of the growth resulting from the approved developments.

Estimating Regional Trip Distribution

StreetLight data was used to help determine the directional distribution of vehicles currently entering and exiting the Cool Springs study area, with specific attention given to the seven growth regions where approved developments are located. More specifically, vehicle volumes were analyzed across the entire study area to determine how vehicles enter and exit each of the individual growth regions.

Using this information, directional distributions of the entering and exiting traffic for each growth region were determined. Gates, which represent the locations where traffic enters and exits the study area, were established as part of the StreetLight analyses.

A combination of StreetLight Data and engineering judgement was used to determine the path vehicles would take to reach each Gate from the starting region. It was assumed vehicles generally follow the same path when entering and exiting the study area.

The overall directional distribution for study area is presented in Figure 3-6. The directional distributions for the individual growth regions are included in Appendix I.

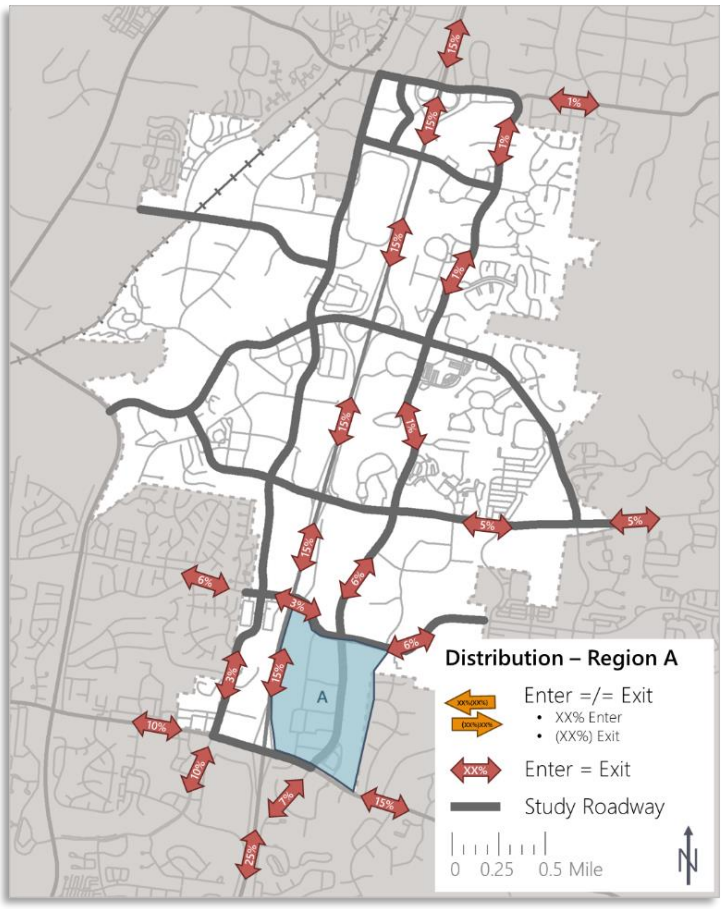


Figure 3-6 StreetLight Trip Distribution - Region A

VISTRO Modeling

The traffic simulation software, PTV Vistro, was used to model the existing and future traffic projections for the Cool Springs roadway network. The Existing Conditions Report detailed specifics regarding the PTV Vistro software and steps utilized in establishing the existing conditions Vistro model.

This section details the development of Future Conditions – Scenario 1 and Future Conditions – Scenario 2 for the Cool Springs Vistro model.

The following steps were used to expand the existing conditions Vistro model to include the future conditions:

1. Background Growth
2. Establish Zones and Gates
3. Add Site Accesses
4. Define Paths
5. Apply Trip Generation
6. Input Trip Distribution
7. Determine Trip Assignment

Background Growths

The annual average growth rate for each approach of each study intersection was presented in Part 3 – Chapter 1. The existing traffic volumes for each study intersection approach were grown by the determined growth rate per year for 10 years. The growth rates are presented in Appendix H.

Establish Zones and Gates

Within Vistro, Zones are used to represent the development sites. Therefore, sixteen Zones were established within the Vistro model to represent the sixteen approved developments located in or near the Cool Springs area. It should be noted that the Zone number within the Vistro model corresponds with the project number associated with the approved development (as presented in Table 3-2 of this report). In Vistro, Zones are indicated by a purple circle, as seen in Figure 3-7.

According to Vistro documentation, "traffic for development Zones is routed to and from traffic 'Gates'". As previously mentioned, the Gates represent the entry/exit points for the study area. As shown in Figure 3-7, Gates are indicated in the Vistro model by blue squares.

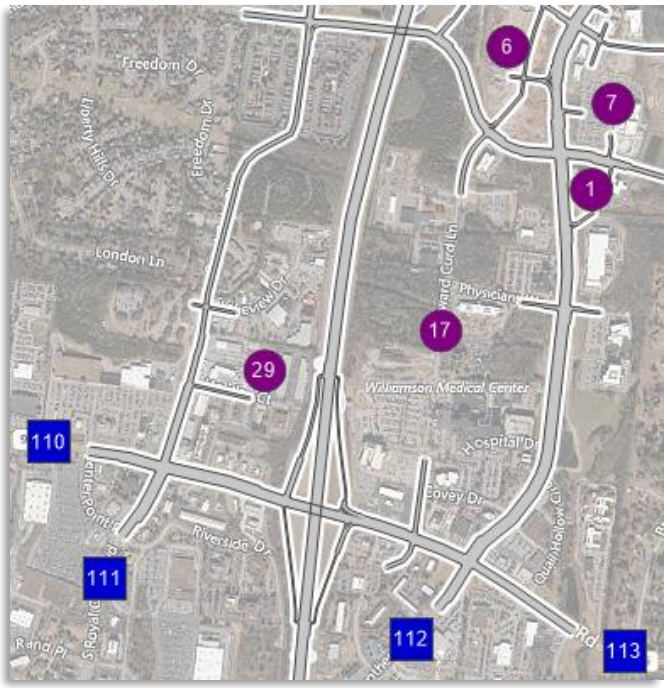


Figure 3-7 Vistro Model Zones and Gates

Add Site Accesses

To properly define the Paths that connect the Zones and the Gates, site accesses for each of the approved developments were added to the Vistro model. The site plans for each of the approved developments were reviewed, and each site access included in the site plan was added to the model. It should be noted that this included the addition of a fourth leg at four of the study intersections. The site plans for the approved developments are provided in Appendix H.

Define Paths

Once the Zone and Gates were established within the Vistro model, the next step was to define the Paths that link Zones and Gates. Paths indicate potential routes vehicles could use to travel between a development Zone and the Gates of the study area or between the Gates of the study area and a development Zone.

StreetLight distributions were used to determine which Gates were utilized by each Zone. Then, all potential Paths were defined between each Zone and their corresponding Gates.

It should be noted that Paths are used to represent both the egress (Zone to Gate) and ingress (Gate to Zone) between Zones and Gates. Additionally, based on the type of site access (full access vs. right-in/right-out only) the number of egress Paths might not be equal to the number of ingress Paths.

While the StreetLight distributions were the primary source for determining which Paths were used by each development/Zone, GoogleMaps and engineering judgement were also used to estimate preferential Paths based on the time of day.

In Vistro, Paths are indicated by a light blue highlighted Zone and Gate and connected by a red line with arrows indicating the direction of the Path. An example of one of the Paths is shown in Figure 3-8. This represents one potential path from Zone 7 to Gate 111.

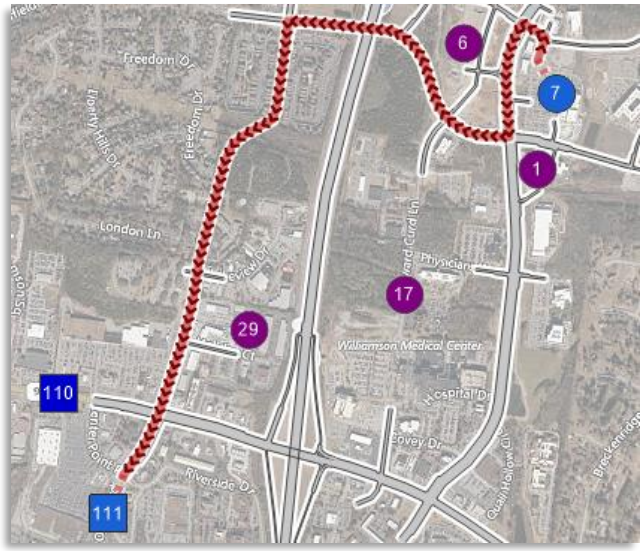


Figure 3-8 Vistro Model Path

Apply Trip Generation

Vistro uses two methodologies to apply ITE's *Trip Generation* to the model:

1. Proposed land uses are input into the model, and the model calculates the entering and exiting trips
2. Entering and exiting trips are input directly into the Vistro model

To maintain consistency with the traffic studies presented in Table 3-2, the method 2 was used. The trip generation for the AM, Midday, and PM peaks for each of the approved developments is included in Appendix H.

Input Trip Distribution

The trip distribution for each development Zone, as discussed above, was input into the Vistro model. The Gate distribution for each growth region is presented in Appendix I.

Determine Trip Assignment

In Vistro, trip assignment indicates the percentage of trips associated with each Path. For example, if two Paths exist between Zone 7 and Gate 111, and neither path is preferential, then the trip assignment for each path would be 50%. If Path 1 is preferred, however, then Path 1 might be 75% and Path 2 would be 25%.

Trip assignment was estimated using StreetLight distribution data, GoogleMaps and engineering judgement.

Capacity Analysis

As previously mentioned, two future conditions with approved development scenarios were tested within this portion of the study. This section presents the following Vistro model results for those scenarios:

- Level of Service (LOS) and Delay
- V/C Ratio
- 95th Percentile Queue Lengths

Level of Service (LOS) identifies how well an intersection is operating based on the ability for an intersection to accommodate vehicle volumes in relation to the available capacity. Based on the amount of vehicular delay, LOS is assigned a "grade" between LOS A and LOS F, where LOS A indicates minimal delay and LOS F indicates excessive delay.

Volume-to-capacity ratio (v/c ratio) indicates how an intersection is operating in terms of capacity, where capacity is the maximum number of vehicles per hour that can utilize an intersection. A v/c ratio less than 0.85 is under capacity, a v/c ratio between 0.85 and 1.0 is approaching capacity, a v/c ratio at 1.0 is at capacity, and a v/c ratio greater than 1.0 is over capacity.

For all scenarios, the improvements presented in Table 3-3 were included in the model. Additionally, Sidra, a roundabout modeling software, was used to evaluate the existing and proposed roundabouts, which, in turn, validated the Vistro results. Tables detailing LOS and queue lengths are presented in Appendix K and Appendix L, respectively. Detailed Vistro and Sidra results for Scenario 1 and Scenario 2 are included in Appendix N and Appendix O, respectively.

Scenario 1: 50% Approved Development

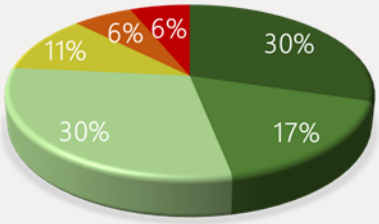
Under Scenario 1, the Vistro model included the existing traffic volumes, background growth, and 50% of the remaining occupancy of the approved developments.

Level of Service (LOS)

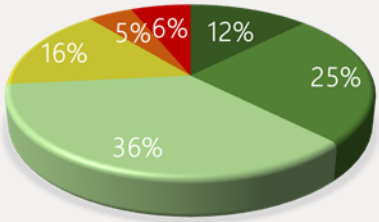
LOS A indicates minimal delay
LOS F indicates excessive delay

	A	B	C	D	E	F
AM	19	11	19	7	4	4
Mid	8	16	23	10	3	4
PM	5	9	21	10	10	9

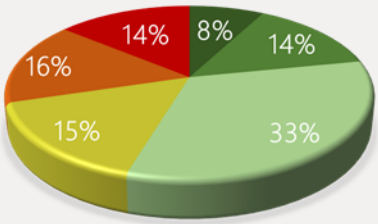
AM Peak



Midday Peak



PM Peak

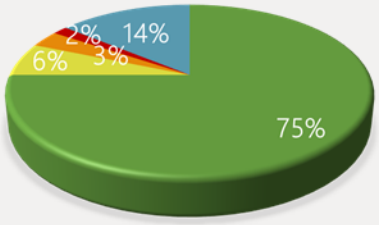


	AM	Mid	PM
< 0.85	48	49	34
0.85 – 0.95	4	2	12
0.95 – 1.00	2	2	4
> 1.00	1	2	5
Unsignalized	9	9	9

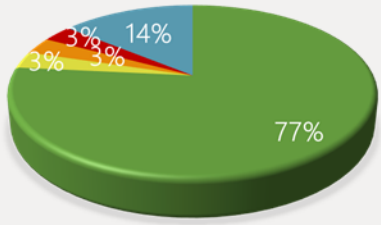
V/C Ratio

<0.85 is operating under capacity
1.0 is operating at capacity
>1.0 is operating over capacity

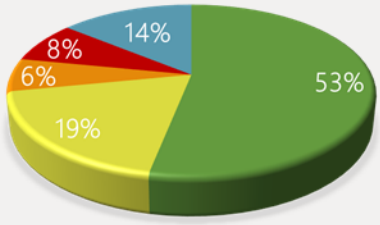
AM Peak



Midday Peak



PM Peak



95th Percentile Queue Length

Tally of intersections where queue length exceeds capacity on at least one approach

AM	22
Mid	30
PM	44

50% of approved developments was considered due to the fluctuating nature of development. Economic conditions, developer finances, changes in workspace/land uses can all lead to a reduction in the final number of trips produced by a proposed development.

Scenario 2: 100% Approved Development

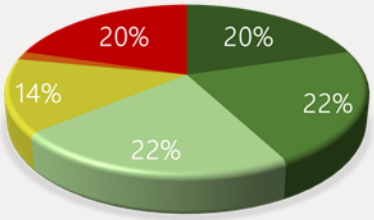
Under Scenario 2, the Vistro model included the existing traffic volumes, background growth, and 100% of the remaining occupancy of the approved developments.

Level of Service (LOS)

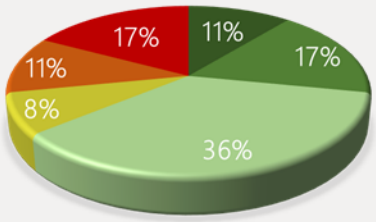
LOS A indicates minimal delay
LOS F indicates excessive delay

	A	B	C	D	E	F
AM	13	14	14	9	1	13
Mid	7	11	23	5	7	11
PM	4	6	16	6	8	24

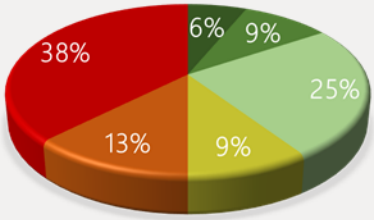
AM Peak



Midday Peak



PM Peak

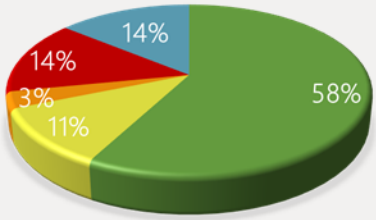


	AM	Mid	PM
< 0.85	37	39	25
0.85 – 0.95	7	6	10
0.95 – 1.00	2	4	3
> 1.00	9	6	17
Unsignalized	9	9	9

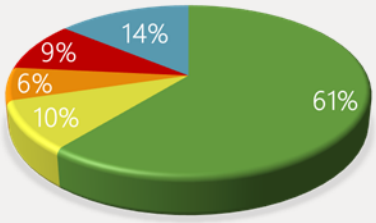
V/C Ratio

<0.85 is operating under capacity
1.0 is operating at capacity
>1.0 is operating over capacity

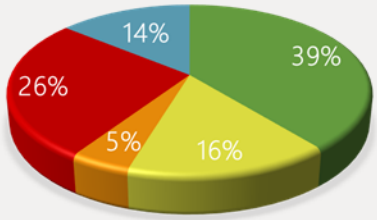
AM Peak



Midday Peak



PM Peak



95th Percentile Queue Length

Tally of intersections where queue length exceeds capacity on at least one approach

AM	24
Mid	38
PM	47

Seldom are developments developed out to 100% of the plan. For the purpose of this study and the approved obligation associated with each approved development, however, the 100% build of the approved developments was taken into consideration and analyzed for this study.

Chapter 4

MAXIMIZED DEVELOPMENT

A key component of assessing future transportation conditions in the Cool Springs area is the development of a future build out scenario. This process entailed determining the maximum development potential within the study area, which helps to identify potential infrastructure improvements that could be needed to accommodate the maximum build out of the study area.

Knowing that there are few truly vacant parcels remaining in the study area, it was assumed that the majority of future development will be comprised of redevelopment and infill opportunities. Using a combination of land use, zoning, and property assessment data, these future development opportunities were quantified in coordination with the City of Franklin Planning Department.

This chapter details the maximized potential land development for each development region and the associated expected trip generation based on existing land uses and available land for development and/or redevelopment.

Land Redevelopment

There were two main redevelopment opportunities explored as part of this effort, both of which were limited to areas zoned as non-residential uses. The first utilized assessment and market values to determine where businesses or building structures were valued significantly less than the land they sit upon. This is a common situation in high-growth areas in which a specific location gradually becomes more valuable than the business that resides there, making it oftentimes more profitable for the property to be redeveloped with a higher land use or intensity. The second redevelopment opportunity involved identifying areas where a significant amount of open space or surface parking was initially constructed with a low-density development in what are now areas that allow for relatively high-density development. Due to the allowable building height in some zoning classifications, previously constructed landscaping and surface parking offers the opportunity to convert potentially underutilized space to a future development with increased density.

With the goal of converting future development potential to vehicular trips, the potential for redevelopment and infill opportunities were aggregated to a regional system related to the Vistro traffic model. In total, there were an estimated 695 acres identified in the study area that could have varying degrees of redevelopment and infill potential in the upcoming years. Allowable densities and uses by zoning classification were applied to these acreages, which resulted in a potential future increase in development and thereby vehicular trips. These assumptions are shown in Table 3-4.

Table 3-4 Maximum Potential Land Development

Region	Redevelopment Acreage	Allowable Building Height	Land Uses
A	102.99	6 stories	Office, Restaurant, and Retail
B	11.93	9 stories	Residential Restaurant, and Retail
C	113.83	9 stories	Office, Residential, Restaurant, and Retail
D	75.60	9 stories	Office, Hotel, Restaurant, and Retail
E	10.34	6 stories	Office, Restaurant, and Retail
F	53.61	6 stories	Office, Residential, Hotel, Restaurant, and Retail
G	110.26	12 stories	Office, Hotel, Restaurant, and Retail
H	--	--	--
I	26.08	3 stories	Office
J	7.24	3 stories	Office
K	97.59	6 stories	Office, Restaurant, and Retail
L	64.51	9 stories	Office, Restaurant, and Retail
M	12.71	6 stories	Office, Restaurant, and Retail
N	8.59	12 stories	Office, Restaurant, and Retail
O	--	--	--
P	--	--	--

Trip Generation

Trip generation estimates for the maximized development scenarios were first established based on assumptions related to the relative proportion of building footprints to open space and surface parking. Based on a sample of properties in the Cool Springs area, it was calculated that generally 40% of each acre identified for redevelopment or infill would be utilized for parking and open space, and the remaining 60% would represent the potential building footprint.

Using Franklin Zoning Ordinance and future land use policy outlined in Envision Franklin, an assumed mix of land uses and densities were developed for each region. The land use mix is as shown in Table 3-4. Each unique land use mix was developed and scaled to a 1-acre lot, which was then applied to the total acreage available by region as shown in Figure 3-9.

ITE trip generation calculations were then applied to determine the expected future traffic volumes generated by each region should the maximized development potential within the study area be realized.

The total trip generation for the AM, Midday, and PM peaks for each of the study area regions is included in Table 3-5 with additional trip generation information included in Appendix J.

Should the maximum redevelopment potential for the study area be realized, approximately 129,980 AM peak hour trips, 204,004 Midday peak hour trips, and 162,190 PM peak hour trips could potentially be added to the network.

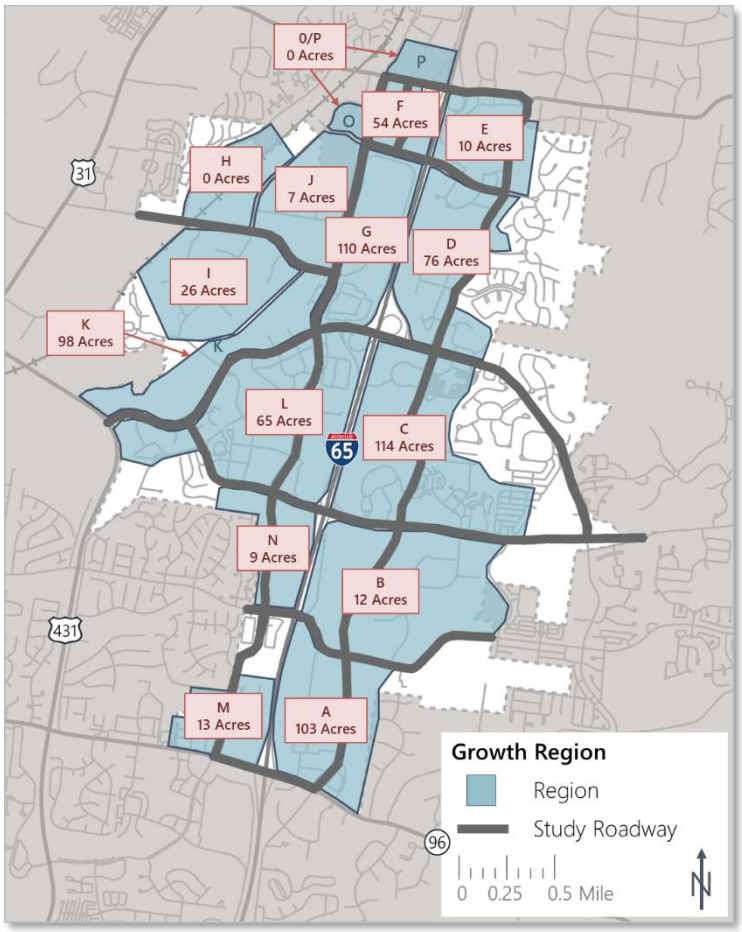


Figure 3-9 Total Redevelopment Potential

Table 3-5 Maximum Development Trip Generation

Region	Trip Generation (vph)		
	AM	Midday	PM
A	11,827	18,883	17,334
B	1,007	1,521	1,288
C	10,260	15,925	14,634
D	8,994	13,946	13,329
E	1,121	1,733	1,756
F	9,546	13,409	10,323
G	50,161	84,831	58,677
H	--	--	--
I	1,652	1,735	1,707
J	448	468	473
K	22,511	33,297	25,209
L	10,519	14,783	13,807
M	1,754	2,743	2,717
N	180	730	936
O	--	--	--
P	--	--	--

Chapter 5

FUTURE CONDITIONS:

SCENARIO 3 AND SCENARIO 4

The Cool Springs Transportation Network Study intends to provide the City of Franklin with a coordinated plan of recommended improvements to be made as development occurs within the study area.

To achieve this, traffic projections were determined based on future conditions with the general background growth, the approved development, as well as, with development that has yet to be planned as presented in the previous chapters of this report.

Two additional scenarios were tested to evaluate the impacts of maximized (re)development within the Cool Springs area:

- Scenario 3 – 25% of maximum development
- Scenario 4 – 50% of maximum development

This section details the steps used to incorporate the maximized development into the Vistro model.

To evaluate the maximized potential future traffic conditions within Cool Springs, the existing Vistro model was updated to include background growth, approved developments, and potential land development. Two scenarios were tested to determine the effects of growth and maximized development on the Cool Springs transportation network.

VISTRO Modeling for Maximized Development Analysis

Part 3 – Chapter 3 of this study detailed the addition of the approved developments into the Vistro model. A similar process was used to add the maximum potential development into the Vistro model. The following steps were taken to incorporate the maximum development scenarios into the Vistro model:

- Zones representing each of the growth regions where development is expected to occur were added to the model. It should be noted that additional Gates were not needed since there are no new major connectors, arterials, or freeways planned that do not already exist.
- Where needed, site accesses were added to the study roadway near the center of each of the growth regions to simulate potential site accesses.
- Paths were defined between each of the potential development Zones and the existing Gates.
- The trip generations for the maximum potential development described in Part 3 – Chapter 4 were input directly into the trip generation section of the Vistro model.
- StreetLight data was used to determine the distribution of vehicles entering and exiting the nine remaining growth regions. These distributions were incorporated into the trip distribution and traffic assignment sections of the model.

Capacity Analysis

As discussed, two future conditions with maximum development scenarios were tested within this portion of the study. This section presents the following Vistro model results for those scenarios:

- Level of Service (LOS) and Delay
- V/C Ratio
- 95th Percentile Queue Lengths

It should be noted that the 100% maximum development scenario was also taken into consideration. When the 50% and 100% maximum development scenarios were tested; however, it was discovered that the majority of study intersections were failing with poor LOS and extensive vehicular delays for both scenarios.

For 50% and 100% development approximately 44% and 78%, respectively, of the study intersections were determined to operate at LOS F with delay exceeding 1,000 seconds (over 16 minutes).

Following discussions with the City of Franklin, it was determined that the 100% maximum development scenario may be unrealistic. Instead, the 25% and 50% scenarios were determined to be a better representation of the market-driven development expected within the Cool Springs area. Therefore, the 100% maximum development scenario was not included within this report.

As previously mentioned, Sidra, a roundabout modeling software, was used to evaluate the existing and proposed roundabouts, which, in turn, validated the Vistro results. Tables detailing LOS and queue lengths are presented in Appendix K and Appendix L, respectively. Detailed Vistro and Sidra results for Scenario 3 and Scenario 4 are included in Appendix P and Appendix Q, respectively.

Scenario 3: 25% Maximum Development

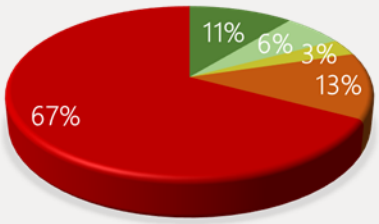
Under Scenario 3, the Vistro model included the existing traffic volumes, background growth, 100% of the remaining occupancy of the approved developments, and 25% of the potential maximized developments.

Level of Service (LOS)

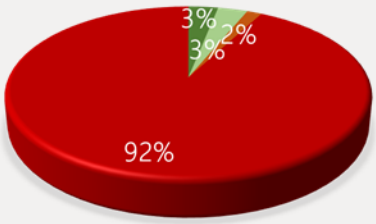
LOS A indicates minimal delay
LOS F indicates excessive delay

	A	B	C	D	E	F
AM	0	7	4	2	8	43
Mid	0	2	2	0	1	59
PM	0	0	3	3	0	58

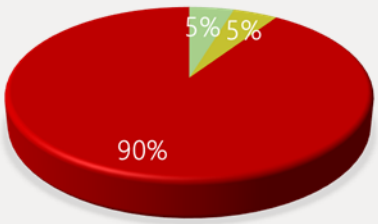
AM Peak



Midday Peak



PM Peak

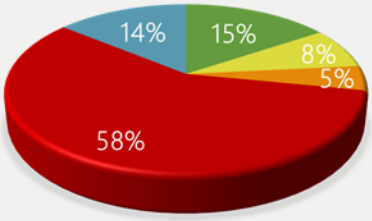


	AM	Mid	PM
< 0.85	10	3	4
0.85 – 0.95	5	1	0
0.95 – 1.00	3	1	0
> 1.00	37	50	51
Unsignalized	9	9	9

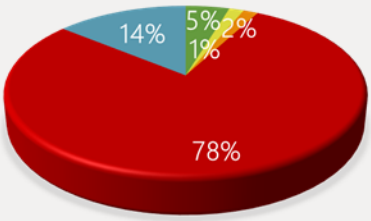
V/C Ratio

<0.85 is operating under capacity
1.0 is operating at capacity
>1.0 is operating over capacity

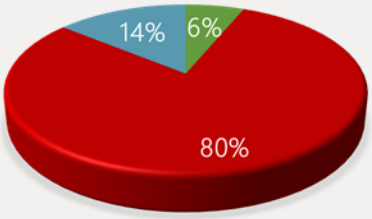
AM Peak



Midday Peak



PM Peak



95th Percentile Queue Length

Tally of intersections where queue length exceeds capacity on at least one approach

AM	50
Mid	61
PM	62

Scenario 4: 50% Maximum Development

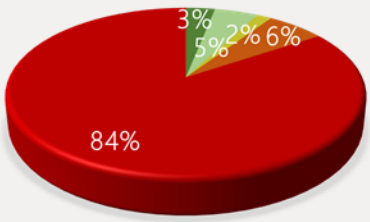
Under Scenario 4, the Vistro model included the existing traffic volumes, background growth, 100% of the remaining occupancy of the approved developments, and 50% of the potential maximized developments.

Level of Service (LOS)

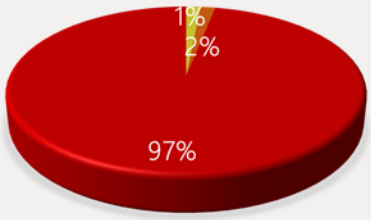
LOS A indicates minimal delay
LOS F indicates excessive delay

	A	B	C	D	E	F
AM	0	2	3	1	4	54
Mid	0	0	0	1	1	62
PM	0	0	0	0	2	62

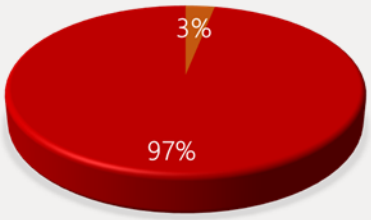
AM Peak



Midday Peak



PM Peak

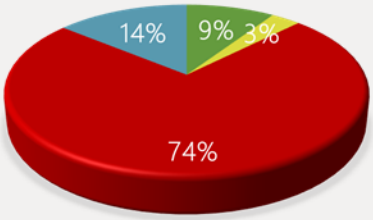


	AM	Mid	PM
< 0.85	6	0	0
0.85 – 0.95	2	1	0
0.95 – 1.00	0	1	0
> 1.00	47	53	55
Unsignalized	9	9	9

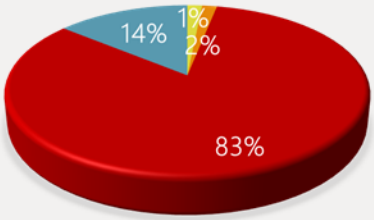
V/C Ratio

<0.85 is operating under capacity
1.0 is operating at capacity
>1.0 is operating over capacity

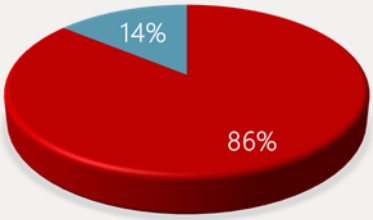
AM Peak



Midday Peak



PM Peak



95th Percentile Queue Length

Tally of intersections where queue length exceeds capacity on at least one approach

AM	56
Mid	62
PM	63

Chapter 6

SCENARIO COMPARISON

Throughout this study, four approved and potential development scenarios were tested. The results of these scenarios were then utilized to determine which study intersections would benefit from infrastructure and/or traffic signal improvements under each scenario. This section details a comparison of the Vistro model results for those scenarios, as well as, the results determined within the Existing Conditions Report.

The four scenarios were as follows:

- Scenario 1 – 50% of approved development
- Scenario 2 – 100% of approved development
- Scenario 3 – 25% of maximum development
- Scenario 4 – 50% of maximum development

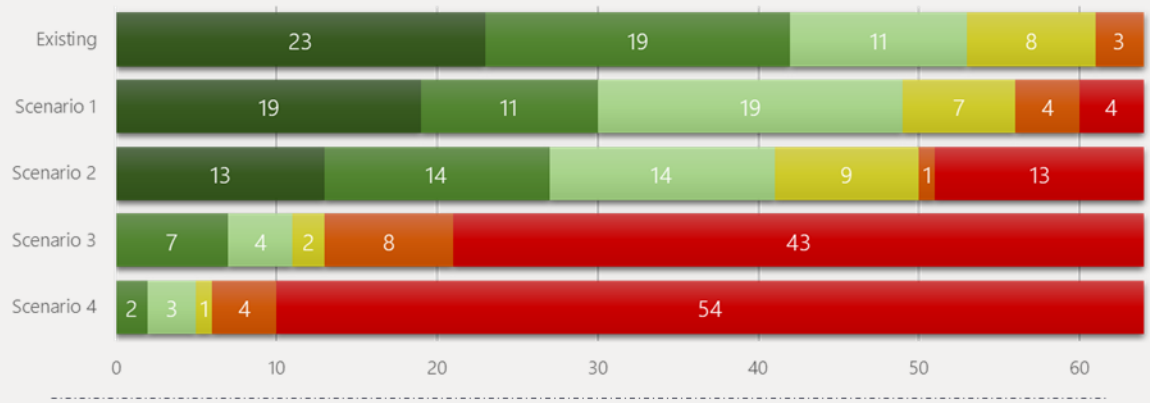
The following Vistro model results were used to compare the tested scenarios and determine which study intersections would benefit from improvements under each of the study scenarios. The following measures were used:

Delay
LOS
V/C Ratio
95th Percentile Queue Length

AM Peak Hour

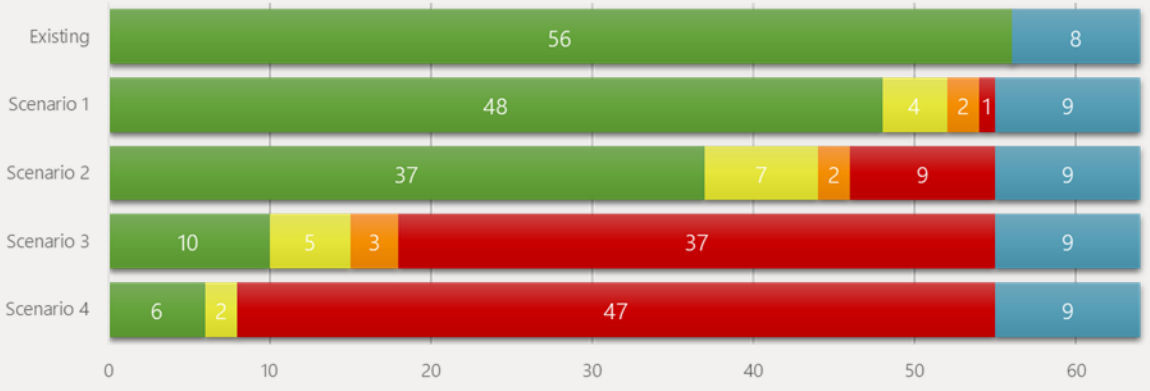
Level of Service (LOS)

	EXIST	FUTURE SCENARIO 1	2	3	4
A	23	19	13	0	0
B	19	11	14	7	2
C	11	19	14	4	3
D	8	7	9	2	1
E	3	4	1	8	4
F	0	4	13	43	54



V/C Ratio

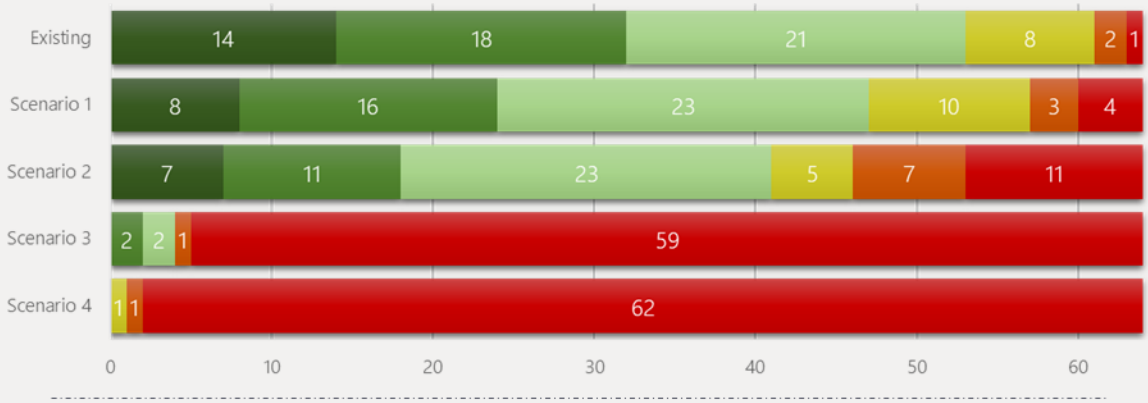
	EXIST	FUTURE SCENARIO 1	2	3	4
< 0.85	56	48	37	10	6
0.85 – 0.95	0	4	7	5	2
0.95 – 1.00	0	2	2	3	0
> 1.00	0	1	9	37	47
Unsignalized	8	9	9	9	9



Midday Peak Hour

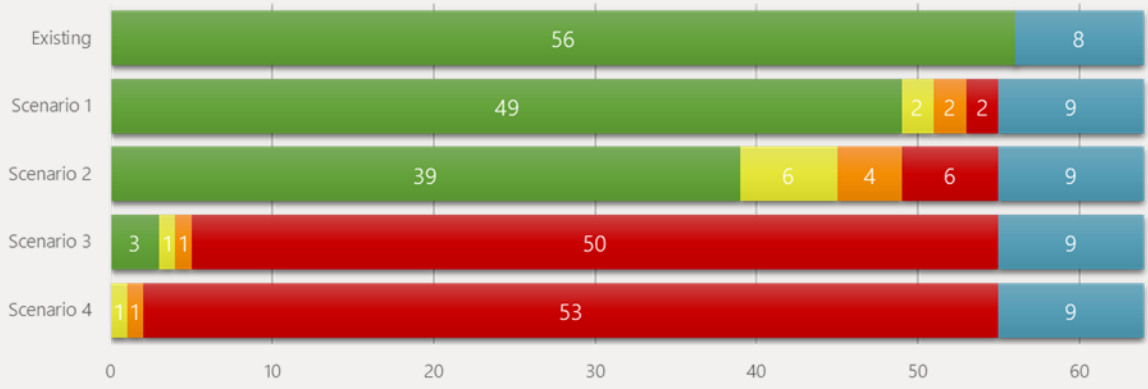
Level of Service (LOS)

	EXIST	FUTURE SCENARIO 1	2	3	4
A	14	8	7	0	0
B	18	16	11	2	0
C	21	23	23	2	0
D	8	10	5	0	1
E	2	3	7	1	1
F	1	4	11	59	62



V/C Ratio

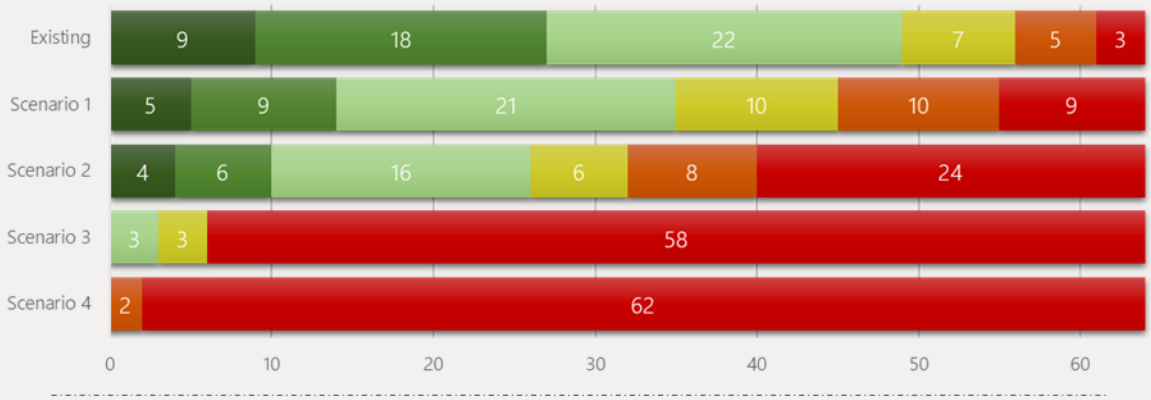
	EXIST	FUTURE SCENARIO 1	2	3	4
< 0.85	56	49	39	3	0
0.85 – 0.95	0	2	6	1	1
0.95 – 1.00	0	2	4	1	1
> 1.00	0	2	6	50	53
Unsignalized	8	9	9	9	9



PM Peak Hour

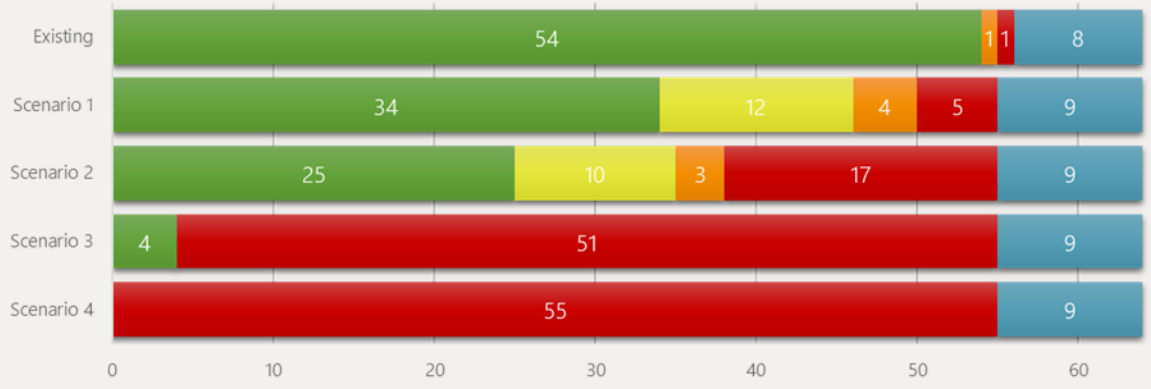
Level of Service (LOS)

	EXIST	FUTURE SCENARIO 1	2	3	4
A	9	5	4	0	0
B	18	9	6	0	0
C	22	21	16	3	0
D	7	10	6	3	0
E	5	10	8	0	2
F	3	9	24	58	62



V/C Ratio

	EXIST	FUTURE SCENARIO 1	2	3	4
< 0.85	54	34	25	4	0
0.85 – 0.95	0	12	10	0	0
0.95 – 1.00	1	4	3	0	0
> 1.00	1	5	17	51	55
Unsignalized	8	9	9	9	9



Part 4

RECOMMENDATIONS

Infrastructure Improvements

Policy Improvements

Transportation Guidelines

Pedestrian Improvements

Travel Demand Management Strategies

Chapter 1

ROADWAY IMPROVEMENTS

The principal purpose of the Cool Springs Transportation Network Study is to provide the City of Franklin with a coordinated plan of transportation improvements to be made as development occurs and to improve safety of all roadway users, improve traffic flow, and preserve roadway capacity.

To support this effort, the four future scenarios were analyzed to determine anticipated and potential growth, and improvements are recommended based on the needs of each scenario.

Infrastructure recommendations were determined based on maintaining LOS E. The recommendations presented in this chapter are for the study intersections operating at LOS F or worse under either Future Conditions – Scenario 1 or Future Conditions – Scenario 2.

When the below improvements are implemented, nearly all of the study intersections are expected to operate at LOS E or better under both Future Conditions – Scenario 1 and Future Conditions – Scenario 2.

This chapter details the roadway infrastructure improvements for the Cool Springs Transportation Network Study, and organizes them into immediate, short-term, mid-term, and long-term recommended infrastructure improvements.

Immediate Improvements

Field inventories were collected for each study intersection in December 2019 and January 2020. From those inventories, an initial set of recommendations was determined for immediate roadway improvements. These improvements include refreshing striping, sidewalk repairs, sign repair/replacement, and additional observations. These recommendations included in Appendix R.

Short-Term Improvements

This section details the proposed short-term recommended improvements. These indicate recommendations that could occur within the next five years. Functional plans for the short-term roadway improvements are presented in Appendix R. Additionally, Vistro model outputs for Future Conditions – Scenario 1 with Improvements and Future Conditions – Scenario 2 with Improvements are presented in Appendix S and Appendix T, respectively. The short-term improvements are included in Table 4-1 and are as follows:

Table 4- 1 Short-Term Recommended Improvements

Intersection	Short-Term Recommendations	LOS and Delay Comparison (Scenario 2) [Improved]		
		AM	MID	PM
Moores Lane and Carothers Parkway (City of Brentwood)	o Add a northbound right-turn lane.	D (36.7)	D (44.4)	F (92.8)
		D [36.2]	**D [39.9]**	**E [61.3]**
Carothers Parkway and Mayfield Drive	o Add an eastbound right-turn lane. This could be incorporated as part of the Eastworks development.	D (54.4)	D (49.2)	F (89.4)
		C [32.8]	**C [32.0]**	**D [39.9]**
Mallory Station Road and Seaboard Lane	o Add a southbound right-turn lane. o Restripe the southbound shared through/right-turn lane to a through lane.	C (22.7)	C (34.9)	E (69.2)
		C [21.6]	**C [23.1]**	**D [43.2]**

Mid-Term Improvements

This section details the proposed mid-term recommended improvements. These indicate recommendations that could occur in the next five to ten years. Functional plans for the mid-term roadway improvements are presented in Appendix R. Additionally, Vistro model outputs for Future Conditions – Scenario 1 with Improvements and Future Conditions – Scenario 2 with Improvements are presented in Appendix S and Appendix T, respectively. The mid-term improvements are included in Table 4-2 and are as follows:

Table 4- 2 Mid-Term Recommended Improvements

Corridor/Intersection	Mid-Term Recommendations	LOS and Delay Comparison (Scenario 2) [Improved] AM	MID	PM
Carothers Parkway	○ Add a southbound through lane between Private Drive south of Mayfield Drive and just south of Physicians Way. ○ Add a northbound through lane between just south of Liberty Pike to just north of Ovation Parkway.	N/A		
McEwen Drive	○ Add an eastbound and westbound through lane between the I-65 Interchange and Turning Wheel Lane.	N/A		
Carothers Parkway and Gillespie Drive/Meridian Boulevard	○ Add a southbound through lane and a southbound receiving lane. ○ The through lane should extend from the intersection of Carothers Parkway and Private Drive south of Mayfield Drive (approximately 500 feet).	D (53.3)	E (57.4)	E (69.9)
		D [35.3]	**C [29.9]**	**D [36.6]**
Carothers Parkway and Corporate Centre Drive	○ Add a southbound through lane and a southbound receiving lane.	C (29.7)	C (34.0)	F (106.9)
		C [23.5]	**B [19.9]**	**C [32.3]**
Carothers Parkway and Tower Circle	○ Add a southbound through lane, a southbound receiving lane, and a westbound left-turn lane.	D (41.8)	C (27.4)	F (148.6)
		C [31.8]	**C [21.5]**	**D [37.7]**
Carothers Parkway and Ovation Way	○ Add a northbound through lane, a northbound receiving lane, a southbound through lane, a southbound receiving lane, and an eastbound right-turn lane.	F (85.3)	E (74.5)	F (176.1)
		D [35.3]	**D [38.5]**	**E [70.7]**
Carothers Parkway and Southstar Drive	○ Add a northbound through lane, a northbound receiving lane, a southbound through lane, and a southbound receiving lane.	F (127.6)	D (50.0)	F (165.6)
		C [33.1]	**C [22.1]**	**D [51.2]**

Corridor/Intersection	Mid-Term Recommendations	LOS and Delay Comparison (Scenario 2) [Improved] AM	MID	PM
Carothers Parkway and Liberty Pike	○ Add a northbound through lane, a northbound receiving lane, a southbound through lane, a southbound receiving lane, and an eastbound left-turn lane.	F (272.7)	F (141.7)	F (176.1)
		E [74.3]	**D [49.7]**	**E [79.7]**
Carothers Parkway and Physicians Way	○ Add a southbound through lane and a southbound receiving lane.	D (48.0)	C (31.8)	F (86.2)
		D [47.0]	**C [27.7]**	**C [25.8]**
Mallory Lane and Cool Springs Boulevard	○ Add a northbound right-turn lane and a southbound left-turn lane. ○ Restripe the northbound through/right-turn lane to a through lane. ○ Based on the final intersection configuration, the left-turn signals may need to operate lead/lag.	D (44.7)	F (84.3)	F (110.2)
		D [42.1]	**D [53.8]**	**E [73.2]**
West McEwen Drive and Mallory Lane	○ Add a southbound left-turn lane. ○ Restripe the outside eastbound left-turn lane to a through lane.	D (45.3)	E (66.3)	F (103.3)
		D [46.9]	**D [52.1]**	**E [78.0]**
Cool Springs Boulevard and I-65 Northbound Ramp	○ Add an eastbound left-turn lane and a westbound right-turn lane. ○ Restripe the westbound shared through/right-turn lane to a through lane.	B (12.8)	D (35.5)	F (156.6)
		A [9.7]	**B [12.6]**	**D [51.8]**
East McEwen Drive and Tower Circle	○ Add an eastbound through lane, an eastbound receiving lane, a westbound through lane, and a westbound receiving lane. ○ Due to the large number of projected vehicles at this intersection, the recommended improvements at this intersection should be reevaluated as development occurs.	F (129.7)	F (181.7)	F (319.0)
		D [45.3]	**E [57.1]**	**F [151.9]**
East McEwen Drive and Carothers Parkway	○ Add a northbound through lane, a northbound receiving lane, an eastbound through lane, an eastbound receiving lane, a southbound through lane, a southbound receiving lane, a westbound through lane, and a westbound receiving lane.	F (84.2)	E (69.4)	F (251.4)
		F [94.4]	**F [99.5]**	**F [180.2]**

Corridor/Intersection	Mid-Term Recommendations	LOS and Delay Comparison (Scenario 2) [Improved] AM	MID	PM
East McEwen Drive and Ovation Parkway	○ Add a southbound right-turn lane, an eastbound through lane, an eastbound receiving lane, a westbound though lane, and a westbound receiving lane. ○ Restripe the northbound through lane to a shared through/left-turn lane. ○ Update the signal phasing to operate as split phasing on the northbound and southbound approaches.	F (84.2)	E (69.4)	F (251.4)
		D [46.5]	**C [28.2]**	**E [61.5]**
Murfreesboro Road and Royal Oaks Boulevard	○ Add a southbound right-turn lane, an eastbound right-turn lane, a westbound left-turn lane, and a southbound receiving lane. ○ Restripe the southbound shared through/right-turn lane to a through lane. ○ Restripe the eastbound shared through/right-turn lane to a through lane.	E (56.5)	F (116.8)	F (137.4)
		D [44.5]	**E [75.5]**	**F [83.7]**
Murfreesboro Road and Edward Curd Lane	○ Add an eastbound through lane and an eastbound receiving lane.	D (44.0)	D (51.9)	F (96.1)
		D [39.6]	**D [37.4]**	**D [39.3]**
Murfreesboro Road and Carothers Parkway	○ Add eastbound through lane and an eastbound receiving lane.	F (164.8)	F (95.1)	F (145.2)
		F [164.6]	**F [94.4]**	**F [117.0]**

Long-Term Improvements

This section details the proposed long-term recommended improvements. These indicate recommendations that could occur after ten years. It should be noted that capacity analysis and functional plans were not developed for the long-term improvements due to the speculative nature of the traffic volumes in the maximized density scenarios. Additional analysis should be conducted as traffic conditions change within the Cool Springs area. These long-term improvements include corridor level improvements and alternative intersection recommendations. The long-term improvements are presented in Table 4-3 and are as follows:

Table 4- 3 Long-Term Recommended Improvements

Corridor/Intersection	Long-Term Recommendations
Carothers Parkway	○ As development occurs, Carothers Parkway should be widened to a six-lane cross-section between Cool Springs Boulevard and Murfreesboro Road. ○ As additional lanes are added to the roadway, consideration should be made into the addition of bicycle facilities along Carothers Parkway.
McEwen Drive	○ As development occurs, McEwen Drive should be widened to a six-lane cross-section between I-65 Interchange and Cool Springs Boulevard.
Cool Springs Boulevard and Carothers Parkway	○ Add two southbound right-turn lanes as bypass lanes that run freely to the northbound I-65 ramp. ○ Displaced Left-Turn Intersection (DLT)/Continuous Flow Intersection (CFI)
Moores Lane and Carothers Parkway	○ Roundabout
East McEwen Drive and Carothers Parkway	○ Center-Turn Overpass Intersection
Carothers Parkway and Ovation Parkway	○ Restricted Crossing U-Turn Intersection (RCUT)/Superstreet
Carothers Parkway and Southstar Drive	○ Restricted Crossing U-Turn Intersection (RCUT)/Superstreet
Carothers Parkway and Liberty Pike	○ Displaced Left-Turn Intersection (DLT)/Continuous Flow Intersection (CFI)
Murfreesboro Road and Carothers Parkway	○ Displaced Left-Turn Intersection (DLT)/Continuous Flow Intersection (CFI) or Jug handle with southbound left-turns utilizing Quail Hollow Road.
Mallory Lane and Cool Springs Boulevard	○ Displaced Left-Turn Intersection (DLT)/Continuous Flow Intersection (CFI)
McEwen Drive and I-65 Interchange	○ Diverging Diamond Interchange (DDI)
East McEwen Drive and Tower Circle	○ Restricted Crossing U-Turn Intersection (RCUT)/Superstreet
Murfreesboro Road and I-65 Ramps	○ Diverging Diamond Interchange (DDI)

As previously mentioned, when the above improvements are implemented, nearly all of the study intersections are expected to operate at LOS E or better under both Future Conditions – Scenario 1 and Future Conditions – Scenario 2. Due to maximum development traffic volumes, it was determined that Future Conditions – Scenario 3 and Future Conditions – Scenario 4 would benefit more from policy improvements rather than further infrastructure improvements. Therefore, no infrastructure improvements are recommended at this time.

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Chapter 2

POLICY RECOMMENDATIONS

Based on the analysis of future scenarios described in Part 3, it is easily discerned that infrastructure improvements alone will not be able to address the operational deficiencies of the study area's transportation system should significant development and redevelopment occur over the next 10 years.

The ultimate goal of the policy strategies and the Cool Springs Transportation Network Study more generally is to ensure that the quality of life for Franklin residents and the economic vitality of the study area are both maintained long term.

This chapter provides an overview of potential policies that could be implemented by the City of Franklin to mitigate traffic impacts of development in tandem with infrastructure improvements. More details on these recommendations can be found in Appendix R.

The City of Franklin has a number of key policies in place to guide how development occurs and impacts the multimodal transportation system, namely the Road Impact Fee, Traffic Impact Study (TIS) requirements, and the Transportation and Street Standards. While these tools are functioning as intended, there are opportunities to modify and expand the suite of strategies available as growth continues to ensure the City's transportation system addresses the needs of roadway users, transit users, bicyclists, and pedestrians. Looking ahead, the intention is that any changes to existing policies or new policies would aid City staff in ensuring that traffic impacts of development are adequately assessed and that appropriate mitigation solutions are explored. In total, the policy recommendations revolve around three key strategies as highlighted in the following pages.

Development Approval Practices

As documented in the Policy Review in Part 2, the City of Franklin assesses the impact of new development using the Highway Capacity Manual (HCM) definition of level-of-service (LOS). Currently, arterial intersections within the City are required to maintain a LOS D before, during, and after development/redevelopment of a particular site with the intention of moving both personal and transit vehicles through the City as efficiently as possible. This standard has become difficult to uphold citywide, but particularly for intersections located at or near interstate ramps and in high-growth areas like Cool Springs. As is common in many urban and suburban areas, many of these key intersections are already operating at LOS E during peak hours with significant physical and fiscal barriers to improving that LOS.

For these reasons, it is recommended that the City's development approval practices be reevaluated to find alternative ways to measure and address development impacts. As a first step, the City should retain a LOS target for intersections affected by development. However, with the recognition that LOS D is not always achievable, development-related impacts will need to be mitigated as much as possible, potentially with different methods than have been used before. In addition, where the LOS metric is not as meaningful, as is the case with over-capacity intersections, the City should explore the use of alternative metrics such as Vehicle Miles Traveled (VMT) to assess systemwide impacts and explore a broader range of mitigation options. The routine use of VMT as a metric of development impact is relatively new, with California leading the way in 2018 with state legislation requiring its use to achieve targets for reduced greenhouse gas emissions. As such, the City should look to monitor the effectiveness reported from such efforts in the near-term to determine the usefulness and applicability of this measure for Franklin long-term.

Trip Reduction Strategies

As a complement to the City's development approval practices, its recently updated zoning ordinance encourages mixed-use development in strategic areas and allows for shared parking arrangements where appropriate. These can be effective tools for encouraging denser and more people-oriented development patterns. However, continued growth in the Cool Springs area will make maintaining the City's quality of life increasingly difficult unless the number of vehicles on the roadways can be significantly reduced. Therefore, it is recommended that in addition to the existing zoning tools, the City create a toolbox of TDM strategies.

TDM strategies are employed with the primary goal of reducing single-occupant-vehicle (SOV) trips during peak periods, typically accomplished through shifts in travel mode or time. Many municipalities have elected to impose requirements for TDM programs or strategies on incoming developments, particularly for those that are expected to generate a significant number of trips. However, the effectiveness of TDM strategies can be difficult to assess and track. For instance, aggressive TDM strategies that combine incentives and improved commute alternatives can report up to 25% trip reduction while separate incentives and improved commute alternatives resulted in only 17% and 9% trip reduction, respectively. This calls for a comprehensive and multipronged approach to TDM. As such, the City's toolbox of strategies should:

- Include a variety of both TDM programs and infrastructure investments that can help reduce vehicular trips;
- Be tailored to Franklin's workforce, development patterns, and existing infrastructure; and
- Be discussed with incoming applicants as the City works through the site development and approval process.

The intention is that increased adoption of these strategies over time will not only reduce SOV trips, but also help the City hone in on the most effective strategies for Cool Springs long-term.

More Multimodal Options

The Cool Springs area has a variety of multimodal transportation infrastructure that accommodates vehicles, transit users, bicyclists, and pedestrians. However, these facilities are often designed, funded, and functioning as independent pieces of a larger system. Though a significant amount of infrastructure exists in Cool Springs specifically, there is still room to improve how it is designed, the purpose it serves, and how it can be funded in the future.

The design of transportation facilities in Cool Springs in many cases complements the largely suburban development patterns with the primary focus on personal vehicles. As Cool Springs continues to grow and become more urban, the design of City streets should reflect the needs and expectations of residents, employees, and visitors alike. Therefore, it is recommended that the City's standard cross sections be evaluated to ensure that they safely and efficiently accommodate various forms of travel, knowing that travel patterns and the needs of roadway users are likely to change in tandem with development patterns. Figure 4-1 presents an example of one of the City's standard cross sections

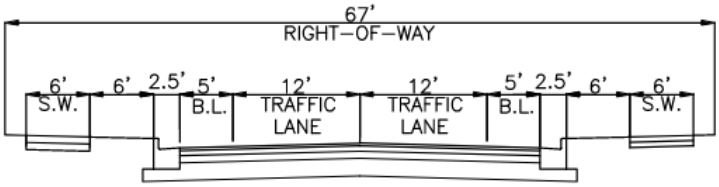


Figure 4- 1 Example of a Roadway Cross Section

In addition, there are new technologies disrupting the transportation industry each year, one of which is the host of micromobility options that are available and being tested across the country. Micromobility is a general term that typically includes a range of transportation options (e.g., bikes, e-bikes, scooters, etc.) available to individuals either personally or through a shared business model. These lightweight vehicles typically travel at low speeds and are particularly suited for trips that may be considered too long to walk, but that are also impractical for driving because of distance or parking availability at a trip destination for instance. In this way,

micromobility options fill a niche in the range of transportation modes. Providing accommodations for micromobility can remove vehicles from the road, reduce the need for surface parking, and improve connectivity between previously inaccessible trip origins and destinations. With the emergence of these options, the benefits are frequently quantified through research efforts, user surveys, etc. For instance, some research has shown that between 35-50% of trips made by e-bikes, a popular micromobility option, would have otherwise been made by automobile, exemplifying the potential for these modes. The City's current regulations limit the possibilities for micromobility in Cool Springs. As this is one area of the City with significant potential for micromobility success, it is recommended that the City explore pilot programs as a means to temporarily test innovative technologies like micromobility options (e.g., e-bikes, scooters, etc.) and assess their long-term potential for reducing trips.

The City of Franklin currently uses its Road Impact Fee ordinance to ensure that new developments are responsible for their pro-rata share of arterial and collector roadway improvements. This fee is calculated based on a development's addition of VMT to the roadway system and the average cost of adding roadway capacity to address that VMT increase. Innovative at the time of inception, this fee structure has served the City well in planning for the financial commitments associated with capital infrastructure improvements. However, as it exists currently, this fee is typically used for capital roadway improvements including but not limited to, new roads, additional lanes, widened lanes, turn lanes, bridges, traffic signals, intelligent transportation system (ITS) improvements, street lighting and associated drainage facilities. It is unlikely that the growth potential in the Cool Springs area can be accommodated with roadway infrastructure alone. Therefore, the City should evaluate the need for dedicating funding to address the growing multimodal transportation needs.

In addition to the specific and actionable policy recommendations presented above, the technical analysis and policy analysis resulted in the development of other high-level considerations for the future transportation network in the Cool Springs area. Though not modeled and primarily development-driven, the improvements outlined below should be considered as a means of developing Cool Springs as a regional activity center. These recommendations are intended to create additional multimodal connectivity across the interstate, capitalize on redevelopment opportunities, and prioritize the efficient movement of people over vehicles.

- Transit Opportunities – The City of Franklin should coordinate with the Tennessee Department of Transportation (TDOT), the Regional Transit Authority (RTA), and the Franklin Transit Authority (FTA) to explore opportunities for increasing the accessibility of the Cool Springs area by both regional and local transit service. At a regional scale, the portion of I-65 between the Moores Cool Springs Boulevard and Moores Lane interchanges is positioned for high-density redevelopment, which presents an opportunity to make the area more accessible for regional transit users. For example, reconfiguring the Cool Springs Boulevard interchange or creating bus pull-offs along the corridor are opportunities to make use of potentially underutilized right-of-way and spur transit-oriented development patterns. In tandem with such improvements, local transit service with

acceptable headway would need to provide connectivity to the area's trip attractions.

- Roadway Opportunities – As redevelopment continues to occur and more vehicular trips are added to the roadway network, the existing infrastructure will inevitably become overburdened. Further complicating this issue is the difference in land uses on either side of I-65, where retail and restaurant uses on the west will continue to impact mid-day and weekend traffic operations and office and residential uses on the east will continue to impact the traditional AM and PM traffic operations. To the extent feasible, the City should look to make additional connections across the interstate that do not involve interchanges. More specifically, connections using Mallory Station Road, Nichol Mill Lane, Crossroads Boulevard, and Jordan Road should be explored as the Cool Springs area redevelops. Furthermore, outside the study area, a new cross-interstate roadway connection should be considered in the vicinity of Fulwood Drive and Carothers Parkway and along Oak Meadow Drive near the Elks Lodge No. 72. This could potentially divert trips from Murfreesboro Road. Finally, the City should explore the opportunity for connections that facilitate only transit, bicycle, and pedestrian movements across the interstate.
- Bicycle and Pedestrian Opportunities – As the land uses in the Cool Springs area become more diverse and intermingled with redevelopment, the City should continue to pursue opportunities for making both local and regional bicycle connections. For example, the City should explore partnering with other municipalities on the creation of a greenway connection to Smith Park that would allow for commuters from Brentwood or Nolensville to park there and commute by bike into the Cool Springs area. Additionally, the City should consider creating long-term bike connectivity between Downtown Franklin and Cool Spring via Bakers Bridge Avenue, Seaboard Lane, General George Patton Drive, or Mallory Station Road using road diets where feasible. As mentioned, consideration should be given to facilitating bicycle and pedestrian movements across the interstate with connections not accessible to vehicles.

The policy initiatives included in this chapter document high-level strategies to help the City of Franklin address increasing growth pressures while actively preserving the quality of life for which the City of Franklin is so well known. Appendix R documents the actionable steps associated with these recommendations and outlines a general timeframe for implementation. All of these recommendations are rooted in promoting smart growth principles, finding innovative ways to manage current and future traffic volumes, and expanding multimodal options.

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01823

DATE: March 24, 2021

TO: Board of Mayor and Aldermen

FROM: Eric Stuckey, City Administrator
Paul Holzen, Director of Engineering
Jimmy Wiseman, Asst. Director of Engineering

SUBJECT:

Consideration Of Ordinance 2021-06, An Ordinance To Update The City Of Franklin Transportation & Street Technical Standards.

PURPOSE:

The purpose of this memorandum is to provide an update to the Board of Mayor and Aldermen on proposed revisions to the City of Franklin, TN Transportation & Street Technical Standards.

BACKGROUND/STAFF COMMENTS:

Over the past few months, staff has been working to update the Transportation & Street Technical Standards.

The Board is required to approve an ordinance for all major revisions to these standards. The revised street standards include numerous administrative changes and revisions to clarify the intent of the standard. Primary revisions to the standard include the following:

1. Updates in coordination with the adopted 2020 Franklin Zoning Ordinance
2. Information now residing as stand-alone documents has been removed and incorporated by reference
    - City of Franklin Traffic Impact Analysis Guidelines
    - Neighborhood Traffic Calming Program
3. Updates to as-built requirements
4. Updates to roadway typical sections
    - Alley sections updated
5. Updates to most standard drawings
    - Accessible on-street parking requirements clarified
    - Streetlight standards updated
    - Intelligent Transportation Systems (ITS) standards updated
6. Updates to allow the City Engineer to issue minor revisions to the adopted standards for administrative changes, error corrections, and clarification purposes

FINANCIAL IMPACT:

There is no direct financial impact to the City of Franklin.

RECOMMENDATION:

Staff recommends that the Board of Mayor and Aldermen approve Ordinance 2021-06.

ORDINANCE 2021-06

AN ORDINANCE TO REPLACE THE CITY OF FRANKLIN, TN, TRANSPORTATION & STREET TECHNICAL STANDARDS, 2021 EDITION, AS ADOPTED BY REFERENCE IN TITLE 16, CHAPTER 11, SECTION 16-1101 OF THE FRANKLIN MUNICIPAL CODE.

WHEREAS, the Board of Mayor and Aldermen of the City of Franklin, Tennessee, adopted the use of the "City of Franklin, Tennessee Transportation & Street Technical Standards" into Title 16, Chapter 11, Section 16-1101; and

WHEREAS, the City Engineer, pursuant to authority granted by the Franklin Municipal Code Title I, Chapter 16, Sections 16-1101 (1) thru (4), has the authority, subject to approval by the Board of Mayor and Aldermen, to adopt street specifications to be used as a basis for review and approval of plans and specifications for development of city streets, rights-of-way, and transportation design and construction prior to acceptance of such infrastructure; and

WHEREAS, the City Engineer has recognized the need to revise the "City of Franklin, Tennessee Transportation & Street Technical Standards" to better reflect the intent of what the City desires and update standards used for design and construction.

NOW THEREFORE:

SECTION I: BE IT ORDAINED BY THE BOARD OF MAYOR AND ALDERMEN OF THE CITY OF FRANKLIN, Tennessee**,** that Section. 16-1101, of Chapter 11, of Title 16 shall be deleted in its entirety and the following substituted in lieu thereof:

(1) *Purpose.* In order to provide better streets throughout the city, reflecting best practices and providing more capacity with safe and comfortable travel for motorists, pedestrians, bicyclists, and transit riders, the Board of Mayor and Aldermen of the City of Franklin have adopted the "City of Franklin Transportation & Street Technical Standards, 2021 edition" ("street specifications"). The adoption of these uniform standards will encourage consistency and quality in street design and construction to meet the health, safety, and welfare of the citizens of Franklin and the traveling public.

(2) *Adoption of street specifications.* The city engineer shall have the authority, subject to approval by the Board of Mayor and Aldermen, to adopt street specifications to be used as a basis for review and approval of plans and specifications for development of city streets, rights-of-way, and transportation design and construction prior to acceptance of such infrastructure.

(3) *Minor revision to adopted street specifications*. The city engineer shall have the authority to issue minor revisions to the adopted street specifications for such items as administrative changes, error corrections, and clarifications that do not substantially alter the content or intent of the street specifications.

(4) *Adoption of administrative regulations.* The city engineer shall have the authority to adopt and amend administrative regulations to effectuate the intent of the street specifications.

Law Dept. approved 03.17.21

(5) *Available in recorder's office.* Once adopted, copies of the street specifications and any administrative regulations adopted shall be placed on file at the city recorder's office and at the city engineer's office.

SECTION II: BE IT FINALLY ORDAINED BY THE BOARD OF MAYOR AND ALDERMEN OF THE CITY OF FRANKLIN, Tennessee, that this Ordinance shall take effect on July 1, 2021, the health, safety, and welfare of the citizens of Franklin requiring it.

Attest:

By: _____
Eric S. Stuckey
City Administrator

CITY OF FRANKLIN, TENNESSEE:

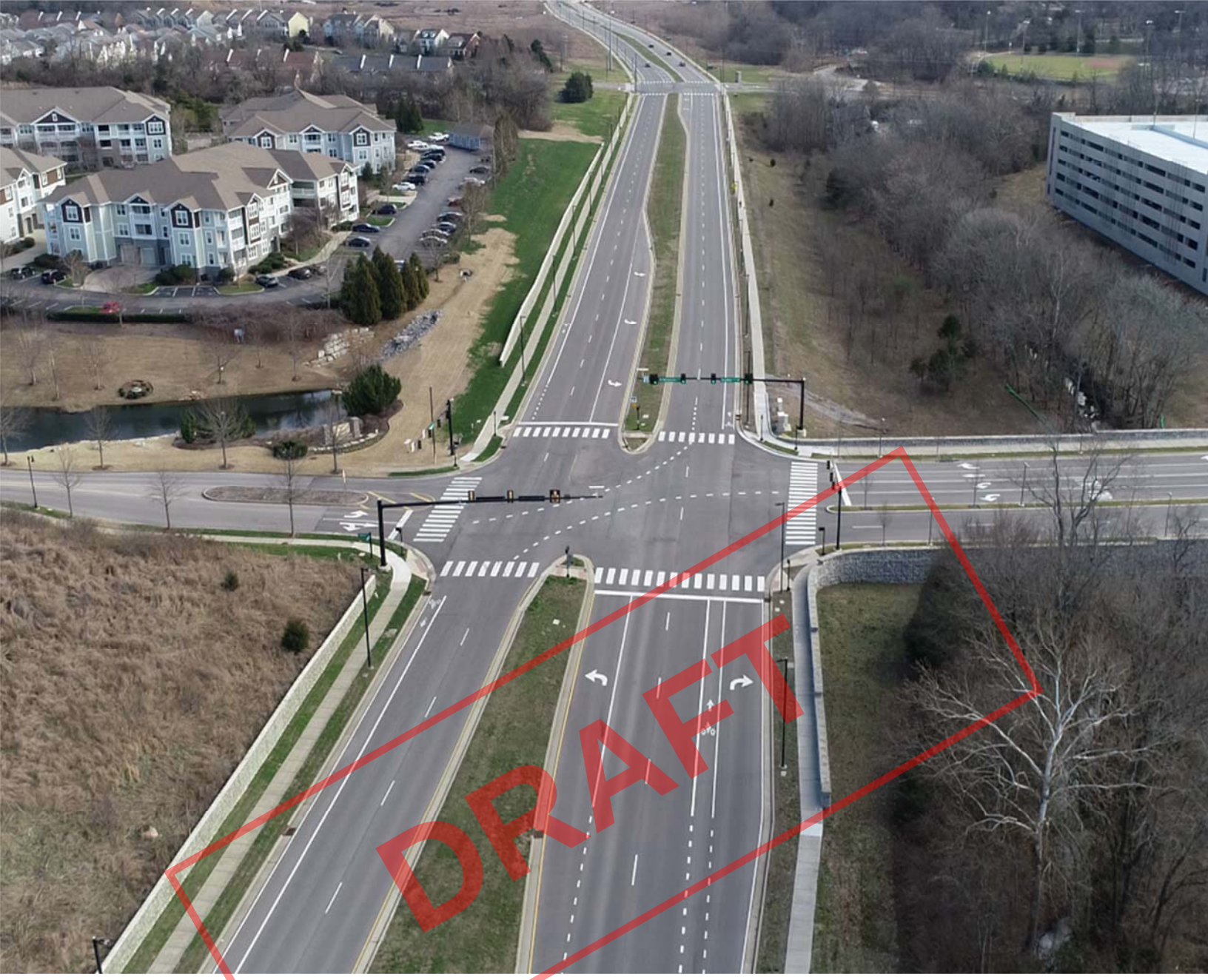
By: _____
Dr. Ken Moore
Mayor

Approved as to form:

By: _____
Shauna R. Billingsley
City Attorney

PASSED FIRST READING: _____

PASSED SECOND READING: _____



FRANKLIN TRANSPORTATION & STREET TECHNICAL STANDARDS

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City of Franklin, TN Transportation & Street Technical Standards, 2021 Edition

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CHAPTER
1

GENERAL PROVISIONS AND REQUIREMENTS

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1.1 Title

These standards shall be known as the "Franklin Transportation and Street Technical Standards", referred to throughout this document as "these Standards."

1.2 Purpose

The purpose of these Standards is to provide reasonable design and construction guidelines for transportation infrastructure within the City of Franklin that promote economical and durable designs and allow for safe and efficient traffic movement.

1.3 Authority

These Standards were adopted by the Board of Mayor and Aldermen (BOMA) and became effective on XXX, 2021 by Ordinance XXXX-XX.

1.4 Applicability

Except as may otherwise be required by law, these rules and regulations govern the construction of new streets, existing streets requiring improvement or rehabilitation, and all associated improvements and appurtenances, both public and private, installed in the City of Franklin, Tennessee ("the City").

1.5 Compatibility

If any provision of these Standards and any other provisions of law impose overlapping or contradictory requirements, or contain any restrictions covering any of the same subject matter, that provision which is more restrictive or imposes higher standards or requirements shall govern unless otherwise specified.

These Standards do not relieve the applicant from provisions of any other applicable code, ordinance, or regulation.

Any conflicts, errors, or omissions in the approval of any application shall not relieve the applicant from compliance with these Standards, or with any other regulatory agency with jurisdiction over the project.

1.6 City Engineer

All places within these Standards that reference the "City Engineer" shall refer to the City of Franklin, Tennessee City Engineer or their designated representative.

1.7Standard Drawings and Typical Street Sections

The Standard Drawings and Typical Street Sections produced by the City of Franklin Engineering Department and available online on the City of Franklin Engineering webpage are incorporated by reference into these Standards.

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1.8 Specifications and Resources

Infrastructure within the City shall be designed and constructed per the latest edition of the following documents:

- "*A Policy on Geometric Design of Highways and Streets*", latest edition, American Association of State Highway and Transportation Officials; AASHTO. (Hereinafter referred to as the "*Green Book*").
- "*Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400)*", latest edition, American Association of State Highway and Transportation Officials; AASHTO.
- "*Guide for the Development of Bicycle Facilities*", latest edition, American Association of State Highway and Transportation Officials; AASHTO.
- "*AASHTO Roadside Design Guide*", latest edition, American Association of State Highway and Transportation Officials; AASHTO.
- "*Traffic Engineering Handbook*", latest edition, Institute of Transportation Engineers
- "*Trip Generation Manual*", latest edition, Institute of Transportation Engineers.
- "*Manual on Uniform Traffic Control Devices for Streets and Highways*", latest edition, U.S. Department of Transportation, Federal Highway Administration; FHWA. (Hereinafter referred to as the "*MUTCD*").
- "*Roundabouts: An Informational Guide*", latest edition, U.S. Department of Transportation, Federal Highway Administration; FHWA.
- "*Public Right of Way Accessibility Guidelines*" latest edition, United States Access Board. (Hereinafter referred to as the "*PROWAG*").
- "*AASHTO LRFD Bridge Design Specifications*", latest edition, American Association of State Highway and Transportation Officials; AASHTO.
- "*Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting, ANSI/IES RP-8*", latest edition, American National Standards Institute, ANSI, and Illuminating Engineering Society, IES.
- The following Publications of the Tennessee Department of Transportation, latest editions. (Hereinafter referred to as "*TDOT Standard Specifications*")
  - "*TDOT Standard Specifications for Road and Bridge Construction*"
  - "*TDOT Survey Manual*"
  - "*TDOT Roadway Design Guidelines*"
  - "*TDOT Standard Drawings*"
  - "*TDOT Traffic Design Manual*"
- The City of Franklin Supplemental Specifications To: The Tennessee Department of Transportation Specifications for Road and Bridge Construction, March 1, 2015 as amended.

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- The City of Franklin Corridor and Connector Streets Economic Development Projects; Zoning Ordinance; Stormwater Ordinance; Subdivision Regulations; Major Thoroughfare Plan; Land Use Plan, and Administrative Manual, latest editions.

In the case of a conflict between the documents above and provisions elsewhere in these Standards, the provisions in these Standards shall govern, unless the construction is within State of Tennessee right-of-way.

1.9 Plan Standards

In order to provide consistency and maintain accuracies, the following criteria are to be adopted for the roadway plans.

Plans submitted must be submitted in PDF and AutoCAD format. Each plan submittal shall be completed digitally through the City's Electronic Plan Submittal Process.

Exemptions to these standards may be granted by the City Engineer upon request, based on project scope and location.

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1.9.1 Survey

Survey information in the form of point data files must be included at the time of plan submission. All survey data gathering shall adhere to "TDOT Standard Specifications".

Survey procedures require that all surveys shall be tied to the State Plane Coordinate System using the Tennessee Geodetic Reference Network (TGRN). All surveyed coordinate values will be based on the North American Datum 1983 (NAD/83) (1995 adjustment) coordinates and appropriate notes indicating such shall appear on the topography plot.

All design computations shall be based on these adjusted coordinate values. This will ensure that all computed points on the project will have coordinate values tied to the State Plane System. Assumed coordinates will not be used.

Coordinate values for all PI's shall be shown on present and proposed (if any are shown) layout sheets within each curve data table. Coordinate values shall also be listed for the beginning and ending points of the project. A notation near the title block in lower right hand corner for each sheet on which coordinates appear shall read, *"Coordinates are NAD/83 (1995), are datum adjusted by the factor of 1.000XXX"* and tied to the TGRN. The "1995" refers to the year of the most recent adjustment of coordinate values in Tennessee and 1.000XXX refers to the actual datum adjustment factor used for the project.

1.9.2 Construction Plan Submittal

The plan submittal shall consist of neat, scaled drawings with specifications and any other pertinent supportive data as required for review approval. These drawings shall include all aspects of the street, grading and drainage, including documentation or supporting evidence that proves sufficient engineering calculations have been performed in accordance with the approved project. The construction drawings and drainage calculations shall bear the stamp of a Registered Tennessee Professional Engineer. Other submittals for approval which are necessary and to be done by the Developer may include, but are not limited to the Franklin Planning Commission; the Tennessee Department of Transportation, the Tennessee Department of Environment and Conservation, and the Tennessee Division of Water Pollution Control, Natural Resources Section.

As a general guideline, the *supporting calculations shall include any engineering information that is pertinent to the project*. These may include, but are not limited to the following:

- Drainage calculations including culvert and bridge analysis, drainage areas, runoff values, energy dissipators
- Intersection sight distance calculations
- Quantity calculations (City projects)
- Structural calculations

The designer is encouraged to add notes on the plans explaining special situations or items which are not readily apparent and that would influence the proposed design. The following sheets and information will be reviewed for quality assurance at this submission:

Title Sheet – Information on the title sheet shall include the following:

- Project numbers
- Project location map including north arrow and scale
- Description of project work type
- Reference points at the beginning and end of the project
- Project lengths, including incidental construction
- Design data including design speed, design criteria, functional classification, terrain, traffic data, etc.
- Signature block

Index and General Notes Sheet – Provide a list of utility owners and addresses that will be affected by the project. The index blocks shall be completed to indicate the sheet numbers for the plans.

Typical Cross Sections – These should show basic configuration and design features. This will typically include the following:

- Lane and shoulder widths tied to centerline
- Construction centerline
- Profile Grade Line
- Cross slopes
- Pavement Design
- Station ranges/limits
- Curbs
- Sidewalk locations and widths
- Bicycle facilities
- Side slopes
- Shoulder configurations if warranted
- Retaining walls, culverts, and bridges if warranted
- Ditches, Seed/Sod areas

Plat Sheet/Property Map – (if required) shall be included for projects that require acquisition of right-of-way.

Plan and Profile Sheets - Elevations and grades of special ditches shall be shown so that accurate right-of-way requirements can be determined. Typically, the plan view and profile shall be shown on the same sheet. In addition to the criteria required for the previous submittal, the plan and profile sheets shall include the following:

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- Horizontal alignment (e.g., horizontal curve data, PC, PI, PT, bearings)
- Vertical alignment and its relationship to grade controlling features
- All alignment controlling features (e.g., high-water levels, existing cross roads and bridges, regulated drains, drainage structures, railroads, under drain criteria, traffic maintenance considerations, cemeteries, historical buildings, parks, ADA requirements, etc.)
- Preliminary drainage details, e.g., bridges and mainline culverts.
- Project limits
- Drainage features (e.g. pipe structures, ditch grades, preliminary inlet spacing for storm-sewer trunk line designs, etc.) and proposed drainage notes
- Public road approach and drive locations
- Construction limits
- Proposed right-of-way
- Approximate roadside barrier locations
- Permanent erosion protection
- Index and general notes sheet shall be up-to-date and accurate.
- The plan and profile sheets shall reflect correct structure notations, sodding, rip-rap and paved sodded ditch locations shall be indicated; earthwork balances are shown for City projects; and removal items are noted.
- If the project is to be funded by the City, tabulated values shall be included in the plan sheets that show quantities of all needed items.
- North Arrow and Scale for each sheet

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Cross Sections – The cross sections shall include the following:

- Profile grade line
- Templates of the typical section placed on the existing cross sections
- Drainage structures
- Approaches and drives
- Clearance to buildings
- Final structure notation and final earthwork areas and volumes

Detail Sheets – The proposed layouts shall be included as follows:

- Turning movements and turn lanes
- Pavement markings
- Signals
- Signs, including sign structures
- Lighting
- Retaining walls
- Special drainage structures
- Superelevation transition diagrams
- Plans for temporary erosion control, traffic maintenance details, and traffic design elements (e.g., intersections, signals, signing and lighting).

Traffic Maintenance Details – The proposed traffic maintenance scheme and phasing shall be outlined and may be accompanied with "TDOT Standard Specifications".

Structure/Drainage Data Table – The preliminary information to be included in the structure data table is as follows:

- Location
- Size
- Type
- Approximate elevations and grades where necessary for clarity
- Type of headwall

Design Information - In addition to the plans, the designer shall include copies of the hydraulic analysis for mainline culverts and bridges, if applicable, and results of any economic analysis that may have been completed for alternative grade lines.

Cost Estimate – A construction cost estimate is required for City funded projects only. Quantities for all major items shall be included in the cost estimate. Miscellaneous pay items previously accounted for as a percentage of the cost estimate and which are not required to complete tables in the plans do not need to be quantified.

1.9.3 Revision of Plans

Should, prior to, or during construction, necessary changes be anticipated that would in the opinion of the City staff constitute significant revision of the plans already approved by the City, said plans shall be revised with said changes shown and resubmitted along with a letter stating why such changes are believed necessary. Changes deemed to be minor in nature by the Street Department Director may be made during construction with the changes noted for inclusion in the "as-built" drawings to be submitted to the City prior to final acceptance.

The City Engineer shall have the right to re-review the entire set of Plans should a revision of the plans be required.

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1.10 Plan Review Procedure / Fees

After receiving approval of the Preliminary Plat, Final Plat, Development Plan, and/or Site Plan, the Developer or Developer's Engineer shall submit construction drawings for approval.

1.10.1 Submittal Requirements and Fees.

Submittal Requirements and Fees can be found in the Municipal Code and the Administrative Manual.

1.10.2 Approval of Drawings and Fees, On-site Approved Drawings Required

The City Engineer must approve plans, calculations and fees prior to the start of any work on the project. A complete set of approved Plans shall be available at the construction site at all times. Plans will not be deemed approved until the City Engineer and Street Department's stamps of approval have been affixed to the cover sheet of the drawings and specifications.

1.10.3 Expiration of Construction Drawings

Expiration of the construction drawings shall coincide with expiration of the Site Plan as per the applicable Franklin Zoning Ordinance.

1.11 Utility Coordination

Locating and coordination for the relocation of existing utilities within the City's right-of-way is the responsibility of the contractor. Tennessee's One-Call shall be utilized in addition to coordination with local

utility owners. The contractor shall at all times protect existing utilities and will be responsible for costs due to damage caused to any utility lines.

1.12 Historical Research Resources

It is the responsibility of the contractor and designer to identify historic properties and to submit and follow plans that take these into account. Record searches can be performed at the Tennessee Historical Commission (THC), which houses the Tennessee State Historic Preservation Office. THC is located in Nashville and is the central repository for information on architectural surveys for the state of Tennessee. Their records can assist the contractor and designer in determining properties along the project corridor that have been listed in the National Register of Historic Places or if they have been inventoried in past surveys. Any records of historic properties shall be noted on the construction plan as measures taken to avoid such properties.

1.13 Permits

Prior to beginning any construction, the Developer and/or Contractor, shall obtain all necessary permits as required by law. Such permits may include, but are not limited to, those required by State of Tennessee, Williamson County and the City.

Prior to beginning any construction activities, the Developer shall obtain all necessary City permits as outlined in Franklin Municipal Code, which may include, but are not limited to, Stormwater Management & Grading Permit, Excavation/Road Bore Permit, Demolition Permit, Building Permit, etc.

1.14 Notification of Construction

In addition to any other notices required by law (e.g., TN One Call, notices to non-participating utilities), before commencing any street construction operations, a 72 hour notice must be given during regular business hours to the Engineering Department (Traffic Operations Center) and Streets Department.

1.15 Quality Control Testing

Construction materials, including aggregate base stone, asphalt, concrete, and roadway sub-grades shall be fully tested in accordance with the designations and requirements within the referenced "TDOT Standard Specifications" sections. Unless otherwise noted within the "Standard Specifications" section, the type and number of tests called for by the referenced standards shall be performed.

Testing shall be done by an independent testing laboratory whose qualifications are approved by the City. Testing results will be submitted to and approved by the City Engineer. The City reserves the right to require industry standard certifications of testing and inspections by the testing laboratory, mills, shops and factories. Such certifications required shall be submitted in duplicate.

The Developer shall provide the necessary labor and supervision required to support field testing by the independent testing firm and inspections by City officials at no cost to the City. Test reports of field testing if applicable shall be submitted directly to the City Engineer. Defects disclosed by tests shall be rectified at no cost to the City. The Developer is required to have the design engineer or a certified quality control inspector present during all phases of construction. A daily log of work performed shall be kept by this individual and submitted to the City upon request.

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1.16 Inspection

All projects shall be subject to inspection during and upon completion of construction by an authorized representative(s) of the City. Presence or absence of an inspector during construction does not relieve the Developer and/or Contractor from adherence to approved plans and material contained in these Standards or from liability. Materials and/or workmanship found not meeting requirements of approved plans and specifications shall be immediately brought into conformity with said plans and specifications.

An authorized representative of the City shall make a final inspection of the project after completion to determine acceptability of the work and for release of performance bonds if required. Before this final inspection can be made, the Engineer responsible for the project shall certify in writing to the City Engineer that the work has been completed in accordance with approved plans and specifications.

The cost for inspection during construction is calculated and paid as part of the Grading and Stormwater Permit. Additional inspection fees will be required only when an inspection requiring City approval fails and requires subsequent re-inspections. The Inspection Fee (current prices can be found in the City of Franklin Municipal Code) shall be paid to the City before issuance of Permits.

Drainage facilities including, but not limited to, culverts, detention basins and ditches, as well as the roadway sub-grade, base stone and binder & surface coarse shall be inspected, tested and given approval at each stage of installation prior to proceeding to the next stage of construction. Final construction inspection for approval and acceptance of streets and drainage systems will not be granted until all work has been completed in accordance with the approved plans.

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1.17 As-Built Plan Submittal

Final as-built plans shall be submitted immediately following completion of construction activities. If the project is developed in phases, as-built plans for each phase shall be submitted once the work is complete in that phase. Acceptance of Facilities will not be issued until satisfactory as-built plans have been approved by the Street Department Director and the City Engineer.

All aspects of the project that have been affected by construction shall be verified and appear on the as-built plans. This would include, but is not limited to the following items:

- All property lines and easements
- Existing structures (Include patio covers, decks, trellises, sheds, pools, fences, poles, etc.)
- Location of all "as-built" work with station and offsets
- Height and location of all fences, walls, screens, tress and hedges over 42" tall
- All commercial driveways, paved areas, and required parking spaces
- All concealed components with station and offsets (include known buried cables, utilities, drainage structures, etc.)
- Video documentation of storm drainage
- Stormwater BMP'S (Detention/ Retention ponds, Bioretention Areas, etc.)
- All Utilities

Public or private stormwater infrastructure with nominal size of 12 inches or greater shall be video-inspected to verify proper installation, and the video recording and associated inspection report shall be submitted as part of the as-built record. The professional preparing the video shall be certified by the Pipeline Assessment and Certification Program (PACP). Video documentation shall be prepared in

conjunction with the preparation of drainage as-builts and shall be provided no more than 90 calendar days prior to a performance release request submittal. Additional testing may be required if warranted by the video inspection.

Other concealed components shall require documented proof to be submitted with the as-built plans in the form of a certified construction log that has been generated by the design engineer or a certified quality control inspector as detailed in Section 1.10 of these Standards.

As-built plans are required to be *endorsed by a Tennessee registered professional engineer and or a registered land surveyor.*

1.18 Acceptance of Facilities

After construction has been completed, a final inspection will take place by the City. City acceptance occurs when the Franklin Municipal Planning Commission releases performance bonds. Acceptance will occur once all contractual agreements have been met and construction meets the extents considered satisfactory under these Standards and deemed as such by the City.

Acceptance will only be issued after As-Built plans that adhere to requirements listed in these Standards have been submitted and approved by the City Engineer.

In the event of requests for acceptance of streets meeting development build-out requirements, but fronting a remaining vacant building lot, the developer shall post a Lot Bond for the vacant lot to insure protection of the as-built street improvements. Such bonds shall meet the requirements of Franklin Municipal Code, regarding Lot Bonds.

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1.19 Existing Streets

Existing streets serving a proposed development shall make offsite safety improvements in accordance with these Standards as determined by the City Engineer.

1.20 Modification of Engineering Standards

The purpose of a modification of engineering standards is to provide limited relief from requirements of these Standards in cases where strict application of a particular requirement would create an exceptional hardship prohibiting the use of land in a manner otherwise allowed under these Standards. Self-imposed hardships, or actions taken by the applicant rather than conditions unique to the land in question, shall not be grounds for a modification of engineering standards.

A modification of engineering standards is not intended to remove inconveniences or financial burdens that the requirements of these Standards may impose of property owners in general.

A request for modification of engineering standards shall be made to the City Engineer in the form of a letter prepared by a licensed professional engineer. Each request shall include the following information. Incomplete requests shall be grounds for denial.

1) Documentation of the exceptional hardship and justification for the request;
2) Identification of the standard to be modified;
3) Identification of the alternative design or construction standard proposed;

4) Cost impacts to the City, including maintenance and replacement costs; and
5) Seal of the licensed professional engineering preparing the request.

The modification of engineering standards shall be considered by the City Engineer on a case-by-case basis and a determination shall be made using the following criteria:

1) Demonstration of an exceptional hardship due to unique physical surroundings, property shape, or topographical conditions of the property involved;
2) The granting of the modification shall not be detrimental to the safety, health, or welfare of the public, or injurious to other property or improvements;
3) The modification complies with acceptable engineering standards; and
4) The modification shall not place an undue financial burden on the City.

1) In approving modifications of engineering standards, the City Engineer may impose such conditions as in his or her judgement, shall secure substantially the objectives, standards, and requirements of these Standards.

1.21 Appeal of City Engineer Order or Decision

Any person aggrieved by any order or determination of the City Engineer may appeal said order or decision to the Building and Street Standards Board of Appeals, established in Franklin Municipal Code, and have such order or determination reviewed by the Building and Street Standards Board of Appeals. A written notice of Appeal shall be filed with the City Engineer, and such notice shall set forth with particularity the decision, action or inaction of the City Engineer complained of and the relief sought by the person filing said Appeal. See City of Franklin Municipal Code for additional details.

1.22 Revisions to these Standards

Per the Franklin Municipal Code Chapter 11, Title 16, Section 16-1101, major revisions to these Standards shall be adopted by ordinance of the City Board of Mayor and Aldermen; however, the City Engineer shall have the authority to issue minor revisions to the adopted standards for such items as administrative changes, error corrections, and clarifications that do not substantially alter the content or intent of the street specifications.

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STREET DESIGN

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2.1 Standards for Design

The purpose of this chapter is to present the City criteria and guidelines for the design of streets and other related elements in the street right-of-way. It is to be used by the City, developers and their engineers in the design of public and private streets for which approval by the City Engineer is required. This chapter is not intended to address streets in the downtown urban core of the City, or streets in designated historic districts, however, certain criteria and guidelines in this chapter may be determined to be applicable to streets in these areas in order to preserve the public health, safety and welfare, as determined by the City Engineer.

2.1.1 General

All design drawings and support data submitted to the City Engineer for approval must be sealed by a registered Professional Engineer, licensed to practice in the State of Tennessee.

The design criteria, as presented, are intended to aid in preparation of plans and specifications, and include minimum standards where applicable. These design criteria are considered minimum and a complete design will usually require more than is presented in this document. Design of streets shall follow *"TDOT Standard Specifications"* unless otherwise noted in these Standards. For items not addressed in *"TDOT Standard Specifications"*, AASHTO's *"Green Book"* and other relevant AASHTO design documents shall be consulted for guidance. Where conflicts exist or interpretations are required, the City Engineer shall make the final determination in consultation with the designer.

2.1.2 Location and Layout of New Streets

The location and layout of new streets shall be as identified in the Major Thoroughfare Plan, Subdivision Regulations and Zoning Ordinance. Streets not identified in the Major Thoroughfare Plan shall meet the needs of the specific development and satisfy all other specific requirements of this chapter. The City Engineer retains the authority to designate collector and arterial streets as needed for circulation and emergency access and retains authority for approval of the overall street layout.

All streets shall have a logical relationship to the existing topography and to the location of existing, platted or planned streets within adjacent properties. In instances where a proposed street is not indicated on the Major Thoroughfare Plan, it should support a rectangular grid or modified grid street network to the maximum extent practicable. Curvilinear street networks shall only be used when topographic or environmental constraints make use of the grid pattern undesirable, or when established development patterns on adjacent lands make the grid pattern infeasible.

The street layout for all subdivisions shall be designed to ensure connectivity, enhance general circulation and to provide secondary points for emergency access. They shall also provide safe, efficient, and convenient vehicular, bicycle, and pedestrian access within and between developments. Certain streets may need to be extended to property boundaries to provide for the future logical extension of the street through adjacent properties. If an arterial or collector street is located within or adjacent to a development, the development shall continue the street to a logical termination point as determined by the City Engineer.

A major component in street layout is neighborhood traffic safety. This is an essential transportation issue in the City. Streets shall be designed to limit excessive traffic speeds and volumes in neighborhoods and provide for safe travel for all modes of transportation including pedestrian, bicycle, and vehicles. In addition, new streets in neighborhoods shall be laid out to minimize opportunities for cut-through traffic.

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2.1.3 Traffic Impact Analysis

The City Engineer or his/her designee may require that a transportation impact analysis (TIA) be prepared for developments or projects meeting the criteria specified in this Subsection. The TIA shall consider traffic capacity and service, traffic controls, intelligent transportation systems (ITS), multi-modal accommodations and safety issues in accordance with the following standards:

(1) When Required

A TIA shall be required to assess the transportation impacts of a proposed development or project when:

(a) The expected number of primary trips generated by a proposed land use exceeds an estimated 1,000 vehicle trips per day or 100 peak hour vehicle trips per day; or

(b) A proposed land use generates less than 1,000 vehicle trips per day, or 100 peak hour vehicle trips per day when:

i. The use is on a site located at or near existing or planned signalized intersections; or
ii. The proposed land use may constitute a threat or danger to the safe and efficient flow of traffic, as determined by the City Engineer or his/her designee.

(c) The City Engineer or his/her designee may waive this provision if a recent, valid traffic study has been completed from which needed traffic impacts and mitigations can be extrapolated.

(d) When a development or project is subject to a land use plan amendment and/or rezoning, said land use plan amendment and/or rezoning application shall be accompanied by a new or updated TIA. At a minimum, the TIA shall provide information on both the existing Level of Service and future Level of Service based on the land use plan amendment and/or rezoning being proposed. This information shall be considered by the City of Franklin Board of Mayor and Aldermen when considering a land use plan amendment and/or rezoning. The Board of Mayor and Aldermen, at their discretion, may require system improvements to mitigate the traffic impacts resulting from a proposed land use plan amendment and/or rezoning, and may require said system improvements to be made by the applicant as a condition of approval. Any subsequent Development Plan associated with an approved land use plan amendment and/or rezoning shall be required to update the original TIA.

(2) Preparation of TIA

Reference the City of Franklin Traffic Impact Analysis (TIA) Guidelines on the City of Franklin Engineering webpage for TIA preparation requirements.

2.1.4 Connectivity

Plans shall achieve internal street connectivity by providing multiple connections to the existing city street network and adjacent lots wherever possible, and in accordance with these Street Standards.

(1) Cul-de-sacs

Cul-de-sacs are permitted only where allowed by the Franklin Zoning Ordinance. Where cul-de-sacs are created, at least one eight-foot-wide pedestrian access easement shall be provided, to the maximum extent practicable, between each cul-de-sac head and the sidewalk system of the closest adjacent street or pedestrian sidewalk or pathway.

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2.1.5 Private Streets

Private streets serving more than one lot shall be built to the same standards as required for public streets and shall be located in a public utility drainage and access easement (PUDAE).

2.2 Street Classification and Right-of-Way

2.2.1 General

Listed below are the classifications of public streets used in the City. These classifications primarily provide different levels of emphasis in regard to traffic movement versus direct access to property. Transportation improvements developed in accordance with the street classification system will help to discourage through traffic from using local neighborhood streets, and local traffic from congesting regional travel facilities. This will not only improve the efficiency of the transportation system in the City, but will also maintain the livability of its neighborhoods.

The City Major Thoroughfare Plan specifically identifies all streets classified as Freeways, Expressways, Arterials and Collectors in the City. Streets without one of these classifications shall normally be considered a Local street. However, the City Engineer shall have the authority to verify all street classifications for the purpose of applying street design standards.

2.2.2 Street Classifications

(1) Freeways and Expressways

A divided arterial highway designed for the unimpeded flow of large traffic volumes. Access to a freeway is rigorously controlled and intersection grade separations are usually required. All freeways and expressways in the City are anticipated to be owned and designed by the Tennessee Department of Transportation (TDOT).

(2) Arterial Streets

Arterial streets are intended to primarily serve moderate to high traffic speeds and volumes within and through the City. Arterial streets may provide some access to abutting property, but only as it is incidental to the primary functional responsibility of travel service for major traffic movements. Arterial streets are classified as either Major Arterials or Minor Arterials depending upon expected traffic usage and adjoining property access.

(3) Collector Streets

Collector streets are intended to primarily serve slow to moderate traffic speeds and volumes and to distribute traffic from the arterials throughout the City to other collectors, arterials and local streets. Collector streets shall provide both land access service and traffic circulation within residential neighborhoods and commercial and industrial areas. Collector streets will be classified as either Major Collectors (further broken down to commercial/industrial or residential), or Minor Collectors depending upon expected traffic usage and adjoining property access. Major Collector streets may have limited driveway access to maintain the street's ability to achieve a safer and efficient traffic flow.

(4) Local Streets

Local streets are intended to primarily serve slow speeds and volumes and to provide access to abutting lands and connections to the higher street classifications. Local streets are to be planned so that future urban expansion will not require the conversion of local streets to collector or arterial streets. Local streets may be commercial/industrial or residential depending

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upon the type and extent of the development and zoning they serve. Local streets may be terminated by a "cul-de-sac" where necessary due to topographic or other constraints.

(5) Alley / Mews

Alleys and mews are intended to primarily serve very slow speeds and volumes associated with the rear access and service functions for residential and commercial properties. Mews are a special type of alley that serves as the only vehicular and emergency access for lots abutting the mews. No vehicle parking area, fence, structure, vegetation, or wall shall be erected, maintained, or planted within the alley / mews right-of-way or within two feet of the edge of the alley / mews pavement/curb, whichever is greater.

(6) Private Streets

Private streets are streets that provide access to more than one lot but are not owned, operated and maintained by the City. Private streets shall be required to meet City design standards as determined by the City Engineer.

(7) Frontage Roads

Frontage roads are streets that normally run parallel to major roadways, usually arterials, to provide access to adjacent properties. Such streets greatly reduce the level of private driveway access to the major streets. Frontage roads are not typically used in the City and must be approved in advance by the City Engineer.

2.2.3 Cross Sections

Typical features and dimensions of standard City streets are illustrated in the Typical Section Drawings. These standard sections may be revised by the City Engineer on a case-by-case basis, to meet specific needs that may exist, or are projected to exist, along a particular street section. The following table summarizes for each standard section the primary design elements and their dimensions.

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Table 2.2 (1) Street Typical Cross Section Elements by Classification

STD DWG #	Street Classification	Right-of-Way	Travel Lanes	Median	Bike Lanes	Sidewalks	Multi-Use Path	Parking Lane
TS-1	Major Arterial	136′	Four @ 12′	40′	Two @ 5′	Two @ 6′	No	No
TS-1	Major Arterial	132′	Four @ 12′	40′	No	One @ 6′	One @ 12′	No
TS-2	Minor Arterial	132′	Four @ 12′	36′	Two @ 5′	Two @ 6′	No	No
TS-2	Minor Arterial	128′	Four @ 12′	36′	No	One @ 6′	One @ 12′	No
TS-3	Major Collector	126′	Four @ 12′	30′	Two @ 5′	Two @ 6′	No	No
TS-3	Major Collector	122′	Four @ 12′	30′	No	One @ 6′	One @ 12′	No
TS-4	Minor Collector	79′	Three @ 12′	No	Two @ 5′	Two @ 6′	No	8′ Parking Allowed
TS-4	Minor Collector	75′	Three @ 12′	No	Two @ 5′	Two @ 6′	No	8′ Parking Allowed
TS-5	High Volume Local	54′	Two @ 12′	No	No	Two @ 5′	No	8′ Parking Allowed
TS-6	Low Volume Local	52′	Two @ 11′	No	No	Two @ 5′	No	8′ Parking Allowed
TS-7	Alley / Mews	Varies	Varies	No	No	No	No	No

2.2.4 Right-of-Way and Easements

(1) Right-of-Way
Minimum right-of-way widths shall be as shown in **Table 2.2 (1)** and in the street classification typical cross section drawings at the end of this chapter. Topography, special design features and other factors may require widths greater than these minimums. The City Engineer shall have final review with determination of any additional right-of-way that is required for the design of a specific street segment.

(2) Easements
There are several types of street-related easements allowed in the City.

i. Public Utility, Drainage and Access Easement (PUDAE) that shall be approved for use by the City Engineer on a case-by-case basis.
ii. Public Utility and Drainage Easement (PUDE) that shall be approved for use by the City Engineer on a case-by-case basis.
iii. Public Access Easement (PAE) that allows multiple users of an access to the street.
iv. Public Drainage Easement (PDE) for drainage purposes only.
v. Slope Easement (SE) that provides for slopes between the street right-of-way and adjacent property.
vi. Temporary Construction Easement (TCE) that may be used to provide adequate construction area in the construction of a street project.

(3) Improvements in Right-of-Way
It is the policy of the City to place all permanent public streets, traffic signals, equipment, traffic signs and street-related features in public street right-of-way, with fee simple ownership by the City.

(4) Additional Right-of-Way Widths on Existing Streets
Developments that adjoin existing streets shall dedicate additional fee simple right-of-way, where necessary, to meet the minimum requirements for the functional street classification of the existing street, or other dimensions as required by the City Engineer. This dedication shall be as follows:

i. The entire right-of-way shall be provided where any part of the development is on both sides of the existing street.
ii. When the development is located on only one side of the existing street, one half (1/2) of the required width of the right-of-way, measured from the center line of the existing roadway, shall be provided. If the development provides improvements to the existing roadway that shifts the centerline of the roadway, then the one half (1/2) of the required width of the right-of-way shall be measured from the new center line of the roadway.
iii. When required by the City Engineer, additional right-of-way shall be required to accommodate future roadway improvements.

(5) Dedication Process
The dedication of right-of-way and easements for street purposes shall normally occur through the platting process. When dedications are required outside the platting process, they shall be dedicated in a manner and format approved by the City Engineer and City Attorney.

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2.3 Design Criteria

The design criteria presented in this section apply to all roadways that are required to be designed and constructed to City standards and specifications. The design criteria presented below shall be used as minimum requirements for new developments and may be increased at the direction of the City Engineer if warranted by safety hazards or traffic operations.

The City Engineer, in consultation with other City departments and State agencies, may allow modifications to the design criteria set forth in this chapter. Modifications may be necessary to allow private or public construction to be compatible with in-place improvements or to address unusual circumstances that justify an alternative design or criteria. Modifications to design criteria may be allowed provided that an investigation by the City Engineer concludes that all of the following criteria can be satisfied.

- The modification to the design criteria is based on sound engineering principles and practices.
- The modification to the design criteria will not create an unsafe or hazardous situation to occur.
- The modification to the design criteria will be equivalent to the minimum criteria set forth herein in terms of functionality, efficiency, durability, structural integrity and long term maintenance.
- The modification to the design criteria will not adversely impact adjacent properties or individual property owners, provided that safety is not compromised.

The City Engineer is authorized to require studies or other pertinent information to be provided by the petitioner to help support or validate the modification request at no cost to the City. See **Chapter 1** for additional information on the variance process.

All streets are to be designed in accordance with the design speeds specified for each street classification in this chapter, or as amended by the City Engineer, and as summarized in **Table 2.3 (1) and Table 2.3 (2)**.

2.3.1 Desired Operating Levels of Service

Reference the Traffic Impact Analysis (TIA) Guidelines on the City of Franklin Engineering Development webpage for Level of Service requirements.

2.3.2 Design Traffic Level

Streets shall generally be designed to accommodate projected future traffic conditions a minimum of twenty (20) years (or another target year agreed to in the Traffic Impact Analysis Memorandum of Understanding (MOU)) after the street is opened to traffic. These projected traffic conditions shall address total daily traffic loads along with directional distribution of the peak-hour loads. These loads shall address typical weekday conditions as well as off-peaks and weekend periods when applicable. Seasonal and special event conditions shall also be considered where appropriate as determined by the City Engineer.

2.3.3 Design Vehicle

All streets shall be designed to accommodate the predominant type and composition of vehicles that can be reasonably expected to travel through them. At a minimum, for streets and intersections designed in the City, the vehicle types in **Table 2.3 (3)** shall be fully accommodated in the design process. For special circumstances other design vehicles may be required by the City Engineer.

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TABLE 2.3 (1) STREET STANDARDS – GENERAL PARAMETERS

Design Feature or Characteristic	Street Classification and Typical Section									
	4-Lane Major Arterial TS-1	4-Lane Major Arterial TS-1	4-Lane Minor Arterial TS-2	4-Lane Minor Arterial TS-2	4-Lane Major Collector TS-3	4-Lane Major Collector TS-3	2-Lane Minor Collector TS-4	2-Lane Minor Collector TS-4	2-Lane High Volume Local TS-5	2-Lane Low Volume Local TS-6
Right of Way (ROW) Width	136’	132’	132’	128’	126’	122’	79’	75’	54’	52’
No. of Travel Lanes	4	4	4	4	4	4	3	3	2	2
Minimum Lane Width	12’	12’	12’	12’	12’	12’	12’	12’	12’	11’
Minimum Lane Width (total)	48’	48’	48’	48’	48’	48’	36’	36’	24’	22’
Median Width	40’	40’	36’	36’	30’	30’	n/a	n/a	n/a	n/a
Curb & Gutter: Vertical or Mountable	V	V	V	V	V	V	V	V	V	V or M
Designated Bike Lanes?	Yes	No	Yes	No	Yes	No	Yes	No	No	No
Bike Lane Width per side	5’	n/a	5’	n/a	5’	n/a	5’	n/a	n/a	n/a
Parking Lane Width	n/a	n/a	n/a	n/a	n/a	n/a	8’	8’	8’	8’
Minimum Sidewalk Width	6’	6’ (1 side)	6’	6’ (1 side)	6’	6’ (1 side)	6’	6’ (1 side)	5’	5’
Multi-Use Path	No	12’ (1 side)	No	12’ (1 side)	No	12’ (1 side)	No	12’ (1 side)	No	No
Grass Strip Width	6’	6’	6’	6’	6’	6’	6’	6’	6’	6’
Left Turn Lanes Req’d?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[c]	No
Right Turn Lanes Req’d?	Yes	Yes	Yes	Yes	Maybe	Maybe	Maybe	Maybe	No	No
Traffic Volume Capacity (1000 veh/day)	>35	>35	25-35	20-25	15-20	15-20	10-15	10-15	2-5	<2
Speed Limit, MPH [note a]	45	45	40	40	35	35	30	30	25	25 or 20
Driveway & Street Access	Very Ltd	Very Ltd	Limited	Limited	Limited	Limited	Frequent	Frequent	Frequent	Unlimited
Continuity of Travel	Very High	Very High	High	High	Moderate	Moderate	Moderate	Low	Very Low	Very Low
Street Lights	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Partial	Partial
Traffic Calming	None	None	None	None	None	None	None	None	Possible	Possible

NOTES: a. Design speed shall be a minimum of 5mph above the posted speed limit.
b. Vertical curb requires shoulder separation from travel lane on posted speeds of 50 mph or greater.
c. Separate Left Turn Lanes required in Commercial or Mixed-Use developments and at all traffic signals.

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TABLE 2.3 (2) STREET STANDARDS – TECHNICAL DESIGN CRITERIA

Design Element		Arterial		Collector		Local		Alley / Mews
		Major	Minor	Major	Minor	High Volume	Low Volume	
Overall Design Parameters								
Design Speed/Posted Speed		50 / 45	45 / 40	40 / 35	35 / 30	30 / 25	25 / 25 or 20	15 / 15
Min Stopping Sight Distance Note a		425’	360’	305’	250’	200’	115’	80’
Passing Sight Distance		1,835’	1,625’	1,470’	1,280’	n/a	n/a	n/a
Horizontal Alignment Note b								
Minimum centerline radius: with no super-elevation (NC) with 0.02 super-elevation with 0.04 super-elevation		1,391’ 1011’ 905’	1,039’ 794’ 711’	762’ 593’ 533’	510’ 408’ 371’	333’ Not Allowed Not Allowed	70’ Not Allowed Not Allowed	55’ Not Allowed Not Allowed
Maximum super-elevation		0.04 ft/ft	0.04 ft/ft	0.04 ft/ft	0.04 ft/ft	n/a	n/a	n/a
Minimum tangent between curves or at intersections		200’	150’	150’	100’	100’	0	0
Vertical Alignment								
Maximum Centerline Grade %		6	7	8 note c	8 note c	8 note c	10 note c	8
Minimum Gutter Flow-line Grade %		0.5	0.5	0.5	0.5	0.5	0.5-1.0	1.0
Min. K-values for Vertical Curves (Stopping Sight Distance)	Crest	84	61	44	29	19	7	7
	Sag	96	79	64	49	37	17	17
Intersection Design								
Minimum sight distance at driveways and intersections (street and topographic features may increase these minimums)		See AASHTO *“Green Book”*						
Access Management								
Distance Between Intersections	Signalized	2,640’		1,320’	1,320’	n/a	n/a	n/a
	Non-signalized	1,200’	600’	300’	300’	200’ note d	200’ note d	n/a
Minimum distance between high volume driveways / alleys / mews & street or other high volume intersections note e		800’	600’	300’	300’	200’	200’	n/a
Minimum distance between low volume driveways & street intersections note e		250’	250’	230’	230’	125’	50’	40’
Minimum distance between low volume driveways note e		250’	250’	150’	150’	50’	20’	10’

NOTE:
a. AASHTO **“***Green Book”* latest standards supersede these requirements and shall be adjusted based on roadway grades.
b. AASHTO *“Green Book”* latest standards supersede these requirements. Requirements based on Low-Speed Urban Streets.
c. These dimensions may be increased or amended by the City Engineer as deemed necessary for safe and efficient street operations.
d. These distances may be reduced to 125 feet when both intersecting streets are cul-de-sacs.
e. Measured from the nearest points of radius returns

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Table 2.3 (3) Design Vehicle Requirements	
Street Classification	Vehicles Accommodated
Alley / Mews	Passenger cars and single-unit trucks.
Local	Passenger cars, single-unit trucks (SU-30), and conventional school buses must be able to turn easily from one street to the next and remain in the correct lane for each street. Combination trucks (WB-50) shall be able to physically traverse local streets by using the full width of the traveled way if necessary, including intersection turns, and without tracking onto the curb at corners.
Minor Collector	Passenger cars, single-unit trucks and conventional school buses must be able to turn easily from one street to the next and remain in the correct lane for each street. Combination trucks (WB-50) shall be able to physically traverse the street by using the full width of the traveled way if necessary, including intersection turns, and without tracking onto the curb at corners.
Major Collector	Passenger cars, transit buses (S-40), single-unit trucks, conventional school buses and combination trucks (WB-62) must be able to turn easily from one street to the next and remain in the correct lane for each street, and without tracking onto the curb at corners.
Major and Minor Arterial	Passenger cars, transit buses (S-40), single-unit trucks, conventional school buses and combination trucks (WB-67) must be able to turn easily from one street to the next and remain in the correct lane for each street, and without tracking onto the curb at corners.
Freeway / Expressway	All approved vehicle types must be able to turn easily onto and off of Freeway/Expressway Ramps from adjacent streets and remain in the correct lane for each ramp/street. These are typically State of Tennessee roadways and shall meet all TDOT design vehicle requirements.

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2.3.4 Minimum Turning Paths of Design Vehicles

All street and intersection geometric designs shall be evaluated to ensure that the minimum turning paths for the selected design vehicles can be safely and efficiently accommodated by the proposed street and intersection geometry.

2.3.5 Design Speed

There are two primary types of speeds that must be considered in the street design process. The first is "design" speed, which is the selected speed used to determine the various minimum geometric design features of the street. The second type is "operating" speed, which is the speed at which drivers operate their vehicles in free-flow conditions. The "85th percentile speed" (the speed at which 85 percent of the vehicles travel at or less) is generally assumed to be the operating (and typically posted) speed of a street.

The design speed selected for street design purposes shall take into consideration several factors including street classification, adjacent land use, topography and sight distance, pedestrian and bicycle activity, and the desired operating speed of the facility. The design speed used in street design shall be approved by the City Engineer and shall generally be in accordance with **Table 2.3 (2)** for desirable design speed by street classification.

2.3.6 Street and Lane Widths

(1) Street Widths

The minimum width of a street pavement section shall be determined by (1) its functional classification as identified in the Major Thoroughfare Plan, and (2) typical cross-sections as shown in the Standard Drawings. Other elements such as topography and Traffic Impact Analysis (such as turn lanes and deceleration/acceleration lanes), and unique street design features may necessitate a change in the minimum street section width. The City Engineer will approve the final required street width.

(2) Lane Widths

The minimum and desirable widths of different types of lanes based on the street classification are provided in **Table 2.3 (1),** and as shown in the Typical Section Drawings. These widths may be modified by the City Engineer based on the specific requirements of a street section.

2.3.7 Special Street Configurations

(1) Cul-de-Sacs

(a) Where Allowed: Cul-de-sacs are permitted only on Local Street classifications and shall not extend for more than five-hundred (500) feet (unless necessitated by topography and approved by the City Engineer) as measured from the center of the cul-de-sac turn around to the nearest right-of way boundary of the adjoining street right-of-way intersection. If adjoining properties, commercial or residential, install fire sprinkler systems, this length may be extended to 1000 feet in accordance with the adopted fire code. In no case shall a cul-de-sac or temporary dead end street serve more than twenty (20) single-family residential lots.

Typical Street Cul-de-Sac

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(b) Secondary Access: Any Local Street with a cul-de-sac that exceeds the maximum lengths above shall be provided with a secondary access point.

(c) Design Requirements: Cul-de-sac streets shall terminate in a circular turn around having a right-of-way radius of at least sixty-five (65) feet, and a paved radius of at least fifty (50) feet at its outside edge. These and other minimum requirements are illustrated in the Standard Drawings.

(d) Prohibited Designs: All cul-de-sac designs must allow for automobiles and typical service vehicles to turn around without requiring backing maneuvers.

(e) Temporary Cul-de-Sac: Where a development is being implemented by sections, a temporary cul-de-sac may be used if the overall development plan allows the cul-de-sac to be eliminated at final build out of the development. Temporary cul-de-sacs shall be replaced with a street connection within three (3) years or less from the date construction starts unless otherwise approved by the Fire Marshall. The cul-de-sac shall be provided with an asphalt turn-around having a radius of at least fifty (50) feet. No designs requiring backing maneuvers will be allowed. The easement radius shall be a minimum of sixty-five (65) feet in areas where there is no adjacent public utility and access easement, and a minimum of sixty (60) feet where public utility and access easements are required and/or provided.

All temporary cul-de-sacs shall be constructed within dedicated street right-of-way or a dedicated Public Utility, Drainage and Access Easement for those areas outside the tangent street right-of-way section. The Easement outside the tangent right-of-way section shall be vacated by the City when the Easement is no longer necessary. Application for vacation of the easement must be initiated and paid for by the Developer or property owner.

A sign must be provided at the end of the temporary cul-de-sac noting that the street will be extended in the future. Signing for temporary, dead-end streets shall be in accordance with the requirements of the Standard Drawings.

(f) Cul-de-Sac Medians: Center median islands in cul-de-sacs are prohibited.

(g) Cul-de-Sac Parking: Parking in a cul-de-sac is prohibited. Four (4) "No Parking" street signs shall be evenly spaced around the perimeter of new cul-de-sacs.

(2) Eyebrows

(a) Where Allowed: Eyebrows shall be permitted only on Local Streets. They may only be used in tangent sections or at intersection corners. Design of eyebrows shall be as shown in **Figure 2.3 (1).**

(b) Design Requirements: Eyebrows shall be a minimum of twenty-five (25) feet in length and a maximum of fifty (50) feet measured along the flow-line. Lengths exceeding fifty (50) feet shall incorporate an island as approved by the City Engineer. Designs that require backing maneuvers for typical use vehicles are prohibited.

Typical Eyebrow

(c) Location: The location of the eyebrow shall be in conformance with intersection spacing requirements as provided in **Access Management Section**.

(3) Dead-End Streets and Alleys / Mews

(a) Where Allowed: Permanent dead-end streets and alleys without cul-de-sac designs are prohibited. Permanent dead-end mews with or without cul-de-sac designs are prohibited.

(b) "Stub" Streets and Alleys / Mews: Temporary dead-end "stub" streets and alleys / mews (without temporary cul-de-sacs) will only be permitted on local streets and alleys / mews at the discretion of the City Engineer. Stubs shall not be longer than one residential lot. See Standard Drawings for design requirements of temporary dead-end "stub" streets.

(c) Signs Required: A sign must be provided at the temporary street or alley / mews end noting that it will be extended in the future.

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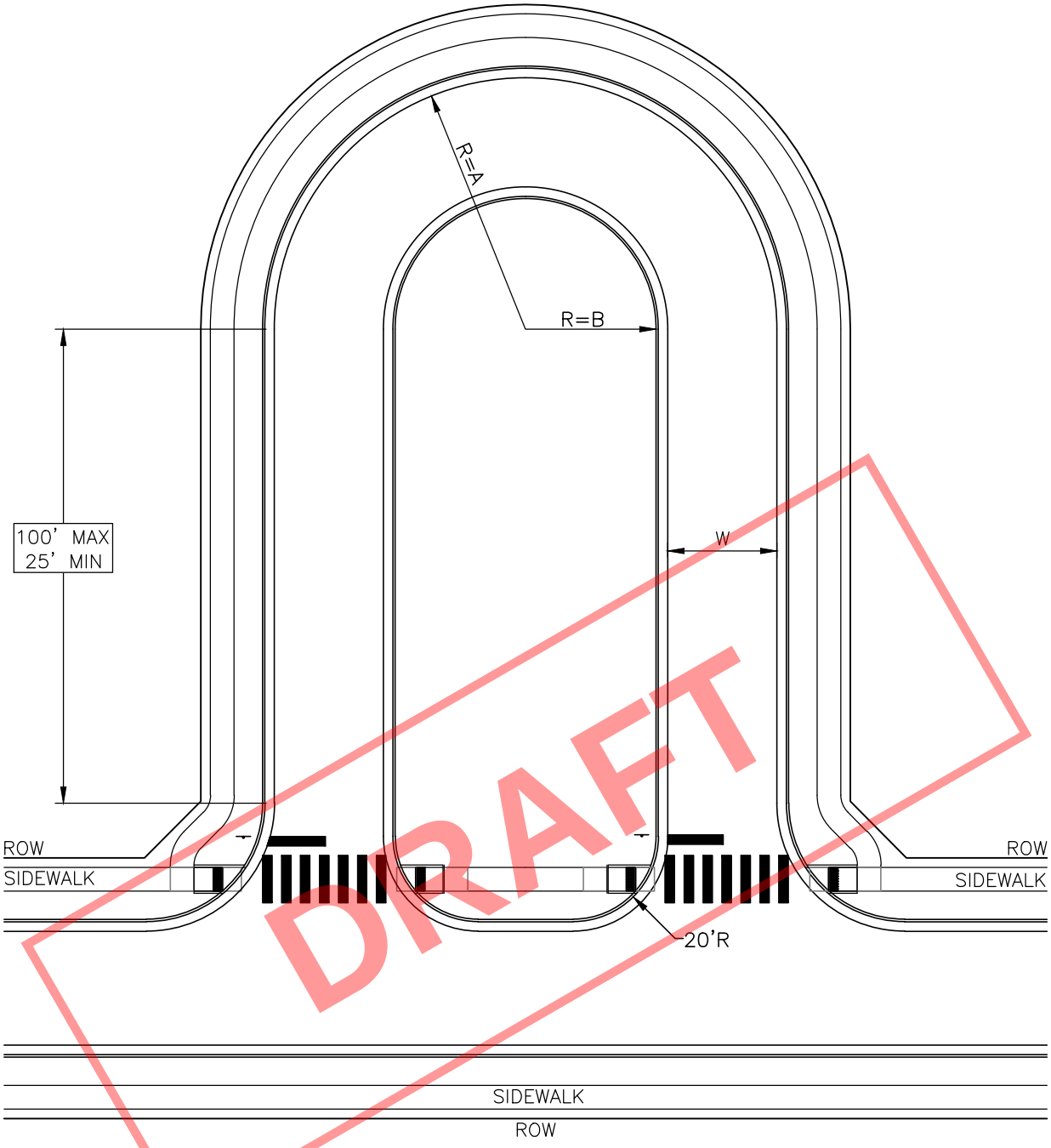

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STREET CLASSIFICATION	RADIUS (MIN.)		NO PARKING	PARKING	
				ONE SIDE	TWO SIDES
	A	B (MAX)	W	W	W
LOCAL SINGLE FAMILY RESIDENTIAL	55'	30'	15'	23'	31'
LOCAL MULTIFAMILY RESIDENTIAL	60'	30'	22'	30'	38'
LOCAL COMMERCIAL & INDUSTIRAL	65'	26'	24'	32'	38'

1) THE SIDEWALK AROUND THE EYEBROW SHALL BE PLACED ACCORDING TO THE STREET CLASSIFICATION. THE SIDEWALK ACROSS THE STREET END OF THE ISLAND IS TO BE PLACED IN THE SAME LOCATION AS ON THE CROSS STREET.
2) MEDIAN MAY BE LANDSCAPED OR HARDSCAPED AS REQUIRED AND SHALL BE MAINTAINED BY THE OWNERS ASSOCIATION.
3) WHEN PARKING IS RESTRICTED TO ONE SIDE, IT SHALL BE PROVIDED ON THE OUT-SIDE OF THE STREET.

HISTORIC FRANKLIN TENNESSEE

N.T.S

Eyebrow Design
FIGURE 2.3 (1)

(4) Half Streets

The City Engineer may allow the construction of half streets on Minor Collector and Local streets when only one side of a street right-of-way is available. A minimum of twenty-two (22) feet of pavement must be provided on any half street. In such cases, the property owner is responsible for right-of-way dedication and construction of the half of the new street section that is adjacent to their property. Typically, these partial street sections will be built to permanent street standards including all curb and gutter, drainage, sidewalks and other elements as called for in the typical section for that street classification. Additional dedication of street easement may be required by the City Engineer in these cases.

(5) Provisions for Future Public Street Intersections

Where provisions are to be made to intersect a future side street with the street being designed, the curb radii and pavement section of the future intersecting street "stub" shall typically be built to the end of the radii curb return. If the expected construction of the future street connection is anticipated to occur more than three (3) years after the primary street is constructed, then the street approach "stub" may be omitted and temporary curb, gutter and sidewalk improvements provided through this section. In such cases, the curb and gutter shall be concrete while the temporary sidewalk or path may be asphalt.

(6) Improvement of Annexed Streets

Streets annexed into the City may be required to meet these engineering standards before they are accepted as City streets. The City Engineer shall evaluate all proposed street annexations to determine their adherence to these standards, and any recommendations for improvements to meet minimum public safety, health and welfare requirements.

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2.3.8 Horizontal Alignment

The design of horizontal curves in street design shall be based on an appropriate relationship between design speed and curvature and on their joint relationships with superelevation and side friction. On Arterial and Major Collector streets, curve radii and tangents shall be as large as possible using the minimums only where necessary. However, minimum radius curves shall be used on Local and Collector streets unless otherwise required. Angle point direction changes are not allowed. All changes in direction shall be made using standard curves.

(1) Horizontal Curve Radii

The minimum allowable centerline radii for horizontal curves shall be as designated in **Table 2.3 (2).** Reverse and compound curves shall be used only when a single radius curve will not work. For driver safety, compound curves shall preferably have a ratio no greater than one and one-half (1.5) where the value of the larger radius is divided by the smaller radius. When they are designed, "*TDOT Standard Specifications"* and AASHTO's "*Green Book"* design standards and procedures shall be used.

Based on typical conditions in the City, the absolute minimum and desirable horizontal curves for streets without superelevation are shown in **Table 2.3 (2)**. This table also provides the minimum tangent distance between reverse curves.

The effect of grade shall also be considered by the designer when selecting horizontal curvature. The design of more complex horizontal curve geometry shall be conducted in accordance with "*TDOT Standard Specifications"*, AASHTO's *"Green Book" and* AASHTO's *"Guidelines for Geometric Designs of Very Low-Volume Local Roads (ADT ≤ 400)".*

(2) Minimum Tangent Length

(a) Intersection: Whenever a minor street intersects a street of higher classification, a tangent length (measured from the nearest gutter flow-line of the intersected street to the point of curvature in the intersecting street) shall be provided for a safe sight distance and safe traffic operation. The minimum required tangent lengths indicated in **Table 2.3 (2)** apply to the minor leg(s) only. The angle of departure shall not exceed ten (10) degrees for the length of the tangent.

(b) Reverse Curves: Reverse curves in streets shall be separated by minimum tangents of between two-hundred (200) and one-hundred (100) feet for arterial and major collector streets as shown in **Table 2.3 (2)**.

(c) Broken Back Curves: Two curves in the same direction (broken back curves) shall be separated by a tangent with a length of at least two (2) times the minimum length shown in **Table 2.3 (2).**

(3) Curves with Small Deflection Angles (10° or less)
To reduce the appearance of kinks in the street, minimum lengths of curve shall be designed with minimum arc lengths as shown in **Table 2.3 (4).**

Table 2.3 (4) Minimum Centerline Arc Length

Street Classification	Minimum Centerline Arc Length (ft)
Local – Residential	100
Local – Commercial & Industrial	200
Minor Collector	250
Major Collector – Residential	250
Major Collector – Commercial & Industrial	300
Minor Arterial	300
Major Arterial	400

(4) Horizontal Curves on Vertical Curves
For driver safety, horizontal curves shall not begin near the top of a crest vertical curve nor near the bottom of a sag vertical curve.

(5) Off-Site Design Centerline, Flow-lines and Cross Sections
To assure that future street improvements will meet these Standards, the centerline, flow-line, and cross sections of all streets, except cul-de-sacs, shall be continued for five-hundred (500) feet beyond the proposed construction. The grade and ground lines of all arterials shall be continued an additional five-hundred (500) feet for a total of one-thousand (1000) feet beyond the end of the proposed construction.

(6) Joining Existing Improvements
Connection with existing streets shall be made to match the existing alignment grade of the existing improvements, in accordance with horizontal alignment criteria.

(7) Cross Slope
Cross slope on a pavement is provided to drain water from the street surface. The design of cross slope shall consider driver comfort and safety.

(a) Minimum Cross Slope: A minimum cross slope on all new streets shall be two (2.0) percent. Minimum cross slope on reconstruction or overlays is one and one-half (1.5) percent. All other values of cross slope shall be independently reviewed and approved by the City Engineer.

(b) Maximum Allowable Cross Slope: Maximum allowable tangent cross slope on all new construction shall be two (2.0) percent. Maximum allowable cross slope on any reconstruction or overlays of existing streets shall be four (4.0) percent.

(c) Cross Slope for Street Modifications: When widening an existing street or adding turn lanes to an existing street, the resulting cross slope of the widened portion shall be within the limits stated above and the new Cross Slope shall be no less than the existing cross slope. However, if the cross slope of the existing street exceeds the Standards then new curb and gutter shall be designed such that the existing pavement, when overlaid, will result in a straight line cross slope grade that meets these

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Standards. Alternatively, the existing pavement may be removed and re-profiled to comply with these Standards.

(d) Cross Slope for Cul-de-Sacs: Cul-de-sac cross slopes shall not be less than two (2.0) percent nor more than five (5.0) percent, with two (2.0) percent being desirable.

(8) Superelevation on Horizontal Curves

The purpose of superelevating a street is to maintain the riding comfort on horizontal curves. Superelevation is not typically used on streets in the City with design speeds at or less than 30 MPH. For design speeds higher than 30 MPH or where superelevation is required or preferred, *"TDOT Standard Specifications"* and AASHTO's *"Green Book"* design standards and procedures shall be used. The following criteria shall be followed:

(a) Where Superelevation Is Permitted: Superelevation may be allowed for curves on Arterial and Collector streets. In no case shall superelevation exceed four (4.0) percent cross slopes. As specified in **Table 2.3 (2),** superelevation shall not be used on Local Streets.

(b) Transition Length: When superelevation is used, use the TDOT method of a 50/50 split of the transition length each side of the tangent point

(c) Drainage: Where superelevation is used, the gutter shall always be an inflow type. The water must enter a storm sewer system or other acceptable outlet from the street rather than crossing the street in sheet flow. Where medians are present in a super-elevated section, water may be allowed to sheet flow from the median to the street gutter.

2.3.9 Vertical Alignment

The design of vertical curves in street design shall be simple in application and shall result in a design that is safe and comfortable in operation, pleasing in appearance and adequate for drainage.

(1) Maximum and Minimum Grades for Streets

The maximum and minimum grades for specific street classifications are shown in to **Table 2.3 (2)**. The centerline grade in the bulb of a cul-de-sac shall not exceed five (5.0) percent.

(2) Grade Breaks

No single point grade break shall exceed four-tenths (0.40) percent, except for the flow line in sag curves where the maximum grade break is one (1.0) percent. In curb returns, a grade break may be as great as three (3.0) percent for extreme circumstances.

(3) Minimum Flow-line Grades

Minimum flow-line grades for gutters shall be one-half (0.50) percent, except in the bulb of cul-de-sacs where the minimum shall be one (1.0) percent.

(4) Grades Through Intersections

The profile grade lines on the legs of an intersection shall be adjusted for a distance back from the intersection to provide a smooth junction and proper drainage. Normally, the grade line of the major street shall be carried through the intersection and that of the minor street shall be adjusted to it. Any changes in profile through an intersection shall meet the crest and sag curve criteria noted below, to the extent deemed practical. The City Engineer shall approve all variations from these criteria.

Intersection approach grades shall consider the deceleration and acceleration that occurs due to traffic control and turning movements. It is desirable to provide near-level intersection approach grades to improve operations and safety within the intersection area. Maximum intersection approach grades are shown in **Table 2.3 (5).**

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Table 2.3 (5) Maximum Grades		
Classification	Maximum Grade	Maximum Grade Approaching Signalized Intersection
Freeway	Determined by TDOT	n/a
Expressway	Determined by TDOT	2 % for 600 ft.
Major Arterial	6 %	2 % for 500 ft.
Minor Arterial	7 %	2 % for 500 ft.
Major Collector	8 %	3 % for 400 ft.
Minor Collector	8 %	3 % for 300 ft.
Local High Volume	8 %	4 % for 200 ft.
Local Low Volume	10 %	4 % for 100 ft.
Cul-de-Sac	5 %	n/a
Alley / Mews	8 %	n/a

(5) Requirements for Using Vertical Curves
The major control for safe operation on "crest" vertical curves is the provision of ample sight distance for the design speed. Crest vertical curves shall be designed to at least provide the minimum stopping sight distance as established in AASHTO's "*Green Book*".

The design of "sag" vertical curves is controlled by headlight distance, passenger comfort, drainage control and general street appearance. At under-crossings the structure may limit sight distance which could cause the need for higher K factors to achieve adequate stopping sight distance.

(6) Joining Existing Improvements
Connection with existing streets shall be made to match the existing grade of the existing improvements, in accordance with vertical alignment criteria (grade breaks shall not exceed allowable).

(7) Vertical Clearance
Vertical clearance above a street shall be a minimum vertical clearance of sixteen and one-half (16.5) feet. The City Engineer may require greater clearance when considered necessary to meet future street operation requirements.

(8) Off-Site Continuance of Grade and Ground Lines
To assure that future street improvements will meet these Standards the grade and ground lines of all local and collector streets, except cul-de-sacs, shall be continued on the plans for five-hundred (500) feet beyond the proposed construction. The grade and ground lines of all arterials shall be continued one-thousand (1000) feet beyond the end of the proposed construction.

(9) Coordinating Horizontal and Vertical Alignments
Horizontal and vertical design shall not be designed independently. Horizontal alignment and profile are among the more important design elements of a street. Their effective combination increases safety, encourages uniform speed, and improves appearance. Some general guidelines for their relationships are:

(a) Curves and grades shall be in proper balance. The designer shall not combine extreme horizontal and/or vertical conditions or introduce significant curves at the end of long tangent sections or flat grades.

(b) Sharp horizontal curvature shall not be introduced at or near the top of a pronounced crest vertical curve, nor shall it be introduced near the bottom of a steep grade approaching or near the low point of a pronounced sag vertical curve.

(c) Both horizontal and vertical curvature and profile shall be made as flat as practical at intersections where sight distance along both streets is important and vehicles may have to slow or stop.

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(d) Designers should begin evaluating horizontal alignment and profile in the preliminary design stage. Proposed alignment and profile shall be submitted to the City for review and comment prior to advancing the design process.

2.3.10 Sight Distance

(1) General
Sight distance calculations shall be based on AASHTO's "*Green Book*" requirements.

All streets designed in the City shall provide adequate sight distance for all types of users, considering both horizontal and vertical alignment. Sight distance shall be carefully considered in the preliminary stages of design when both the horizontal and vertical alignment may still be subject to adjustment. Specific sight distance requirements include:

(2) Sight Obstructions
Any object within a sight distance triangle more than twenty-four (24) inches above the flow-line elevation of the adjacent street shall constitute a sight obstruction, and shall be removed or lowered. Such objects include but are not limited to berms, buildings, parked vehicles on private property, cut slopes, hedges, trees, shrubs, mailbox clusters, utility cabinets or tall crops. Since vehicles parked on-street are under the control of the City, parked vehicles shall not be considered an obstruction for design purposes. The city may limit parking to protect visibility as needed. The sight distance shall be measured to the approach lane positions as shown in **Figure 2.3 (2**). In no case shall any permanent object encroach into the line-of-sight of any part of the sight distance triangle. Street trees within the sight distance easement may be excepted from this requirement if pruned up to eight (8) feet, and the trunks at maturity do not collectively hinder sight lines as determined by the City Engineer. The shaded portion of the diagram depicts the sight triangle area where site element heights and locations are strictly limited.

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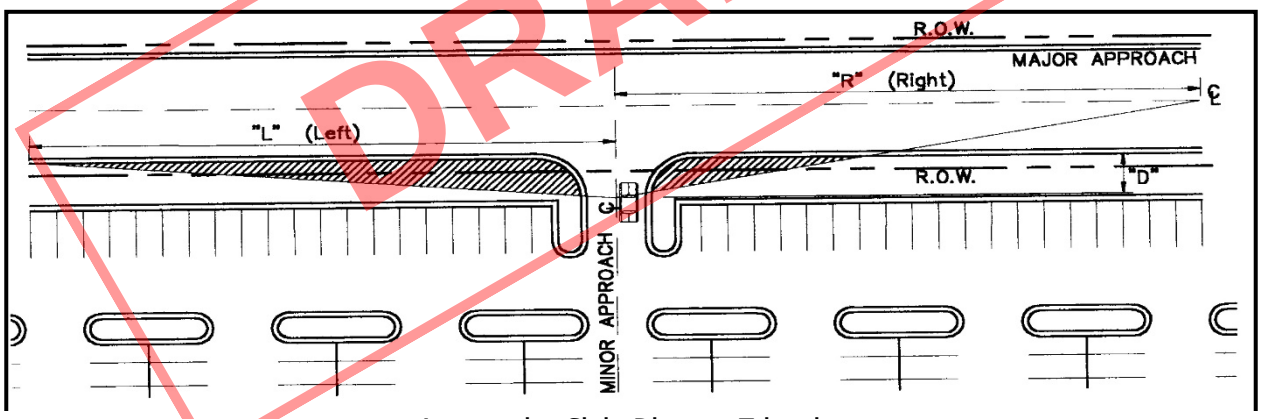

Intersection Sight Distance Triangle
Figure 2.3 (2)

During the street design process, the designer shall identify and correct for any sight obstructions that could limit the driver's sight distance beyond the distances noted above. This process shall investigate both the vertical and horizontal plane for sight obstructions. No landscaping or hardscaping shall be permitted within a corner area that will block the line of sight for pedestrian visibility (not higher than twenty-four (24) inches and possibly less depending on street geometry).

Street intersections shall be designed so that adequate sight distance is provided along all streets. The required sight distance shall be determined by the design speed and grades of the street and the acceleration rate of an average vehicle. In addition, for all streets that intersect with Arterial and Collector streets, the sight distance must be large enough to allow a vehicle to enter the street and accelerate to the average running speed without interfering with the traffic flow on the Arterial or Collector Street.

Intersection sight distance is generally determined based on the different types of traffic control at an intersection. In most cases sight distance triangles will be required as described below. The different situations, or cases, that must be considered are defined in the following discussion.

(3) Sight Distance Easements

All sight distance easements must be shown on the street plan/profile plans. All necessary sight distances must be within the public right-of-way or a sight distance easement dedicated to the City. When the line of sight crosses onto private property, a "Sight Distance Easement" shall be dedicated to provide the required clear sight distance. The easement or right-of-way shall be dedicated to the City; however, maintenance shall be the responsibility of a private entity such as the property owner or the appropriate home owners association (HOA).

2.3.11 Lane Transitions

Lane transitions are necessary when through lanes require lateral transitions without the use of horizontal curves. Also, when constructing a street that will directly connect with an existing street of different width, it is necessary to install a transition taper between the two. The length of taper depends upon the lateral offset distances between the outside traveled edge of the two sections and the design speed of the roadway. Formulas for determining transition taper lengths are shown below:

For Speeds ≤ 40 MPH: $L = \frac{W * S^2}{60}$

For Speeds > 40 MPH: $L = W * S$

L = transition taper length, feet
W = width of pavement offset, feet
S = roadway design speed, MPH

When transition tapers are located on a curve, the separate halves of the roadway shall be designed with different curves to create the taper without any angle points in the curvature.

2.3.12 Auxiliary Lanes

Auxiliary through lanes may be required along sections of any arterial or collector street to address existing or projected capacity or safety issues, at the determination of the City Engineer.

2.3.13 Intersections

Intersections shall be designed to provide for the safety of motorists, pedestrians, and bicyclists. Designs shall be based on criteria from the ITE's "*Traffic Engineering Handbook*" and AASHTO's "*Green Book*".

Typical Intersection of Arterial Streets

(1) Basic Intersection Design

By their nature, intersections are conflict locations. Vehicles, pedestrians, and bicycles all cross paths. Each crossing is a conflict point. Intersections contain many conflict points. The basic design of intersections includes the following objectives:

- Minimize points of conflict;
- Simplify areas of conflict;
- Limit conflict frequency; and
- Limit conflict severity.

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These objectives can be achieved using the design elements presented as follows.

(2) Minimum Number of Intersection Turn Lanes

Intersections planned and constructed in the City shall allow for a minimum number of lanes to provide acceptable levels of traffic operations. **Table 2.3 (6)** identifies the minimum number of turn lanes to be provided at typical arterial, collector and local street intersections. The City Engineer may increase or decrease these requirements based on a traffic impact analysis or other relevant factors.

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Table 2.3 (6) Typical Minimum Intersection/Interchange Requirements						
Class	**Intersecting With A:**					
	Major Arterial	**Minor Arterial**	**Major Collector**	**Minor Collector**	**High Volume Local**	**Low Volume Local**
Major Arterial	Separate Rights Double Lefts Possible Interchange	Separate Rights Double Lefts Possible Interchange	Separate Rights Double Lefts Possible Interchange	Separate Rights Double Lefts Possible Interchange	Should not connect	Should not connect
Minor Arterial	Separate Rights Double Lefts Possible Interchange	Separate Rights Double Lefts on Arterial	Separate Rights on Arterial Lefts on Collector	Separate Rights on Arterial Lefts on Collector	Should not connect	Should not connect
Major Collector	Separate Rights Double Lefts Possible Interchange	Separate rights Single lefts	Single lefts Possible separate Rights Possible roundabout	Single lefts Possible separate Rights Possible roundabout	Possible Lefts on Collector	Possible Lefts on Collector
Minor Collector	Separate Rights Double Lefts Possible Interchange	Separate rights Single lefts	Single lefts Possible separate Rights Possible roundabout	Single lefts Possible separate Rights Possible roundabout	Possible Lefts on Collector	Possible Lefts on Collector
High Volume Local	Should not connect	Possible Lefts on Arterial	Possible Lefts on Collector Possible roundabout	Possible Lefts on Collector Possible roundabout	Possible roundabout	Possible roundabout
Low Volume Local	Should not connect	Should not connect	Possible Lefts on Collector Possible roundabout	Possible Lefts on Collector Possible roundabout	Possible roundabout	Possible roundabout

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NOTE: It is assumed that , at a minimum, single left turn lanes will be provided at all public street intersections along major streets, and will also be provided on any collector approach to an arterial street.

(3) Location of Intersections
Intersections create turning movements and therefore conflict points in the traffic stream. It is therefore essential that they be carefully planned, located and designed to function effectively and safely. For intersection location criteria, refer to **Section 2.3.23, Access Management and Design**.

(4) Spacing of Intersections
Intersections with arterial and collector streets shall be as shown on the Major Thoroughfare Plan. When not shown, intersection spacing shall be determined based on a traffic circulation and operations analysis considering elements such as left and right turn lane requirements, traffic weaving movements, location of private access points, and traffic signal coordination. In no case shall these intersections be less than those shown in **Table 2.3 (2)**. Street jogs and/or intersections on local streets of less than two-hundred (200) feet shall not be allowed, except where both intersecting streets are cul-de-sacs in which case the street jogs with centerline offsets of less than one hundred and twenty-five (125) feet shall not be allowed.

(5) Lane Alignment
All lanes shall be in alignment through each intersection, with a maximum of a two (2) foot shift in a hardship situation only, subject to approval by the City Engineer. Should a shift of greater than two (2) feet be allowed, special markings and signs may be required to support that shift design.

(6) Angle of Intersection
Crossing streets shall intersect at ninety (90) degrees whenever possible. In no case shall they intersect at less than eighty (80) degrees or more than one-hundred (100) degrees.

(7) Horizontal Alignment and Vertical Profile

(a) Horizontal: The horizontal alignment of streets through an intersection shall be designed in conformance with **Tables 2.3 (2)**. Intersections may be placed on horizontal curves, provided that the tangent lengths given in **Tables 2.3 (2)** are provided on the minor street and the required intersection sight distance is met.

(b) Vertical: The street profile grade shall not exceed the percentages shown in **Table 2.3 (5)** for the approaches to the intersection, as measured along the centerline of the street. The profile grade within the intersection streets shall not exceed three (3) percent.

(c) Prevailing Street Grade: The grade of the street with the higher classification shall prevail at intersections. The lesser street shall adapt to the grade of the major street. Grading of adjacent property and driveways shall adapt to the street grades. When streets are of equal classification, the City Engineer shall determine which street grade prevails.

(8) Exclusive Left Turn Lanes
Exclusive left turn lanes shall be provided on all arterial streets and other streets wherever left turn lanes are specified as needed by an access plan, required by these Standards or warranted and approved by the City Engineer. The Designer shall use information in the traffic impact study, when available, to determine whether an exclusive left turn lane is warranted on non-arterial streets.

(a) At Signalized Intersections: A separate left turn lane shall be required unless otherwise determined by the City Engineer.

(b) At Unsignalized Intersections: Left turn lanes may be required at approaches to intersections for which the combination of through, left, and opposing volumes exceeds warrants as stated in a traffic analysis**.** The City Engineer will determine which peak hours to consider in this evaluation. The traffic impact analysis (TIA) shall make recommendations for the location and dimensions of all left turn lanes.

(c) Design Criteria: Left turn lanes shall be designed to provide the following functions:

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i. A means for safe deceleration outside the high speed through lane.
ii. A storage length long enough for left turning vehicles so that signal phasing can be optimized and intersection delay minimized.
iii. A means of separating movements at unsignalized intersections to reduce left turn impacts on other flows.

The design elements for a left turn lane are the approach taper, bay taper, lengths of lanes, width of lanes, and departure taper. For a graphical representation of bay taper and approach taper lengths, see **Figure 2.3 (3)**. The required left turn lane widths shall be as specified in **Table 2.3 (1)**. Other dimensions shall be as defined in the traffic impact analysis (TIA).

(9) Exclusive Right Turn Lanes

Exclusive right turn lanes shall be provided at locations where they are specified as needed by an access plan, or where required by the applicable traffic impact study, approved by the City Engineer.

(a) Warrants for Right Turn Lanes: The traffic impact analysis (TIA) shall determine whether a right turn lane is to be provided at intersections or accesses.

(b) Design Criteria: Right turn lanes shall be designed to accomplish the following functions:

i. Provide a means of safe deceleration outside the high speed through lane.
ii. Provide a separate storage area for right turns to assist in the optimization of traffic signal phasing.
iii. Provide a means of separating right turn movements at stop controlled intersections.

The design elements are the approach taper, bay taper, lengths of lanes, width of lanes, and departure taper. For approach taper lengths and other elements, see **Figure 2.3 (4).**

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Pedestrian Refuge

(c) Pedestrian Refuge: Where pedestrian refuge is required between a right turn lane and through lanes, it shall be designed in accordance with **Figures 2.3 (5).**

(10) Acceleration/Deceleration Lanes

For each high volume driveway and major intersection, acceleration/ deceleration lanes shall be considered. The specific designs for these lanes shall be in accordance with the design for left and right turn lanes given above. *NCHRP Report 279* shall also be consulted during the design process for additional guidance.

(a) Acceleration Lane Transition Tapers: The traffic impact analysis (TIA) shall determine the necessary distances for designing acceleration lane lengths and tapers, subject to approval of the City Engineer.

(b) Deceleration Lane Transition Tapers: The traffic impact analysis (TIA) shall determine the necessary distances for designing deceleration lane lengths and tapers, subject to approval of the City Engineer.

(c) Left Turn Approach and Bay Tapers: When left turn lanes are designed with lateral transitions, the formula on **Figure 2.3 (3)** shall be used to compute the necessary distances, subject to approval of the City Engineer.

(d) Right Turn Approach and Bay Tapers: When right turn lanes are designed with lateral transitions, the approach and bay taper formulas on **Figure 2.3 (4)** shall be used to compute the necessary distances, subject to approval of the City Engineer.

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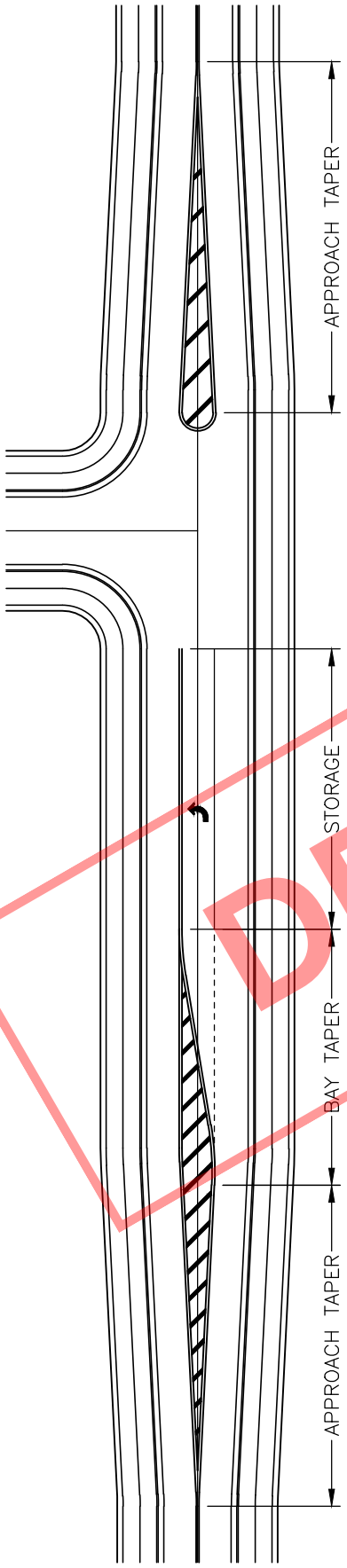

1) APPROACH TAPER
   L=W*S, SPEED ≥ 45 MPH
   $L=W*S^2/60$, SPEED < 45 MPH
   L = LENGTH OF TAPER IN FEET
   W = WIDTH OF OFFSET IN FEET
   S = DESIGN SPEED IN MPH

2) BAY TAPER
   L=WS/3

3) STORAGE
   BASED ON TRAFFIC IMPACT STUDY

	TAPER RATIONS					
TAPER	DESIGN SPEED					
TYPE	25	30	35	40	45	50
APPROACH	11:1	15:1	21:1	27:1	45:1	50:1
BAY	9:1	10:1	12:1	14:1	15:1	17:1

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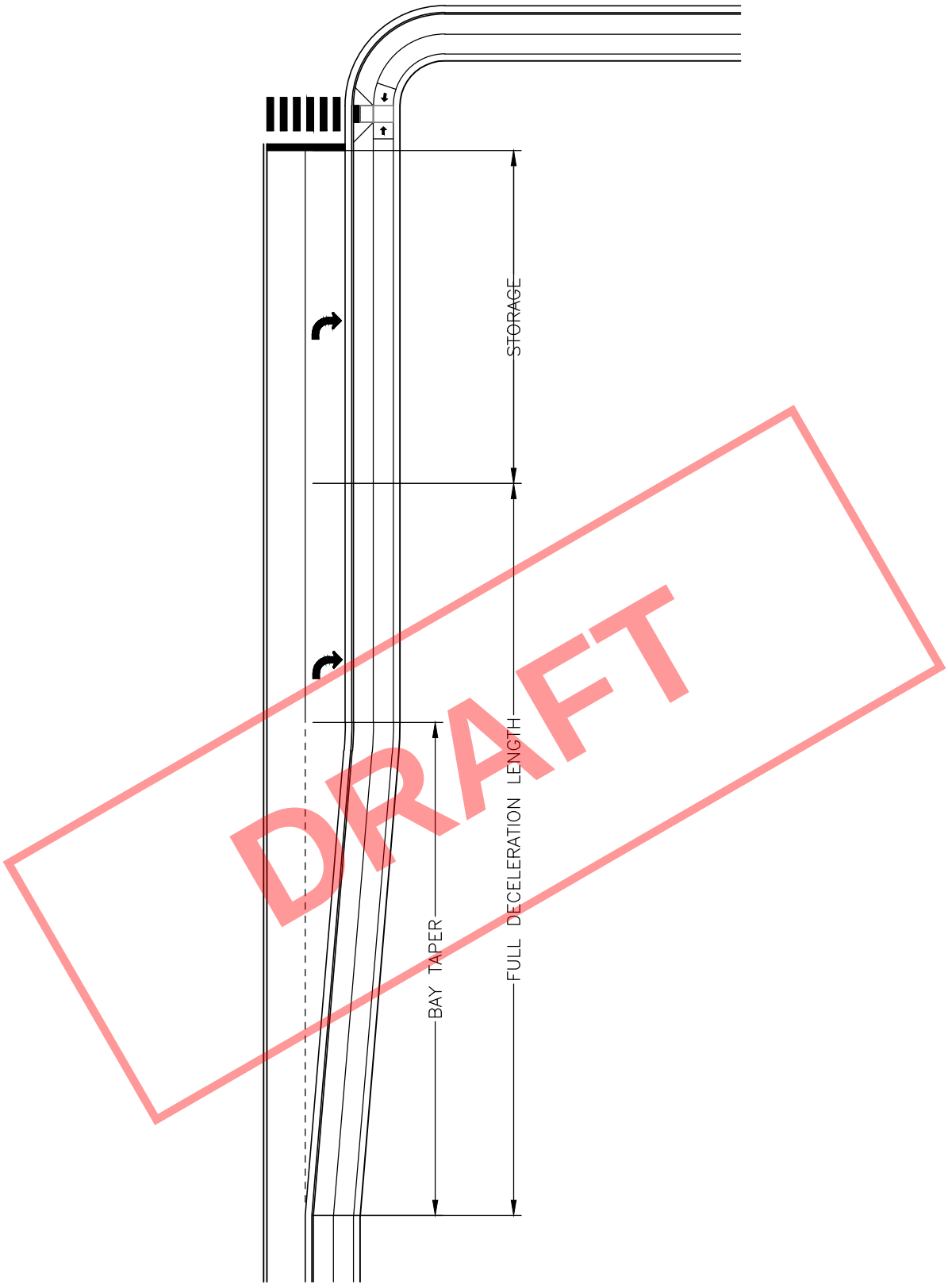
LEFT TURN LANE
FIGURE 2.3 (3)



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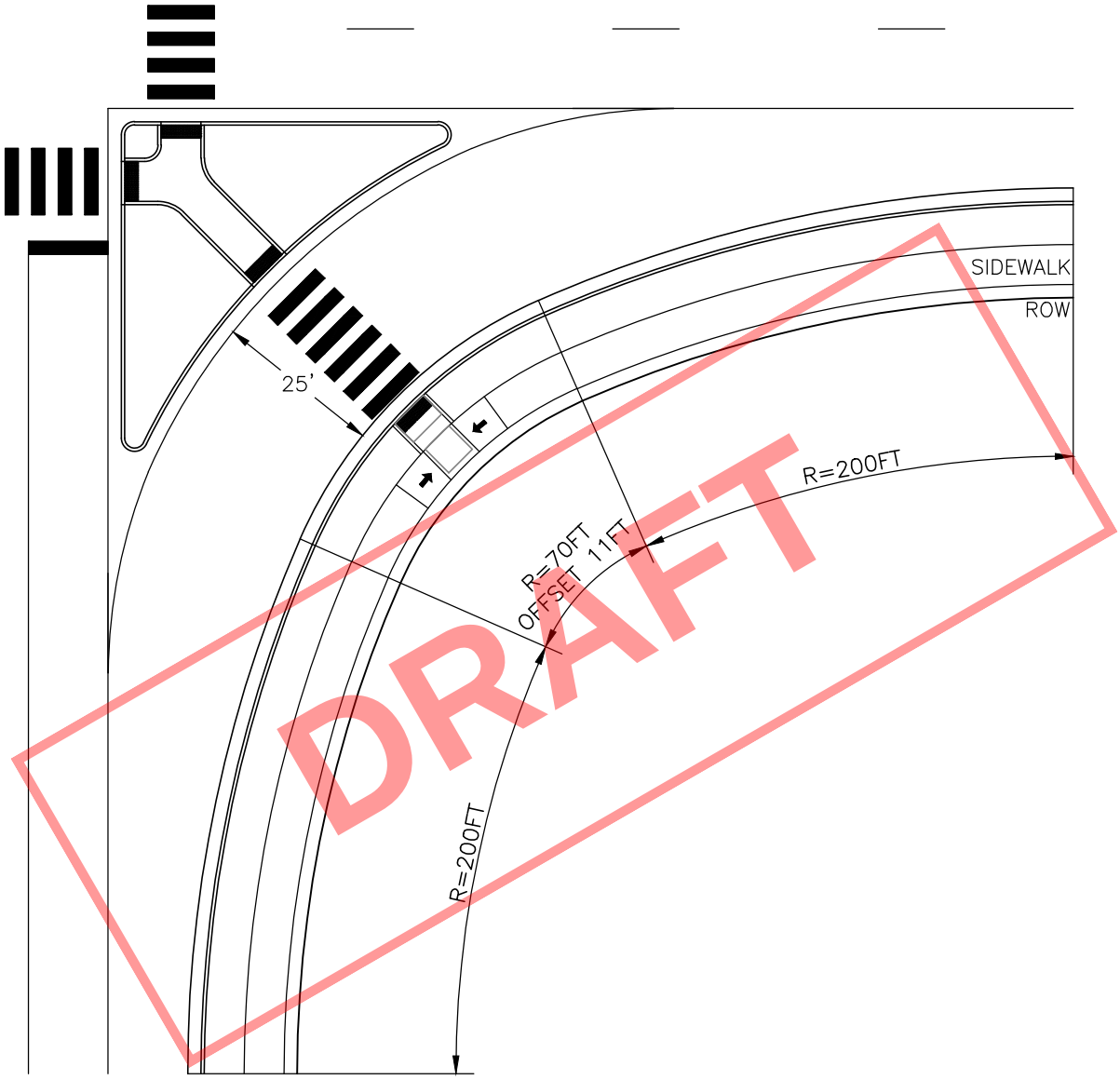
RIGHT TURN LANE
FIGURE 2.3 (4)



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1) SEE GREEN BOOK AND TDOT STANDARDS FOR DESIGN OF CORNER ISLANDS.
2) REFER TO MUTCD AND TDOT STANDARDS FOR PAVEMENT MARKINGS.
3) TURNING RADIUS BASED ON DESIGN VEHICLE AND ROADWAY CLASSIFICATION.

N.T.S

PEDESTRIAN REFUGE ISLAND DESIGN WITH CONTINUOUS RIGHT TURN AND THREE-CENTERED CURVE
FIGURE 2.3 (5)

(11) Curb Returns

(a) Radii of Curb Returns: The corner radii at street intersections shall meet the following minimum requirements in **Table 2.3 (7)** unless otherwise approved or required by the City Engineer. For curb returns on a State Highway, TDOT's curb radii requirements shall supersede these requirements. At street intersections in residential areas, the minimum radius of curb return shall be twenty-five (25) feet. In industrial and commercial areas, and when a residential street intersects with a non-residential street, the minimum curb return radius shall be thirty (30) feet. Should the expected right-turning truck volumes exceed ten (10) vehicles per hour in the design hour, then the designer shall use larger radii or 3-centered compound curves to provide for the turning movements of the larger vehicles. Where the angle of the street intersection is less than ninety (90) degrees, the City Engineer may require greater radii. See **Table 2.3 (3)** for general requirements regarding vehicle turning needs at intersections.

Table 2.3 (7) Operating Characteristics of Intersection Corner Radii

Corner Radius	Operational Characteristics
≤ 9	Not appropriate for passenger cars
25-30	Low speed turn for passenger car; crawl-speed for single unit trucks with minor lane encroachment
40	Moderate speed turn for passenger cars. Low speed turn for single unit trucks with minor lane encroachment.
50	Moderate-speed turns for all vehicles up to WB-50

(b) Curb Return Grades: The desirable grade for gutter flow-lines around the curb return shall be a minimum of one (1) percent. The minimum allowable grade for gutter flow-lines around curb returns shall be a minimum of one-half (0.5) percent.

(12) Traffic Islands

(a) Corner Islands Separating Right Turns: Standard corner islands shall be used in four (4) or six (6) lane Arterial/Arterial intersections to channelize traffic where required to provide pedestrian refuge or where required by the City Engineer. The corner islands shall be designed as raised islands in accordance with **Figure 2.3 (5)** and "*Green Book*" Standards**,** for a right turn lane continuing to an exclusive lane or for a right turn lane stop or yield condition, respectively. The striping shall be in accordance with the requirements of the Traffic Control Section.

(b) Median Islands Separating Opposing Traffic: Median islands are required at all Arterial/Arterial intersections. If raised medians are not required by these Standards, the median islands may be raised or painted. The length of the island shall include the appropriate approach taper, bay taper and length of lane required by these Standards, or supported by another approved resource standard. The design shall be as follows:

Typical Raised Median

i. No Obstruction. Medians must not obstruct the minimum left turn radius for the design vehicle(s).
ii. Drainage. Landscaped medians shall include drainage facilities to handle sprinkler run-off and nuisance flows. When low maintenance landscaping is used in conjunction with trickle irrigation, drainage requirements may be waived and outfall curb and gutter shall be used.
iii. Median Islands Required. Median islands are standard on all new 6-lane and 4-lane Arterial streets. These islands shall be designed to provide pedestrian refuge.

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(c) Median Islands on Minor Arterials, Collectors, or Local Streets: Raised medians may be placed in Minor Arterial, Collector, and all Local streets. If medians are included, they shall be placed in the public right-of-way, and they must meet the following standards for design:

i. No Obstruction. The medians may not obstruct the design vehicle turns.
ii. Visibility. The medians must be placed such that the required visibility in the intersection is not obstructed.
iii. Undiminished Use. Medians must be placed so they do not diminish the intersection use except where designing a right-in/right-out intersection.
iv. Alignment. Lanes on one side of the intersection must align with the correct lanes on the opposite side of the intersection.
v. Median Maintenance. Most medians will be maintained by parties other than the City. The maintenance responsibility must be defined on the Final Plat or Development Agreement. The City will maintain selected medians, primarily along State highways based on agreements with TDOT.
vi. Public Use. The City may use these islands for street signing and may choose to remove the medians if it is deemed necessary by the City Engineer.
vii. Additional Right-of-way. The Developer shall dedicate all additional right-of-way necessary to include these medians.
viii. Compliance with these Standards. The median design must comply with all applicable median criteria in these Standards and the streetscape standards of the City.

(d) Turn Prohibition Islands: An intersection may be designed with islands to prohibit left and right turn movements into or out of the intersection. Typically, these islands should not be used unless there is also a street median present to ensure that improper movements are not made.

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Turn Prohibition Island

e) Splitter Islands on Roundabouts: In modern roundabout designs, raised splitter islands shall be designed in accordance with the Federal Highway Administration "*Roundabouts: An Informational Guide*" to direct traffic and provide pedestrian refuge.

(13) Right-of-Way

All intersection rights-of-way and utility easements shall be dedicated to provide adequate right-of-way to include sidewalks, access ramps, and utilities. Additional right-of-way may be required at intersections to provide space for additional left or right turn lanes without reducing the widths of standard required facilities. Where standard intersections are used, additional right-of-way may be required to accommodate the potential installation of a roundabout in the future.

(14) Channelization

Channelization refers to physical or visual guides used to separate vehicles, bicycles and pedestrians into particular lanes.

(a) Intent of Channelization:
Channelization is intended to:

Channelization at intersection

i. Prohibit undesirable or wrong way movements.
ii. Define desirable vehicular paths.
iii. Encourage safe vehicle speeds.
iv. Separate points of conflict wherever possible.
v. Cause traffic streams to cross at right angles and merge at flat angles.
vi. Facilitate high-priority traffic movements.
vii. Facilitate traffic control scheme.
viii. Remove decelerating, stopped, or slow vehicles from high-speed through-traffic streams.
ix. Provide safe crossings for pedestrians/bicycles.
x. Provide safe refuge for pedestrians.

(b) Specific Channelization Requirements: Channelization shall be required at locations where it is necessary for safety or to protect the operation of the major street. Examples include:

i. Providing raised medians in all Arterials where left turns are prohibited.
ii. Prohibiting undesirable turning movements such as right and left turns, in and/or out.
iii. Providing exclusive turning lanes, with appropriate striping.
iv. Providing travel lanes, with widths as specified in the standard street cross sections.
v. Raised islands must be large enough to be visible to vehicle drivers. Therefore, no single island, including pedestrian paths and/or pedestrian refuge, shall be smaller than 100 square feet.

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(15) Street Narrowing
Minor Collector or Local streets may be narrowed at intersections to provide more visibility for pedestrians. This shortens the distance necessary for pedestrians to cross the street. The narrowing shall not encroach into bike lanes or travel lanes. Narrowing may not be used on Major Collectors without any parking lanes, on any Arterials, or where the standard width is necessary. When narrowing is proposed, turning paths shall be evaluated to ensure that anticipated service vehicles (fire, sanitation, school buses) can be accommodated with the proposed design.

(16) Roundabouts
Roundabouts are considered a form of traffic control. Roundabouts shall be considered as two types: (1) Modern Roundabouts and (2) Mini Roundabouts.

(a) Modern Roundabouts: Modern Roundabouts shall be specially designed to the specific need on high traffic volume streets and used to improve traffic flow. Roundabouts shall be designed based on the FHWA's, *"Roundabouts: An Informational Guide"*, *"TDOT Standard Specifications"* for typical layout and comply with all *"PROWAG"* requirements.

(b) Design Experience. The design shall be performed or checked by a registered Professional Engineer who has designed a minimum of two roundabouts, located on either collector or arterial streets.

(c) Mini Roundabouts: Mini Roundabouts may be allowed in a neighborhood setting for traffic calming. Mini roundabouts may be used on Local Streets. The design shall be performed in accordance with the FHWA *Roundabout Design Guide*, or other design criteria approved by the City Engineer.

2.3.14 Sidewalks, Curbs & Gutters, Shoulders and Ditches

(1) Sidewalks

Typical Sidewalk with Grass Strip

(a) Typical Cross-Sections: Street cross sections that include sidewalks shall be as specified in this chapter and as shown on the Typical Section Drawings.

(b) Clear Zone: Sidewalks shall be designed to provide a desirable lateral clear zone of six (6) feet, except when located at back of curb. Vertical clearance shall be at seven (7) feet or higher.

(c) Other Sidewalk Requirements: Refer to **Section 2.4, Pedestrian Facilities,** and Zoning Ordinance for other related sidewalk requirements and guidance from the City's Major Thoroughfare Plan.

(d) Location of Sidewalks: Sidewalks are required on both sides of all streets in the City except Mack Hatcher Parkway, Interstate 65, rural roads, alleys and mews. Sidewalk design shall comply with the standards in this section.

(e) Setback: Sidewalks shall typically be set back a minimum of six (6) feet behind the street curb. The intervening space between the back of the curb and the edge of the sidewalk is intended for the placement of street trees and other roadside features.

Along nonresidential and mixed-use lots within urban areas, sidewalks may be located at the back of the curb. In no instance shall the intervening space between the back of the curb and the façade of a building be less than twelve (12) feet.

(f) Minimum Width: Sidewalks and trails running along streets shall meet the minimum widths as specified in **Table 2.3.1**.

(g) Ramps: Ramps meeting requirements of the Americans with Disabilities Act (ADA) shall be installed at the intersection of all sidewalks with public streets. Ramps shall be designed in accordance with the Standard Drawings and shall comply with *Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way*.

(h) Configuration

i. Sidewalks shall be constructed of concrete, textured pavers or a combination of these materials, and shall be raised above the adjacent street level. In special circumstances, brick sidewalks may be allowed by the City Engineer, provided that an agreement is executed requiring maintenance by others.
ii. Pedestrian street crossings at intersections may be raised above the adjacent street level as a traffic-calming measure.
iii. Sidewalks shall connect with existing or planned sidewalks at property boundaries.
iv. Sidewalks shall connect building entries within and between developments.
v. Except where brick or pavers are used, all public sidewalks shall maintain a brushed concrete finish for safety.

(i) Inlets: Drainage inlet accesses located in a sidewalk shall be integrated with sidewalks. The inlet access shall be flush with the sidewalk surface. No manholes, inlets, or other storm sewer facilities are

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allowed within curb ramps. Refer to the drainage study requirements for sizing of inlets. Inlets are not allowed in the curb return, but shall be located at or behind the tangent points of the curb returns.

(j) Payment In-Lieu of Sidewalks: See City of Franklin Zoning Ordinance.

(2) Curb and Gutter

Type and Location: **Table 2.3 (1)** notes the type of curb and gutter to be used for the various street classifications and sections. See the Standard Drawings for City details for combined curbs and gutters.

(a) Post Curbs - Post curb sections without an integral gutter pan shall not be used unless approved by the City Engineer. Under no circumstances will they be used when water flows along the curb face.

(b) Ribbon Curbs - Ribbon curb, which is typically 8 inches wide at the top and is cast near the asphalt surface, may be used in locations such as adjacent to medians where surface water runoff is conveyed over the curb to detention areas.

(c) Standard Combined Curb with Gutters - The standard vertical face curb and gutter section consists of a 6-inch wide concrete curb cast integral with a 24-inch wide sloping gutter for a combined width of 30 inches. Local streets shall be allowed to use 18-inch wide sloping gutter as approved by the City Engineer.

(d) Spill Curbs - Where curb and gutter sections are used in superelevated streets and adjacent to medians, the gutter pan shall be sloped away from the median ("spill curb") to allow sheet flow toward the drainage structures.

(e) Mountable Curbs - The standard mountable curb or "rollover" curb is to be cast integral with a 12-inch wide gutter pan for a combined width of 24 inches. Vane grating for mountable curbs requires a width transition of the gutter pan to match the traffic edge of the drain casting.

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Vertical combined curb and gutter

Rollover curb with grate transition

(3) Shoulders

All streets constructed in the City shall be constructed with curb and gutter. However, in extenuating circumstances, shoulders may be allowed by the City Engineer on a case by case interim basis. Where authorized, they shall be provided in addition to the elements shown on the typical cross sections contained at the end of this chapter.

(4) Roadside Ditches

(a) Location: Ditches are not normally allowed in the City unless otherwise approved by the City Engineer.

(b) Ditch Profile: The profile grade of the ditch shall be maintained at a minimum slope of one (1.0) percent and a maximum slope of five (5.0) percent. The side slopes of the ditches outside of the right-of-way shall be a minimum of 4:1 and meet any specific criteria of the drainage study. Flatter slopes may be considered when a paved invert is designed for the ditch bottom.

(c) Ditch Slope: The slope and capacity of any roadside ditches shall be maintained in any areas that driveways cross the ditch. Each site is required to provide a concrete pipe, a minimum of fifteen (15) inches in diameter, calculated to meet capacity and strength requirements of the drainage study. The pipe shall be designed to have no less than twenty-four (24) inches of cover over the pipe. All portions of the driveway within the right-of-way shall be paved with concrete or asphalt.

(d) Ditch Maintenance: All driveway improvements within the right-of-way including piping, ditches, curb and gutter, and sidewalk are generally the responsibility of the City.

2.3.15 Medians

(1) General Requirements

General criteria for medians are specified in **Table 2.3 (1)**. Also refer to the Franklin Zoning Ordinance. In the City, medians are required on all Arterial and Major Collector Streets. Raised medians are preferred, but depressed or painted medians may be allowed on a case by case basis. Other medians may be required by the City Engineer for specific circumstances to control traffic. Medians requested by developers may be approved as long as additional rights-of-way are dedicated and all maintenance shall be done by viable private parties. The minimum width of any raised median shall be four (4) feet wide, from face-of-curb to face-of-curb.

Typical Street Median

(2) Turn Lane and Access

The design of medians shall include the evaluation for current and future turn lanes and accesses.

(3) Design of Openings

Median openings shall be designed to accommodate the selected design vehicle for all movements. Raised island and other geometric design features shall be installed at median openings when necessary to prohibit certain turning or cross movements in the intersection.

Typical Median Opening

(4) Spacing of Openings

The effectiveness of medians is diminished by frequent and/or poorly spaced median openings. Openings should therefore be carefully coordinated with public and private street access points. Median openings shall be located only at major public or private access points, or at midblock locations if needed to serve U-turns. Optimum location of openings is best determined based on the findings of a Traffic Impact Analysis. Minimum spacing on major streets should normally be at least six-hundred (600) feet to accommodate back to back left turn lanes and weaving between openings.

(5) Drainage

Landscaped medians shall be provided with drainage facilities to handle sprinkler runoff and nuisance flows. Sprinklers shall be designed to prevent spray onto the pavement surface. A properly designed drain system shall be required.

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(6) Nose Design
Vehicle tracking templates shall be used to determine the optimum position and design of the median nose so that vehicles do not track onto the median, and are coordinated with other movements in the intersection. The minimum radius for nose curbs shall be two (2) feet to flow-line.

(7) Paving
When medians are not landscaped, they shall be paved with stamped, colored, or broom finished concrete in accordance with the City's streetscape standards.

(8) Transitions
The ends of medians shall transition into turn lanes with a minimum radius of one-hundred (100) feet. Change in curb directions must be accomplished with the use of radii. Angle points shall not be allowed.

(9) Objects
No permanent structures, including light poles, fire hydrants, trees, walls or other fixed objects in the median shall be placed within clear zone as determined by the *Green Book*, or in any location that would obstruct sight distance except for structures as approved in these Standards. All objects placed within the clear zone shall be an approved TDOT/FHWA breakaway design.

2.3.16 On-Street Parking

(1) General
This chapter defines the parking criteria for on-street parking, including Downtown parking, parking on cul-de-sacs, and other special areas. Parking may be allowed on Local and Minor Collector streets at the discretion of the City Engineer. Parking shall not be allowed on Major Collector and Arterial streets.

(2) Parallel Parking
Parallel parking is permitted on certain streets as approved by the City Engineer.

(3) No Parking Signs
For all streets in which parking is limited or not allowed, "No Parking" street signs may be required as a part of the street design.

(4) Non-Parallel Parking
Diagonal parking shall not be allowed on City public streets and shall not be allowed to utilize the public street for maneuvering. The City Engineer must specifically approve any on-street parking areas that are not designed as parallel parking. All areas approved for diagonal parking shall be designed at an angle of thirty, forty-five, or sixty degrees, as approved by the City Engineer.

(5) Parking in Cul-de-Sacs
See **Section 2.3.7(1).**

(6) On-Street Accessible Parking Requirements
Where on-street parking is provided on the block perimeter and the parking is marked or metered, a minimum number of parking spaces must be accessible and shall comply with the *Public Rights-of-Way Accessibility Guidelines.* Where accessible parking spaces are constructed in conjunction with a new street, a 5'-0" wide access aisle, exclusive of the gutter, is required regardless of the parking space location along the block face. Additional right-of-way shall be dedicated as necessary to accommodate the accessible parking space, access aisle, and sidewalk beyond. (**See Figure 2.3 (6)**)

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(7) Inset Parking
On-street parking shall be inset from the curb line unless otherwise allowed by the City Engineer. In these cases, additional right-of-way will likely be required to provide the roadside features shown on the typical cross sections.

Typical Inset Parking

(8) Driveway Clearance
A vehicular parking space within the street shall be designed with a minimum clearance of six (6) feet from the edge of a driveway.

(9) Intersection Clearance
A vehicular parking space in the street shall be designed with a minimum clearance of thirty (30) feet from the intersection flow-line. The designer shall establish the minimum clearance by reviewing sight distance requirements in the *Green Book*.

(10) Mailboxes
Special consideration shall be given to mailbox locations near on-street parking such that parked vehicles do not interfere with mail delivery.

(11) Sidewalks and Trails Adjacent to On-Street Parking
Sidewalks, trails, and grass strips adjacent to on-street parking shall meet the minimum widths as specified in **Table 2.3.1**. In the rare occurrences where space constraints necessitate the sidewalk or trail to be located immediately adjacent to the on-street parking, the grass strip may be removed subject to the approval of the City Engineer. In these cases, the sidewalk or trail width shall be as specified in **Table 2.3.1**, but not less than 7 feet.

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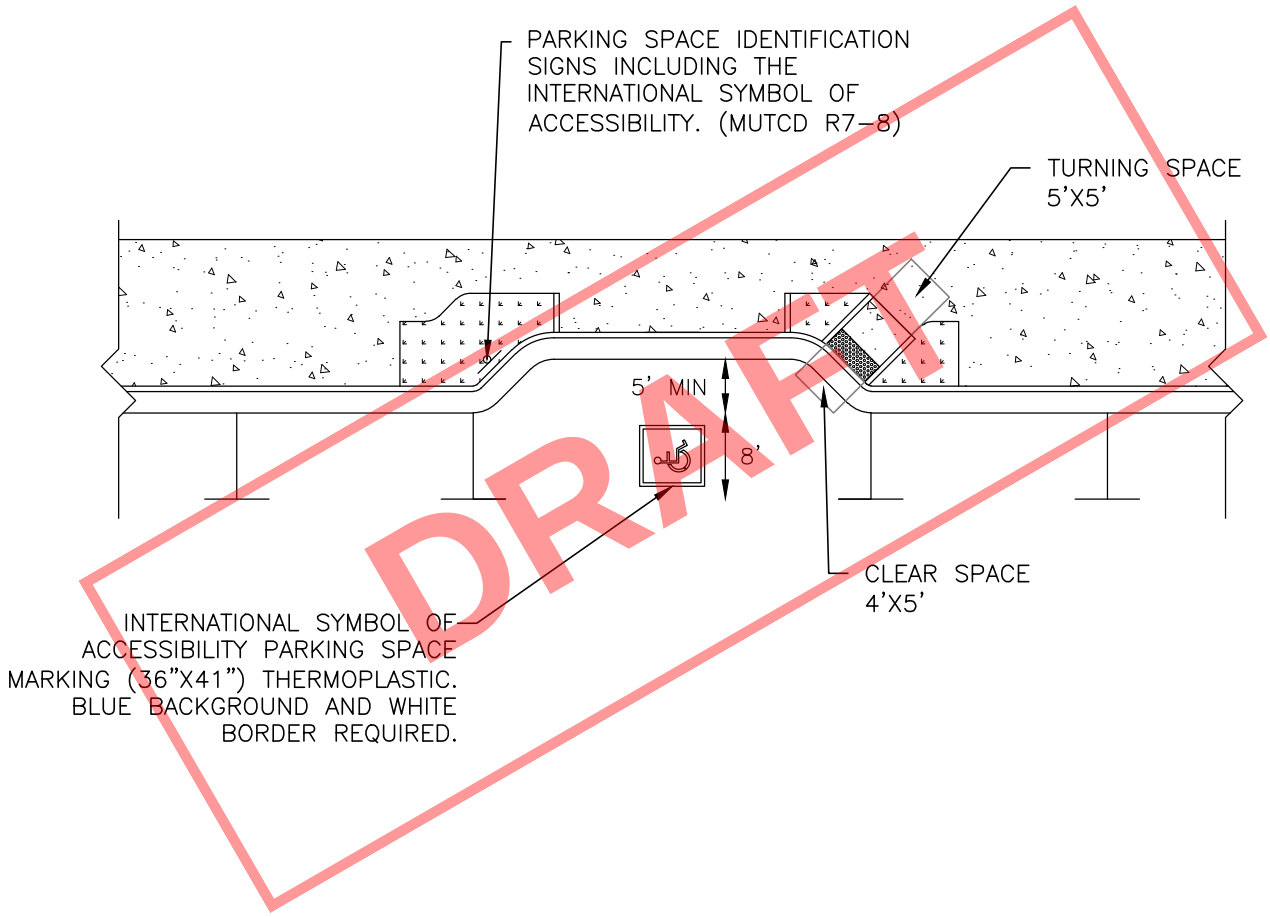

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1) VEHICLES MAY PARK AT THE CURB OR AT THE PARKING LANE BOUNDARY AND USE THE SPACE REQUIRED ON EITHER THE DRIVER OR PASSENGER SIDE OF THE VEHICLE TO SERVE AS THE ACCESS AISLE.
2) SEE PROWAG STANDARDS FOR THE NUMBER OF ACCESSIBLE PARKING SPACES THAT MUST BE PROVIDED ON THE BLOCK PERIMETER WHERE ON–STREET PARKING IS PROVIDED.
3) PARKING SPACES MUST BE IDENTIFIED BY SIGNS DISPLAYING THE INTERNATIONAL SYMBOL OF ACCESSIBILITY.
4) ACCESSIBLE PARKING SPACES SHOULD BE LOCATED WHERE THE STREET HAS THE LEAST CROWN AND GRADE AND CLOSE TO KEY DESTINATIONS.
5) SIDEWALK ADJACENT TO ACCESSIBLE PARALLEL PARKING SPACES SHOULD BE FREE OF SIGNS, STREET FURNITURE, AND OTHER OBSTRUCTIONS TO PERMIT DEPLOYMENT OF VAN SIDE–LIFT OR RAMP OR VEHICLE OCCUPANT TO TRANSFER TO A WHEELCHAIR OR SCOOTER.
6) MODIFIED VERSIONS OF THIS DETAIL ARE ALLOWED BUT SHALL COMPLY WITH PROWAG STANDARDS.

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ACCESSIBLE ON–STREET PARALLEL PARKING SPACE
FIGURE 2.3 (6)

2.3.17 Bridges

(1) Lane and Sidewalk Widths
The width of street travel lanes and sidewalks across bridge structures shall be equal to the widths on the street approaching the structure. Sidewalk and lane widths shall not be reduced from approach dimensions when crossing a bridge structure. Grass strip width may be eliminated across the bridge.

(2) Rails
All bridge rail or safety barriers shall concrete or metal beam guardrail constructed in accordance with approved "*TDOT Standard Specifications"* as approved by the City Engineer. Bridge rails shall incorporate aesthetic features such as form liners or stone veneers where approved by the City Engineer.

(3) Approach End Treatments
All approach end treatments for bridge rails shall be required at each end and shall be in accordance with "*TDOT Standard Specifications"* as approved by the City Engineer.

2.3.18 Clearance Requirements

(1) General
Streets shall be designed to minimize the potential for traffic accidents involving fixed objects beside the street travel way. The street designer shall consult the latest edition of the AASHTO "*Roadside Design Guide"* to design the safest possible roadside along City streets.

(2) Horizontal Clearance to Obstructions
The AASHTO "*Roadside Design Guide"* shall be consulted in the design process to identify the suggested clear zone dimensions and/or barrier for the street being designed. Regardless of this guidance, the desirable minimum lateral clearance from the face of curb to the nearest edge of an object is two (2) feet.

(3) Vertical Clearance
The minimum vertical clearance above a street is sixteen feet and six inches.

(4) Guardrails
The type and location of guardrails used in the City shall be approved by the City Engineer on a case-by-case basis and comply with TDOT and FHWA standards. Wood Guard rails are prohibited on public and private roadways within the City of Franklin.

2.3.19 Barriers and Fencing

(1) Roadside Barriers
All safety barriers shall be TDOT/FHWA approved crash-tested barriers. Aesthetic treatments such as stone veneer, concrete with a form liner finish, or painted railings may be used with the approval of the City Engineer.

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Bridge Rail Barrier

(2) Median Barriers

All median divider barriers shall be TDOT approved, crash-tested barriers walls. Glare screens may be required for high volume streets as approved by the City Engineer.

(3) Fencing

No fencing shall be installed in the street right-of-way. Fencing installed behind the right-of-way shall not result in sight distance less than the recommended distances in this document.

Access Fencing

(4) Maintain Sight Distance

No fencing or barrier installed in or adjacent to the street right-of-way shall result in sight distance less than the recommended distances in this document.

2.3.20 Provision for Utilities

This section sets forth the criteria and location requirements for all utilities located within the right-of-way and/or public utility easements located adjacent to public rights-of-way, such as: water, sewer, storm sewer, subdrains, power (electric and natural gas), phone, cable television (CATV), traffic signals and mailboxes. The appropriate utility department or agency shall determine all final alignments of utilities in consultation with the City Engineer. For new and widened streets, provisions shall be made to include conduit for future signal interconnects and all required pull boxes.

(1) General Requirements

Standard plan requirements and layout requirements are discussed in earlier sections. Refer to **Figure 2.3 (7)** for general utility placement guidelines.

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(2) Minimum Depth

Utilities shall be located at least thirty-six (36) inches below the finish grade elevation, unless specifically approved to be less by the City Engineer. The minimum depth of cover for storm sewer pipes may be reduced to twenty-four (24) inches to the top of pavement. Greater depth of cover may be specified by the City Engineer.

(3) Access Covers

(a) Clearance: All manhole lids, utility access covers, and range box access covers shall be flush with the street finished surface. If located in concrete drives or sidewalks, all access covers shall be set flush with surrounding concrete.

(b) Wheel Path: Manholes or valves installed in the street travel way shall not be designed or constructed in the wheel path of the travel lane or at any location within a bike lane.

(4) Trees and Large Shrubs

(a) Buried Utilities: Trees, berms or large shrubs shall not be placed directly over buried utilities in the public right-of-way or easement. Additional horizontal clearances from the trunk of any tree or shrub to any buried utility may be required by the respective utility department or agency, as required for access, repair and/or maintenance activities.

(b) Overhead Utilities: Trees shall not be planted under overhead power lines when mature growth of the tree would encroach within the influence areas of the power lines.

(5) Use of PVC Sleeves by Franchised and Private Utilities

(a) General: It is the intent of these standards to reduce the amount of open cuts in the street. Therefore, franchised and private utility companies shall install all utilities within a non-corrosive sleeve equivalent to Schedule 80 PVC or other sleeves encased in concrete, slurry or flowable fill material, across all public streets to accommodate future repairs without street cuts.

(b) Exceptions: Steel gas line street crossings will not require sleeves.

(c) Depth: Sleeves shall be installed at a minimum depth of forty-two (42) inches from the top of the pipe to the top of pavement or thirty-six (36) inches from the top of pipe to the top of subgrade, whichever is greater.

(d) Location: Unless otherwise approved by the City Engineer, all utility sleeves shall be located within fifteen (15) feet of the parallel gutter flow-line of the existing street and shall be coordinated with other utilities. Sleeves shall be separated for existing buried utilities in accordance with the utility owner requirements. Ten feet of separation is typically preferred.

(e) Street Cuts: Utility crossings of existing streets shall be performed in accordance with an approved Street Crossing Permit as issued by the City. Installations utilizing jacking or boring under the street is the primary methods. Open cuts must be justified for need.

(f) Potential Signalized Intersections: Refer to **Chapter 8, Signal Design,** for guidance on underground facilities for traffic signals.

(6) Location Criteria

(a) General: The utility locations discussed below are recommended for new development and preferred in the case of existing streets and established developments.

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(b) Water Mains: Water mains shall be located on the north and east sides of streets approximately seven (7) feet south or west of the north or east gutter flow-line. Water mains shall be separated by a minimum of ten (10) feet horizontally from sanitary sewer and storm sewer facilities. The vertical depth of the water lines shall meet the requirements of the appropriate utility department or agency.

(c) Fire Hydrants: Fire hydrants shall be located two (2) feet minimum from curb and gutter flow-line or two (2) feet minimum from back edge of a sidewalk or ten (10) feet minimum from edge of pavement if no curb is present. In addition, the water line shall be located such that the valves will not be in the wheel path of the street lane.

(d) Sanitary Sewer: Sanitary sewer shall be on the centerline of the street pavement. If a median is present, the sanitary sewer line shall be located six (6) feet west or south of the median. The sanitary sewer shall be located such that the manhole locations are not within the wheel path of the street lane. The vertical depth of the sanitary sewer lines shall meet the requirements of the sanitary sewer standards of the City.

(e) Storm Sewer: The storm sewer shall be placed so the manhole locations are not within the wheel path of the street lane. The storm sewer lines shall meet the requirements of the storm sewer standards as provided in this document.

(f) Natural Gas: Gas mains shall be located either within the right-of-way or in an adjacent easement on the south and west sides of the street. For double mains (a main on each side of the street), the requirement of north and east/south and west may be waived by the City Engineer.

(g) Power and Street Lighting: Generally, power and street lighting conduits shall be located on both sides of the street either within the right-of-way or in an adjacent easement. Double conduits (a conduit on each side of the street) may be acceptable as approved by the City Engineer.

(7) Other Systems

(a) Cable TV/Telephone: Cable TV and telephone lines generally serve properties from the back. For mains along the street front the utility shall coordinate the location in the right-of-way or easements with the City Engineer. All pedestal boxes, new and relocated, located in the right-of-way between the curb and the sidewalk shall be installed below ground.

(b) Mailboxes: Mailboxes shall be installed a minimum of one and one-half (1.5) feet from the face of the curb, or travel lane. Mailboxes shall not cause any sight obstruction for motorists exiting side streets or driveways. Mailbox supports shall not pose a fixed object hazard for vehicles and pedestrians.

(c) Poles

i. Location: Poles, signs, and any other above ground streetscape (except regulatory signs) shall be located within five (5) feet of the right-of-way line or ten (10) feet from the travel lane (flow-line), whichever is most restrictive.
ii. Clearance: Street light poles shall be placed no closer to the street than two (2) feet behind a vertical curb line and no closer than two (2) feet to any sidewalk.
iii. Pole Requirements: The City Engineer may require breakaway poles on public right-of-way where speed limit is 40 MPH or higher.
iv. Engineer Approval: All poles within the public right-of-way must be approved by the City Engineer prior to the permit application for installation.
v. Other Requirements: All signs and heights shall meet the requirements of **Chapter 8, Traffic Signs and Marking**.

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(d) Subdrains: Subdrain main lines may be permitted within the public right-of-way. The Developer shall be required to provide additional information and soils investigation. In addition, subdrains shall be designed in accordance with the requirements of this document. If the soils investigation shows that subdrains are required for private property foundations, these lines may be designed to be installed within the public right-of-way only if all requirements of these Standards are met.

i. Private Property. Subdrains built within the right-of-way for private drainage shall be private improvements and shall have provisions for viable maintenance by the local homeowners association or other private entities. The City may require the private party to abandon or relocate such subdrains.
ii. Public Property. A subdrain is public if it is used to drain public improvements, such as the street/pavement section.
iii. Depth. Top of pipe shall be at least thirty-six (36) inches below pavement surface.
iv. Outlet. All subdrains shall outlet to a detention pond, inlet, or other approved location. Each outlet shall have a device to prohibit backflow into outlet pipe.
v. Perforated subdrains for private improvements shall not be allowed within any public right-of-way or easement.
vi. Professional Engineer. Subdrains must be designed by a Professional Engineer and are subject to approval of the City Engineer.

(8) Utility Crossings with Bridge Structures

Conduit sleeves may be required within the bridge structures to provide for electrical, gas, telephone, and cable crossings. The City Engineer may require additional sleeves to be designed with the bridge structure for sewer, water, or other utilities.

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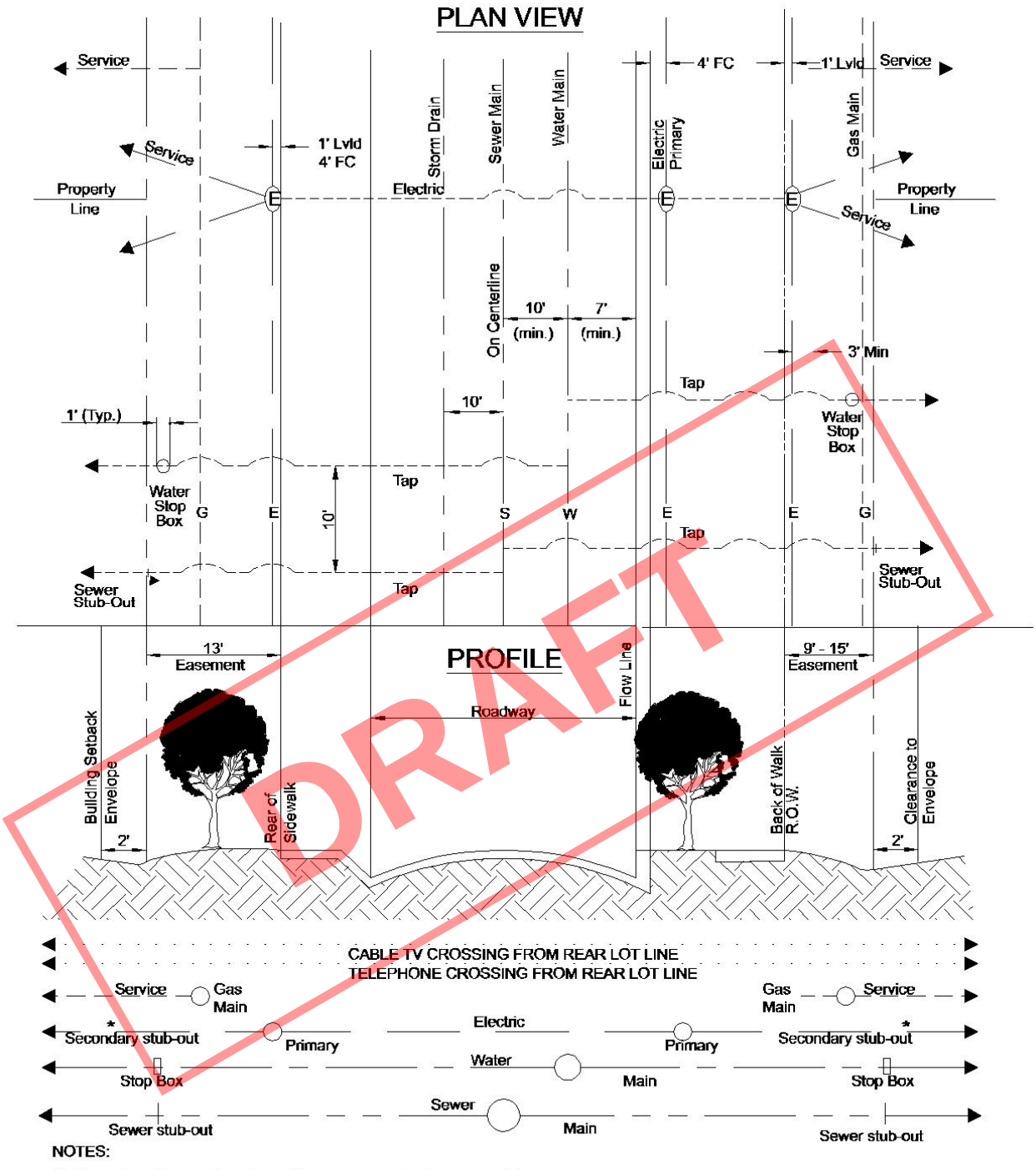

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NOTES:

1. No scale to the drawing above. All measurements shown are minimums.
2. Storm and sanitary sewers, manholes, water valves or telephone manholes are not allowed in the wheel path.

Utility Location Guidelines
Figure 2.3 (7)

2.3.21 Emergency Access Street Requirements

Any emergency street access not on public right-of-way shall be provided in accordance with the Emergency Access Section in the City Zoning Ordinance, or in accordance with the requirements of the City Fire Marshall.

(1) Grade

The grade of the fire lanes shall be a minimum of one-half (0.5) percent and a maximum of ten (10.0) percent.

(2) Cross Slope

The Cross Slope of the fire lanes shall be a minimum of one (1.0) percent and a maximum of four (4.0) percent.

(3) Lane Width

The lane width shall be a minimum of twenty (20) feet from the edge of the street to edge of the street and shall be in an access Easement. The access easement shall have a minimum width of twenty (20) feet. The lane widths may be required to be increased through horizontal curves to accommodate fire truck passage.

(4) Vertical Clearance

There shall be a minimum of thirteen and one-half (13.5) feet of vertical clearance over the entire fire lane.

(5) Barricade

The fire lane may contain an approved barricade, but it must be of a type approved by the City Fire Marshall.

(6) Signs and Markings

The fire lane shall contain signs and markings as required by the City Fire Marshall.

(7) Street Surface

The surface of the street must be a paved surface complying with Local Street pavement thickness requirements, unless approved otherwise by the City Engineer.

(8) Maintenance

All access streets shall be maintained and kept clear for emergency use at all times.

2.3.22 Bus Stops

(1) General

The minimum design criteria for the location and construction of bus stops is as described below. The City Engineer may vary any of the following requirements as deemed appropriate for the site and its particular situation. The Designer shall propose and the City Engineer will approve the exact location of the bus stop in a proposed development. All bus bay locations shall be coordinated with the City Engineer.

Bus stop locations may be required to be constructed with special pavement designs. Developments shall include a trolley shelter along streets served by trolleys at locations identified by the Transit Agency. A statement confirming the viability and availability of the site as a current and/or future trolley stop, and the appropriateness of the design of the shelter, shall be obtained from the agency. If the stop is deemed not viable, then the City Engineer may waive the trolley shelter requirement.

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(2) Bus Lane Width
Bus bays shall be at least ten (10) feet wide.

(3) Approach Leg (Near-side) Minimum Criteria
Bus stops on the approach leg of an intersection shall be at least fifty (50) feet long for a single bus, plus a sixty (60) to eighty (80) foot transition distance kept clear approaching the stop.

(4) Departure Leg (Far-side) Minimum Criteria
Bus stops on the departure leg of an intersection shall provide a fifty (50) foot long loading area plus forty (40) to sixty (60) feet of transition distance.

(5) MidBlock Stops
Midblock stops shall be designed with entrance and exit designed for the posted speed limit in accordance with transition criteria approved by the City Engineer.

(6) Bus Bays
All bus pullouts and bays required by the City shall be designed and constructed in accordance with AASHTO guidelines.

(7) Bus Shelters
For access and design guidelines for bus shelters required by the City, refer to *AASHTO* guidelines and *"PROWAG"* standards.

(8) Bus Pullout Lanes
Bus pullouts shall be constructed with no less than fifty (50) feet between an intersection curb return (point of curvature, P.C.) and the beginning of the lead-in taper.

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2.3.23 Access Management & Design

(1) General
Driveway and street access to the public street system shall be evaluated in the preparation of any plans and Traffic Impact Analysis. The City Engineer may modify any of the requirements of the driveway location and design standards based on trip generation, topography, and/or the anticipated impacts on traffic safety and movement on the street. Notwithstanding any other provisions of these standards, an access, which demonstrates a potential threat or danger to the public and/or which could affect the safe and efficient flow of traffic, may be denied by the City Engineer, based on commonly accepted and applied traffic engineering principles.

(2) Driveway Design Criteria
Plans shall provide for compliance with the minimum standards noted below for access from one or more lots to a public street:

(3) Number of Driveways Permitted
Access to streets shall be provided to lots either by means of shared access easements, private-drive easements, including frontage or rear access drives, or direct access.

(a) From Arterial Streets

i. Shared-access or private-drive easements shall be used to serve multiple lots. However, when these are unavailable or deemed unnecessary by the City Engineer, then single lots fronting less than six-hundred (600) feet along an arterial street shall have no more than one driveway onto the arterial street.
ii. Lots fronting between six-hundred (600) feet and twelve-hundred (1,200) feet along an arterial street may have a second driveway, provided that the City Engineer may approve additional driveways based on trip generation or topography.

iii. Lots fronting in excess of twelve-hundred (1,200) feet along an arterial street may have additional driveways, provided that the City Engineer may approve additional driveways based on trip generation or topography, and it is determined that the impact to traffic safety and movement on the street will be minimal.

iv. Access to a corner lot fronting on two arterial streets shall be required to have access from the street with the lower average daily traffic volume. Access to a corner lot fronting on an arterial street, and bordered by a collector or local street, shall be required to have access only from the collector or local street. A lot may be permitted to have an additional driveway from the abutting arterial street, provided that the City Engineer may approve additional driveways based on trip generation or topography, and it is determined that the impacts on traffic safety and movement on the street will be minimal. Approval may be conditioned upon other geometric improvements which will mitigate traffic impacts.

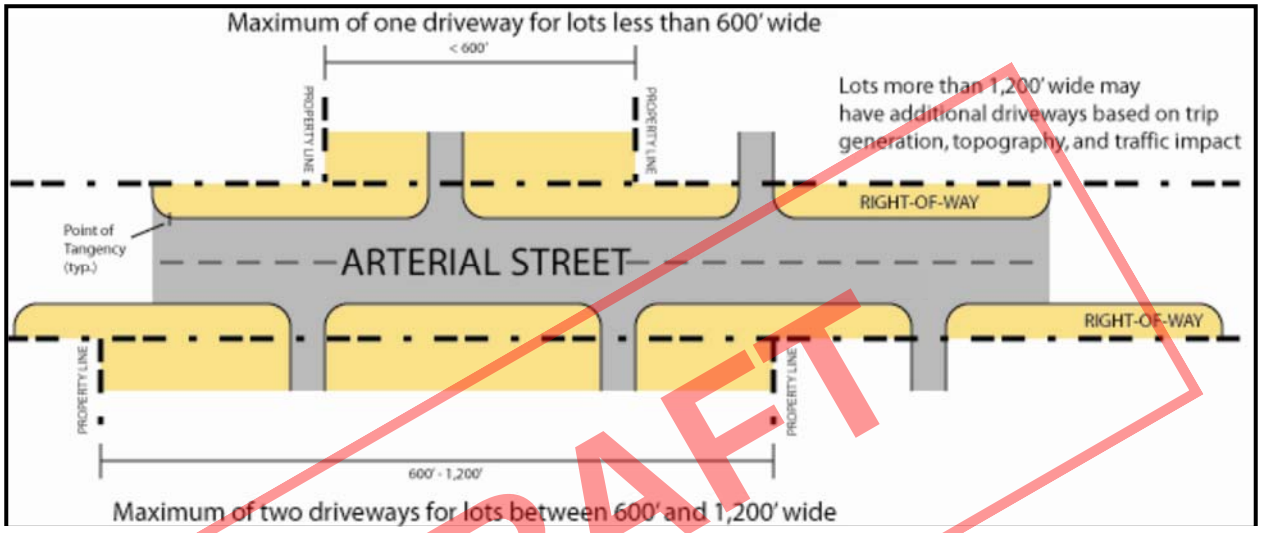

Figure 2.3 (8) – Arterial Street Driveway Spacing Criteria

(b) From Collector Streets

i. Single lots fronting less than three-hundred (300) feet along a collector street shall have no more than one driveway onto the collector street.

ii. For nonresidential uses, lots fronting more than three-hundred (300) feet along a collector street may have more than one driveway, provided that the City Engineer may approve additional driveways based on trip generation or topography, and it is determined that the impacts on traffic safety and movement on the street will be minimal.

iii. Access to a corner lot fronting on two collector streets shall be required to have access from the street with the lower average daily traffic volume. Access to a corner lot fronting on a collector street, and bordered by a local street, shall be required to have access only from the local street. A lot may be permitted to have an additional driveway from the abutting collector street, provided that the City Engineer may approve the driveway based on trip generation or topography, and it is determined that the impact on traffic safety and movement on the street will be minimal.

iv. In general, no access shall be permitted to residential lots from collector streets. However, where no alternative access is available, residential lots with one-hundred and twenty-five (125) feet of frontage or less shall be permitted to have one driveway. Residential lots fronting in excess of one-hundred and twenty-five (125) feet along a collector street may have more than one driveway, provided that the City Engineer may approve an additional driveway only if it will have a minimal impact on traffic safety and movement on the street. Driveways shall be a minimum of fifty (50) feet apart, measured from the nearest point of the radius return of the two driveways.

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Figure 2.3 (9) – Collector Street Driveway Spacing Criteria

(c) From Local Streets

i. There shall be no more than one driveway for lots fronting less than one hundred (100) feet along a local street.

ii. Lots fronting in excess of one-hundred (100) feet along a local street may have more than one driveway, provided that, if approved by the City Engineer for nonresidential uses or the Codes Department for residential uses, the additional driveway will be justified based on trip generation or topography, and it is determined that the impact on traffic safety and movement will be minimal. Driveways shall be a minimum of fifty (50) feet apart, measured from the nearest point of the radius return of the two driveways.

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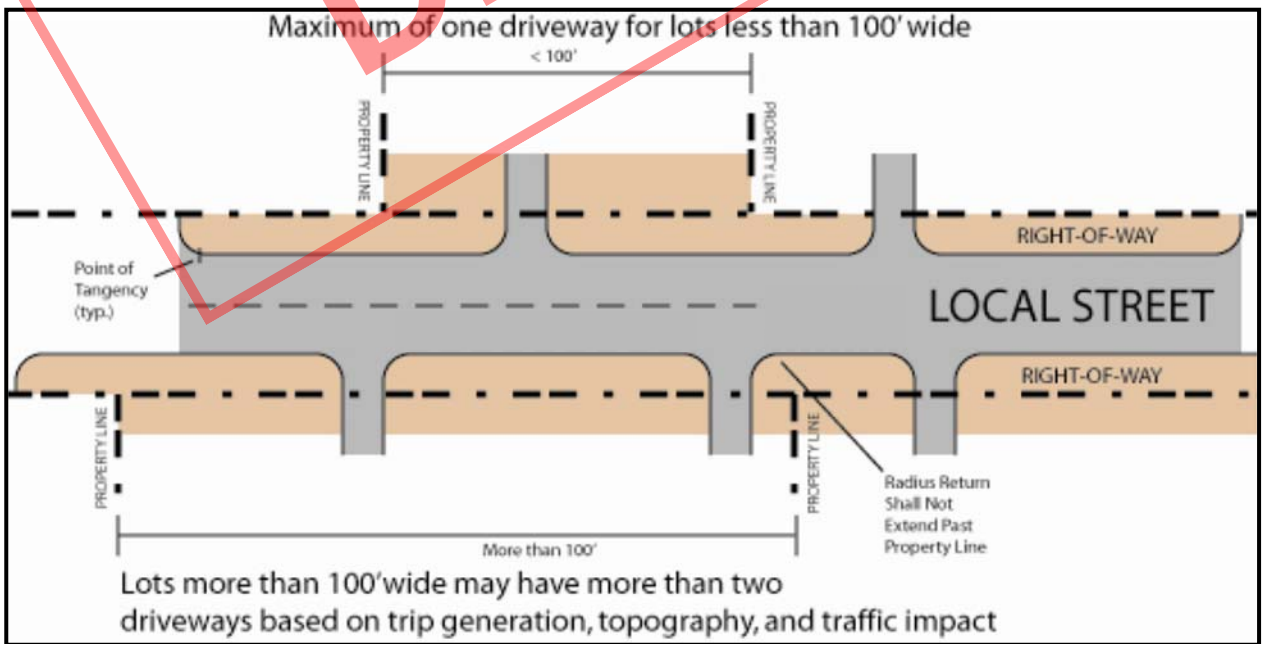

Figure 2.3 (10) – Local Street Driveway Spacing Criteria

(4) Minimum Distance from Intersections

(a) No low volume driveway to an arterial street shall be established within two-hundred and fifty (250) feet of an intersecting street. See **Figure 2.3 (11)** for design criteria.

(b) No low volume driveway to a collector street shall be established within two-hundred and thirty (230) feet of an intersecting street. See **Figure 2.3 (12)** for design criteria.

(c) No low volume driveway to a high volume local street shall be established within one-hundred and twenty-five (125) feet of an intersecting street. On low volume local streets, no low volume driveway shall be established within fifty (50) feet of an intersecting street. See **Figure 2.3 (13)** for design criteria.

(d) All distance measurements shall be made from the nearest point of tangency of the curve of the intersecting street right-of-way to the nearest point of radius return of the driveway.

(e) For residential uses, a corner lot abutting two local streets may have a driveway with less than the above required distance from the intersecting street, if, in the opinion of the City Engineer, the driveway will not adversely affect traffic safety and movement on the streets.

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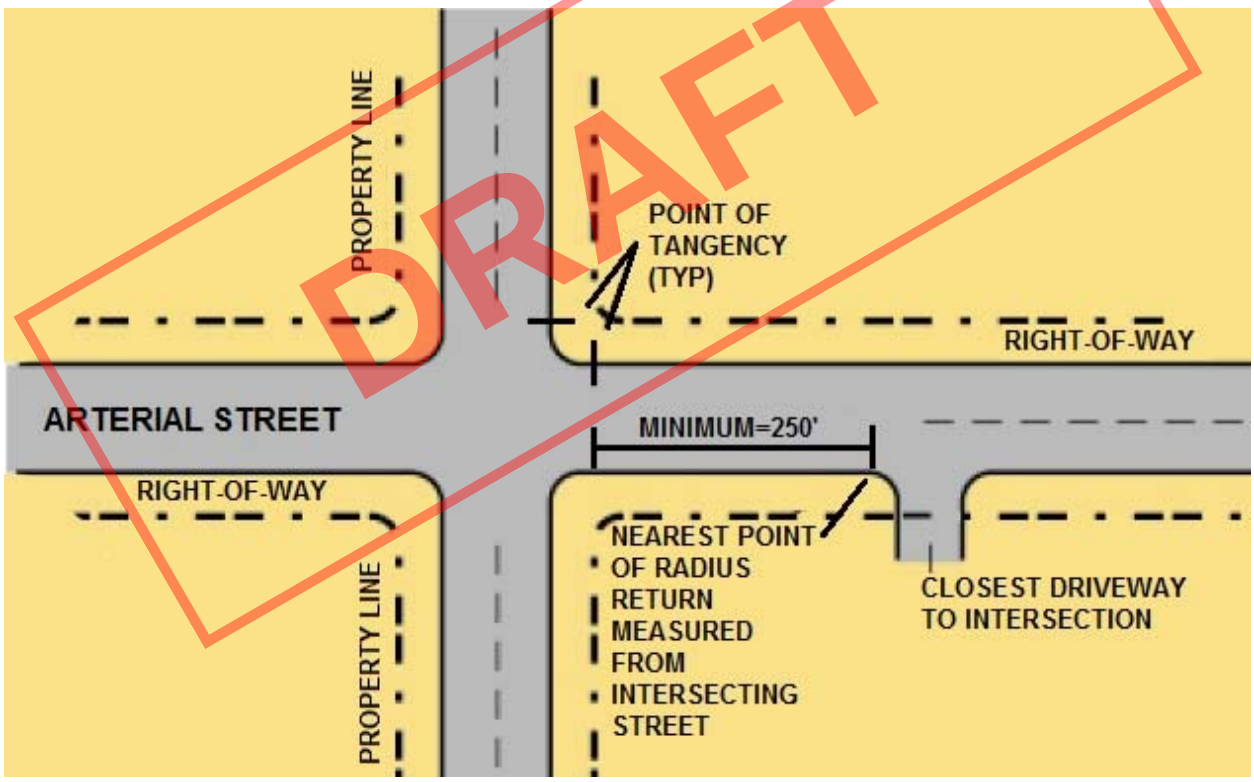

Figure 2.3 (11) – Arterial Street Driveway Intersection Clearance

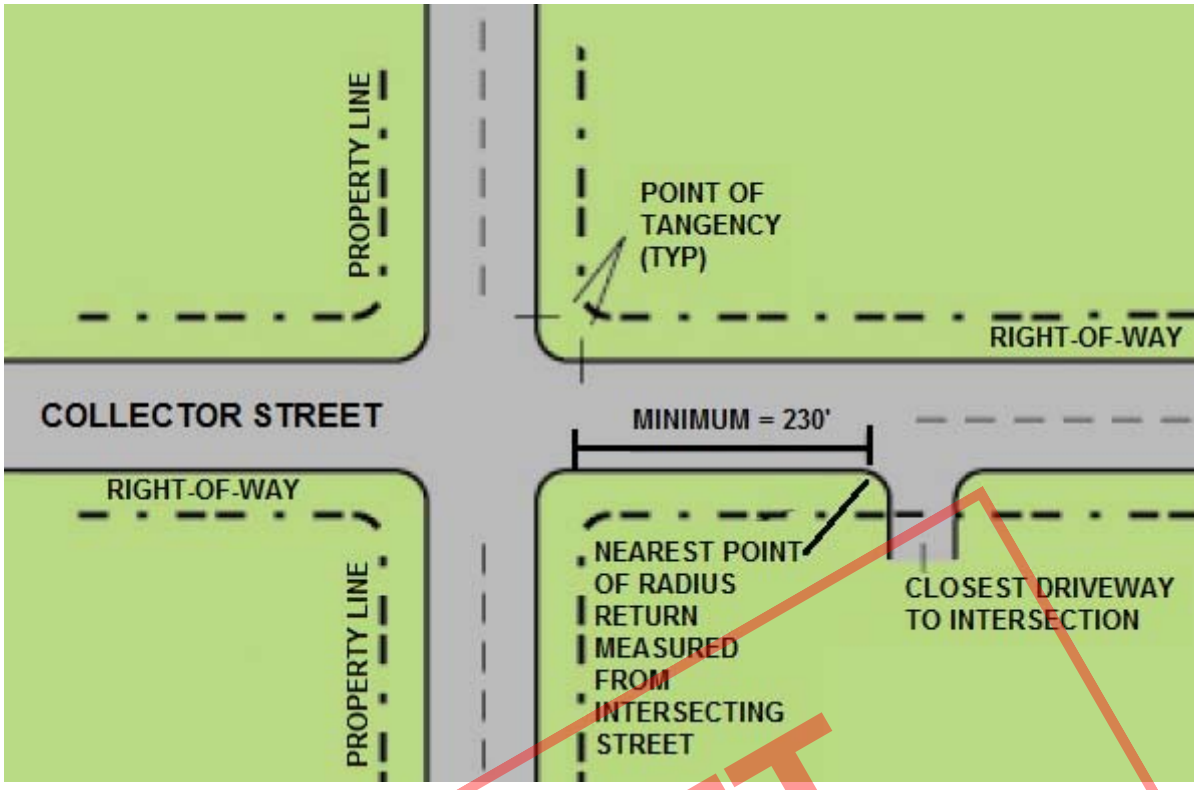

Figure 2.3 (12) – Collector Street Driveway Intersection Clearance

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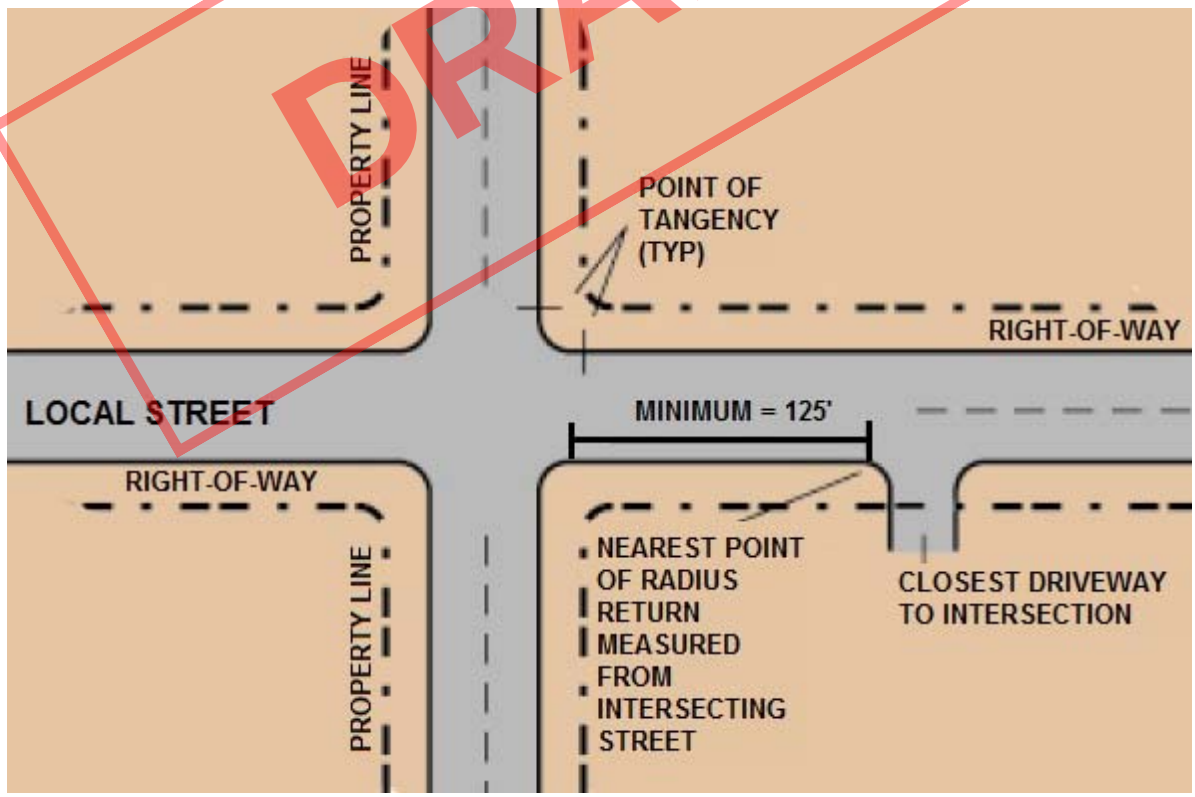

Figure 2.3 (13) Local Street Driveway Intersection Clearance

(5) Minimum Distance Between Driveways on Separate Lots

(a) The minimum distance between driveways serving separate lots shall not be less than those shown Table 2.3(2).

(b) The minimum distance may be reduced, provided that, if approved by the City Engineer for nonresidential uses, or Building and Neighborhood Services Department for residential uses, the following conditions exist, based on commonly accepted and applied traffic engineering principles: the use of shared-access or private street easements is not feasible or possible; exceptional topographic constraints or unusual site conditions exist at the driveway location (such as in-place utility or drainage features) which would make strict application of the standard exceptionally and/or practically difficult or unduly harsh; application of this section would conflict with other sections of this ordinance; and where the reduction would not constitute a threat or danger to the safe and efficient flow of traffic.

(6) Minimum Distance from Property Line

No driveway, other than a shared-access driveway, shall extend beyond a straight line projection of any side or rear lot line; provided, however, that the provisions may be waived subject to approval by the City Engineer for nonresidential uses or the Codes Department for residential uses.

(7) Deceleration Lanes

Approval of a nonresidential use driveway to an arterial or a collector street may be conditioned upon construction of a deceleration lane. The lanes shall be required in conjunction with each driveway to arterial or collector streets where a proposed land use will increase traffic volumes on the existing street to a total in excess of one-thousand (1,000) vehicle trips per day or one-hundred (100) peak-hour vehicle trips per day. The deceleration lane, a minimum of twelve (12) feet wide, measured from the face of the curb for curb sections without a monolithic gutter, the edge of the gutter for a monolithic curb and gutter section, or the edge of the shoulder line for a non-curbed section to the center of the lane line, shall be constructed to City standards with the length measured from the centerline of the driveway according to AASHTO's *"Green Book"*.

(8) Acceleration Lanes

In instances of unusual topography or traffic safety considerations, the City Engineer may require the construction of an acceleration lane for nonresidential uses. The length of taper and total length shall be determined based on AASHTO's *"Green Book"* and other commonly accepted and applied traffic engineering principles.

(9) Left-Turn Storage Lane

(a) Approval of a nonresidential use driveway to an arterial street or to a collector street which does not have an exclusive left-turn storage lane may be conditioned upon the construction of a left turn storage lane with appropriate median and/or pavement markings.

(b) The requirement and design of each storage lane, including the paved approach, bay, and departure tapers, shall be determined from the recommendations of the traffic study and approved by the City Engineer based on commonly accepted and applied traffic engineering principles. See **Figure 2.3 (3)** for design criteria.

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(10) Shared-Access Easements

(a) In the re-subdivision of property, the City Engineer may require private driveway easements or other conditions that require multiple lots or parcels to have shared vehicle access locations to arterial or collector streets such as through the use of rear-access or frontage drives where, in accordance with commonly accepted and applied traffic engineering principles, these may be necessary in order to provide for the safe and efficient flow of traffic. Rear-access or frontage drives shall be used only when they can be designed properly to provide safe and efficient access for properties.

(b) Where shared-access easements are required, the subdivision plat shall state that the transfer of lots shall be subject to the provision of such easements, which shall provide for a guaranteed, unrestricted, right of access to all other owners providing such easements and that the owners of lots subject to shared-access easements shall be required to execute an agreement specifying responsibility for construction and perpetual maintenance of the easements in accordance with the approved access plan. The agreement shall specify that the parties thereto shall hold the City harmless from liabilities resulting from unsafe conditions on shared-access easements.

Copies of the agreements from the current owners of lots through which shared-access easements are to run shall be filed with the City Engineer. Construction on shared-access easements shall not be commenced until all agreements are filed. Copies of all subsequent amendments to the agreements shall also be filed with the City Engineer.

(c) In the event that the owners fail to maintain shared-access easements in a safe and stable driving condition, the Building and Neighborhood Services Director, after appropriate notice, may have the unsafe or unstable conditions corrected and bill the owners for all reasonable costs. Should the owners fail to pay the City the amount of such charge within thirty (30) days from receipt of a certified invoice, then the costs shall be certified to the City Attorney, who shall process a lien on the properties upon which the expenditure was made.

(11) Driveway Approach Length and Restrictions

Driveways for nonresidential, multi-family, and other similar uses must extend a minimum of thirty (30) feet into the property from the lot line abutting the street before the edge of the driveway may be intersected by a parking lot space, aisle, or drive. The minimum length of the driveway restriction may be extended, provided that it is determined by the City Engineer that anticipated traffic volumes and commonly accepted and applied traffic engineering principles justify the need for longer, controlled storage lanes. See **Figure 2.3 (14)** for design criteria.

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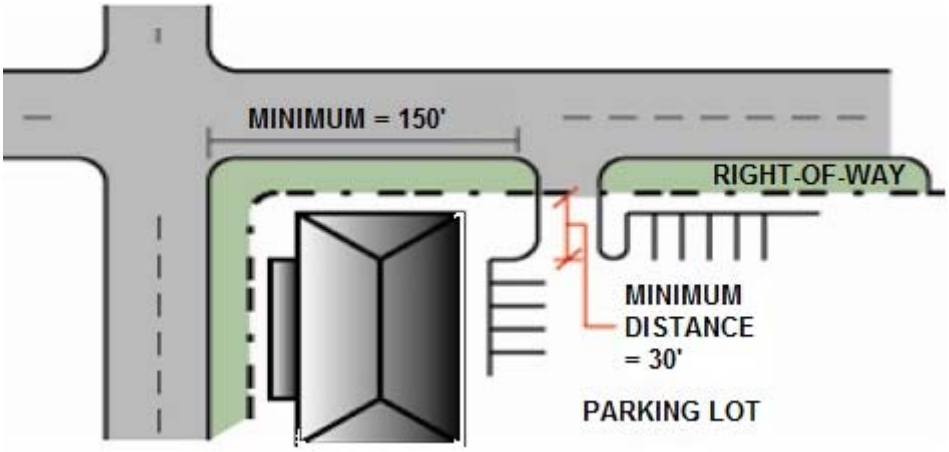

Figure 2.3 (14) – Driveway Approach Design Criteria

(12) Driveway Width Requirements

(a) The width of driveways, measured at the nearest points of the radius returns, shall meet the requirements in the table below.

(b) Driveways to nonresidential uses may exceed the maximum width, provided that it is determined by the City Engineer that the need to provide safer turning movements and/or the number of trips generated for truck traffic to or from the property will justify the need for additional driveway lanes.

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Table 2.3 (8) Driveway Width Requirements

Use	Drive Width (feet)	
	Minimum	Maximum
Residential (to individual dwelling units)	10	20
Nonresidential – One Way Traffic	15	20
Nonresidential – Two Way Traffic [note a]	24	36

NOTE: a. Multilane driveways may be wider subject to the approval of the City Engineer.

(13) Median Driveways

Median driveways, in which ingress and egress lanes are separated by a minimum four (4) foot wide raised concrete curb median, may exceed the maximum two-way width, provided that the individual ingress or egress lane will not exceed the limits of one-way access width, and the median will not exceed fourteen (14) feet in width. These dimensions and lanes may be increased for higher-volume driveways if justified by a Traffic Impact Study. Additionally, monuments, walks, vegetation, or signing must not be located in the median in such a way as to interfere with driver vision and safety when entering or exiting the driveway.

(14) Radius Return at Driveway Entrance

(a) The radius return connecting the edge of the acceleration or deceleration lane or through-traffic lane and edge of driveway shall meet the requirements of **Table 2.3 (9).**

(b) The radius of the driveway return to nonresidential uses may exceed the maximum radius length, provided that it is determined by the City Engineer that the need to provide safer

turning movements and/or the number of trips generated to or from the property for truck traffic will justify the need for additional radius length.

Table 2.3 (9) Radius Return at Driveway Entrance		
Use	Radius (feet) [1]	
	Minimum	Maximum
Residential	5	15
Nonresidential:		
- Arterial Street	25	40
- Collector Street	25	30
- Local Street	10	25

NOTES: [1] A driveway flare may be used instead of a curve for residential uses.

(15) Pavement Markings and Signing
Driveways with more than one ingress or egress lane shall have the pavement surfaced marked with center lines, lane lines, channelization lines, stop lines, and symbol arrows plus traffic control signing in accordance with the requirements of the *"MUTCD"*. The pavement markings and signing shall be continually maintained by the property owner in good condition and visible to drivers at all times.

(16) Materials
All driveway areas within the public right-of-way used for vehicular traffic shall be paved with Portland cement concrete (PCC) from the edge of street pavement to the edge of right-of-way or to the back of the sidewalk, whichever is farthest from the curb. PCC may only be required to extend to the back of sidewalk if approved by the City Engineer. In the event a driveway serving a residential use is crossed by a concrete sidewalk, the portion of the driveway from the sidewalk to the flare of the driveway shall utilize the same material and finish as the sidewalk.

(17) Additional Right-of-Way
The applicant shall provide or dedicate additional right-of-way and/or easement if it is determined by the City Engineer that the right-of-way and/or easement is necessary for street improvements, such as acceleration/deceleration lanes, as established on the approved access plan.

(18) Offset from Opposite Streets
Intersections of streets with Major Arterial streets shall only align with streets intersecting on the opposite side of the Arterial street where a traffic signal or Roundabout will be permitted unless a raised median exists within the Arterial street that restricts the access at the intersections to right-in and right-out turns only. All other intersections must be offset by a minimum of one-hundred and twenty-five (125) feet or greater as required by the City Engineer.

(19) Avoiding Conflicts in Center Left Turn Lane
When establishing the placement of offset accesses (either driveways or intersections), ensure that traffic making left-hand turns into the accesses does not conflict or compete for the simultaneous use of a center left turn lane.

(20) Potential for Future Signalization
For any driveway access to a Major Arterial, an Access Management Plan and a signal progression plan may be required by the City Engineer. Generally, private direct access is discouraged onto a Major Arterial street to allow the Arterial to better meet its primary function. Public street access to a Major Arterial, where left turns are to be permitted, must meet the signal spacing criteria and the Access Management Plan. Access points that do not meet these requirements shall normally be limited to right turns only, unless they meet the requirements above.

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(21) Public Street Intersection Spacing
Local streets should not typically intersect Arterials, but where they do they shall be spaced at a minimum of six-hundred and sixty (660) feet. Full movement access to Major Arterials shall be limited to one-half mile intervals wherever possible, plus or minus approximately two-hundred (200) feet, in order to achieve good speed, capacity, and optimal signal progression. However, to provide flexibility for both existing and future conditions, an approved engineering analysis of signal progression shall be made to properly locate any proposed access that may require signalization.

(22) Right Turns Only
Left turns may be prohibited, allowing right turns only. If left turns are restricted, raised medians will be required to prevent the left turn movements. Access points to arterials will normally be limited to right turns only (through signing and a raised median), unless:

(a) The access has the potential for signalization, in accordance with the general spacing requirements in this section,

(b) Left turns would not create unreasonable congestion or safety problems and not appreciably lower the level of service, and

(c) Alternatives to the left turns would not cause unacceptable traffic operation and safety problems to the general street system.

(23) Entrance-Only and Exit-Only Approaches
Driveway approaches, where the driveway is to serve as either an entrance-only or exit-only drive, shall be appropriately signed by, and at the expense of, the property owner to guide motorists in proper driveway operation. The property owner shall provide whatever means are necessary to ensure that motorists will use the driveway in the intended manner.

(24) Profile
The profile of a driveway approach and the grading of the adjacent area shall be such that when a vehicle is located on the driveway outside the traveled portion of the street the driver can see a sufficient distance in both directions to enter the street without creating a hazardous traffic situation. The driveway profile grade within twenty (20) feet of the flow line shall not exceed eight (8) percent unless a variance is approved by the City Engineer. Driveways within the sidewalk and parkway area of the right-of-way shall slope toward the street. See **Figures 2.3 (15)** for allowable grades and grade breaks for driveway approaches.

(25) Adjustments for Existing Structures
Any adjustments made to utility poles, street light standards, fire hydrants, catch basins or inlets, traffic signs and signals, or other public improvements or installations required for the curb openings or driveways shall be accomplished without cost to the City.

(26) Access to Streets with No Curb and Gutter
Private drive access to Local, Collector, or Arterial streets that have no curb and/or gutter improvements shall be constructed to meet the following requirements:

(a) **Surface Requirements**: The driveway shall extend from right-of-way line to edge of existing driving surface and shall be constructed based on local street section or concrete driveway per City Standard Drawings.

(b) **Right-of-Way**: New driveway accesses from private property to existing pavement shall be paved within the right-of-way. On Local rural streets HBP or concrete pavement shall be installed from

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the right-of-way line to the edge of the traveled street. The width of the driveway within the right-of-way shall be twelve (12) to twenty-two (22) feet.

(c) **Culvert**: A culvert shall be installed at the established roadside ditch flow-line elevation beneath the private drive access. The culvert diameter shall be specified by the approved storm drainage report or in absence of the report by the City. A culvert shall be installed in the flow-line of the borrow ditch of a size necessary for the design storm flow (fifteen (15) inch minimum diameter). The pipe shall have flared end sections. The minimum cover over the culvert shall be twenty-four (24) inches. Additional cover may be required for heavy vehicles.

(d) **Sketch Plan**: A drawing of the proposed driveway installation showing all dimensions shall be submitted with the right-of-way or Access permit application.

(27) Entrance Angle

In general, the entrance angle for all driveway approaches and intersections shall be as near ninety degrees (90°) to the centerline of the street as possible. The minimum angle that will be permitted is ninety degrees (90°) plus or minus ten degrees (10°) for a minimum of twenty-five (25) feet measured perpendicular to the street and measuring from the curb or edge of pavement toward the private property served.

(28) Access Approaches

Access approaches shall not be approved for parking or loading areas that require backing maneuvers within the right-of-way except on Local Residential streets. All off-street parking areas on Collector and Arterial streets must include on-site maneuvering areas and aisles to permit user vehicles to enter and exit the site in forward drive.

(29) Minimum Off-Street Parking Set Back Distance

Parking maneuvers within a parking lot shall not restrict entering vehicles from safely and efficiently entering the driveway from the public street. The minimum parking setback distance for non-residential driveways is 30 feet from the right-of-way line as described in **Section 2.3.23(11).** The City Engineer may increase this distance based on a Traffic Impact Study.

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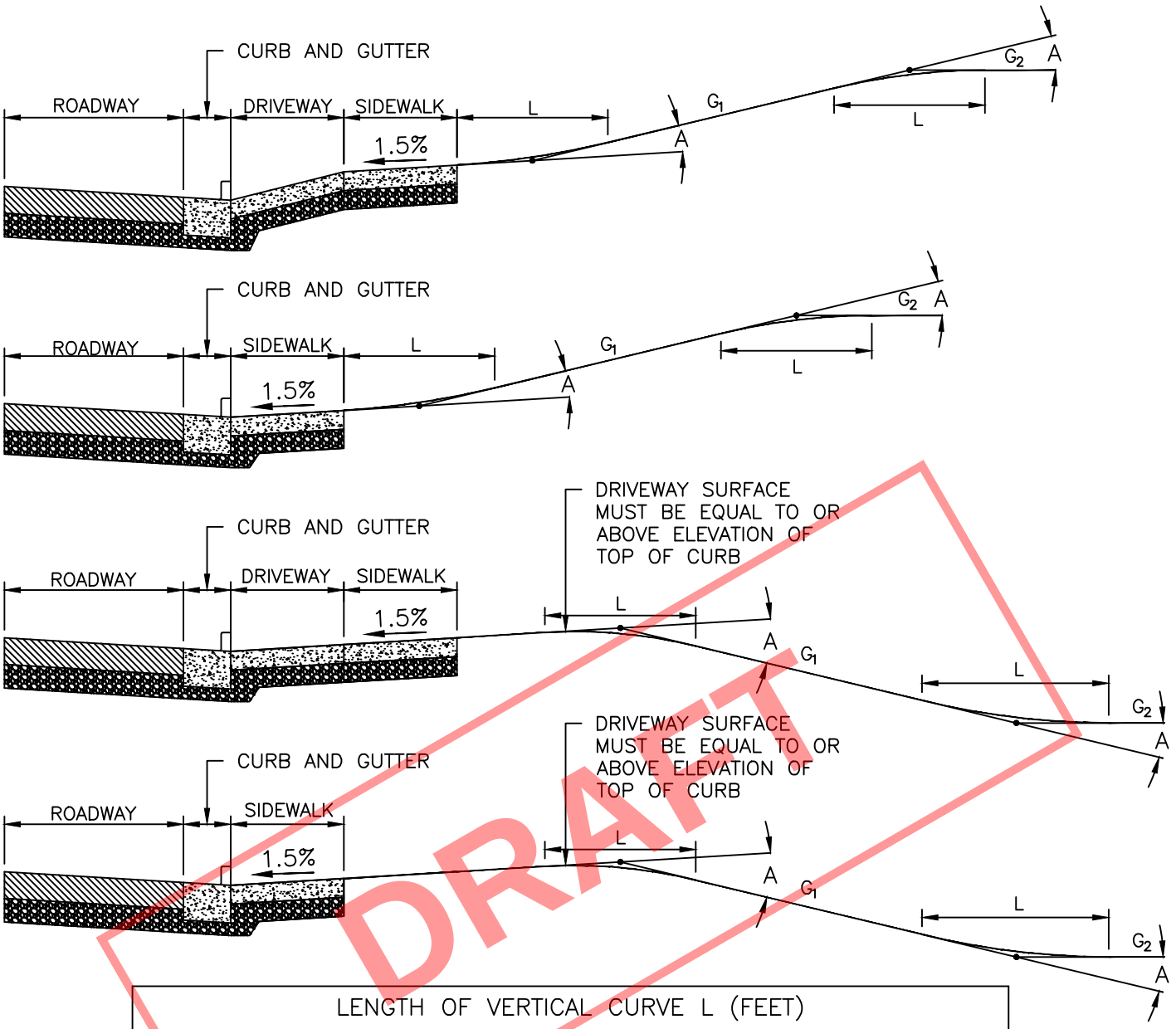

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LENGTH OF VERTICAL CURVE L (FEET)				
CHANGE IN GRADE, A	CREST MINIMUM LENGTH		SAG MINIMUM LENGTH	
	DESIRABLE	MINIMUM	DESIRABLE	MINIMUM
4–5%	5 Ft	3 Ft	7 Ft	4 Ft
6–7%	6 Ft	4 Ft	8 Ft	5 Ft
8–10%	8 Ft	5 Ft	10 Ft	7 Ft

1) GRADES SHALL BE COMPATIBLE WITH THE SITE REQUIREMENTS FOR SIGHT DISTANCE AND DRAINAGE, TO PREVENT EXCESSIVE DRAINAGE RUNOFF FROM ENTERING THE ROADWAY OR ADJACENT PROPERTY.
2) MAX CHANGES IN DRIVEWAY GRADES WITH A VERTICAL CURVE (BETWEEN THE PAVEMENT CROSS SLOPE AND THE DRIVEWAY APRON SLOPE) IS 10% FOR PRIVATE RESIDENTIAL DRIVEWAYS AND 8 PERCENT FOR ALL OTHER DRIVEWAYS.
3) MAXIMUM DRIVEWAY GRADES WITHIN TWENTY (20) FEET OF THE FLOW LINE SHOULD BE LIMITED TO 8 PERCENT UNLESS APPROVED BY THE CITY ENGINEER. WHERE POSSIBLE, THE DRIVEWAY GRADE SHOULD BE LIMITED TO 6 PERCENT OF LESS WITHIN THE ROADWAY RIGHT–OF–WAY
4) THE LENGTH OF THE VERTICAL CURVE BETWEEN THE PAVEMENT CROSS–SLOPE AND THE DRIVEWAY APRON IS A FUNCTION OF THE ALGEBRAIC DIFFERENCE IN THE GRADES. SEE TABLE ABOVE FOR DESIRABLE AND MINIMUM LENGTHS FOR THESE VERTICAL CURVES.

HISTORIC FRANKLIN TENNESSEE

N.T.S

DRIVEWAY APPROACH PROFILE DESIGN CRITERIA
FIGURE 2.3 (15)

(31) Drainage

(a) Drainage at Curb Cuts: Where curb cuts are allowed, concentrated storm water runoff from property adjoining the right-of-way shall not be discharged across the sidewalk. These flows must be directed elsewhere or directed to a sidewalk chase where storm water may pass under a sidewalk section.

(b) Sheet Flow Drainage: Sheet flow drainage is allowed where it does not interfere with the pedestrian use of the sidewalk

(32) Change in Use

If the use of an existing access to right-of-way changes, or there is a change in the use of the property, the change in access use must be approved through the development review process, access management plan, or traffic impact analysis. Change in access or property use may include, but is not limited to, change in the amount or type of traffic (twenty (20) percent or twenty-five (25) vehicles per hour, whichever is less), structural modifications, remodeling, change in type of business, expansion in existing business, change in zoning, change in property division creating new parcels, etc.

(33) Un-permitted Access

Any access, driveway, or curb-cut which is constructed within public right-of-way without a right-of-way or access permit issued by the City (or State if a State highway) shall be subject to removal. Failure to remove the un-permitted access may result in the removal of said access by the City. The cost for removal shall be charged to the property owner from which the access originates.

(34) Abandoned Access

If a parcel of land with direct access has been in a state of non-use for more than one year, re-commencement of access use shall be considered a change in use. If the use of the access exceeds the design limitations of the access or does not conform with the present code, a new approval may be required through the development plan review process, access management plan, or the City's work in right-of-way permit.

(35) Removal

Any curb opening or driveway that has been abandoned shall be removed and restored by the property owner except where such abandonment has been made at the request of, or for the convenience of, the City.

(36) Access Permit Required/Appeals

(a) No curbs or rights-of-way shall be cut, paved, or otherwise altered for the purposes of obtaining access until a permit approving the access cut has been secured from the City and/or any other governmental agency owning or controlling street right-of-way.

(b) Whenever the City disapproves the location and design of a residential access, or when it is claimed that an equally good or more desirable access plan can be employed, or when it is claimed that the true intent and meaning of these standards have been misconstrued or wrongly interpreted, then the property owner, or his duly authorized agent, may appeal the decision to the City Engineer.

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2.4 Pedestrian Facilities

All streets shall accommodate pedestrian travel as called for in this chapter

2.4.1 ADA Requirements

All pedestrian facilities provided within a City street right-of-way or easement shall be designed to accommodate movement by the disabled as required by the *Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way*.

2.4.2 Typical Sections

(1) Sidewalk Location

The minimum cross sections for sidewalks are provided in **Table 2.3 (1)**, and as shown in the Typical Section Drawings. These cross-sections are consistent with the City's Major Thoroughfare Plan and shall be used to construct sidewalks along both sides of a street. As shown, the cross sections are dependent upon the classification of the street on which they are located. For additional information regarding street classifications and street cross-sections, see **Section 2.2**.

(2) Sidewalks on Streets with Ditches

On a street that has ditches instead of curb and gutter; the sidewalk shall be five (5) feet wide and constructed of concrete. It shall also be located behind the ditch. Vertical objects shall be placed at least one (1) foot from the sidewalk edge. A one (1) foot wide graded area that has a maximum slope of 6:1 shall be provided on each side of the sidewalk. The grass strip buffer, which contains the ditch and is located between the innermost graded area and the edge of the street, shall be at least twelve (12) feet wide and shall be landscaped with grass. Drainage requirements may dictate an increased ditch section.

2.4.3 Managing Access for Pedestrian Safety

Unlimited access creates many points where conflicts may occur between pedestrians and vehicles entering or leaving the street. By restricting the number and size of driveways along a street, many of these potential conflicts can be avoided. Multiple driveways that have multiple lanes and continuous access driveways shall be avoided. When possible, multiple driveways shall be combined. If these driveways serve adjacent properties, cross-access drives between the properties shall be provided in order to eliminate the need for multiple driveways. Continuous access driveways shall be re-designed to create a limited number of entry/exit points. This design shall include grass strips between the street and the parking lot to prevent access at unwanted locations.

2.4.4 Intersections

All intersections shall be designed with the assumption that pedestrians will be present. Signalized intersections shall have crosswalks that are clearly marked. They shall also have ramps, landings, pedestrian push buttons, and other pedestrian features that are accessible to everyone. The signing and pavement markings at intersections shall clearly indicate how all street users should operate.

2.4.5 Sidewalk Ramps

A sidewalk ramp shall be constructed for each crosswalk at each street corner, as illustrated in the Standard Drawings. In addition to providing the shortest, direct route between sidewalks, this practice makes it easier for pedestrians crossing the street to see right-turning vehicles. If only a single, diagonal sidewalk ramp is provided at a street corner, then right-turning vehicles approach pedestrians crossing the intersecting street from behind. If two perpendicular sidewalk ramps are provided, then right-turning vehicles will approach the pedestrians from the side.

2.4.6 Corners

An obstruction-free area shall be provided at street corners between the curbs and a continuation of the adjacent property lines. At a minimum, this distance shall be twenty feet. Only pedestrian push button posts and other pedestrian features shall be located in this area.

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2.4.7 Crosswalks

(1) Crosswalk Locations

Crosswalks shall be provided at each stop controlled leg of intersections where significant pedestrian activity is encouraged or exists. Crosswalks across non-stop controlled legs of intersections shall not be allowed. Midblock crossings will be reviewed on a case-by-case basis and per 2.4.7 (3) below. All crossings shall conform to Public Right-of-Way Accessibility Guidelines (PROWAG) guidelines.

Standard Crosswalk

(2) Crosswalk Markings

Crosswalks shall be clearly marked with a "ladder" pattern, as shown in the Traffic Control chapter, so that they are highly visible to all street users. Crosswalks that are marked with reflective white thermoplastic tape are more visible than those that are marked with brick or cobblestone, especially at night and during rain. Crosswalks that are marked with brick or cobblestone can be made more visible by outlining them with reflective white thermoplastic tape or white concrete outline. Brick and cobblestone are not recommended for crosswalks because these materials can create bumpy paths that are difficult for people with limited mobility to navigate.

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(3) Midblock Crosswalks

Midblock crosswalks shall adhere to the following criteria:

(a) Midblock pedestrian crossing facilities shall abide by the MUTCD and FHWA "*Guide for Improving Safety at Uncontrolled Crossing Locations*", July 2018 Updated, with applicable countermeasures per roadway facility type and as approved by the City Engineer (See Table 1 of the "*Guide for Improving Safety at Uncontrolled Crossing Locations*" for recommended countermeasures).

(b) Midblock pedestrian crossings may be considered when protected intersection crossings are spaced greater than 400 feet or so that crosswalks are located no greater than 200 to 300 feet apart in high pedestrian volume locations. Examples of high volume pedestrian locations include mixed-use pedestrian/bike paths not near a stop controlled intersection, neighborhood pool/park facilities that are located away from a protected intersection crossing, school crossings, parking lots in which pedestrians must cross a roadway to get to an office building, mixed use developments with few stop controlled intersection crossings, etc.

(c) Midblock crosswalks shall be located at least 125 feet from the nearest side street or driveway so that drivers turning onto the major street have a chance to notice pedestrians and properly yield to pedestrians who are crossing the street.

(d) Proper stopping sight distance at design speed shall be required. Landscaping or other objects that hides or shields a pedestrian waiting to cross a midblock crossing shall not be allowed.

(e) Safety street lighting shall be installed on both sides of midblock crossings.

(f) Advance crosswalk warning signs and/or yield lines may be required by the City Engineer.

2.4.8 Detectable Warning Surfaces

The *Accessibility Guidelines for Pedestrian Facilities in the Public right-of-Way* calls for detectable warnings for pedestrian street crossings, including curb ramps and blended transitions, certain median and refuge islands, and rail lines. These surfaces feature a distinctive pattern of raised domes to provide a tactile cue detectable by cane or underfoot at the boundary between pedestrian and vehicular routes. The City's standard material for installing detectable warnings shall be (ADA Solutions, Inc. or approved Equal) cast in place and shall contrast visually with adjacent walking surfaces either light-on dark or dark-on light. Brick red detectable warnings shall be used within City of Franklin right-of-way, and yellow detectable warnings shall be used within State of Tennessee right-of way.

2.4.9 Transit Stops

Transit stops shall typically be located at the far side of an intersection**.** This design encourages pedestrians to cross behind the bus, improving their visibility to oncoming vehicles. A bus stop located on the near side of an intersection blocks the site lines between pedestrians and motorists. The preferred location for a transit stop waiting area is in the buffer strip between the sidewalk and the street. All transit stops shall comply with *Public Rights-of-Way Accessibility Guidelines*.

2.4.10 Grade-Separated Pedestrian Crossings

Grade-separated pedestrian crossings may be warranted across freeway, expressway or arterial streets where the volume of projected vehicular and pedestrian traffic justifies the expense of such a facility. Pedestrian overpasses and underpasses shall be designed based on *Public Rights –of - Way Accessibility Guidelines*. Where the grade separation directs the pedestrians under the street, the subway path shall be substantially illuminated and recessed into the structure.

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2.5 Bicycle Facilities

All streets designed in the City shall accommodate bicycle travel as called for in this chapter of these standards and further defined in the City's Major Thoroughfare Plan (latest edition). Specific streets as outlined in the Plan shall receive the design treatments so designated.

Typical bike lane with signing and markings

2.5.1 Types of Facilities

A bicycle lane is a travel lane that is between four (4) and six (6) feet wide and that is designated for exclusive use or preferential use by bicyclists. The City standard shall be as shown in **Table 2.3 (1).** Bicycle lanes are separated from travel lanes with a lane stripe and are identified by pavement markings and signing. These facilities shall be one-way facilities, located on the right side of the street, that carry bicycle traffic in the same direction as the adjacent motor vehicle traffic. Another type of bicycle lane is a shoulder bikeway. A shoulder bikeway is a paved shoulder that is at least five (5) feet wide and that is separated from motor vehicle traffic by a lane stripe. It is also designated by signing. Unlike a bicycle lane, a shoulder bikeway is not designated exclusively for bicyclists. It may serve as a location to temporarily park a damaged vehicle, or it may serve other functions. Typically, shoulder bikeways are applied to rural streets that do not have curb and gutter.

2.5.2 Bicycle Shared Streets

A shared street is a street in which motorists and bicyclists share the same travel lanes. There are three types of shared streets. These are:

- Wide outside lane (WOL)
- Signed shared roadway (SSR)

- Local street

(1) A WOL is a travel lane, located on the right side of the street, that is typically fifteen (15) feet wide and that is shared by motorists and bicyclists. The extra width that is provided by a WOL allows motorists to comfortably pass bicyclists without changing lanes and without getting too close to the bicyclists. WOLs are identified by signing and can include pavement markings.

(2) A SSR is a street that is shared by motorists and bicyclists and is identified by signing. Unlike WOLs, SSRs do not provide additional street width for bicyclists. However, they should provide features that make them suitable for bicyclists. These features include traffic control devices that are sensitive to bicyclists, bicycle-safe storm grates, and smooth pavement surfaces. They should also be routinely swept in order to prevent debris from accumulating on the street. Typically, SSRs are reserved for streets that have a high demand for bicycle traffic but cannot accommodate a bicycle lane or WOL due to physical constraints. SSRs should be considered as temporary bicycle facilities and should be replaced by bicycle lanes or WOLs as soon as this is feasible.

(3) Local streets are typically low-speed, low-volume streets. Therefore, they do not usually require special treatment in order to accommodate bicyclists. However, signing may be used to identify a through-bicycle route that follows a local street.

2.5.3 Multi-use Paths/Greenways

A multi-use path/greenway is a designated facility that is used for bicycling, walking, running, skating, and other forms of non-motorized travel. It is physically separated from motorized vehicular traffic by a barrier or open space, and can be located within a street right-of-way or an independent right-of-way. Paths/greenways are typically twelve (12) feet wide. They are not part of the street network, but may travel parallel to certain street segments. Also, these facilities may follow the course of natural boundaries, such as rivers and streams, or man-made boundaries, such as railroad lines and utility easements. See Typical Section Drawings.

2.5.4 Bicycle Typical Sections

The recommended cross-sections for bicycle lanes, shared streets, and multi-use paths are presented in the Typical Section Drawings. These cross-sections are generally consistent with the recommendations of the City's Major Thoroughfare Plan. In addition to the recommendations contained in this plan, AASHTO's "*Guide for the Development of Bicycle Facilities"* and the "*MUTCD"* shall be consulted in order to determine appropriate pavement markings, signing, etc. for new bicycle facilities.

2.5.5 Intersections

Intersections shall be designed so that a bicyclist's path of travel is direct, logical to both bicyclists and motorists, and is as similar to the path of motor vehicle travel as possible. Also, bike lanes shall extend to the stop line/ crosswalk and shall not extend through the pedestrian crossing.

(1) T-Intersections

Bike lanes at T-intersections shall be constructed according to the design illustrated in the City's Major Thoroughfare Plan. As shown, left and right turn lanes for bicycles shall be provided unless severe physical constraints prevent the construction of two bicycle turn lanes. If physical constrains do exist, then the bicycle turn lanes can be omitted as long as the vehicular left turn lane is fourteen (14) feet wide. With either design, the bike lane across from the intersection shall be striped through the intersection. However, this bike lane shall not be striped through the crosswalks.

(2) Intersections without Exclusive Right Turn Lanes

When a bike lane is present at an intersection that does not have an exclusive right turn lane, the solid bike lane stripe shall be replaced with a dashed line at least fifty (50) feet prior to the stop line/crosswalk.

(3) Intersections with Exclusive Right Turn Lanes

At intersections with exclusive right turn lanes, the paths of motorists and cyclists should cross in advance of the intersection in order to reduce the number of conflicts that occur at the intersection. The pavement

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markings shall direct bicyclists to the left of the exclusive right turn lane. The bike lane stripes shall be dashed across the area where motorists should cross into the right turn lane. The solid bike lane markings shall resume when the right turn lane achieves full width and shall continue to the stop line/crosswalk. Under severe physical constraints, the bike lane can be terminated if the outermost through lane is fourteen (14) feet wide.

(4) Intersections with Dual Right Turn Lanes
At an intersection with a right turn lane and a shared through/right turn lane, the bike lane shall terminate at the location where the taper for the right turn lane begins. A dashed line shall be striped between the edge of pavement at the terminus of the bike lane to the lane stripe between the dual right turn lanes. The shared through/right turn lane shall be fourteen (14) feet wide. Also, signing alerting motorists and bicyclists of the approaching lane configuration is recommended.

(5) Complex Intersections
Intersections of multiple streets and intersections that have offset lanes or skewed streets can create confusion for motorists and bicyclists. When possible, these intersections should be realigned so that the intersecting streets are perpendicular to each other, with only two streets intersecting at a given point. If a complex intersection cannot be avoided, then bike lanes at the intersection shall be defined with a dashed line strip through the intersection. However, the bike lanes shall not be striped through the crosswalks.

2.6 Traffic Calming

2.6.1 General
This section presents acceptable methods of neighborhood traffic calming that are determined by the City to be acceptable for use on existing local streets. This chapter also provides for specific design criteria for a number of traffic calming methods.

(1) Intended Use
The necessity or desire for traffic safety and calming stems from the perception that local streets, particularly in residential areas, do not always function as intended. These streets shall be low traffic volume streets used for direct access to residences on the street. They are also intended as a multi-modal system that is shared by vehicular, bicycle, and pedestrian traffic equally, in a manner that minimally impacts residents in these areas.

(2) For New Street Design
The devices presented in this section are generally not intended for use on new streets. New street design is addressed earlier in this section. New local streets are to be designed to minimize cut through traffic, high volumes, and high speed operation and to maximize the efficiency of the street to provide vehicular access and bicycle and pedestrian traffic. Plans prepared for new streets serving residential, nonresidential, and mixed-use development shall comply with the following standards:

(a) Minimal street widths, short block lengths, on-street parking, controlled intersections, roundabouts, and other traffic calming measures shall be used on all local and minor collector streets to the maximum extent practicable.

(b) In cases where residential development has been organized around a grid street network, measures to interrupt or terminate long vistas exceeding twelve-hundred (1,200) feet in length shall be employed to the maximum extent practicable. Such measures shall include, but shall not be limited to:

i. Curvilinear street segments;
ii. Street jogs or off-sets designed to require vehicles to slow their travel speed;

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iii. Street chicanes or neck downs;
iv. Terminated vistas;
v. Mid-block traffic circles; and
vi. Stop signs at street intersections, where warranted.

2.6.2 Traffic Calming Design Criteria

Reference the City of Franklin Neighborhood Traffic Calming Program (NTCP) on the City of Franklin Engineering webpage for traffic calming requirements.

2.6.3 Traffic Calming Techniques

(1) Approved Techniques

There are a variety of techniques that can be used to calm traffic on local, residential streets. Techniques that are specifically permitted, as well as techniques that are specifically prohibited, in the City are described below. Techniques that are specifically permitted are summarized in the following table, which also identifies the potential benefits and disadvantages of each.

Table 2.6 (1)
POTENTIAL IMPACTS OF TRAFFIC CALMING TECHNIQUES THAT MAY BE USED IN THE CITY OF FRANKLIN

Measure	Potential Benefits			Potential Disadvantages			Cost
	Speed Reduction	Volume Reduction	Conflict Reduction	Limits Local Access	Increases Emergency Response Time	Extent of Maintenance Required	
Chicane	●	●	●	○	◎	◎	$$-$$$
Curb Extension	◎	○	○	○	○	◎	$-$$
Education	◎	○	◎	○	○	○	$
Enforcement	◎	○	◎	○	○	○	$-$$
Lower Speed Limit	◎	○	○	○	○	○	$
Raised Median	◎	○	◎	◎	○	◎	$-$$
Road Diet	◎	○	◎	○	○	○	$-$$$
Speed Table/Hump	●	◎	●	○	◎	◎	$-$$
Traffic Circle	●	◎	●	○	◎	◎	$$-$$$

● Substantial Benefits/Disadvantages ◎ Minor Benefits/Disadvantages ○ No Benefits/Disadvantages
$ Low Cost $$ Moderate Cost $$$ High Cost

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(a) Chicane: A chicane shifts motorists' path of travel by creating a horizontal diversion in the roadway. A chicane is usually formed by a series of curb extensions that are placed on alternating sides of the roadway. These curb extensions reduce the roadway width and force motorists to steer from one side of the roadway to the other in order to travel through the chicane. See **Figure 2.6 (2)** for a typical drawing of this technique.

(b) Curb Extensions: Curb extensions are formed by extending the curb on one or both sides of the roadway into the vehicular travel lanes to reduce the paved roadway width. The reduction in width creates "slow points" in traffic flow. Curb extensions are also commonly referred to as chokers, neck downs, traffic throats, and pedestrian bulbs. Curb extensions reduce the width of the roadway at intersections and create shorter crossing distances for pedestrians. The reduction in lane width encourages motorists to slow down when driving through the intersection. See **Figure 2.6 (3)** and **Figure 2.6 (4)** for a typical drawing of this technique.

(c) Education: Education is a key component of all traffic calming projects in the City. Before implementing physical traffic calming measures, the City Engineer will work with participating neighborhoods to educate their residents regarding safe, on-street, vehicular travel. The City Engineer will assist the neighborhood associations/groups in developing educational programs for the residents. However, it will be the responsibility of the neighborhood associations/groups to implement the educational programs.

(d) Enforcement: Enforcement efforts will be combined with neighborhood education as a first step in all traffic calming projects in the City. The Police Department will work with the City Engineer to help resolve traffic problems, such as speeding. Enforcement efforts may involve the use of speed trailers and may include tickets for violators.

(e) Lower Speed Limits: Establishing lower speed limits may help to reduce speeding and cut-through traffic in residential neighborhoods. Some local, residential roadways have speed limits that are posted at 30 MPH or more. It may be desirable to lower the speed limits on these roadways to the City's default speed limit, which is 25 MPH for local, residential streets.

(f) Raised Median: A raised median is an elevated island that is constructed on the centerline of a two-way street to reduce the width of the adjacent travel lanes. Raised medians can be paved or landscaped. They create "slow points" in the roadway, can serve as pedestrian refuges for pedestrians crossing the street, and can be used in conjunction with other traffic calming measures. See **Figure 2.6(5)** for a typical drawing of this technique.

(g) Travel Lane Reduction: Reducing the number of travel lanes, or the width of travel lanes, on a roadway can be an effective technique for calming traffic on that street. This process, called a "road diet", can help to reduce vehicular speeds, reduce the number of conflict points for right-of-way users, and can help make streets more bicycle and pedestrian-friendly. Road diets can be accomplished by adding parking lanes, adding bike lanes, adding a median, or by reclaiming some of the roadway width, which can create room for sidewalks and street trees.

(h) Speed Table/Hump: A speed table/hump is a wide and flat undulation that is placed on a street, typically across the width of the roadway, to reduce vehicular speeds. They have a height of three (3) to four (4) inches and a length of twelve (12) or twenty-two (22) feet. Speed humps shall be distinguished from speed bumps, which are much shorter (six to twelve inches long) and have been associated with maintenance, safety, and liability concerns. The speed table/hump that may be used in the City is twenty-two (22) feet long and three (three) inches high. See **Figure 2.6 (6)** for a typical drawing of this technique.

(i) Traffic Circle: A traffic circle is a raised, circular island that is typically placed in the center of a residential street intersection to allow traffic to flow through the intersection without being controlled by a stop sign or a traffic signal. The design of a traffic circle requires motorists to travel through the intersection in a counter-clockwise direction around the island, which reduces the number of conflict points and reduces vehicular speeds. A traffic circle creates a horizontal deflection in the roadway, which causes motorists to slow down as they travel through the intersection. See **Figure 2.6 (7)** for a typical drawing of this technique.

(2) Prohibited Techniques

(a) Rumble Strips: Rumble strips are raised buttons, bars, or groves that are closely placed on a roadway at regular intervals. They cause both noise and vibration in vehicles as motorists drive over them. Typically, rumble strips are used to alert motorists of unusual conditions ahead. As motorists get used to the rumble strips, the strips become less effective over time. Rumble strips can result in increased noise levels for nearby residents. Also, rumble strips require a high amount of maintenance. For these reasons, rumble strips shall not be used as a traffic calming technique in the City.

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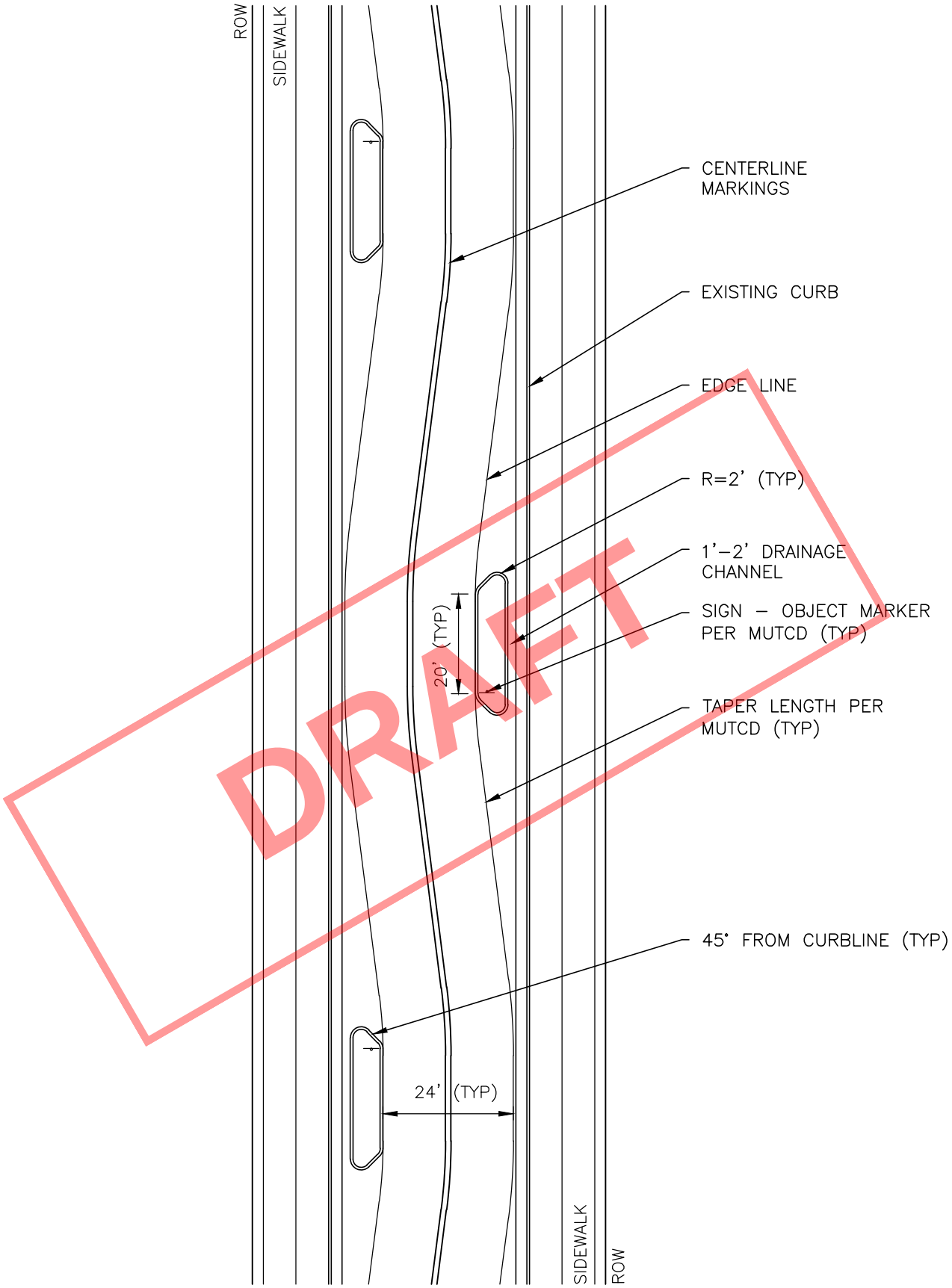

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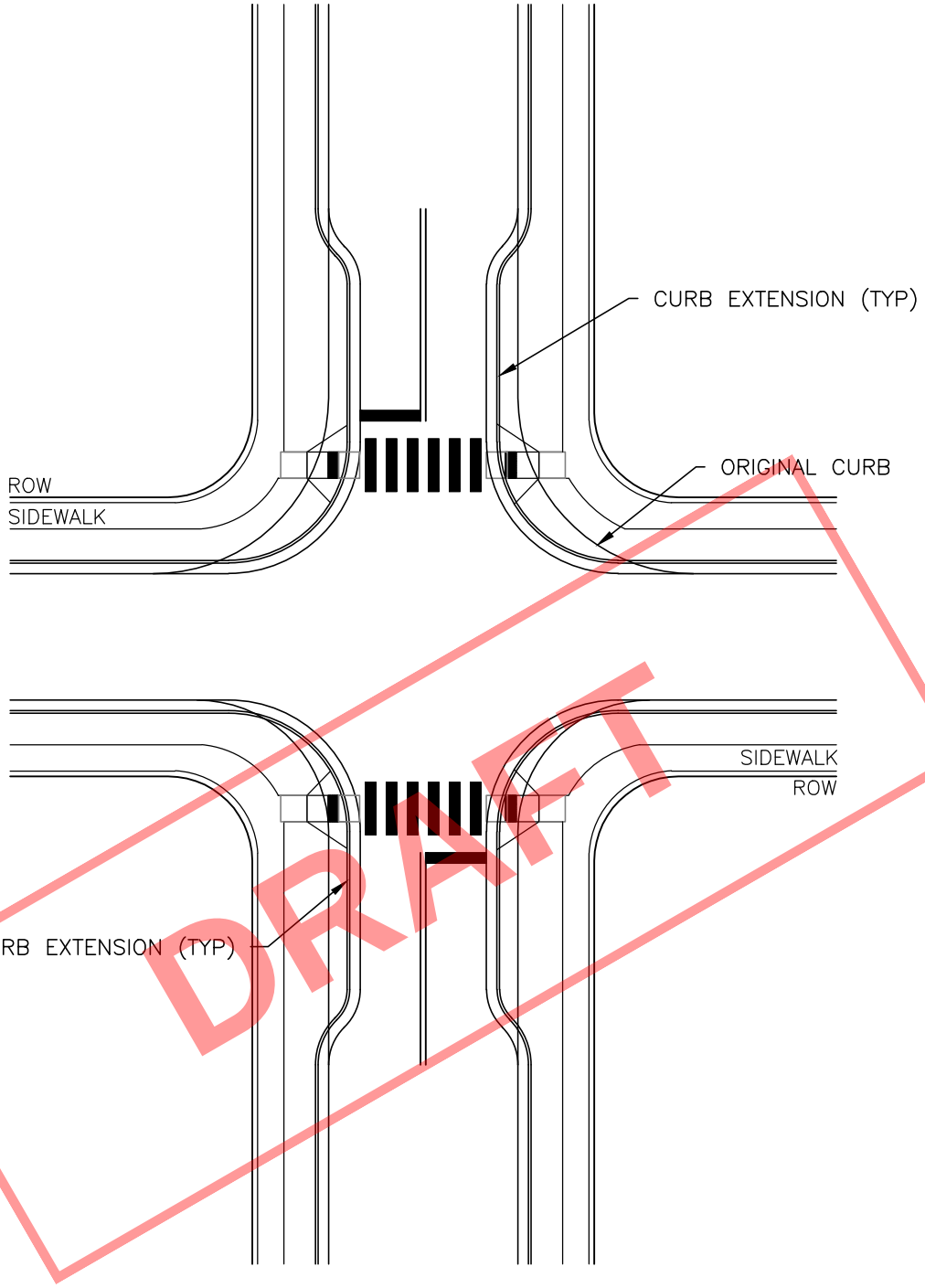
CHICANE
FIGURE 2.6 (2)



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1) INTERSECTION RADII SHOULD ACCOMMODATE DESIGN VEHICLES APPLICABLE TO STREET.
2) MID-BLOCK CURB EXTENSIONS SHOULD BE COMBINED WITH CROSSWALKS WHERE POSSIBLE.
3) LENGTH OF CURB EXTENSIONS MUST RECOGNIZE SITE CONDITIONS, EX. DRIVEWAY LOCATIONS.

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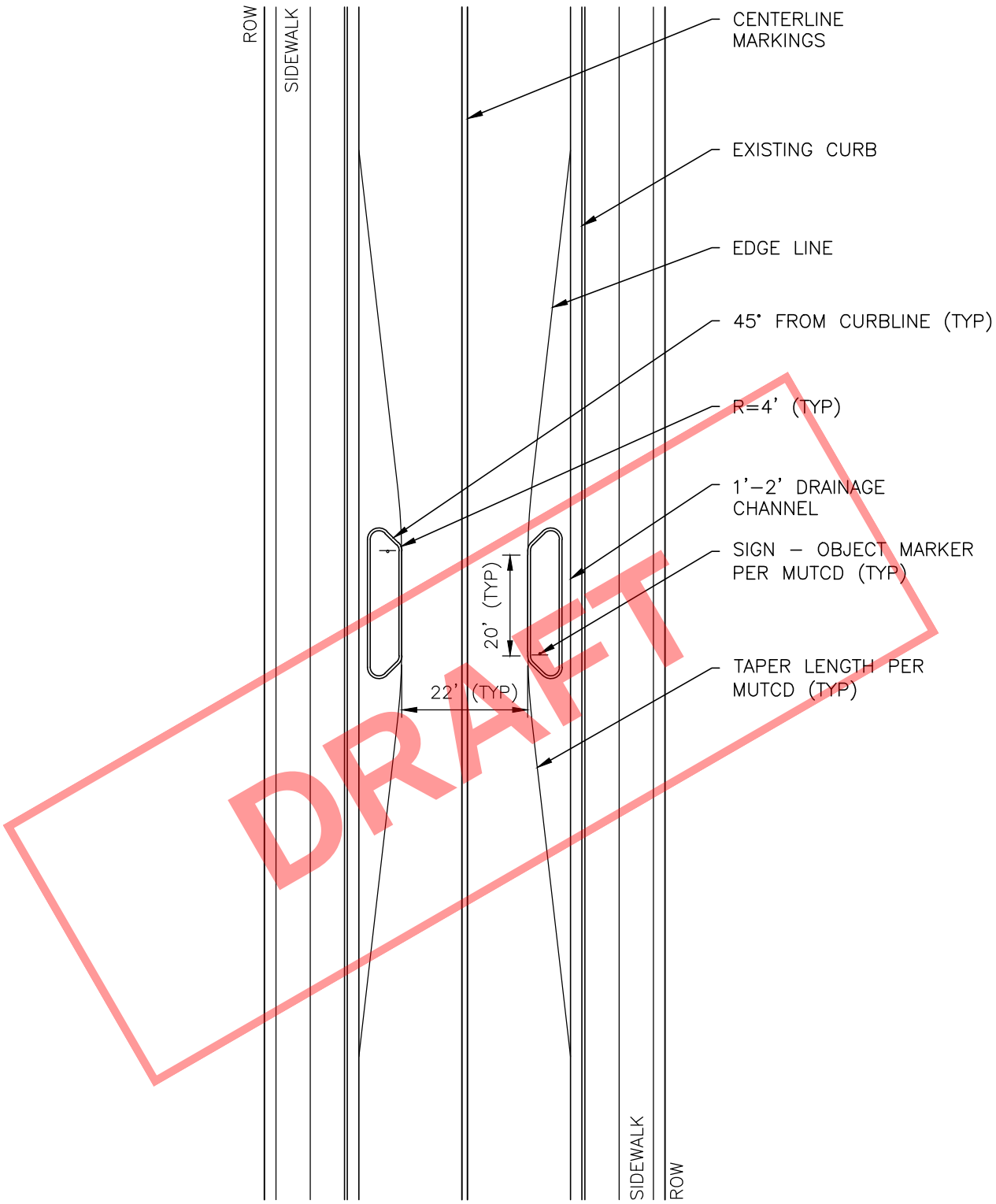
CURB EXTENSION
FIGURE 2.6 (3)



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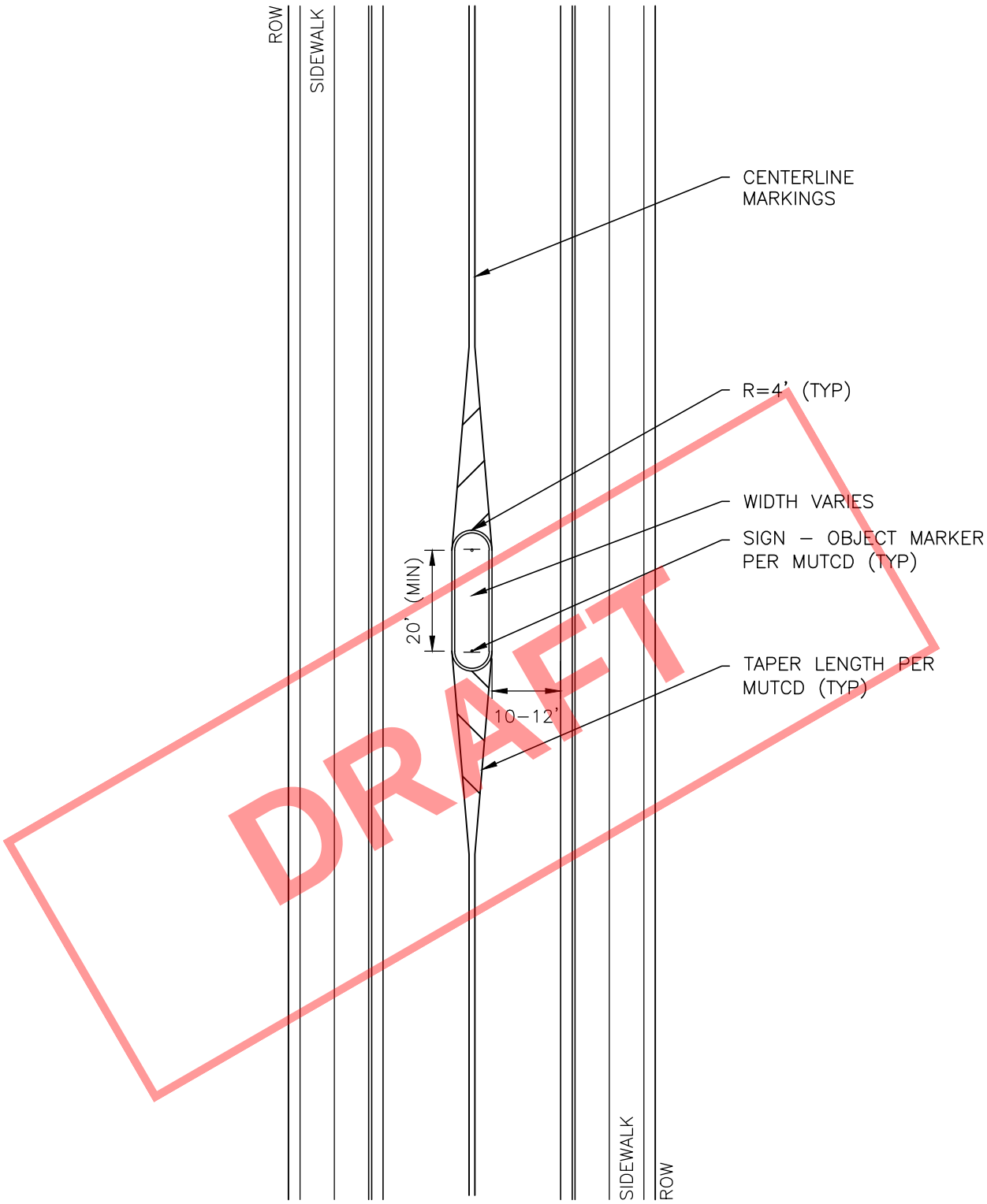
CURB EXTENSION – CHOKERS
FIGURE 2.6 (4)



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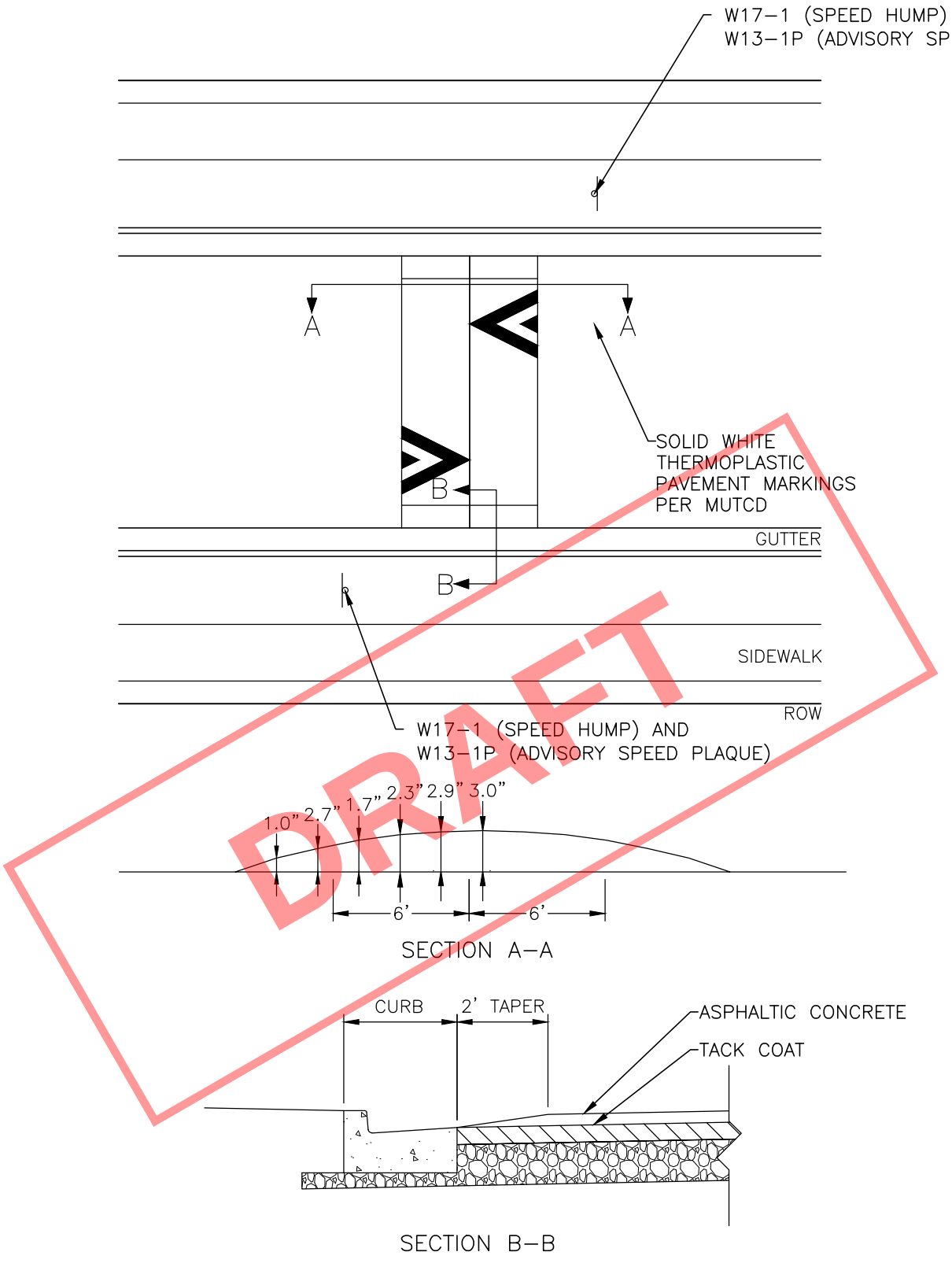
RAISED MEDIAN ISLANDS
FIGURE 2.6 (5)



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1) SIGNS AND MARKINGS SHALL BE IN ACCORDANCE WITH MUTCD & ITE PRACTICES.
2) ADVANCE SIGNING AT EACH LOCATION IS OPTIONAL WHEN PART OF AN AREA WIDE SCHEME.
3) CROSS–SECTION SHOWS APPROXIMATE ELEVATION FOR 3" (MAX) SPEED HUMP
4) SPEED HUMPS SHALL NOT BE PLACED OVER MANHOLES, VALVES, JUNCTION BOXES, ETC.
5) SPEED HUMPS MUST BE PLACED AT LOCATIONS APPROVED BY THE CITY ENIGNEER
6) DESIGN SHALL BE MODIFIED TO ACCOMMODATE FIELD CONDITIONS (EX. DRAINAGE).

HISTORIC FRANKLIN TENNESSEE

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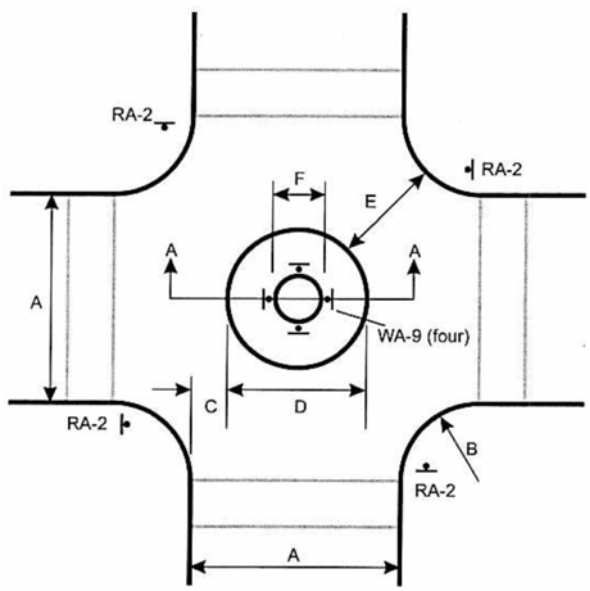
SPEED BUMP
FIGURE 2.6 (6)

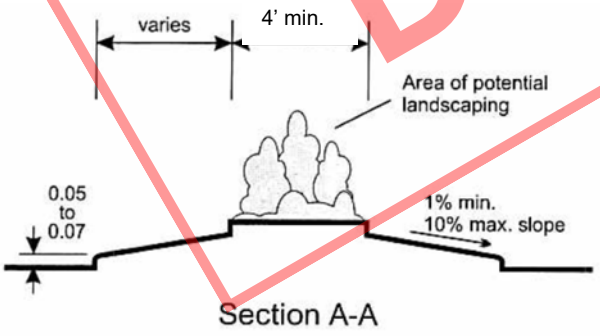
Figure 2.6 (7) Mini Traffic Circle



Dimension Chart for Varying Roadway Widths				
A Roadway Widths	B Curb Return Radius	C Off-set Distance	D Circle Diameter	E Min. Opening Width
20	15.5	5.5	8.5	16.0
	17.5	5.0	9.0	16.5
	22.5	4.5	10.5	18.0
	26.5	4.0	11.5	19.0
24	14.0	5.5	12.0	16.0
	16.0	5.0	12.5	16.5
	21.0	4.5	14.0	18.0
	25.5	4.0	15.0	19.0
28	12.0	5.5	15.0	16.0
	14.0	5.0	15.5	16.5
	19.5	4.5	17.0	18.0
	24.0	4.0	18.5	19.5
32	10.5	5.5	15.5	16.0
	12.5	5.0	19.0	16.5
	17.5	4.5	20.5	18.0
	22.0	4.0	22.0	19.0
	25.0	3.0	23.0	20.0
36	10.0	5.5	22.0	16.5
	11.0	5.0	22.5	16.5
	16.0	4.5	23.5	18.0
	20.0	4.0	25.0	19.0
	22.5	3.0	26.0	19.5
40	11.0	5.0	26.0	17.0
	12.0	4.5	27.0	17.0
	18.5	4.0	28.0	19.0
	22.0	3.0	29.5	20.0
44	10.0	5.0	29.5	17.0
	13.0	4.5	30.0	18.0
	17.0	4.0	31.5	19.0
	21.0	3.0	33.0	20.0

Legend:

A	Roadway Width
B	Curb Return Radius (10' min.)
C	Off-Set Distance (5' max.)
D	Circle Diameter
E	Opening Width (See Table above)
F	Raised Island Diameter (4' min.)



Section A-A

Minimum Opening width to be provided to all crosswalks

A deflection triangle painted on the pavement on each approach to the traffic circle may be apppropriate.

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DRAINAGE DESIGN

Section	Section Title	Article	Article Title	Pg
3.1	Overview			3-2
3.2	Requirements	3.2.1	Design Criteria	3-2
		3.2.2	Drainage and Hydrology Calculations	3-3
3.3	Ditch Sections			3-4
3.4	Detention / Retention Basins			3-4
3.5	Best Management Practices (BMPs)			3-4
3.6	Inspection and Laboratory Testing			3-4

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3.1 Overview

As it relates to roadways, the objective of surface drainage is to remove storm water from the traveled roadway as rapidly as possible so that traffic may move safely and efficiently. This is accomplished through careful roadway engineering practices such as using proper cross slopes, longitudinal grades, and cross drainage structures. Streets are not to be designed as conveyance systems for surface water. However, all streets must be so designed as to provide for the discharge of surface water from the right-of-way of the streets by grading and drainage as shall be approved by the Street Department Director and the City Engineer. Hydraulic capacities and locations of drainage structures in the public street right-of-way shall be designed to take into consideration upstream and downstream properties and to secure as low a degree of risk of traffic interruption by flooding as is consistent with the importance of the street being designed.

In the case of private development design, the planning and design of the overall drainage system shall be done simultaneously with the road or street layout and gradient planning and design. Where positive lot drainage is proposed, coordination of the road or street grades and the finished lot elevations must be achieved.

3.2 Requirements

3.2.1 Design Criteria

(1) Design Frequency

Design frequency for roadway drainage facilities is based on achieving a balance between construction cost, maintenance needs, amount of traffic, potential flood hazard to adjacent property and expected level of service. The design frequencies presented below are the minimum that will achieve this balance for the various road classifications and types of drainage facilities.

Cross structures and drainage structures shall be designed based on the design frequencies in **Table 3.1** such that they:

i. Shall not significantly increase the flood hazard for adjacent property;
ii. Shall permit maintenance of traffic on roads and streets under design flood conditions.
iii. Shall limit the encroachment onto the traveled lanes which could cause a hazard to traffic.

	Interstate and Limited Access Roadways	Arterials	Collectors	Local Road
Inlet Design Frequency	50-yr	10-yr	10-yr	10-yr
Storm Sewer Design Frequency	50-yr	10-yr	10-yr	10-yr
Culvert Design Frequency	50-yr Check for 100-yr	50-yr Check for 100-yr	50-yr Check for 100-yr	50-yr Check for 100-yr
Roadway Freeboard	50-yr	50-yr	50-yr	50-yr
Ditch Design Frequency	50-yr	10-yr	10-yr	10-yr

Table 3.1

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(2) Drainage Inlets

Drainage inlets shall be designed and located to limit the spread of water on the traveled way to no more than one half of the travel lane width. Bike lanes and shoulders may be used full width for spread. Because grates may become blocked by trash accumulation, curb openings or combination inlets with both grate and curb openings are advantageous for City streets. These inlets and grates shall be located outside the travel lanes to minimize shifting of vehicles attempting to avoid them. Inlet grates shall also be designed to accommodate bicycle and pedestrian traffic where appropriate. Drainage inlets located at low points along the streets and at the end of cul-de-sacs are to be as a minimum double inlet catch basins/curb inlets. Grate inlets shall be moved to curb and gutter when adding turn lanes. The grate shall be replaced with a manhole lid for any structure remaining in the turn lane.

(3) Storm Sewers

Where water cannot be adequately discharged by surface drainage, storm sewers shall be required. Public streets are not to be used to collect and convey storm water runoff other than that which falls on a lot fronting that street. In addition, the street and drainage design shall be such that storm water runoff shall not be allowed to flow across street intersections. The minimum slope of storm sewer pipes shall not be less than 0.50%. Flow shall not be directed into a junction at an angle less than 90 degrees from that leaving the junction. Headwalls shall be oriented to be in line with the flow. Flow from the 10-year design storm event shall not surcharge above storm sewer interior crown elevations or create hydraulic jump conditions.

3.2.2 Drainage and Hydrology Calculations

The Engineer of Record shall determine the appropriate analysis method for determining flows and design of the drainage system for both volume and water quality requirements. The rational method shall be an acceptable method for peak flow estimating for drainage basins of less than one hundred (100) acres. The Engineer of Record should be familiar with the limitations of each of the methods so that appropriate methods are applied. The City Engineer may require a particular method on critical portions of the drainage system. The methods shall be limited to and comply with the methods as outlined in the "*TDOT Standard Specifications*".

Drainage and hydrology calculations shall be submitted with the construction plans. The calculations shall include:

- Drainage area calculations include area in acres, runoff coefficients, a description of runoff calculation methods used, including rainfall intensity, and runoff (Q) used in calculations.
- Culvert cross sections clearly showing invert and outlet elevations, culvert lengths, roadway elevation and lengths.
- Energy Dissipation Design calculations.
- Computer analysis report output. Method shall be acceptable to the City Engineer.
- Force effects (including earth pressure, dead load, and vehicular dynamic loading) on buried drainage structures if requested by the City Engineer.
- Summary of high water elevations if open channel flow is present.

All necessary support data shall be submitted, including a map detailing the drainage basin and sub-basins, storm event, methods for calculating peak runoff, headwater and tail water conditions (assumed and calculated), methods for sizing channels and culverts, flow depths on channel and channel lining calculations. All design drawings, calculations and support data shall be submitted to the City Engineer for approval and must be sealed by a registered Professional Engineer licensed to practice in the State of Tennessee.

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3.3 Ditch Sections

Erosion Prevention and Sediment Control is a significant issue during and after construction. The City has a Stormwater Management Ordinance that serves as the City's primary Stormwater guideline. Adherence to these ordinances is required at all times during the construction of ditch sections to ensure that slopes and channels will continue to function adequately.

3.4 Detention / Retention Basins

Detention basins are used to collect and hold stormwater runoff for a period of time to compensate for increases in stormwater runoff caused by reduced ground surface perviousness due to activities such as paving or building construction. Retention basins are similar to detention, but they retain a certain portion of the runoff in the basin. Both types of basins must adhere to the current edition of the City's Stormwater Ordinance.

3.5 Best Management Practices (BMPs)

The City has compiled a Best Management Practices Stormwater Management Manual that is designed to assist contractors, developers, and various businesses and industries to comply with the guidelines set forth by the National Pollution Discharge Elimination System (NPDES) Phase II Rule. The BMP Stormwater Management Manual should serve as the major tool to insure that the guidelines set forth in the City's Stormwater Management Ordinance are followed during the design and construction of transportation projects.

3.6 Inspection and Laboratory Testing

It is the developer's responsibility to perform all materials testing required. The owner's engineer or his representative, familiar with assumptions inherent in the structure design, shall review the construction in sufficient detail to confirm that the construction is as specified. Inspection shall occur as frequently as necessary to assure that the construction conforms to the plans and specifications. Inspection shall be by qualified technical personnel experienced in the inspection of similar structures. Testing of materials shall conform to the requirements of "*TDOT Standard Specifications"* and applicable interims.

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CHAPTER 4

EARTHWORK AND DEMOLITION

Section	Section Title	Article	Article Title	Pg
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4.1 Overview

This Section includes all clearing and grubbing, stripping topsoil, excavation, embankment, trench excavation, backfilling, demolition of transportation features/structures and testing required for construction of city streets within the City. Earthwork embankments and excavations shall be constructed in close conformance with the lines, grades and typical cross sections shown on the approved plans. Work associated with demolition and abandonment will consist of the demolition, removal and satisfactory disposal of items that have been selected for demolition on approved construction plans. Demolition will not be approved until satisfactory arrangements have been made to maintain traffic. Demolition of all items, including those not detailed below, shall be coordinated with the City and/or the Director of Building and Neighborhood Services Department. For all earthwork operations, the developer/contractor will be required to provide testing from an independent geotechnical firm pre-approved by the City.

4.2 Reference Specifications

Unless modified by these Standards, all earthwork materials and construction requirements shall conform to "*TDOT Standard Specifications*".

4.3 Clearing and Grubbing

Clearing the right-of-way of all vegetation and debris shall be limited to an area bounded by a line established within the project limits unless otherwise directed by the engineer. Complete removal of shrub and tree roots is required except for sound undisturbed stumps and roots that will be a minimum of 5 feet below proposed subgrade or slopes which may be allowed to remain.

4.3.1 Tree Protection: Living trees with drip lines located beyond the construction lines are to remain undisturbed and protected by the contractor. The Developer will be responsible for establishing the lines of construction clearing in accordance with the above requirements.

4.3.2 Burning Permit: Burning of cleared vegetation and perishable debris is not allowed unless approved by the City Fire Department by issuance from the Fire Marshall of the required burn permit.

4.3.3 Debris Removal: Unless otherwise approved, all debris (i.e. cleared trees, brush, fences, building materials, etc.) shall be removed from the right-of-way, out of view from the street, and shall not be buried or otherwise become part of the street subsurface. Removal of cleared materials from the developer's property shall be legally disposed of.

4.4 Excavation

Excavation within the right-of-way includes stripping topsoil, grading of the street and required ditches, borrow material, channel excavation, rock excavation and undercutting. Excavation shall be performed in close conformance to the lines, grades, side slopes and typical cross sections of the approved construction plans.

4.4.1 Property Protection: Excavation shall be performed in a safe and orderly manner with due consideration given to protection of adjoining property and trees outside the clear lines. Approved erosion control measures shall be installed and regularly maintained to insure protection of adjacent properties. Excavated material when required shall be stockpiled in such a manner as to not obstruct streets, driveways or sidewalks.

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4.4.2 Structure Excavation: Excavation for bridges and pipes shall be in accordance with "*TDOT Standard Specifications*". Excess rock excavation below foundation elevations shall be filled with leveling concrete. Excess rock excavation below the elevation of the bottom of the pipe bedding, cradle or encasement shall be filled with material of the same type and placed and compacted in the same manner as the bedding material.

4.4.3 Channel Excavation: Excavation within waterways will require approved permits prior to commencing operations, and the equipment shall be kept out of the waterway to the greatest extent possible.

4.4.4 Blasting: Rock excavation requiring blasting shall be performed only after obtaining blasting permits from the City of Franklin Fire Marshall. Blasting operations shall be performed only by experienced, licensed blasting contractors. Blast areas shall be protected with mats or earth overburden to prevent flying debris. When blasting near public areas or motorists, blast zones are to be set up with proper signing and flagmen to secure the blast area prior to detonating explosives. The contractor shall be responsible for all damages and shall repair or replace any and all damages at no expense to the City. A pre-blast survey will be required by the Engineering Department.

4.5 Undercutting

When unsuitable material such as tree roots, trash, concrete and asphalt fragments or soft organic or plastic clays are encountered in the subgrade, the area shall be undercut and backfilled with select material.

4.5.1 Limits of Undercutting: Areas and depths of undercutting required for existing streets will be determined by City officials during inspections of subgrade construction and for final acceptance of city streets. The extent of undercut areas shall be determined by proof-rolling the subgrade. Undercutting required after curbs are installed shall be located no closer than 12 inches from the nearest concrete face.

4.5.2 Proof-Rolling: Vehicles for proof-rolling shall be tandem axle dump trucks fully loaded with a minimum material payload of 23 tons.

4.5.3 Backfill: Suitable material shall consist of approved, competent soil from the site that matches the soil classification of the subgrade, or approved classified rock (surge rock). Backfill material shall be placed in lifts not to exceed 12 inches, and each lift shall be compacted with a dozer or other approved heavy equipment.

4.5.4 Stabilization: Geotextile fabrics may be used to strengthen backfill material in undercut areas provided the contractor can demonstrate their effectiveness on test repair areas at the same site or based on the recommendations of a pre-approved geotechnical engineer.

4.6 Embankment

Embankment material shall consist of approved soil or rock obtained from on-site excavations or hauled from a borrow pit area, and shall be placed in fill embankments in reasonably close conformance with the

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lines, grades, side slopes and typical cross sections shown on the approved plans. All embankments shall be placed in accordance with "*TDOT Standard Specifications"*.

4.7 Trench Excavation

Trenches cut within the limits of the subgrade shall be excavated to neat lines to minimize disturbance of the surrounding material. The contractor/ developer is solely responsible for the stability of trench excavations and conformance with OSHA regulations.

All excavation for pipe and utility installation shall be performed in accordance with the "*TDOT Standard Specifications"*.

4.7.1 Existing Street Cuts: Utility trenches cut into existing streets shall be performed in such a manner as to maintain the existing integrity and rideability of the street. Trench limits shall be saw-cut a minimum of 2-inch deep into the existing pavement. Excavation width shall be limited to the minimum width required to permit satisfactory jointing of the pipe and thorough backfilling.

4.7.2 Backfill: Utility trenches excavated into existing streets shall be backfilled as indicated on the Standard Drawings. Each layer of backfill material shall be placed with optimum moisture content and thoroughly compacted with mechanical tampers.

4.7.3 Flowable Fill Backfill: For trench excavations subject to moderate and heavy truck traffic, the excavation shall be backfilled with flowable concrete fill. Pipe bedding shall be installed and thoroughly compacted prior to placement of flowable fill material.

4.7.4 Pavement Replacement: Base stone and asphalt paving shall be placed over trench backfill with thicknesses and gradations equal to the existing street pavement section, see Standard Drawings. Each course of base stone and asphalt shall be thoroughly compacted with mechanical tampers. Trench excavations within public streets shall be milled and overlay a minimum of fifty (50) feet on either side of the trench unless otherwise approved by the City Engineer.

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4.8 Underdrains

In addition to stormwater drainage structures and appurtenances, subgrade underdrains are required under city streets adjacent to medians with irrigation systems. Underdrains shall consist of free draining crushed stone, 4-inch diameter perforated pipe and filter cloth. All underdrains shall be constructed in accordance with "*TDOT Standard Specifications"*.

4.9 Street Damages

Damage to existing streets and structures, utilities, trees, or private property shall be repaired and restored to its original condition by the Contractor.

4.10 Demolition

4.10.1 Removal of Drainage Structures

Where portions of existing drainage structures lie within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure. Pipe designated to become the property of the City of Franklin shall be carefully removed and every precaution taken to avoid breaking or damaging the pipe.

4.10.2 Removal of Pavement, Sidewalks, Curbs, Etc.

All pavement, base course, sidewalks, curbs, gutters, driveways, etc. shall be removed and disposed of as follows: If the items are more than two feet below sub-grade elevation, they shall be broken into sizes not to exceed two feet in maximum dimension and remain in place, unless it interferes with succeeding items of construction. If the items are less than two feet below the sub-grade elevation, they shall be removed and disposed of.

Failure of the plans to identify the existing of concrete pavement under asphaltic pavement shall not be construed to imply that concrete is not present. It is the contractor's responsibility to determine the presence of concrete pavement when it is not identified by the plans.

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CHAPTER 5

PAVEMENT DESIGN

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5.1 Overview

The Contractor (Developer) shall provide all plant, labor, material and equipment to furnish and construct the bituminous concrete pavements in conformity with the lines, grades, thickness and typical cross sections shown on the construction standards and specified herein, or as called for on the approved plans and specifications.

The specifications referenced for each material shall fully apply and no deviations from said specification limits or quality will be permitted unless specifically stated otherwise in this Section. The failure of any component of a product to comply with the referenced specifications shall constitute failure of the whole product.

The Contractor (Developer) shall obtain approval of the subgrade and stone base from the Street Department Director prior to commencing with the paving operations.

For all paving operations, the developer/contractor will be required to provide testing from an independent geotechnical firm pre-approved by the City. See **Chapter 1** for additional testing and inspection requirements

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5.2 Requirements

5.2.1 General Criteria

(1) Existing Streets
For existing streets, the City Engineer may require testing of the existing pavement and base structure to determine if an overlay is feasible, or if reconstruction is necessary. The City Engineer shall notify the Developer if and when this testing is required prior to the Final Pavement Design Report.

(2) TDOT Design Standards
The design criteria and procedures presented follow "*TDOT Standard Specifications*".

(3) Pavement Type
Streets are to be constructed of asphaltic concrete pavement, base course material, or subbase material (where required), placed on compacted subgrade.

(4) Treated Subgrade
The use of treated subgrade, treated base, and/or full depth asphalt pavement may be acceptable when designed and submitted by the designer, and approved by the City Engineer in accordance with these standards as well as "*TDOT Standard Specifications*".

(5) Approval
A preliminary pavement design shall be submitted with final construction plans. The City Engineer shall review and approve the Pavement Design Report prior to construction.

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5.3 Design Criteria

5.3.1 Design Factors

(1) ADT & Equivalent Daily Load Applications (EDLA)
Loading values can be calculated using TDOT approved ADT numbers or Equivalent Daily Load Applications (EDLA) and Equivalent Single Axle Loads (ESAL) units if available. The City of Franklin Major Thoroughfare Plan traffic data shall be used as a reference.

(2) Minimum Pavement Section
The Standard Drawings provide the default acceptable pavement sections for each street classification based on assumed subgrade support and traffic values. These pavement thicknesses may be used for preliminary planning purposes, cost estimates, or final pavement designs when approved by the City Engineer. All pavement thickness designs must be based on actual subgrade support test results and traffic projections for the specific project. In specifying layer thickness, the designer shall consider how the pavement section will be physically constructed (e.g. Specify how to construct 2' of treated subgrade.)

(3) Flexible Pavement Strength Coefficients
Nonstandard design coefficients may be used, only if approved in advance by the City Engineer. In addition, design values must be verified by pre-design mix test data and supported by daily construction tests.

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5.3.2 Special Considerations

On paved surfaces, within public right-of-ways, do not use or operate tractors, bulldozers, off-road trucks or other power-operated equipment, the treads or wheels of which are so shaped as to cut or otherwise damage such surfaces. Damaged roadways shall be repaired to the City's satisfaction by the Contractor (Developer). Placing of mats or using other methods of protection may be allowed subject to the approval of the Street Department Director.

Any roadway surface damaged shall be promptly restored to a condition at least equal to that in which they were found immediately prior to the beginning of operations. Suitable materials and methods shall be used for such restoration. All dirt and mud tracked on existing roadways shall be removed promptly.

Prior to overlaying existing asphalt, the City Engineer may require nondestructive testing to determine the amount of overlay necessary to bring the street to current standards. The method of nondestructive testing and the data obtained must be in a form compatible with the pavement management system for the City Engineer. All "pot-holes," utility trench settlement, cracking, and any similar imperfections shall be repaired to the City Engineer's satisfaction prior to overlaying. The following shall serve as a guideline for the rehabilitation and repairing of existing asphalt streets in the City:

(1) General - The contractor is to provide the necessary labor, materials and equipment to restore and maintain the various street and driveway surfaces of all types, pavement and driveway bases, curbs, curbs and gutters, and sidewalks disturbed, damaged, or demolished during the performance of the work.

(2) Permits - Before starting any work, secure the necessary permits to work within the City or State ROW and easements when surface materials will be disturbed or demolished. Separate street excavation permits are required for street cutting and road subsurface boring/jacking operations. See City of Franklin Municipal Code for permit requirements and fees.

(3) Materials

The quality of materials used in the restoration of existing streets, parking areas and driveways shall produce a finish surface equal to or better than the condition before work began. Compacted crushed stone backfill shall be in conformance with "*TDOT Standard Specifications"*.

Asphalt for a temporary patch shall be Bituminous Plant Mix Surface Course (Cold Mix) as specified in "*TDOT Standard Specifications"*.

(4) Execution

Where trenches have been opened in any roadway or street that is a part of the State of Tennessee highway system, restore surfaces in accordance with the requirements of "*TDOT Standard Specifications"*. All other restorations shall be done in accordance with the City Standards;

Before trenching in paved areas the Contractor shall saw-cut the pavement in a straight line along the sides of the proposed trench to allow for pavement removal and trench excavation without damage to adjacent pavement. During construction, suitable precautions shall be taken to protect the pavement edges and surfaces and to minimize damage.

Upon completion of the utility installation, including backfill, fill the trench with crusher run and temporary pavement patch until such time that the permanent pavement patch will be constructed. The temporary patch shall be placed the same day or within 24 hours. The temporary pavement patch shall consist of at least twelve (12) inches of compacted stone base brought to within two (2) inches of the surface of the existing permanent pavement. A two (2) inch layer of cold mix asphaltic concrete shall then be applied to protect the base, prevent "pot holes" or "chuck holes", and provide a reasonably smooth pavement surface until the permanent patch is made. The temporary pavement patch shall be placed within twenty-four (24) hours of the completion of the utility installation. Permanent Hot Mix patching shall only be applied after the Cold Mix patch has been completely removed.

Concrete curbs, gutters and sidewalks shall be restored as required to match existing construction. Replace damaged sections with complete new sections or squares; patching of damaged sections will not be permitted.

When a manhole or valve box frame and cover, or other utility casting, requires adjustment to an elevation one inch or more above the existing pavement grade and is exposed to traffic before final paving is completed, a temporary ramp shall be constructed by feathering a cold mix for 360 degrees around the casting. A taper slope of not less than two feet per one inch shall be used. During the final paving operation, the temporary ramp shall be removed from around the casting to allow for the permanent paving installation.

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5.3.3 Special Requirements

Unless otherwise determined by the City Engineer, full-depth milling and resurfacing of the roadway shall be required for all cuts within the roadway limits. The limits of milling and resurfacing shall extend 50' past the trench edge in each direction. The final limits of associated with milling and resurfacing shall be determined by the City Engineer.

5.4 Asphaltic Concrete Pavement Design

Pavement is required to be a 20-year design. All pavement design shall comply with "*TDOT Standard Specifications"* and meet or exceed the minimum requirements as shown in the Standard Drawings.

5.5 Rigid Pavement Design

For concrete rigid pavement, see **Chapter 6, Concrete,** for concrete riding surfaces.

5.6 Design Report

The pavement design report shall be prepared by an independent geotechnical laboratory under the supervision of and signed and stamped by a Professional Engineer registered in the State of Tennessee. The report shall make a recommendation for a typical pavement structural section based on known site soil conditions and the valid traffic impact study. The following list of items shall be included in the report:

(1) Vicinity map to locate the investigated area.

(2) Scaled drawings showing the location of final borings.

(3) Final Plat with street names.

(4) Scaled drawings showing the estimated extent of subgrade soil types and EDLA for each street classification.

(5) Pavement design alternatives for each street classification.

(6) Tabular listing of sample designation, sample depth, Group Number, liquid limit, plasticity index, percent passing the No. 200 sieve, AASHTO Classification, Group Index and soil description.

(7) R-value test results of each soil type used in the design.

(8) Borrow source identification.

(9) Pavement design computer printouts or nomographs properly drawn to show Soil Support - EDLA - SN

(10) Design calculations for all phases of soil report.

(11) Design coefficient used for asphalt, base course, etc.

(12) A discussion of potential subgrade soil problems including, but not limited to:

(a) Heave or settlement prone soils.

(b) Frost susceptible soils.

(c) Ground water.

(d) Drainage considerations (surface and subsurface).

(e) Soluble sulfates in subgrade.

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(f) Other factors or properties that could affect the design or performance of the pavement system.

(13) Recommendations to alleviate or mitigate the impact of problems discussed in the previous paragraph.

5.7 Installation

Installation shall be in accordance with "*TDOT Standard Specifications"*.

5.8 Testing, Inspection and Acceptance

All pavement installations and repairs will require the contractor to submit material testing certifications to the City Engineer. Materials shall meet the requirements found "*TDOT Standard Specifications"*.

The City Engineer reserves to right to request any additional tests deemed necessary for acceptance.

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CHAPTER 6

CONCRETE

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6.1 Overview

This Section includes cast-in-place and pre-cast concrete, including reinforcement where required, concrete materials, mix design, placement procedures, and finishes. All concrete pavements, sidewalks, ramps, driveway aprons, curb and gutter sections, paved ditches, pipe and pipe end treatments, box culverts and bridges, drainage structures, foundations and wall panels and all other miscellaneous concrete elements indicated on the approved drawings shall be constructed in accordance with these Standards unless approved otherwise by the City. All concrete shall be ready mixed concrete and not field mixed unless otherwise approved.

The Contractor (Developer) shall provide all materials, labor, and equipment necessary for the completion of all concrete work in accordance with the lines, grades, thickness and typical cross sections shown on the construction standards specified herein, or as indicated on the approved plans.

6.2 Reference Specifications

Unless modified by these Standards, all concrete materials and construction requirements shall conform to "*TDOT Standard Specifications*".

Where project plans and specifications refer to particular items, materials, equipment and construction requirements, the appropriate section of "*TDOT Standard Specifications*" shall apply. "*TDOT Standard Specifications*" sections regarding compensation shall not apply unless directed by the City Engineer. The absence of a description or specification for any item of work shall automatically refer to the appropriate section of "*TDOT Standard Specifications*".

"*TDOT Standard Specifications*" shall apply for all structural concrete to be used in load carrying structures including box and slab culverts, foundations including drilled caissons, traffic signal and overhead sign foundations, retaining walls and girder bridge members. Section 604 also specifies the requirements of concrete used in structures as well as other miscellaneous or incidental items. Miscellaneous concrete items such as sidewalks, curbing and gutters, rigid street pavement, medians, driveways, paved ditches and roadside sign foundations, shall meet the requirements of "*TDOT Standard Specifications*".

All precast concrete including precast drainage structures, headwalls, box culverts, pipe, temporary barriers, noise and retaining walls, and bridge members shall meet the requirements of TDOT's Standard Operating Procedure regarding the "*Manufacture and Acceptance of Precast Concrete Drainage Structures, Noise wall panels, and Earth Retaining wall products*". This document requires that all producers of precast concrete products be certified in accordance with national quality standards developed by the National Precast Concrete Association (NPCA), the American Concrete Pipe Association (ACPA) and/or the Prestressed Concrete Institute (PCI). Certified producers must submit a copy of their certifications and documentation that have successfully completed the annual inspections. The City Engineer may waive the requirements of precast concrete producer certification on a case-by-case basis.

6.3 Submittals

Where required in the project plans, technical performance and/ or quality certification of concrete materials proposed for the work shall be submitted to the City Engineer for approval. Such submittals may include the following:

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6.3.1 Concrete Mix Designs

Concrete mix designs are required for load carrying structures such as bridges, box culverts, junction boxes within the roadway and retaining walls. Mix designs shall be prepared and certified by approved materials testing company, or alternately, an existing TDOT approved design may be submitted provided the design is approved within the calendar year. Mix designs shall certify all admixtures and cement replacement such as fly ash proposed for the project concrete.

6.3.2 Reinforcing Steel

Certifications for reinforcing steel used in load carrying structures shall be submitted to the City Engineer. Letter of certification shall bear the signature of the supplier's representative and shall certify that the reinforcing meets the requirements of "*TDOT Standard Specifications"*.

6.3.3 Miscellaneous Items

Items included in the concrete work such as handrails, anchors, joint materials, curing materials and other items may require submittals and or representative samples at the discretion of the City Engineer.

6.4 Curbing and Sidewalks

6.4.1 Residential Sidewalks

All residential street sidewalks within the City shall be constructed within the street right-of-way and shall meet all City requirements and standard drawings. The sidewalk forms and base material shall be inspected prior to concrete construction.

It is the contractor's responsibility to ensure safety and maintain access for pedestrians when sidewalks are under construction and to protect the in place work from damage or vandalism.

Traffic control devices including cones, barrels and signs may be required on high volume streets to warn vehicular traffic in advance and adjacent to the area of construction.

(1) All concrete sidewalks shall be a minimum uniform thickness of 4" using Class A Concrete, minimum 28-day compressive strength of 3,000 psi. Sidewalks shall be constructed on 4 inches (minimum) of compacted, granular aggregate base stone (TDOT Class A, Grade D Base Stone). The base stone shall be mechanically compacted to a firm, even surface in reasonably close conformity with the grade and cross section required.

(2) Subgrade soil which in the opinion of the City Engineer is soft or subject to large volume changes, shall be excavated and replaced with suitable material as approved by the City Engineer.

(3) Where driveway and alley approaches cross the sidewalk, the minimum concrete thickness of the approach slab shall be 6". See Standard Drawings for details. Granular base material for driveways shall be compacted base stone material conforming to Class A, Grading D of "*TDOT Standard Specifications"*. A 2" lowered curb height above the gutter line shall also be maintained at the front edge of the driveway approach.

(4) Reinforcement of residential sidewalks is required and shall consist of synthetic fiber reinforcement.

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(5) Sidewalk cross slope shall be 1.5% (2.0% Max) sloping toward the curb. Longitudinal sidewalk grades within a street or highway right-of-way shall not exceed the general grade established for the adjacent street or highway. Pedestrian street crossings shall be 5 percent maximum.

(6) For detached sidewalks, the difference in elevation between the top of sidewalk and the top of curb at any adjacent location shall not exceed the grade difference produced by a maximum 4:1 slope.

(7) Sidewalk surface is to receive a light broom finish, to achieve a sandy texture with texture lines perpendicular to traffic. Exposed aggregate sidewalk finishes are not acceptable within the street right-of-way.

(8) All exposed concrete edges shall be rounded to a 1/2" radius.

(9) Final longitudinal surface variations shall not exceed 1/4" under a 12-foot straight edge and transverse variation shall not exceed 1/8" in 5 feet. Low spots which allow water to pond will not be acceptable.

(10) Transverse control joints shall be spaced 5 feet maximum and shall be placed at right angles to traffic. Joints shall also be placed to intersect all inside or re-entrant corners. Joints shall be formed with a grooving trowel to a depth of 1 inch. The top edges of the grooves shall be rounded to 1/4" radius.

(11) Longitudinal control joints are required for sidewalk widths greater than 6 feet and less than 10 feet. Two longitudinal joints are required for sidewalks greater than 10 feet. Longitudinal joints shall be centered in the width of the sidewalk.

(12) Expansion joints shall be constructed with 1/2" thick pre-molded rubberized expansion joint filler (manufactured by J.D. Russell Company, or equal). Bituminous fiberboard shall not be used. Expansion joint material shall extend the full width of the sidewalk and the depth shall extend to within 1 inch of the top surface. Space expansion joints at 30 feet maximum spacing and at each driveway and at any cold joint. Expansion joints are also required at the back edge of driveway approaches between the approach and the private drive and at each side interface with the sidewalk.

(13) 1" thick pre-molded expansion joints are required when sidewalks are adjacent to curved sections of the street curb and when curb is placed adjacent to buildings and/ or retaining walls. Use 1/2" isolation joints around other fixed objects like utility poles and hydrants. Use 1/2" expansion joints between the curb and sidewalks where constructed adjacent to each other.

(14) Sidewalks and bikeways shall not be opened to pedestrian or bicycle traffic for at least 24 hours after placement. The contractor shall provide and maintain measures to restrict use during the curing period.

(15) Concrete driveway aprons shall not be opened to vehicular traffic for at least 7 days after placement or until test cylinder breaks indicate an attained compressive strength of 2500 psi.

(16) Backfill sidewalks flush with the surface of the walk and the surrounding ground line with soil. For detached sidewalks, backfill the area between the curb and the sidewalk on a straight line from the top of walk to the top of curb, but not to exceed a 4:1 slope.

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6.4.2 Commercial Sidewalks

In addition to and including the above requirements for residential street sidewalks, commercial sidewalks within the City shall be constructed to the following requirements:

(1) Driveway and alley approaches crossing the commercial sidewalks shall have a minimum concrete thickness of 8 inches. See Standard Drawings for details. Granular base material for driveways shall be compacted base stone material conforming to Class A, Grading D of "*TDOT Standard Specifications*". A 2-inch lowered curb height above the gutter line shall also be maintained at the front edge of the driveway approach.

(2) Isolation joints are required around penetrations in the sidewalk such as fire hydrants, utility poles, manholes, and adjacent to any fixed structure such as a building or retaining wall. Use 1" thick joints against buildings and retaining walls and 1/2" thick pre-molded non-bituminous expansion joint material shall be used in all other locations.

(3) All valve boxes, manhole covers and other castings in the sidewalk area shall be adjusted to the grade of the sidewalk.

(4) Commercial sidewalk widths shall be specifically reserved for pedestrian travel. Furniture, planters, newspaper stands and other protruding obstacles shall be kept clear of a minimum required width of 4 feet. Obstacles in the pedestrian path shall be eliminated or a widened pathway around the obstacle will be required.

6.4.3 Bikeways

Where desired, concrete bike paths within the City shall be constructed using the same requirements of commercial sidewalks except that control joints shall be saw cut 1" deep through the concrete slab in lieu of tooled joints to improve rideability. Expansion joint material shall be recessed 1/2" minimum below the riding surface.

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6.4.4 Accessible Ramps

All sidewalks within the City shall include compliant accessible ramps at all intersections, crosswalks and commercial driveways. Accessible ramps shall be constructed in accordance with the City Standard Drawings.

(1) Concrete for ramps to be Class A and shall be finished by light broom finish texturing.

(2) Install a 1/2-inch pre-molded, rubber expansion joint between the ramp section and the sidewalk and between the ramp section and the curb.

(3) Truncated dome detectable warning areas shall be installed using Armorcast Detectable Warning Panel or approved equivalent.

(4) Minimum concrete thickness for an accessible ramp shall be 8 inches.

6.4.5 Curb and Gutter Sections

All concrete curb and gutter sections shall be constructed in accordance with details shown in the Standard Drawings and the project plans. Curb openings will be located as shown on the approved plans and will be evaluated based on acceptable access control requirements by the City.

(1) Class A Concrete shall be used for all curb and gutter sections and the concrete mix shall be air-entrained.

(2) Curb and gutter sections shall be constructed on compacted stone aggregate base for residential and commercial streets. Extruded curbs are to be constructed on asphalt binder course surfaces for residential streets.

(3) Curb and gutter sections shall be reinforced with synthetic fiber reinforcing.

(4) Control joints for curb and gutter sections shall be spaced at a maximum of 10 feet.

(5) Expansion joints are required at all tangent points in curved sections, between curbs and sidewalks and between curbs and other rigid objects such as buildings, catch basins and driveway aprons.

(6) Where curbs are attached to the sidewalk, expansion joint spacing shall match the spacing of expansion joints in the sidewalk.

(7) Maximum expansion joint spacing for detached curbs shall be 100 feet.

(8) Curbs and gutters shall be constructed to follow the geometry of the roadway unless noted otherwise on the plans. Curved sections of curb shall conform to the roadway curve geometry with smooth continuous curves with no chorded portions.

(9) Flow lines of gutters shall be true to line and grade with no areas of ponding water. Final longitudinal surface variations shall not exceed ¼ inch under a 12-foot straight edge.

(10) Concrete finish for curb and gutter sections shall be a light broom finish with finish lines parallel to the flow of water.

(11) Curb and gutter sections aprons shall not be opened to vehicular traffic for at least 7 days after placement or until test cylinder breaks indicate an attained compressive strength of 2500 psi.

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6.5 Stamped Concrete and Brick Pavers

6.5.1 Stamped Concrete

For areas designated by the City, concrete finishing may incorporate imprinting or stamping and coloring of the exposed finish for improved aesthetics. Stamped concrete finishes are to be performed only by qualified contractors with a minimum of five-years experience in commercial concrete stamping finishes. For projects with proposed concrete stamping, the proposed pattern, finish and color shall be submitted with related product data to the City Engineer for approval. Prior to construction, a mock-up sample of a minimum 4 square feet size shall be constructed to demonstrate a typical finished product for review and approval by the City.

Concrete stamped areas may include color of the final surface by applying a colored antiquing release agent just after initial set of the concrete. Concrete may also contain a color additive provided the colorant additive is mixed at the batch plant and the color is completely dispersed in the concrete. After concrete curing, the colored concrete surface shall be sealed with a clear sealer containing at least 30% solids in a minimum of two coats. Alternate method of coloring the concrete surface may be submitted to the City Engineer for approval.

6.5.2 Concrete Unit Pavers

While stamped concrete is the preferred method for aesthetic enhancement of concrete surfaces, concrete pavers may be used to create borders or bands within sidewalk areas. Pavers will not be allowed in areas subject to vehicular traffic unless otherwise approved by the City Engineer.

All paver units shall be concrete pavers installed over concrete mats with bituminous adhesives. Clay brick paver units shall not be used. Pavers subject to vehicular traffic shall be required to have a minimum of 10" thick poured concrete base with weep holes filled with bedding material and a ¾" thick bituminous setting bed (E-Mix). All other pavers shall have a minimum of 4" thick poured concrete base with a ¾" thick bituminous setting bed (E-Mix). See Standard Drawings for examples of standard drawings.

6.6 Rigid Concrete Pavement

For specific locations on city streets with large volumes of truck traffic and damage to asphalt pavement due to braking forces, rigid concrete pavement may be utilized. Typical locations for its use include intersection approaches, particularly at the bottom of steep grades. Thin concrete overlay with thickness of 4 inches or less, commonly referred to as "white topping" and are constructed over existing hot mix asphalt shall not be used on City streets.

Minimum design requirements for new concrete pavements include a fiber reinforced, 8-inch concrete pavement thickness on 10 inches of compacted mineral aggregate base stone. Use of Class CP (3000 psi strength) concrete is a minimum requirement with the additional requirement of High Early Strength cement for a reduced construction time. Concrete pavement construction shall be in accordance with "*TDOT Standard Specifications*".

6.7 Concrete Reinforcement

Where indicated on the approved drawings, concrete for load carrying structures such as box and slab culverts, bridges and retaining walls shall be reinforced with steel bar reinforcement, welded wire fabric and pre-stressing strands. Sidewalks, curbs, combined curb and gutters and concrete pavement areas shall be reinforced with synthetic fiber reinforcement.

All steel reinforcing materials required for load carrying structures shall meet the requirements of "*TDOT Standard Specifications*" unless noted. Sizes, spacing, gauges, locations and arrangements shall be as shown on the approved plans. Where project plans do not depict reinforcing placement plans or schedules, the contractor shall develop and submit reinforcing steel shop drawings to the City Engineer for approval. All hooked bars shall conform to CRSI standard hook details.

In the case of bridge decks, top slabs of box and slab culverts used as riding surfaces, concrete barrier rails and bridge sidewalks, all reinforcing steel shall be epoxy coated per "*TDOT Standard Specifications*". In addition, the dowel bars projecting from the footing into the back face (backfill side) of the wall stem in retaining walls shall also be epoxy coated.

6.7.1 Reinforcing Materials

Use the reinforcing materials below where indicated on the approved plans:

(1) Steel Reinforcing shall be deformed steel bars conforming to ASTM A 615, Grade 60.

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(2) Steel reinforcement for bridge decks and top slab of box bridges and slab culverts when used as the riding surface shall be epoxy coated. All concrete bridge railing shall also require epoxy coated reinforcement.

(3) Smooth steel dowel bars shall conform to ASTM A 615

(4) Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

(5) Prestressing steel shall be in accordance with ASTM A416

(6) Synthetic Fibers (fiber reinforced concrete): Fibrillated or monofilament polypropylene fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

6.8 Concrete Placement

All formwork shall be constructed in accordance with *"TDOT Standard Specifications"* using pre-manufactured metal forms or dressed form lumber and plywood. Formwork shall be adequately braced, mortar tight and true to line and grade. Provisions shall be made during placement of concrete to minimize aggregate separation and ensure proper consolidation throughout the pour. To highlight a few key requirements of *"TDOT Standard Specifications"* in particular, the contractor shall ensure the following placement operations are observed:

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(1) Elapsed time from truck loading to delivery and placement shall be limited to 90 minutes when the air temperature is 90 degrees or less. When the air temperature exceeds 90 degrees, this time is reduced to 60 minutes.

(2) Concrete that does not meet the specified limits regarding slump, air content, temperature and delivery time shall not be used unless approved by the City Engineer.

(3) Concrete shall be mechanically vibrated with suitable vibrators operating within the concrete unless otherwise directed by the City Engineer.

(4) Concrete may not be placed from a chute discharge height greater than five (5) feet.

(5) No concrete other than foundation seals shall be placed underwater.

(6) Do not add water to concrete during delivery, at project site, or during placement unless the concrete delivery ticket indicates that mix water was withheld at the plant. In such cases only the amount withheld per cubic yard may be added at the jobsite.

(7) Concrete shall be placed in cold weather only when the air temperature is 40 degrees and rising.

(8) Protect newly placed concrete from air temperatures below 40 degrees with insulation blankets to maintain the concrete temperature at not less than 45 degrees for a period of 120 hours after placement.

6.9 Inspection and Laboratory Testing

It is the contractor's responsibility to ensure quality concrete meeting "*TDOT Standard Specifications"* is delivered and placed on the project. All quality testing of the concrete shall be performed by an independent testing company pre-approved by the City in accordance with Section 1 of these Standards. All quality testing performed by the testing agency is subject to monitoring and review by the City Engineer to ensure established procedures are followed. Reports of testing shall be certified and submitted to the City within ten days of actual testing to document the quality control before final acceptance of the project. The contractor will be responsible for the costs associated with all testing and also re-testing due to failed acceptance tests.

Required tests for concrete construction to be performed by the testing agency include:

(1) Slump
(2) Yield
(3) Entrained air content
(4) Mix temperature
(5) Representative test cylinders

6.9.1 Testing Frequency

One composite sample (4 test cylinders) for each day's pour of each concrete mix exceeding 5 cu. yd. but less than 25 cu. yd. plus one set for each additional 50 cu. yd. or fraction thereof.

Concrete placement operations shall be inspected by an on-site superintendent to ensure placement of the concrete meets requirements of "*TDOT Standard Specifications"*. On-site inspection is required to be documented by the contractor and recorded in a field book subject to review by the City Engineer.

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CHAPTER 7

STRUCTURES

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7.1 Overview

This Section includes all fabricated, installed and erected structures and appurtenances related to street construction including pipes, culverts, headwalls, box culverts and bridges, retaining walls and sign supports.

7.2 Reference Specifications

Unless modified by these Standards, all structure materials and construction requirements shall conform to "*TDOT Standard Specifications"*.

7.3 Pipe Culverts and Storm Sewers

Pipe used for cross drains under the street or side drains under driveways shall be rigid concrete pipe. Pipe manufactured from ADS plastic pipe may only be used outside of the street right-of-way. Plastic pipe may enter the back side of a street drainage structure provided it extends away from the street right-of-way or under a driveway and not under the street. All pipe culverts, side drains and storm sewers shall be furnished and installed in accordance with "*TDOT Standard Specifications"*.

Reinforced concrete pipe is standard for city streets

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7.3.1 Concrete Pipe

Concrete Pipe shall be reinforced Class III rigid pipe and shall be round, oval or flat based as shown on the approved plans. All precast concrete pipe shall be manufactured in accordance with the "*TDOT Procedures for Manufacture and Acceptance of Precast Concrete Drainage Structures, Noise Wall Panels and Earth Retaining Wall Products"*.

7.3.2 Corrugated Metal Pipe

Corrugated metal pipe shall not be allowed within the City of Franklin. Extensions of existing Corrugated Metal Pipe shall not be allowed. Existing Corrugated Metal Pipe shall be removed in its entirety and replaced with Concrete Pipe unless otherwise approved by the City Engineer.

7.3.3 High-Density Polyethylene (HDPE) Pipe

This pipe may be used for site drainage, but shall not be used under streets or driveways. HDPE pipe may exit from the back side of a street drainage structure and extend off of the City ROW. Max pipe diameter shall be 36 inches.

7.3.4 Poly Vinyl Chloride (PVC) Pipe

PVC pipe shall not be allowed within the City of Franklin.

7.3.5 Pipe Bedding

Pipe bedding for pipe shall comply with "*TDOT Standard Specifications"*.

7.3.6 Pipe Sizes

Normal pipe sizes readily available from suppliers may be used to satisfy drainage requirements. Minimum pipe size for side drains and storm sewers shall be 15-inch diameter.

7.3.7 Pipe Backfill

Pipe backfill shall comply with "*TDOT Standard Specifications"*.

7.3.8 Pipe Cover

The minimum depth of cover for storm sewer pipes is twenty-four (24) inches to the top of pavement.

7.4 Pipe Culvert Endwalls and Inlets

Pipe culvert endwall treatments may be precast or cast-in-place concrete and are required for all pipe locations within the street right-of-way.

(1) End treatments for a culvert shall consist of either an endwall or safety end section conformed to the slope of the roadway embankment. The choice of end treatment for a culvert shall be determined by the type of facility being served, the culvert size and whether the ends of the culvert are within the clear zone as defied by AASHTO Standards. "*TDOT Standard Specifications*" shall be followed when selecting the appropriate endwall. The City Engineer shall have final determination on the type and final placement of all endwalls.

(2) To improve the aesthetics of pipe headwalls, textured concrete finishes simulating stacked stone may be used. Additionally, veneers of stone or brick may be applied to exposed surfaces to enhance the appearance from the street.

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Protected Endwall with Stone Veneer

TDOT Safety Endwall

7.5 Storm Drainage Structures

Storm drainage structures consist of junction boxes, drop inlets, catch basins and manholes which may be constructed as precast concrete sections or cast-in-place concrete. Inlet and outlet pipes shall extend through the walls of structures a sufficient distance to make connections, but shall be cut flush with the inside surfaces of the box structure.

Vane grate for curb and gutter section

7.5.1 Catch Basin Castings

Catch basin castings that are damaged during construction will be rejected. Castings shall be set true to line and grade. Standard catch basin grates shall be per "*TDOT Standard Specifications*" or as specified in **the** Standard Drawings, or as approved by the City Engineer.

7.5.2 Concrete Catch Basins and Junction Boxes

Standard catch basins and junction boxes are precast concrete or cast-in-place where directed by the Engineer. Catch basins and junction boxes shall be designed and detailed on the plans or shall be "*TDOT Standard Specifications*". Knockout structures shall not be used.

7.5.3 Additional Pipe Openings

All boxes, existing or new installation, requiring additional pipe openings shall be neatly cored by means of mechanically sawing through wall of structure. Any damages caused to the structure or use of other means to create openings may require replacement, as determined by an authorized representative of the City of Franklin.

7.5.4 Trench Drains

Trench drains shall not be used within public right-of-way unless otherwise allowed by the City Engineer.

7.6 Box Culverts and Bridges

Box culverts and bridges shall be designed in accordance with AASHTO's "*LRFD Bridge Design Specifications*" and "*TDOT Standard Specifications*". Design drawings shall be sealed by a Professional Engineer licensed to practice in the State of Tennessee.

Bridges spanning the floodway shall provide a minimum clearance of 1-foot between the 100-year base flood elevation (BFE) and the lowest point of the bridge superstructure. Bridges shall also be able to pass the 500-year flood without structural failure.

7.7 Pedestrian Bridges

Pedestrian bridges shall be designed in accordance with the *AASHTO "LRFD Guide Specification for Design of Pedestrian Bridges"* (latest edition). Design drawings shall be sealed by a professional engineer licensed to practice in the State of Tennessee. Where pedestrian bridges allow passage of maintenance vehicles and small trucks, the vehicular loading shall be accounted for in the design of the bridge. For bridges prohibiting maintenance vehicular traffic, provisions shall be made to restrict access by means of suitable barriers, bollards or other permanent barricades.

7.8 Retaining Walls

Retaining walls shall be designed in accordance with the AASHTO "*LRFD Bridge Design Specifications*" (latest edition). Design drawings for retaining walls over 48 inches in height measured from the bottom of the footing to the top of the wall shall be sealed by a professional engineer licensed to practice in the State of Tennessee.

Retaining walls shall be designed for a live load surcharge corresponding to the maximum design loading, but in no case less than 250 psf applied over the full extents of right-of-way. Retaining wall designs shall provide a minimum sliding and overturning factor of safety of 1.50 and a minimum global stability factor of safety of 1.30. Unless otherwise permitted by the City Engineer, retaining walls shall be located outside of right-of-way with no elements necessary for wall stability located within right-of-way or public utility easement extents. Walls outside of, but supporting, right-of-way or public utility easements shall not utilize timber or rockery retaining

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walls. Walls within right-of-way or public utility easements shall consist of cast-in-place concrete walls meeting TDOT standards, unless otherwise permitted by the City Engineer.

Pedestrian and/or vehicular guards shall be provided when a pedestrian and/or vehicular path, respectively, extends to within five (5) feet of the top of a retaining wall or where otherwise deemed necessary by the City Engineer.

7.9 Overhead Sign and Ground Mounted Sign Supports

Sign support structures and foundations shall be designed, fabricated and erected in accordance with "*TDOT Standard Specifications*". Design drawings for overhead sign supports shall be sealed by a professional engineer licensed to practice in the State of Tennessee.

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SIGNAL DESIGN

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8.1 Introduction

The purpose of this chapter is to outline the City's review process for traffic signal plans and highlight basic design requirements for traffic signal installations and/or modernizations. This chapter outlines plan and design requirements for the various stages of review and also discusses some basic design elements the City requires on traffic signal projects.

Traffic signal technology changes at a rapid pace; the City reserves the right to change its traffic signal standards and specifications at any time without advance notice.

8.2 Administration

8.2.1 Signal Warrants

For the installation of traffic signals to be considered, the location must satisfy the warrants outlined in the most recent edition of the *"MUTCD"*. In high growth areas where significant changes in traffic conditions are expected due to the development of the area, hourly volumes for 5 years after full build-out shall be estimated and compared with the *"MUTCD"* signal warrants. The growth rate utilized to estimate the future traffic volumes is subject to the review and approval of the City Engineer prior to its use. The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic signal. The City Engineer shall make the final recommendation regarding the location of any new traffic signal. For state routes within the city, TDOT and City will review to make final decisions regarding signal warrants.

8.2.2. Engineering Study

An engineering study will be required for all proposed traffic signal installations. The engineering study shall evaluate the effects of the proposed traffic signal on progression. The engineering study shall include the estimation of future volumes and an analysis of the progression of traffic through the signal system, as defined by the City Engineer. The evaluation shall include any planned future traffic signal installations. The analysis shall be submitted to the City Engineer for review and shall include capacity analysis (using Synchro, HCM Cinema or other software as approved by the City Engineer), as well as time-space diagrams of the signal system. The study periods shall be the AM, midday and PM peak hours, although other time periods may be required. Signal timing optimization for a corridor may be required depending on traffic impact analysis.

8.2.3. Signal Spacing

Signalized intersections shall be located to maintain progression of traffic along arterial streets. This normally entails relatively uniform spacing and sufficient distances between signals to allow vehicles to travel at reasonable speeds. Optimal spacing of traffic signals is always the desire of the City. The optimal spacing is a function of the cycle length and the progression speed of traffic along the major street, but a general guideline is that signals should be placed at least a quarter of a mile apart. New signal locations shall be subject to spacing requirements on a case by case basis as determined by the City Engineer. Proposed signal locations not adhering to this spacing will be reviewed. The spacing requirements may be waived if the City Engineer determines that the proposed traffic signal will not significantly hinder the progression traffic along the major street. If the proposed location is rejected, the City Engineer may require either the relocation of the proposed signal location, to better accommodate progression, or the evaluation of other alternatives, for management of the traffic generated by the side street / private access.

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8.2.4. Private Benefit Signals

Private benefit signals provide signalized access to private streets or developments. These signals are generally required when the property owners must improve access from their site onto the major street or facilitate movement between developments on opposite sides of the street.

(1) Required Installations: If the Traffic Impact Study for a new development indicates that a traffic signal will be warranted within 10 years of full build-out, the City Engineer may require the inclusion of a traffic signal as a part of the development plan. The financial responsibility for these signals shall be in accordance with the arrangements made during preparation of the development plan. The time frame for installation is dependent on the traffic projections and subject to the discretion of the City Engineer. The site development plans will not be approved until provisions for the installation of the traffic signal or other alternative measures to enhance the safe movement of traffic through the intersection are included in the plans.

8.2.5 Designer Prequalifications

The design of traffic signals shall be performed by the City or a qualified Engineer approved by the City. The design staff for any firm supplying traffic signal plans to the City must be familiar with the traffic signal design procedures used by the City. At the request of the City, the design engineer may be required to provide copies of their most recent traffic signal design and / or modification projects to the City Engineer prior to their being assessed as qualified.

8.2.6 Intersection Design Study (IDS)

An IDS must be prepared for any intersection that is proposed for the installation or modernization of traffic signals. Engineering work associated with the IDS will include topographical surveys, preparation of a base map, roadway geometric design, traffic signal layout and traffic signal phasing. The IDS shall include the traffic signal warrant study, detailed preliminary intersection and signalization design to meet present and future traffic needs, a list of needed rights-of-way, and a total project cost estimate suitable for budgeting purposes. An IDS that has been reviewed and approved by the City Engineer is required prior to the submittal of traffic signal plans for review. If an IDS does not exist for the intersection, one shall be prepared as part of the project presentation stage of design (described in the following section). If an IDS exists and, at the discretion of the City Engineer, the traffic conditions at the intersection have significantly changed since the preparation of the IDS, an update of the IDS may be required.

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8.3 Design Standards

8.3.1 Referenced Standards

The design of traffic signals is under the jurisdiction of the City and shall conform to the requirements and specifications outlined in this chapter. Traffic signal design on State highways in the city shall meet the requirements of the City as approved by TDOT. All traffic signal design shall conform to the requirements of the *"MUTCD"*, *"TDOT Standard Specifications"* and *"Special Provision Regarding Section 730f – Traffic Signals City of Franklin 730 General Requirements"*

8.3.2 Design Requirements:

(1) Internally illuminated Street Name Signs - Temple Edge-Lit Internally-Illuminated LED Street Signs shall be installed on all mast arms. Signs shall have a Green Background and rigid mount back brace.

(2) Radar Detection System - Wavetronix detectors (Stop Bar and Advanced) complete with wiring and detector circuits for counting traffic shall be used on all approach lanes

except for exclusive right turn lanes that will operate with the associated through and/or left turn phases. In addition to stop bar and advance detectors in the thru lanes of moderate and/or high speed approaches (35 mph or greater), system detection shall be installed in the opposite direction thru lanes at the same location (subject to lane restrictions) as the advance loops.

(3) Signal Head Assembly

i. Shall be fabricated from cast aluminum. The signal housing shall be painted federal yellow (Signal housing in the Historic Downtown area shall be painted gloss black). Door faces shall be painted gloss black. Visors shall be constructed of sheet aluminum and the exterior painted gloss black. Visors shall be of the cutaway tunnel type. LED reflectors with polycarbonate lens shall be required.
ii. Backplates shall be furnished and attached to the signal head. All backplates shall be louvered on each of the four sides of the panel, and fabricated from black ABS UV stabilized plastic sheet.
iii. Bracket mounted signal heads shall be supported by mounting brackets consisting of assemblies of 1 ½" standard pipe size. All members shall be either plumb or level, symmetrically arranged, and securely assembled. Construction shall be such that all conductors are concealed within the poles and mounting assembly.
iv. Signal indications on mast arms shall be aligned per "*TDOT Standard Specifications".*

(4) Electrical Service Connection - Underground service connection shall be installed per the Standard Drawings. The service pedestal shall be Milbank Model No. CP3B "SL" Series CP3B11110A22SL1.

(5) Vehicle Detector (Infrared and GPS Activated Priority Control) – All traffic signal installations shall include dual GPS/infrared Opticom emergency vehicle priority control system complete with detectors, wiring and card in the cabinet (3M system).

(6) Cabinet / Controller – The following shall be required for all traffic signals:

i. The Cabinet shall be an Eagle ELS1014 size "P-UPS" base mounted cabinet with integrated UPS compartment. The UPS system shall be a Clary SPD2000 PD-N for rack mounting.
ii. The Traffic Controller shall be an Eagle EPAC 3108-M52 with
iii. A Fiber Connection Inc. "Gator Patch" Model # GP20L006FRB-xx-1 fiber optic distribution panel and drop cable shall be installed in the cabinet. (xx is cable length to splice pull box in meters).
iv. NEMA Signal Monitor shall be Eberle Design Inc. SSM-12LEip Series.
v. Surge Protector shall be EDCO ACP-340 (120 VAC – 1 Phase)
vi. Loadswitch shall be Eagle Load Bays NEMA TS-1 TF4000 Series, with 16 load bay positions and 8 flash relay positions.

(7) Pedestal Pole – shall be powder coated black with a square pedestal base and installed per "*TDOT Standard Specifications"*. Specialty poles and standards shall be required by the City Engineer in the Historic Downtown area.

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(8) Cantilever Signal Support

i. Signal Support shall be Cantilever type and powder coated black. The installation of strain poles shall generally not be approved by the City and will be reviewed on a case by case basis by the City Engineer. Specialty poles and standards shall be required by the City Engineer in the Historic Downtown area.
ii. Combination mast arms and other equipment necessary to provide intersection lighting will be required for all new traffic signal installations and modernizations. Aluminum and painted mast arm/signal poles, luminaire arms, and extensions shall be used.
iii. Any street light luminaire extensions (aluminum and painted) shall be approved by the City Engineer. A minimum 30-foot luminaire mounting height and a minimum 15-foot luminaire arm (aluminum and painted) shall be used to mount the streetlight fixture. The attachment height for mast arm to pole shall be per approved shop drawings.

(9) Countdown Pedestrian Signal, Push Button Post, Button and Sign

i. All items shall be in compliance with "*MUTCD"* and ITE specifications.
ii. Pedestrian signals and pushbuttons shall be provided at all signals unless otherwise directed by the City Engineer. All pedestrian signals shall have both audible and vibrotactile walking indications.
iii. Yellow 16-inch LED countdown pedestrian signal with visor and a clamshell / banding mounting system are required, with ADA pedestrian buttons for all standard pedestrian movements with marked crosswalks (Pedestrian signal housing in the Historic Downtown area shall be painted gloss black). Housing material shall be one-piece die-cast aluminum alloy.
iv. Pedestrian buttons shall be the bulldog type with audio alert, LED light, and sign housing/back plate. The accessible push button system with voice messages (APS) shall be used only where approved by the City Engineer.

(10) Battery Back-up and Power Conditioner – An uninterruptible power supply (U.P.S) shall be provided at all signals and shall be manufactured by Clary SP Series, Model PD, SP20000PD-N integrated PIM and Programmable Digital Display. Installation shall include SNMP Adapter SP-09G and outpost Batteries OP96SC-41

(11) Two 3-inch conduits (Schedule 40 PVC minimum) will be used for wiring between the signal bases and the cabinet.

(12) Pull box covers installed in the roadway shall meet or exceed TDOT specifications.

(13) Loop Lead-Ins shall be per "*TDOT Standard Specifications"* with the exception of provide a minimum 2-inch diameter conduit for better accessibility.

(14) Designer shall be required to include provisions for new streets and widening projects to include conduit for future signal interconnects and pull boxes as required.

(15) All shop drawings for signals are to be approved by the City Engineer prior to installation.

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8.3.3 Traffic Signal System Requirements

(1) The installation of a fiber optic interconnect is required between signalized intersections that are within 1/2 mile of one another or if analysis indicates that the signals would benefit from signal coordination. Communications interface must be installed as a part of the project if one does not exist already. All traffic signal systems will use IP based communications protocols and equipment shall have IP addressable ports.

(2) The City Engineer may require the installation of detection for the purpose of collecting traffic counts.

8.3.4 Electrical Requirements

(1) The traffic signal design shall conform to the National Electric Code.

(2) Traffic signal equipment shall conform to NEMA standards.

(3) Fiber optic interconnect shall include a copper tracer, pull string/jet line, marker tape and curb markers in all ITS conduit.

(4) Power back up shall be provided at locations required by the City Engineer, with the ability to provide stop-and-go control for up to one hour.

(5) The traffic signal plan shall include a continuous grounding plan for the intersection.

(6) Double hand holes are required at all traffic signal cabinet locations.

(7) Power disconnects shall be provided.

(8) New power installations shall be continuously metered by MTEMC.

(9) Service pedestals shall contain circuits and test switches for safety lighting and illuminated street name signs.

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8.3.5 Construction

Traffic signal installations / modernizations shall be constructed in accordance with applicable sections of the *"TDOT Standard Specifications"*.

8.3.6 Materials and Construction Notes

The specifications for traffic signal equipment and related appurtenances required by the City are maintained by the Engineering Department. A copy of these specifications is included and subject to change by the City Engineer.

8.3.7 Pedestrian Signals and Timings

The *"MUTCD"* identifies the situations in which pedestrian signal shall be used and the situations in which pedestrian signals shall not be used. Because one should assume that pedestrians will be present at all intersections in the City to some level, all signalized intersections shall be designed to accommodate pedestrians. Other locations that have high pedestrian volumes with marked crosswalks may also warrant the installation of a dedicated pedestrian actuated traffic signal, subject to review and approval by the City Engineer.

Bicyclists are required to follow the rules of the road, including those related to traffic signals. Therefore, signal timing and detection shall accommodate the needs of bicyclists. Traffic signal clearance intervals are recommended to be timed to provide bicyclists with sufficient time to react, accelerate, and proceed through an intersection on the clearance interval. Normally, a bicyclist can travel through an intersection under the same signal phasing arrangement as motor vehicles. However, special consideration of bicyclists' needs may be necessary at multi-lane crossings and at acute angle intersections, which take longer to cross. The clearance interval shall take into consideration a bicyclist's speed of 6-8 MPH, and a perception/reaction/braking time of one (1.0) second. Traffic detectors for traffic-actuated signals are recommended to be set to detect bicycles.

There are various types of detector loops that can be used for bicycle lanes. Quadruple and diagonal quadruple loop detectors generally provide for bicycle detection, unlike standard loops, which are difficult to adjust to detect bicycles. Detectors shall be located in the bicyclist's expected path of travel. When bicycle lanes are not present, pavement markings shall be used to indicate where bicyclists should position themselves in order to activate the signal detector.

The "*MUTCD*" and "PROWAG" standards shall be consulted regarding pedestrian signal timings. However these documents contain some differences. Each of these documents shall be reviewed, and the most stringent requirements shall be applied when designing pedestrian signal timings.

8.4 Signal Phasing and Timing

8.4.1 Purpose

The City has adopted a set of traffic signal timing and phasing guidelines which are to be implemented at signalized intersections under their jurisdiction. The purpose of these guidelines is to establish standard practices and operational procedures for traffic signal timing parameters to be used by City staff and consulting engineers performing signal timing services for City. This policy is in no way in conflict with "*MUTCD*". Should a conflict arise, the "*MUTCD*" shall prevail.

The guidelines in this document are to be implemented at new traffic signal installations, traffic signal upgrades, and along signalized corridors as they are re-timed. The adoption of these guidelines does not imply that each and every traffic signal under the jurisdiction of the Engineering Department will automatically comply with these new guidelines. Rather, traffic signal settings will be updated along signalized corridors throughout the City as they are retimed.

These guidelines have been established to provide guidance on various signal timing parameters. However, signal timing shall be evaluated for all situations independently based upon standard traffic engineering principles and local intersection characteristics. Necessary adjustments shall be made to meet the traffic conditions at each individual signalized intersection. These guidelines should serve to provide consistent, safe, and efficient control of traffic signals within the City.

8.4.2 Vehicle Clearance Intervals

The "*MUTCD*" requires that vehicle clearance intervals consist of a required yellow change interval and an optional red clearance interval. The "*MUTCD*" defines both the yellow change and red clearance intervals as:

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Yellow Change Interval – the first interval following the green interval during which the yellow signal indication is displayed.

Red Clearance Interval – an optional interval that follows a yellow change interval and precedes the next conflicting green interval.

The timing of Yellow Change and Red Clearance intervals are to be established per the ITE Recommended Practice.

8.4.3 Pedestrian Control Features

There are a number of pedestrian-related items that are covered in this portion of the guidelines. They include recommended pedestrian walking speeds, minimum pedestrian walk intervals for pedestrian signal phasing, guidelines for pedestrian clearance intervals. The City adheres to *"MUTCD"* recommended standards for pedestrian timing.

8.4.4 Pedestrian Push Button Usage

Pedestrian push button actuation is recommended for pedestrian phases that cross the 'main street' approaches so that 'side street' vehicle phases do not have to accommodate pedestrian timings unless they are actuated via a pedestrian push button. The need for push button actuation to cross side street approaches shall be determined via engineering judgment by the City. For the purposes of determining main street approaches in reference to pedestrian timings, the main street approaches will be considered the signalized approaches that are coordinated and are therefore non-actuated. If a traffic signal is pre-timed or fully-actuated, the differentiation between main street and side street does not apply for this situation.

8.4.5 Walk Rest Modifier Option

During main street vehicle signal phases that are non-actuated, there are often situations where the vehicle split is significantly larger than the required pedestrian walk and clearance intervals. Rather than increasing the pedestrian clearance interval to accommodate the additional time available, City staff will allow the signal controller to extend the length of the pedestrian walk interval. There are however, situations where this option, known as the walk rest modifier, should not be allowed. Such applications where the walk rest modifier should not be utilized include the following: (a) cases where right-turn volumes are heavy across the pedestrian crossing area, (b) cases where permissive left-turn volumes are heavy across the pedestrian crossing area, and (c) any other cases where City staff has determined that the walk rest modifier option should not be implemented.

8.4.6 Minimum Vehicle Green Times

Minimum vehicle green times shall be short enough so that green time is not wasted, yet not so short such that motorists unexpectedly see the yellow change interval while entering the intersection and become confused. The minimum times documented in this section of the policy are the minimum allowed which does not suggest that all signalized intersections will utilize these minimum values. Greater minimum green times are allowed; however values lower than these mentioned below are not recommended. In addition, the percentage of trucks shall also be reviewed on an intersection-by-intersection basis since a high percentage of trucks may necessitate increasing the minimum green time controller setting. Maximum green time setting are not discussed in this policy since they vary significantly by location and are based on signal operation, vehicle demand, and other operational characteristics.

Minimum Green Times for Left-turn Phases - A minimum green time setting of five (5) seconds is allowed for left-turn phases.

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Minimum Green Times for Side Street Through Phases - A minimum green time setting of seven (7) seconds is allowed for side street phases.

Minimum Green Times for Main Street Through Phases - A minimum green time setting of ten (10) seconds is allowed for main street through phases.

8.4.7 Main Street and Side Street Definitions

It is often obvious, when comparing approach geometry, traffic volumes, road classification and/or route continuity, which roadway is considered the 'main street' and which is considered the 'side street'. However, there are instances where there is no clear cut distinction between the two. Some intersections include two main streets. For the purposes of selecting minimum green time settings, the City Engineer will apply the above factors in determining whether or not a main street approach exists.

8.4.8 Left-Turn Signal Phasing Guidelines

Left-turn phasing guidelines as discussed in the ITE *Traffic Engineering Handbook* are to be used for assistance in assessing the need for left-turn phasing at signalized intersections under City jurisdiction. There are two Transportation Research Record documents suggested by ITE for traffic engineers to consider where determining the need for some form of protection for left turn phases. They are:

From J. E. Upchurch. Guidelines for Selecting Type of Left-turn Phasing. In *Transportation Research Record* 1069, Transportation Research Board, National Research Council, Washington, D.C., Figure 5, p. 37.

From Asante, S. A., S. A. Ardekani, and J. C. Williams. Selection Criteria for Left-Turn Phasing and Indication Sequence. In *Transportation Research Record* 1421, Transportation Research Board, National Research Council, Washington, D.C., 1993, Figure 4, p. 17.

These guidelines shall be used as a tool for determining the need for left-turn phasing at signalized intersections along with engineering judgment by the traffic engineer.

In addition to the guidelines referenced above, there are two additional guidelines that are to be adopted as City policy:
(1) Exclusive/permissive left-turn signal phasing is allowed when three (3) opposing through lanes exist as long as there is no accident experience problem and/or sight distance issue that would hamper the safety of permissive left-turn movements.
(2) Exclusive left-turn signal phasing shall be installed where multiple left-turn lanes exist.

8.4.9 Protected/Permissive Left-Turn Phase Operation

Phasing for eight-phase signal controllers shall prohibit a phase change from main street green to a main street left-turn phase if the left-turn phase operates protected/permissive. In the absence of a side street actuation, the signal controller shall remain in main street green to allow left-turn movements to occur on the permissive green.

Where left-turn delay and/or safety problems exist, the City may investigate and apply the flashing Yellow Arrow (FYA) protected/permitted signal display, in accordance with the guidelines described in the "*MUTCD*" All such installations shall provide the regulatory signs as required in the "MUTCD". City Engineer approval shall be required for the FYA.

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8.4.10 Split-Phase Timing Operation Guidelines

The term split-phase signal operation describes a signal phasing sequence where one approach is given exclusive right-of-way into the intersection followed by the opposing approach being provided exclusive right-of-way into the intersection. This operation eliminates left-turn conflicts; however, it is often described by traffic engineers as an inefficient signal phasing option since the entire intersection is given a red indication to service only one of the four signalized approaches. The City Engineer may require intersection upgrades to remove split-phase operations to improve or maintain level of service. For traffic signals under the jurisdiction of the City, the following situations may necessitate the need for split-phase timing operation:

(1) Where offset approaches exist that may cause motorist conflicts/confusion if permissive phasing were implemented.

(2) Where intersection width prevents opposing left turn movements from operating concurrently. The City Engineer may require intersection upgrades to correct the opposing left turn movements. Prior to implementing split-phase operation due to this geometric limitation, the installation of lead-lag phasing shall also be considered.

(3) When an accident problem exists between left-turn and through movement conflicts that has not been successfully remedied via other operational improvements.

(4) Where a sizeable volume imbalance exists on the side street approaches.

(5) Where a second left-turn lane is needed but must be shared with a through movement lane. The City Engineer may require intersection upgrades to correct this issue and maintain adequate level of service.

(6) Where the need to serve the left-turn volume is relatively close to the time needed to serve the through movement volume. For each case, a capacity analysis shall be performed comparing split-phase timing operation versus other signal phasing options prior to implementation.

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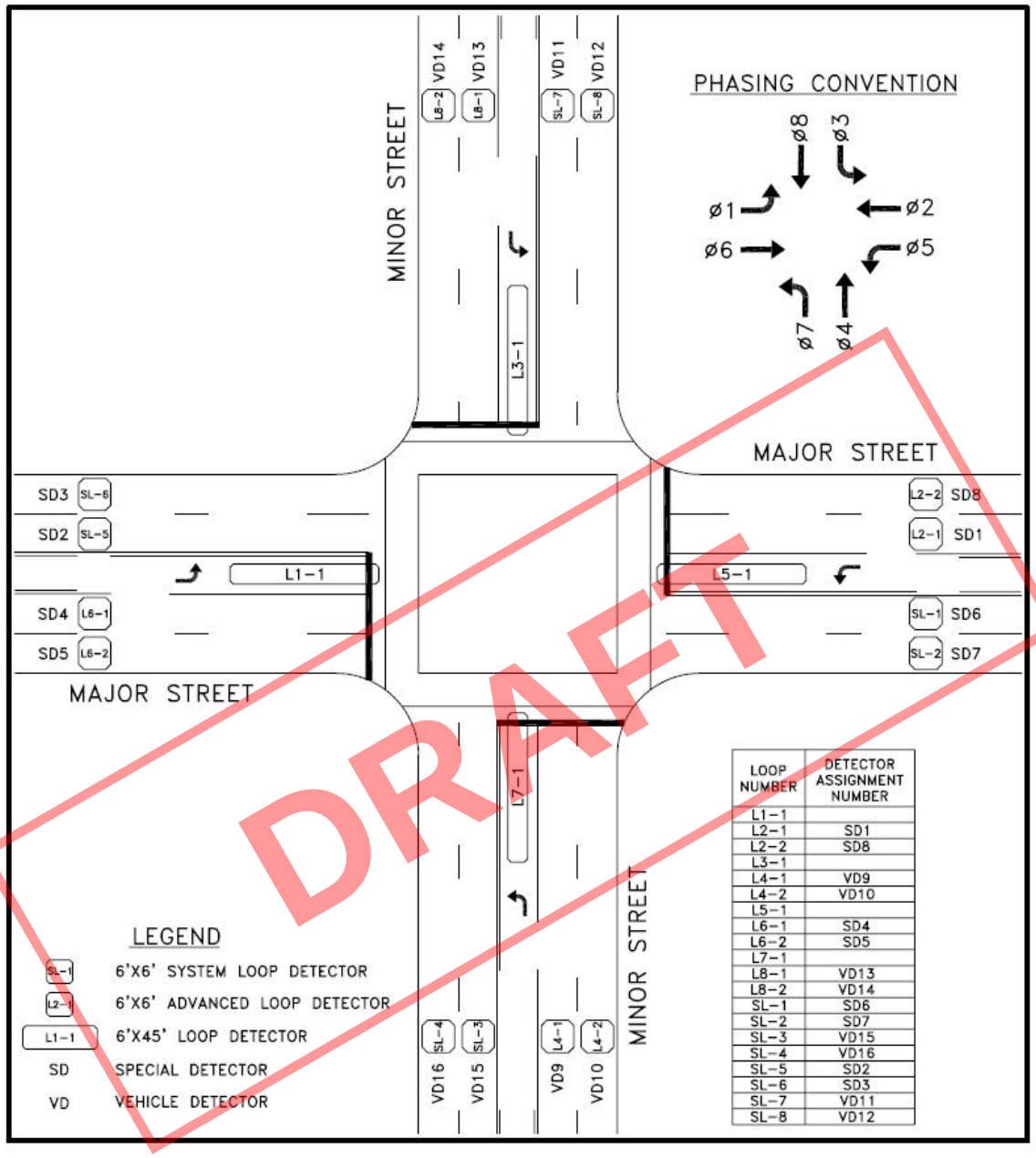

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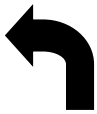
Typical Detector Numbering and Phasing Convention

PHASING MAP FOR NORTH/SOUTH MAIN STREET

Phase 1 – NBLT	Phase 2 – SB Thru	Phase 3 – EBLT	Phase 4 – WB Thru
			
Phase 5 – SBLT	**Phase 6 – NB Thru**	**Phase 7 – WBLT**	**Phase 8 – EB Thru**

PHASING MAP FOR EAST/WEST MAIN STREET

Phase 1 – EBLT	Phase 2 – WB Thru	Phase 3 – SBLT	Phase 4 – NB Thru
Phase 5 – WBLT	**Phase 6 – EB Thru**	**Phase 7 – NBLT**	**Phase 8 – SB Thru**

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8.4.11 Leading/Lagging Left Turn Operation

Leading/Lagging Left Turn operation shall be considered as an option for signal operation. It must consistently operate in the same mode throughout the day. Leading and lagging assignments may not be changed by time-of-day.

STREET LIGHTS

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9.1 Introduction

Adequate lighting shall be provided to ensure safe movement of persons and vehicles in the public right-of-way, and to assist for security purposes. The primary purpose of streetlights is to illuminate the public traveled ways to a level and uniformity that provides for the safe passage of public traffic, both vehicle and pedestrian.

9.2 Definitions

AFG: Above finished grade.

COF: City of Franklin

LEED: Leadership in Energy and Environmental Design

LED: Light Emitting Diode

LLF: Light Loss Factor: A percentage of the initial light output of a fixture that will be present at the maintained average life of the fixture.

MTEMC: Middle Tennessee Electric Membership Corporation: Cooperatively owned electric power distributor for the 4-county area of Williamson, Wilson, Rutherford, and Cannon counties of Tennessee.

NFPA: National Fire Protection Association

Street Light: A raised source of light on the edge of a street or walkway, which is turned on or lit at a certain time every night.

Street Lighting System: A series of street lights within the same development or project.

IES: Illuminating Engineering Society of America.

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9.3 Ownership / Responsibilities

In General, ownership shall be based on the roadway classifications as indicated below:
Local and Private Streets – Street lighting placed on local and private streets shall be owned and operated by MTEMC and shall be required to meet the minimum requirements as outlined herein.
Collector and Arterial Streets – Street lighting placed on Collector and Arterial Streets shall be owned and operated as determined by the City Engineer.

9.3.1 Responsibilities Delineated

(1) Developer/Property Owners' Association/Contractor Responsibilities:

(a) Submit lighting plans for approval by the City of Franklin.

(b) Obtain a City of Franklin electrical permit for City or Privately owned and operated street lights.

(c) Obtain MTEMC approval for street lighting systems that are to be owned and operated by MTEMC.

(d) Responsible for utility initiation charges and energy usage charges until City accepts ownership.

i. Ownership for private development project occurs at the time the City of Franklin releases all performance sureties. The Franklin Municipal Planning Commission (FMPC) must approve the lighting of the City owned part of the projects prior to turn-over to maintenance and billing.

ii. Ownership for City capital projects occurs at the time the entire project is substantially complete and accepted by the City.

(2) City of Franklin (COF) Responsibilities:

(a) COF shall review and approve all street lighting through appropriate submittals in accordance with Site Plans, PUD Development Plans, Preliminary Plats, Final Plats, Infrastructure Plans, Lighting Plans, and Lighting Calculations.

(b) COF shall inspect, review and approve final record drawings associated with the record lighting plans.

i. MTEMC owned and operated street lights:

- COF shall inspect street light locations as shown on the City approved construction documents.
- COF shall coordinate with MTEMC to specify the billing rate class for the new street light services.

ii. COF owned and operated street lights

- COF shall inspect conduit pole bases.
- COF shall perform scheduled ditch/conduit inspections before ditches are closed.
- COF shall perform scheduled foundation inspections before concrete is poured.
- COF shall preform electrical inspections on the customer side of the meter.
- COF shall perform final inspections before lights are connected to the MTEMC system.

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9.4 Design Guidelines

Street lighting systems will be implemented in such a way as to improve the development in which the system is serving. The specifics of each street light will be reviewed by the City, as outlined herein, to ensure that any proposed street light will enhance its surroundings and improve public safety while also optimizing energy efficiency and cost savings. The City of Franklin has adopted the following basic lighting standards.

9.4.1 General Design Standards

All street lighting of public and private streets in the City shall be designed in accordance with these standards. Adjacent bikeways and pedestrian ways are to be included when associated with the public right-of-way.

(1) Underground Electric Service
Street lighting shall be installed with underground electric service on all newly developed dedicated public streets in the City. Curb returns shall be installed after the installation of the electrical system, including underground vaults. The Developer is responsible for coordinating with MTEMC for all aspects of electrical service.

(2) Fixture Type
All luminaires shall have a LED light source. The city seeks to minimize light pollution and avoid distributing light into windows of residents. All fixtures shall include cutoff shields or other mechanisms so that light levels outside of the right-of-way does not exceed levels stipulated by LEED for the lighting zone of the project. No luminaries shall have any blinking, flashing or fluttering lights or other illuminating device which has a changing light intensity, brightness or color, nor is any beacon light permitted, except those required for fire alarm and/or emergency systems.

(3) Fixture Location

(a) The final installation location and quantity of all street lights shall be determined by detailed calculations, coordination with the site during design and approved by the City Engineer.

(b) Poles may be located within landscaped areas or islands; however, to avoid conflicts with required trees, the location of poles shall yield to existing mature trees. Proposed trees shall be relocated to avoid conflicts with light standards.

(c) Unless otherwise approved by the City Engineer or their designee all street lighting equipment conduits and foundations shall be located in the street right-of-way.

(d) When locating proposed lighting, the designer shall avoid possible conflicts with above-ground and below-ground utilities.

(4) General Layout Criteria

(a) A minimum of two lights shall be placed at every intersection with the exception of alleys. Intersections with alleys will only require one light. (See **Figure 9.1 and 9.2**)

(b) Signalized intersections may be lighted using combined streetlights and/or lighting located on the signal mast arms. A minimum of four lights shall be placed at every signalized intersection.

(c) Roundabout lighting shall be in accordance with recommendations of IES DG-19-08 "Design Guide for Roundabout Lighting." Lighting shall make roundabout visible from a distance, and make key conflict areas more visible. If continuous roadway lighting is not present, transition lighting is to be provided.

(d) Railroad crossing lighting will conform to the latest version of the Railroad-Highway Grade Crossing Handbook (FHWA) and the Lighting Handbook (FHWA). If considered a conflict, luminaire supports shall be placed in areas of accessibility. Where placed in the clear-zone of a high speed road, they shall have a break-away base.

(e) All bridge underpasses, where vehicles, pedestrians, bicyclists, or equestrians may be present, shall require lighting.

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(f) Where sidewalks are attached to the curb, street lights shall be installed behind the sidewalk (in right-of-way or easement) with at least 1-foot clearance on Local streets (2 feet clearance on Major Collectors and Arterials). Poles within the clear zone shall be breakaway designs.

(g) For sidewalks detached from the curb, street lights shall preferably be located between the curb and sidewalk and installed a minimum of 2 feet from the back of curb, and 2 feet clear from all walks (1 foot on Local Streets). Poles within the clear zone shall be breakaway designs.

(h) Non-Curbed Streets - On streets without curb and gutter, street lights shall be place no closer than ten (10) feet to the edge of the traveled way. Poles within the clear zone shall be breakaway designs.

(i) Street Lighting in Medians - Street trees shall not be placed within 30 feet of a street light. Understory trees shall be no closer than 15 feet to any street light. Poles within the clear zone shall be breakaway designs.

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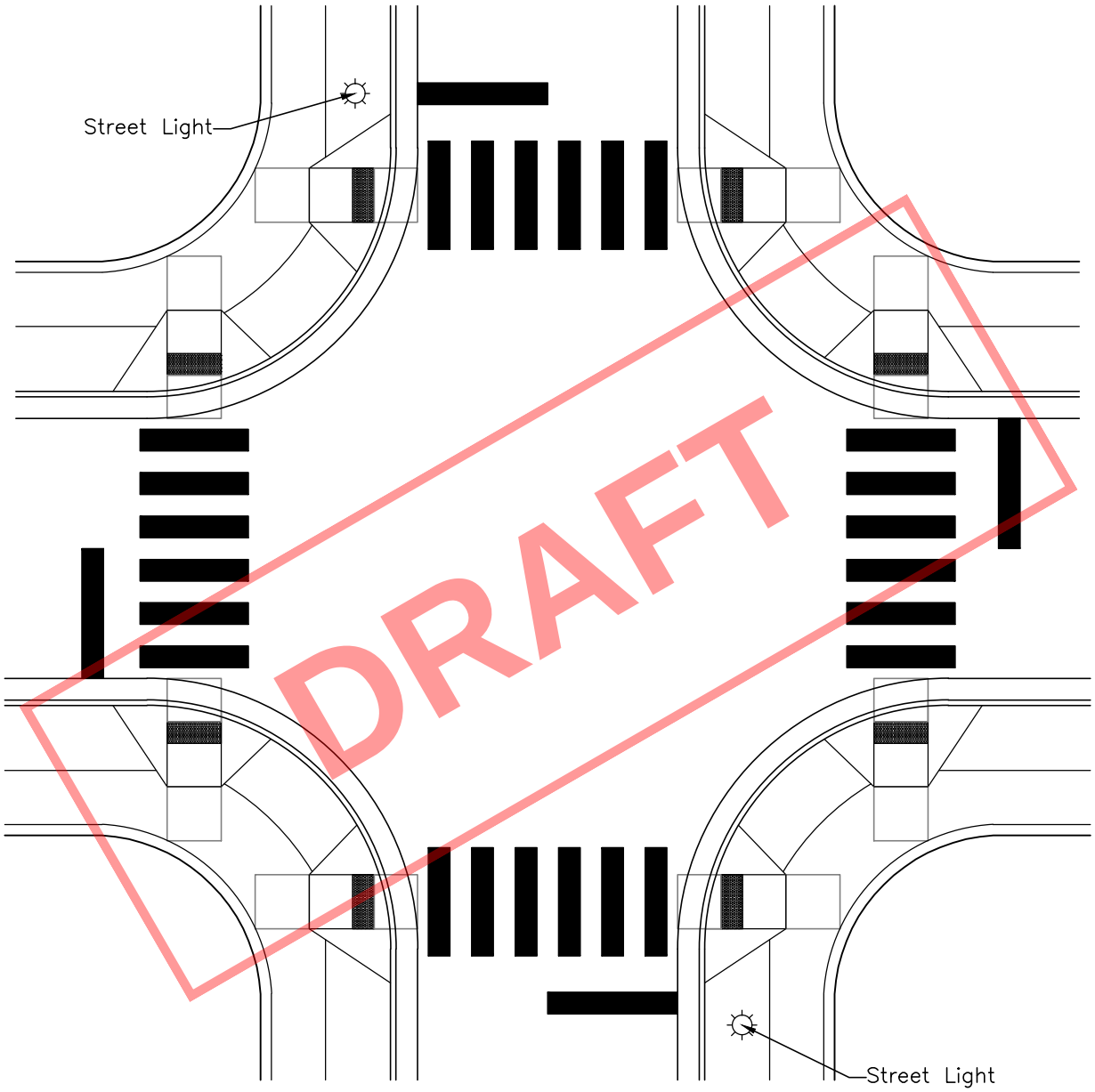

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FIGURE 9.4 (1)
NON–SIGNALIZED INTERSECTION PRESCRIPTIVE LIGHTING

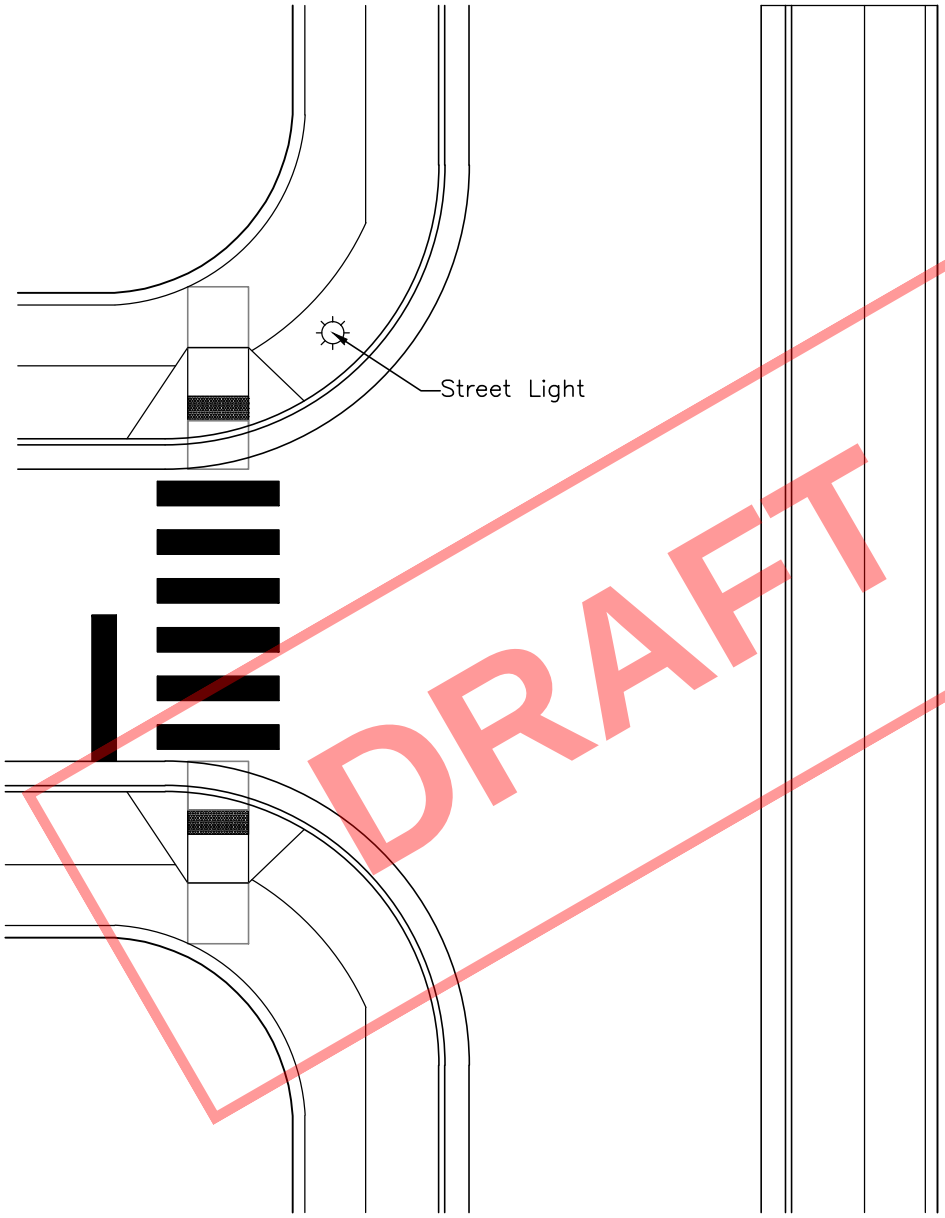

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FIGURE 9.4 (2)
TEMPORARY CUL–DE–SAC

9.4.2 Local, Private, and Minor Collector Streets

In addition to the General Design Standards, all street lighting on local, private, and Minor Collector streets shall be LED and installed per MTEMC standard drawings. MTEMC shall be responsible for operation and maintenance of all street lighting on local and private streets.

Energy cost associated with lighting on public streets shall be the responsibility of the City of Franklin, TN.

Energy cost associated with lighting on private streets shall be the reasonability of an association of the development.

(1) Prescriptive Lighting Standards

All local, private, and Minor Collector streets shall have prescriptive lighting based on the following standards:

(a) Max Spacing of light poles shall not exceed 300' with a clear line of sight within the ROW from one pole to the next (excluding landscaping). (See **Figure 9.3**)

(b) Street lighting shall be placed in every cul-de-sac and dead end streets (Temporary or permanent). (See **Figure 9.2** and **Figure 9.3**)

(c) Street lights shall be placed thirty (30) inches from curb face to center, in line with trees in the furnished zone between the sidewalk and the curb.

(d) Poles shall be placed a minimum of ten (10) feet from driveway aprons;

(e) Street light poles and foundations shall not be located over any other utilities. When locating proposed lighting, the designer should avoid possible conflicts with above-ground and below-ground utilities.

(f) Street light poles shall be located along lot lines whenever possible.

(g) Streetlight mounting height shall be limited to 16 feet AFG.

Upon the request of any owner of property to which this subsection applies, the City Engineer may approve an alternative prescriptive lighting plans. In making this determination, the City Engineer may consider specific design constraints such as large lot subdivisions.

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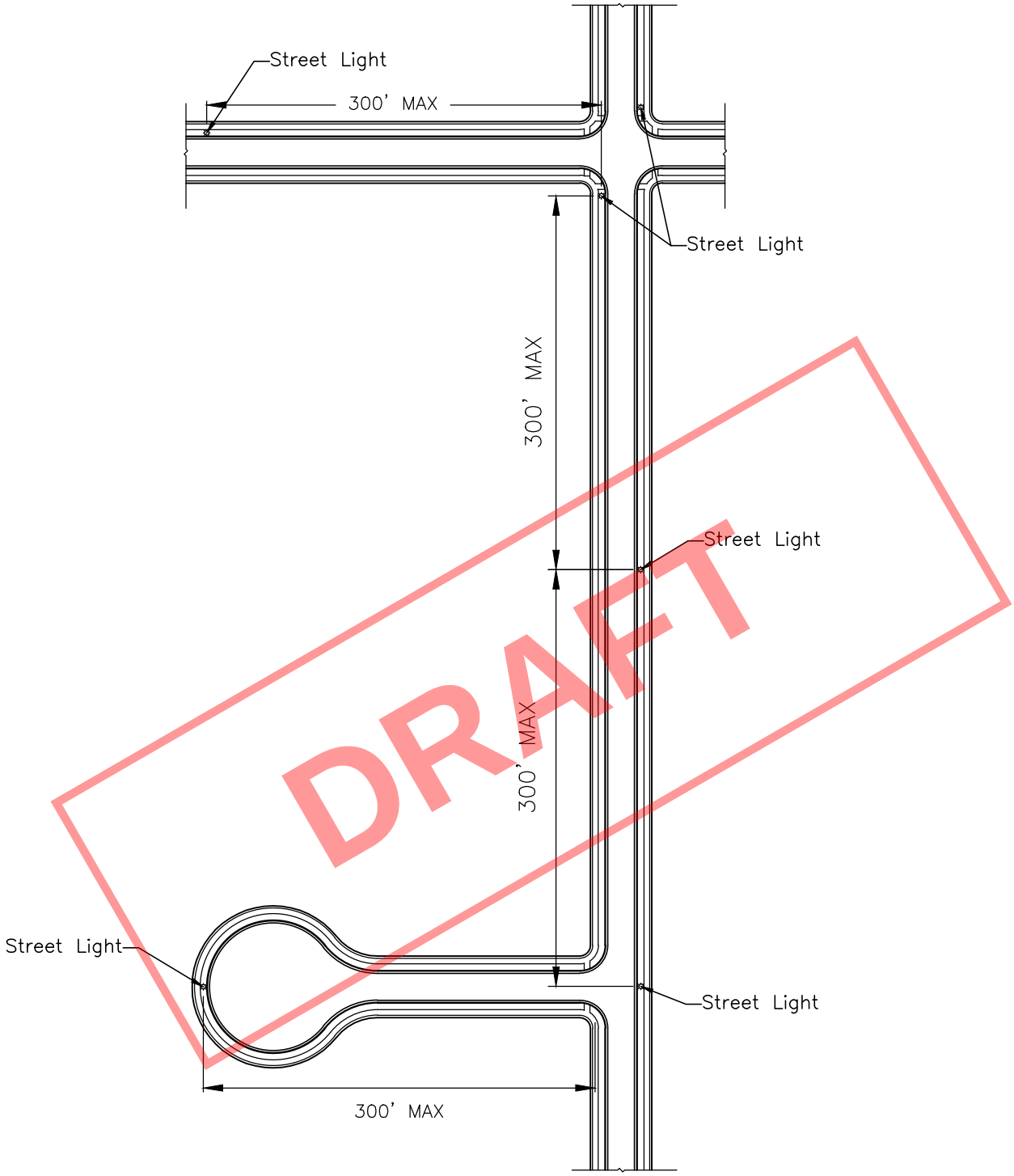

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FIGURE 9.4 (3)
LOCAL AND PRIVATE STREET PRESCRIPTIVE LIGHTING

9.4.3 Major Collector and Arterial Streets

In addition to the General Design Standards, street lighting on Major Collector and Major and and Minor Arterial streets shall meet the standards set forth in the *Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting (ANSI/IES RP-8), latest edition issued by the American National Standards Institute, ANSI, and the Illuminating Engineering Society, IES, and related documents therein.* The RP-8 is considered a live document, and any supplemental revisions are to be adhered to unless otherwise directed by the City Engineer.

Roundabouts shall conform to the standards set forth in Design Guide Roundabout Lighting (ANSI/IESNA DG-19-08) or latest version thereof.

Trespass light shall be limited to values defined by LEED and shall be based on the lighting zone of the project. Lighting zones shall be as adopted by the IES to describe the ambient lighting conditions/sensitivity of the area.

The street classification and lighting zones used on a project shall be approved by the City Engineer.

(1) Light Temperature

Street lighting shall be of a color temperature approved by MTEMC.

(2) Minimum Wiring Design

Street lighting within the City of Franklin shall be designed as follows:

(a) All wiring methods and equipment construction shall conform to the latest edition of the National Electrical Code adopted by the City of Franklin. Basic wiring shall conform to the Streetlight Installation Detail (see standard drawings).

(b) All splices to be approved solderless waterproof connectors of proper size.

(c) All empty conduits shall have a ¼" nylon pull rope provided insides.

(d) All conduits shall be sealed with an approved duct seal. Conduits stubbed for future extensions shall be capped.

(e) All pull box covers shall be secured with brass hold down bolts and inscribed "**COF STREET LIGHTING**".

(f) All street lights equipped with a photocell control shall have the photocell oriented to the north.

(g) All wire shall be THHN A.W.G. with the minimum size to be No. 8 in runs between poles. Wire runs from junction box to fixture shall be minimum No. 10.

(3) Pull Box and Conduit Design

(a) All conduit to be used shall be a minimum of 2" diameter, except from each street light to the adjacent pull box which may be 1" diameter PVC or metal, and shall have the following cover from top of conduit.

i. Within sidewalk of parkway areas: 3'-0" min. Schedule 40 PVC.
ii. Within roadway areas: 3'-0" min. Schedule 80 PVC.

(b) All metal conduit and other metal parts shall be continuously bonded and grounded.

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(c) All bends and/or offset shall be made with factory sections and there shall be no more than three factory bends per conduit run.

(d) Unless otherwise approved by the City of Franklin Street Department, Standard TDOT or COF pull boxes shall be used for all street lighting. See TDOT and COF standard drawings.

(e) Junction boxes shall be located at the base of every pole and not more than 200'-0" apart on long runs.

(f) Pull boxes shall be located a minimum of 18" from the face of the curb to the center of the pull box.

(g) When pull boxes are subject to vehicular traffic, they shall be set on concrete footings and cast iron traffic covers (minimum H-20 rating) shall be installed. A concrete ring shall be provided around the pull box per manufacturer's instructions for application in paved area.

(h) Provide a minimum 18" vertical and horizontal clearance from all other utilities. When clearance cannot be provided concrete encasement shall be required.

(i) Conduit shall be run parallel and perpendicular to the roadway.

(4) Metering Requirements

(a) All City owned and maintained street lights shall be metered. A metering plan will be submitted as part of the lighting plan, and will show, at minimum, all meter locations, wiring extents, and installed meter type(s).

(b) In order to reduce long-term maintenance costs, the City requires the following:

i. The City seeks to connect as many street lights as possible to each power meter to minimize the total number of meters.
ii. The City will not accept ownership and maintenance of street lights that are on the same meter as other non-street lighting electrical uses.

(c) The only service pedestal accepted for use in the City of Franklin is the type "SL" Millbank Service Pedestal.

(5) Other Requirements

(a) The developer/project engineer shall make arrangements for service points with the City of Franklin. Service Points shall be designed to minimize the number of power meters and this shall be verified by City of Franklin through review of the lighting plan.

(b) New developments within an existing developed area shall provide the entire lighting system, including luminaires.

(c) All street light systems shall be designed for 240-volt service unless approved by the City Engineer due to circumstances/availability.

(d) Pole Identification Numbers for metal poles shall be a minimum of 2.5" x 4.5" and located at base of pole with COF approved identification, reflective white on black with adhesive backs.

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(e) The City seeks to minimize light pollution and avoid distributing light into the windows of residents. All fixtures shall include cutoff shields or other mechanisms so that light levels outside of the right-of-way does not exceed levels stipulated by LEED for the lighting zone of the project.

(f) Any existing lighting system to be transferred to ownership of the City of Franklin shall be compatible with LED retrofit fixtures. LED fixtures and bulbs shall be specified by the Street Department Director or their designee.

(g) Any street light installed shall be selected from the City of Franklin approved list.

(h) All Wiring shall be underground without prior approval from the City Engineer.

9.4.4 Submission Requirements (MTEMC Owned Street Lights)
The following documentation shall be submitted for City of Franklin review and approval prior to approval of site plan or infrastructure plan.

(1) Lighting Plan

(a) Location, type, and height of all lighting

(b) Clearly identified/labeled property lines, streets and sidewalks.

9.4.5 Submission Requirements (City Owned Street Lights)
The following documentation shall be submitted for City of Franklin review and approval prior to approval of site plan or infrastructure plan.

(1) Lighting Plan

(a) Location, type, and height of all lighting

(b) Location, type, and wiring specifications of all power meters

(c) Details on color, materials, lumen output, light output color (temperature), and wattage for all lighting fixtures

(d) Grid spacing of calculation points on roadways shall be two transverse points per lane at each longitudinal point along one luminaire cycle. Maximum 16.4 feet between longitudinal points.

(e) Maximum illumination at property lines (for non-residential and multi-family projects only). This is on and off roadways.

(f) Clearly identified/labeled property lines

The following charts shall be provided on the drawings of all lighting designs (example data for tables shown):

Street and Site Lighting Data

Street and Site Lighting Data	
Development Standard:	
Land Use:	

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Zoning District:	
Height of Proposed/Existing Building:	
Pole Height:	
Pole/Fixture Color:	
Color of Light (in Kelvin):	
Luminaire Wattage:	
Luminaire Volt-Amps:	
Luminaire Lumens:	
Luminaire Light Loss Factor (LLF):	
The Lighting Plan has been designed to meet the City of Franklin Standards, and the approval of the Planning Commission/City of Franklin. Changes shall not be made to the approved Lighting Plan unless approved by either the relevant department Director or the Planning Commission. *Additional lines or tables may be added if multiple lighting styles are to be used in a development or as needed.	

Load Center Load Requirements

LIGHTING LOAD CENTER "3" LOAD REQUIREMENTS					
CIRCUIT NUMBER	LINE WATTS	AMP LOAD	VOLT DROP (%)	CIRCUIT BRKR. SIZE	LIGHTING CONTACTOR SIZE
3-1	3900	16.25	1.86	30A / 2P	30A / 2P
3-2	2703	18.75	1.94	30A / 2P	30A / 2P
3-3	2400	12.5	1.7	30A / 2P	30A / 2P
3-4	2400	12.5	1.77	30A / 2P	30A / 2P
				SPACE	SPACE
				SPACE	SPACE
TOTAL:	11403W	60.0A		MAIN: 100A	

Lighting Design Input Data

LUMINAIRE FIXTURE	MOUNTING HEIGHT	IES DISTRIBUTION CLASSIFICATION	AIM/TILT ANGLE	LIGHT LOSS FACTOR	LUMENS USED (PER FIXTURE)	POLE HEIGHT	COLOR TEMPERATURE	PHOTOMETRIC CURVE NUMBERS
Holophane Teardrop, LED	30'	III	N/A	0.91	10898	30'	4000 K	ESL_150_4K_AS_X_4
Holophane Teardrop, LED, Double Head	30'	III	N/A	0.91	10898	30'	4000 K	ESL_150_4K_AS_X_4

Calculation Summary

Calculation Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Intersection (Main & 1st)	Illuminance	Fc	2.82	N/A	N/A	2.01	N/A
Intersection (Main & 2nd)	Illuminance	Fc	2.9	N/A	N/A	1.38	N/A
Intersection (Main & 3rd)	Illuminance	Fc	3.01	N/A	N/A	1.25	N/A
Main St – East_2_Luminance	Luminance	Cd/Sq.m	1.51	1.9	1.1	1.37	1.73
Main St – East_2_Veil_Lum	Veiling Luminance	Cd/Sq.m	0.21	0.3	0.1	2.1	3
Main St – East_Luminance	Luminance	Cd/Sq.m	1.54	2.1	1.2	1.28	1.75

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Main St – East_Veil_Lum	Veiling Luminance	Cd/Sq.m	0.19	0.4	0.1	1.9	4
Main St – West_2_Luminance	Luminance	Cd/Sq.m	1.46	1.9	1.2	1.22	1.58
Main St – West_2_Veil_Lum	Veiling Luminance	Cd/Sq.m	0.16	0.3	0.1	1.6	3
Main St – West_Luminance	Luminance	Cd/Sq.m	1.62	2.4	1.3	1.25	1.85
Main St – West_Veil_Lum	Veiling Luminance	Cd/Sq.m	0.21	0.3	0.1	2.1	3

(2) Lighting Calculations

Calculations shall be submitted as part of a development plan, site plan or infrastructure construction plan submission. The lighting calculations shall include:

(a) Horizontal illuminance (foot-candles) on pavement/sidewalk

(b) Vertical illuminance (foot-candles) along sidewalks and at pedestrian conflicts

(c) Veiling glare (Lvmax/Lmin)

(d) Lighting layout with fixture isoline contours of illuminance on street level:

i. 3 FC – Light Purple
ii. 2 FC – Red
iii. 1 FC – Light Blue
iv. 0.5 FC – Green
v. 0.25 FC – Dark Blue
vi. 0.1 FC – Black

(e) Voltage drop for each branch circuit

(f) Lighting Design Input Data

i. Fixture type
ii. Fixture mounting height
iii. Lumens/fixture used
iv. Distribution type
v. Aim/tilt
vi. Color temperature
vii. Light Loss Factor (LLF)

(g) Include drawings that show the calculation grids (with results) with fixture lighting iso-contours (templates) and drawings that have lighting rendered with iso-contour lines.

(h) Calculations shall be performed in the latest version of AGI-32. Calculations shall be submitted on drawings that match construction drawings (and include overall). Include a copy of the lighting calculation software input/calculation file of approval submittals and as installed calculations.

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9.4.6 Light Levels

Lighting shall be designed to the recommendations of the Illuminating Engineering Society of North America for levels, uniformity, and veiling luminance. The illuminance/luminance shall take into account the roadway surface classifications (R-class). For most cases, the R2 and R3 classes will be acceptable.

The following tables are from IES RP-8-14 and IES DG-19-08. Any changes to IES documents supersedes these values.

Table 9.4.1 – Lighting Design Criteria for Streets

STREET CLASSIFICATION	PEDESTRIAN AREA CLASSIFICATION	AVG. LUMINANCE L_{avg} (cd/m²)	AVG. UNIFORMITY RATIO L_{avg}/L_{min}	MAX. UNIFORMITY RATIO L_{max}/L_{min}	MAX. VEILING LUMINANCE RATIO LV_{max}/L_{avg}
MAJOR / ARTERIAL	HIGH	1.2	3.0	5.0	0.3
	MEDIUM	0.9	3.0	5.0	0.3
	LOW	0.6	3.5	6.0	0.3
COLLECTOR	HIGH	0.8	3.0	5.0	0.4
	MEDIUM	0.6	3.5	6.0	0.4
	LOW	0.4	4.0	8.0	0.4

L_{avg} – minimum maintained average pavement luminance
L_{min} – minimum pavement luminance
LV_{max} – maximum veiling luminance

Table 9.4.2 – Illumination for Intersections

Illumination for Intersections				
Functional Classification	Average Maintained Illumination at Pavement by Pedestrian Area Classification in Lux/fc			E_{avg}/E_{min}
	High	Medium	Low	
Major/Major	34.0/3.4	26.0/2.6	18.0/1.8	3.0
Major/Collector	29.0/2.9	22.0/2.2	15.0/1.5	3.0
Major/Local	26.0/2.6	20.0/2.0	13.0/1.3	3.0
Collector/Collector	24.0/2.4	18.0/1.8	12.0/1.2	4.0
Collector/Local	21.0/2.1	16.0/1.6	10.0/1.0	4.0

Note: The High, Medium, and Low Pedestrian Areas are described in Section 5.1.1 of IES RP-8-14.

Table 9.4.3 – Recommended Illuminance for Roundabouts

Illumination for Roundabouts				
Functional Classification	Maintained Average Horizontal Illuminance in Lux/FC on the Pavement based on Pedestrian Area Classification			E_{avg}/E_{min}
	High	Medium	Low	
Major/Major	34.0/3.4	26.0/2.6	18.0/1.8	3:1
Major/Collector	29.0/2.9	22.0/2.2	15.0/1.5	3:1
Major/Local	26.0/2.6	20.0/2.0	13.0/1.3	3:1
Collector/Collector	24.0/2.4	18.0/1.8	12.0/1.2	4:1
Collector/Local	21.0/2.1	16.0/1.6	10.0/1.0	4:1
Local/Local	18.0/1.8	14.0/1.4	8.0/0.8	6:1

Table 9.4.4 – Recommended Values for High Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways

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	E_{avg} (lux/fc)	EV_{min} (lux/fc)	E_{avg}/E_{min}*
Mixed Vehicle and Pedestrian	20.0/2.0	10.0/1.0	4.0
Pedestrian Only	10.0/1.0	5.0/0.5	4.0

E_{avg} – minimum maintained average horizontal illuminance at pavement
E_{min} – minimum horizontal illuminance at pavement
EV_{min} – minimum vertical illuminance at 1.5m above pavement
*Horizontal only

Table 9.4.5 – Recommended Values for Medium Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways			
	E_{avg} (lux/fc)	EV_{min} (lux/fc)	E_{avg}/E_{min}*
Pedestrian Areas	5.0/0.5	2.0/0.2	4.0

E_{avg} – minimum maintained average horizontal illuminance at pavement
E_{min} – minimum horizontal illuminance at pavement
EV_{min} – minimum vertical illuminance at 1.5m above pavement
*Horizontal only

Table 9.4.6 – Recommended Values for Low Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways			
	E_{avg} (lux/fc)	EV_{min} (lux/fc)	E_{avg}/E_{min}*
Rural/Semi-Rural Areas	2.0/0.2	0.6/0.06	10.0
Low Density Residential (2 or fewer dwelling units per acre)	3.0/0.3	0.8/0.08	6.0
Medium Density Residential (2.1 to 6.0 dwelling units per acre)	4.0/0.4	1.0/0.1	4.0

E_{avg} – minimum maintained average horizontal illuminance at pavement
E_{min} – minimum horizontal illuminance at pavement
EV_{min} – minimum vertical illuminance at 1.5m above pavement
*Horizontal only

Table 9.4.7 – Recommended Values for the Pedestrian Portion of Pedestrian/Vehicle Underpasses

Maintained Illuminance Values for Walkways			
	E_{avg} (lux/fc)	EV_{min} (lux/fc)	E_{avg}/E_{min}*
Day	100.0/10.0	50.0/5.0	3.0
Night	40.0/4.0	20.0/2.0	3.0

E_{avg} – minimum maintained average horizontal illuminance at pavement
E_{min} – minimum horizontal illuminance at pavement
EV_{min} – minimum vertical illuminance at 1.5m above pavement
*Horizontal only
References 1, 2, 3, and 4 in Annex D of IED RP-8-14 give more background information on the design criteria.

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9.5 Record Drawings

Project applicant or designee shall provide record drawings that depict construction to the City prior to the request for City to acceptance.

(1) MTEMC Owned Street Lights – All Fixture locations.

(2) COF Owned Street Lights – Street Light record drawings shall provide the following: Service connection points, service panel parameters, conduit locations (including distance from face of curb and depth), and all fixture locations.

9.6 City of Franklin Approved Street Light Options

(1) Local and Private Streets – See MTEMC LED Street lights for all local and private roads

(2) Downtown Historic Franklin – See Approved COF Streetscape Lighting fixtures. Lighting fixtures to be approved by the Department Review Team.

(3) Arterial and Collector Streets – See Approved COF lighting fixtures.

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TRAFFIC SIGNS AND MARKINGS

Section	Section Title	Article	Article Title	Pg
10.1	Signing	10.1.1	Type and Location of Signs	10-2
		10.1.2	Design, Installation, and Maintenance	10-2
		10.1.3	Sight Visibility Standards for Traffic Control Signs	10-2
		10.1.4	New Street Signing	10-2
		10.1.5	Other Standards	10-2
		10.1.6	Sign Posts, Supports, and Mountings	10-2
		10.1.7	Sign Reflectivity	10-3
		10.1.8	Sign Blanks	10-3
10.2	Pavement Marking and Striping	10.2.1	Type and Location of Striping and Markings	10-3
		10.2.2	Design, Installation, and Maintenance	10-3
		10.2.3	Crosswalks	10-4

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10.1 Signing

10.1.1 Type and Location of Signs

The City Engineer shall make the final determination regarding the type and location of signing controls within the right-of-way. These controls shall include traffic control signs (regulatory and warning), street name signs, delineators, and permanent barricades.

10.1.2 Design, Installation, and Maintenance

Permanent traffic control devices on public rights-of-way and private streets shall be fabricated and installed in accordance with this chapter, the latest revision of the *"MUTCD"* and *"TDOT Standard Specifications"*.

Bicycle facilities shall be designated with signing. AASHTO's *"Guide for the Development of Bicycle Facilities"* and the *"MUTCD"* shall be consulted in order to determine appropriate signing for new bicycle facilities. Signs should be used in moderation in order to avoid distracting street users. When signs are used, they shall be highly visible and easily understood by all street users. Signs that are directed at bicyclists are smaller versions of standard street signs. This is because bicyclists typically travel at slower speeds than motorists and are typically closer to the signs than motorists are. Standard street signs that are directed at motorists also apply to bicyclists.

10.1.3 Sight Visibility Standards for Traffic Control Signs

These standards are to provide for tree placement and configuration of City streets such that adequate sight distance is provided for traffic control signs. Typical sign types would be mid-block warnings, speed limit signs and stop signs. The recommended standards recognize that different criteria are needed for different travel speeds.

(1) On streets designated at speed limit 20 MPH or 25 MPH, the first tree in front of the sign is to be placed a minimum of forty-five (45) feet before the sign.

(2) On streets designated at speed limit 30 MPH, the first tree in front of the sign is to be placed a minimum of sixty (60) feet before the sign.

(3) For trees exceeding ten (10) feet of canopy vertical clearance from the ground, the first tree in front of the sign is to be placed a minimum of twenty-five (25) feet before the sign.

(4) Where signs are placed at the front end of curb extensions or bulb-outs, the above tree placements do not apply.

10.1.4 New Street Signing

Permanent signing, unless otherwise approved by the City Engineer, shall be completely in place before any new street is opened to the public.

10.1.5 Other Standards

These Standards are to be used in conjunction with other applicable City Regulations. The City Engineer may allow the installation of decorative posts and sign frames. In these cases, the developer, homeowners' association or other responsible entity shall be responsible for the maintenance of these special installations. Decorative traffic supports, whether city-provided or developer-provided shall be black or dark green in color.

10.1.6 Sign Posts, Supports, and Mountings

Sign posts, supports and mountings shall comply with *"TDOT Standard Specifications"*. In general, a 2-inch 12 gage square galvanized steel post section with perforated knockout tubes shall be the Cities

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standard for ground mounted signs. All other signs shall be per "*TDOT Standard Specifications"* and reviewed on an individual basis. Posts must be of appropriate length to comply with the "*MUTCD"* and "*TDOT Standard Specifications"*.

10.1.7 Sign Reflectivity

All traffic control signs must be fabricated with reflective materials. All reflective materials must qualify as High Intensity Grade for all signs except those signs for schools, pedestrians and overhead street name blades. For these signs, Diamond Grade sheeting shall be used. All signs or traffic control devices must have a minimum 7-year materials warranty.

10.1.8 Sign Blanks

Aluminum blanks of 0.080 gauges are standard, except for signs larger than 30 x 30 inches, which shall be 0.125-gauge aluminum.

10.2 Pavement Marking and Striping

10.2.1 Type and Location of Striping and Markings

The City Engineer shall make the final determination in regards to the type and location of pavement striping and marking within the right-of-way during the review of the project signing and striping plans. All pavement marking on public and private roadways shall be specified and installed in accordance with these Standards; all designs shall be in accordance with these Standards, the *"MUTCD"* and "*TDOT Standard Specifications"*.

Bicycle facilities shall be designated with pavement markings. AASHTO's "*Guide for the Development of Bicycle Facilities"* and the "*MUTCD"* shall be consulted in order to determine appropriate pavement markings for new bicycle facilities. A bike lane shall be separated from motor vehicle travel lanes by a solid white line that is six (6) inches wide. The width of this line can be increased to eight (8) inches for added distinction. If on-street parking is present, a four (4) inch wide solid white line shall be used to separate the bike lane from the parking lane.

10.2.2 Design, Installation, and Maintenance

Permanent striping and marking, unless otherwise approved by the City Engineer, shall be completely in place before any new street is opened to the public. For streets opened to traffic prior to final surfacing and striping, the use of reflectorized paint installed to permanent standards at the end of each day's work shall be allowed. In addition, pavement markings shall be updated as needed to comply with "*TDOT Standard Specifications"* and "*MUTCD"* standards.

New striping on new streets, overlays, and chip seals, etc. will require Extruded or Ribbon-Dispensed Thermoplastic Pavement Markings. Spray Thermoplastic Markings will be evaluated on a case by case basis by the City Engineer. As an alternate, the Contractor may apply preformed thermoplastic markings material for stop bars, cross walks, legends, or directional arrows. Snowplowable raised pavement markers shall be provided on state routes within the City. All pavement markings shall be installed per "*TDOT Standard Specifications"*.

Permanent striping and marking on the roadway centerline shall be installed on each segment of roadway construction on the same day the final lift of asphalt concrete pavement is placed on that roadway segment. New traffic striping of lane lines, crosswalks, and stop bars (skip white and solid white) shall be installed on each segment of roadway construction within one Calendar Day of the final lift of asphalt concrete pavement placed on that roadway segment.

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10.2.3 Crosswalks

Crosswalks shall be used at all signalized intersections, approved crossings, school routes, adjacent to schools, and as otherwise directed. Mid-block crosswalks shall be approved on a case-by-case basis subject to and engineering study as approved by the City Engineer. Standard Crosswalk Configuration shall consist of a 10-foot minimum width and 24-inch wide "Continental" style bars and shall be used for all crosswalks unless otherwise approved by the City Engineer. Where concrete pavement is present, the specific manufacturer's primer must be applied as per manufacturer's specifications.

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GLOSSARY

AASHTO: American Association of State Highway and Transportation Officials.

ACCESSIBLE PEDESTRIAN SIGNAL (APS): A device that communicates information about pedestrian timing in non-visual format such as audible tones, verbal messages, and/or vibrating surfaces. (MUTCD)

ACCESS EASEMENT: A publicly owned area of land granted by adjacent landowners or reserved as part of a development plan and being part of the City right-of-way for the purpose of accessing public improvements for maintenance.

ACTUATED OPERATION: A type of traffic control signal operation in which some or all signal phases are operated on the basis of actuation. (MUTCD)

ACTUATION INDICATOR: Either a light, a tone, a voice message, or both audible and visual indicators that indicate to pedestrians that the button press has been accepted.

ACTUATION: Initiation of a change in or extension of a traffic signal phase through the operation of any type of detector. (MUTCD)

ALERT TONE AT ONSET OF WALK INTERVAL: A very brief burst of high frequency sound, rapidly decaying to a 500 Hz WALK tone, to alert pedestrians to the exact onset of the walk interval.

APPROACH: The portion of an intersection leg which is used by traffic approaching the intersection

APS: See Accessible pedestrian signal.

ARMY CORPS OF ENGINEERS: Provides engineering services as a government agency as it relates to civil engineering projects.

AUDIBLE BEACON: Use of a sound source to provide directional orientation and alignment information.

AUTOMATIC VOLUME ADJUSTMENT: An APS volume control that is automatically responsive to ambient (background) sound; automatic gain control.

AUXILIARY LANE: The portion of a street adjoining the traveled way for parking, speed change, turning, weaving, truck climbing and other purposes supplementary to through traffic movement.

AVERAGE DAILY TRAFFIC (ADT): The total bi-directional volume of traffic passing through a given point during a given time period (in whole days), divided by the number of days in that time period.

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BICYCLE PLAN: Plan initiated by the City to promote multi-modal transportation and to provide safe and accessible facilities for bicycles and pedestrians. Standards address design features of bicycle facilities.

BOMA: Board of Mayor and Alderman

BRAILLE STREET NAME: Provision of the name of the associated street in Braille above the APS pushbutton.

BUTTON ACTUATED TIMER (BAT): See Extended button press.

CAPACITY: The maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform segment of a lane or roadway during a given time period under prevailing traffic, roadway and control conditions.

CITY STANDARDS & SPECIFICATIONS: Those standards prescribed for the construction of streets, sidewalks, driveway access points, curb and gutter set out in this manual and the City Code.

CITY: The City of Franklin, TN

CITY ENGINEER: A licensed professional engineer employed by the City or his duly authorized representative serving to direct and oversee engineering design, coordination and implementation of private and City capital improvements as well as public safety and welfare. All places within these Standards that reference the City Engineer shall refer to the City of Franklin, Tennessee City Engineer or their designated representative.

CLEARANCE INTERVAL INDICATOR: Tones sounding during the pedestrian clearance interval that are differentiated from the walk interval indicator (tones).

BUILDING AND NEIGHBORHOOD SERVICES DIRECTOR: City official responsible for directing the enforcement and interpretations of the provisions of national and local building codes.

COMMERCIAL DRIVEWAY ACCESS: Any driveway access point that does not meet the definition of residential driveway access.

CONNECTIVE STREET: A street within a development, other than a cul-de-sac street or loop street, which will allow vehicular and pedestrian circulation to adjoining developments; thereby providing for community-wide circulation.

CONTROLLER UNIT: That part of a controller assembly that is devoted to the selection and timing of the display of signal indications. (MUTCD)

CORNER CLEARANCE: At an intersecting street, the distance measured from the edge of pavement curb line or the intersection of right-of-way lines to the beginning of outside driveway radius.

CROSSWALK.: (a) that part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or

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in the absence of curbs, from the edges of the traversable roadway, and in the absence of a sidewalk on one side of the roadway, the part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the centerline; (b) any portion of a roadway at an intersection or elsewhere distinctly indicated for pedestrian crossing by lines or other markings on the surface. (MUTCD)

CYCLE LENGTH: The time required for one complete sequence of signal indications. (MUTCD)

DEAD-END STREET: A local access system street opened at one end only with special provisions for a vehicle to turn around.

DESIGN SPEED: Usually up to five miles per hour above the expected operating speed of the facility under design.

DETECTABLE WARNING: A standardized surface feature built in or applied to walking surfaces or other elements to warn visually impaired people of hazards on a circulation path.

DETECTOR: A sensing device used for determining the presence or passage of vehicles or pedestrians. (MUTCD)

DEVELOPER: A site planner or subdivider.

DEVELOPMENT OR DEVELOPMENT PLAN: Any site plan or subdivision.

DRIVEWAY ACCESS POINT: A point of ingress and egress, or both, which is considered a private driveway. It can be either a residential access point or a commercial driveway access point.

DRIVEWAY WIDTH: The narrowest width of driveway measured parallel with the edge of street.

EXTENDED BUTTON PRESS: On APS, holding the ped button down between 1-3 sec. may activate special features, including audible beaconing and extended pedestrian clearance interval.

FHWA: Federal Highway Administration

FIXED TIME OPERATION: See Pretimed operation.

FLASHING (FLASHING MODE): A mode of operation in which a traffic signal indication is turned on and off repetitively. (MUTCD)

FLOW LINE: The transition point between the gutter and the face of the curb. For a valley curb it is the center of the pan. Where no curb exists, the flow line will be considered the edge of the traveled way.

FULL-ACTUATED OPERATION: A type of traffic control signal operation in which all signal phases function on the basis of actuation. (MUTCD)

GRADING PERMIT: Permit issued by the City of Franklin Engineering Department that allows the contractor to begin grading work.

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HBP: Hot bituminous pavement

INTERSECTION: (a) the area embraced within the prolongation or connection of the lateral curb lines, or if none, the lateral boundary lines of the roadways of two highways that join one another at, or approximately at, right angles, or the area within which vehicles traveling on different highways that join at any other angle may come into conflict; (b) the junction of an alley or driveway with a roadway or highway shall not constitute an intersection. (MUTCD)

INTERVAL SEQUENCE: The order of appearance of signal indications during successive intervals of a signal cycle. (MUTCD)

INTERVAL: The part of a signal cycle during which signal indications do not change. (MUTCD)

ITE: Institute of Traffic Engineers

LEVEL OF SERVICE: A measurement of the quality of service on transportation infrastructure. This is generally links to transportation trip time as it relates to speed.

LOCATOR SIGNAL: See Pushbutton locator tone.

LONG BUTTON PRESS: SEE EXTENDED BUTTON PRESS.

LONG CANE: A cane individually prescribed to provide safety and orientation information to persons who are blind or visually impaired; typically much longer than a support cane and not intended for support; typically has a white, reflective surface.

LOOP STREET: A street which is designed to discourage through traffic from other areas and both ends of the loop street connect with the same intersecting street.

MAJOR STREET: The street normally carrying the higher volume of vehicular traffic. (MUTCD)

MAJOR THOROUGHFARE PLAN: Plan in initiated by the City of Franklin Planning Department to address some design features as they relate to thoroughfares.

MEDIAN: That portion of a divided roadway separating the traveled ways for traffic in opposite directions.

MEWS: A special type of alley that serves as the only vehicular and emergency access for lots abutting the mews.

MINOR STREET: the street normally carrying the lower volume of vehicular traffic. (MUTCD)

NCHRP: National Cooperative Highway Research Program

PASSIVE PEDESTRIAN DETECTION: A feature that uses sensors (piezo-electric, infrared, microwave, or video camera serving remote sensor software) to trigger, cancel, or lengthen pedestrian timing, or to trigger the pushbutton locator tone when the pedestrian enters the detection zone.

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PAVEMENT MARKINGS: All lines, words or symbols, except signs officially placed within the roadway or parking area to regulate, warn or guide traffic.

PCC: Portland cement concrete

PEAK-HOUR VOLUME: Hourly traffic volume used for roadway design and capacity analysis, usually occurring during one or more peak travel hours during a 24 hour period.

PEDESTRIAN CHANGE INTERVAL: An interval during which the flashing UPRAISED HAND (symbolizing DONT WALK) signal indication is displayed. When a verbal message is provided at an accessible pedestrian signal, the verbal message is "wait." (MUTCD)

PEDESTRIAN PHASE (OR PED PHASE): The cycle of pedestrian timing consisting of three parts: (1) The walk interval (WALK sign); (2) the pedestrian clearance interval (flashing DON'T WALK); and the pedestrian change interval (steady DON'T WALK).

PEDESTRIAN SIGNAL HEAD: A signal head, which contains the symbols WALKING PERSON (symbolizing WALK) and UPRAISED HAND (symbolizing DON'T WALK), that is installed to direct pedestrian traffic at a traffic control signal. (MUTCD).

PEDESTRIAN: People who travel on foot or who use assistive devices, such as wheelchairs, for mobility.

PERMISSIVE MODE.: A mode of traffic control signal operation in which, when a CIRCULAR GREEN signal indication is displayed, left or right turns may be made after yielding to pedestrians and/or oncoming traffic. (MUTCD)

PLANNING COMMISSION: Appointed board of local citizens responsible for decision making related to growth and development within the City.

PREEMPTION CONTROL: The transfer of normal operation of a traffic control signal to a special control mode of operation. (MUTCD)

PRETIMED OPERATION: Type of traffic control signal operation in which none of the signal phases function on the basis of actuation. (MUTCD)

PRIORITY CONTROL: A means by which the assignment of right-of-way is obtained or modified. (MUTCD)

PROTECTED MODE: A mode of traffic control signal operation in which left or right turns may be made when a left or right GREEN ARROW signal indication is displayed. (MUTCD)

PROWAAC: Public Rights of Way Access Advisory Committee of the U.S. Access Board, that includes advocates, engineers, architects, and public works officials.

PUDE: Public utility and drainage easement

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PUSHBUTTON LOCATOR TONE: A repeating sound that informs approaching pedestrians that they are required to push a button to actuate pedestrian timing and that enables pedestrians who have visual disabilities to locate the pushbutton. (MUTCD)

PUSHBUTTON MESSAGE: A speech message that provides additional information when the APS pedestrian pushbutton is pushed.

PUSHBUTTON: A button to activate pedestrian timing. (MUTCD)

REMOTE ACTIVATION: A handheld pushbutton device allowing a pedestrian to send a message over a short distance to call the ped phase.

RESIDENTIAL DRIVEWAY ACCESS: A driveway access point serving a single family dwelling, mobile home, detached townhouse, two attached townhouses, duplex, multi-unit supportive housing residence, supportive housing residence which is required to provide no more than two (2) off-street parking spaces, or a driveway serving a nonresidential use if the daily volume of two-way driveway traffic is expected to be less than fifty (50) vehicles.

RIGHT-OF-WAY CENTER LINE: (1) The right-of-way centerline of a two-way street shall be a point equidistant between the inside edges of the innermost through travel lane in each direction of travel. (2) The right-of-way centerline of a one-way street shall be a point equidistant between the outside edges of the outermost through travel lanes in the direction of travel. (3) Where the alignment of an existing street is to be altered or changed, the right-of-way centerline shall be determined in accordance with the new realignment plan, provided the City and/or TDOT have approved the plan. (4) In special cases where non-symmetrical street widening has occurred or other unique situations not covered by the above exist, the right-of-way centerline shall be defined by the Transportation Director.

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RIGHT-OF-WAY, (ROW) : An interest in land to the City which provides for the perpetual right and privilege of the City and it's agents, franchise holders, successors, and assigns to construct, install, improve, repair, maintain, and use a public street, including related and customary uses of street rights-of-way such as sidewalk, bike path, landscaping, traffic control devices and signage, sanitary sewer, stormwater drainage devices, water supply, cable television, electric power, gas, and telephone transmission and related purposes in, upon, over, below, and across the right-of-way. The City is authorized to remove, and keep removed from the rights-of-way all trees, vegetation, and other obstructions as is determined to be necessary by the City to maintain, repair, and protect facilities located in the right-of-way

ROADWAY: See definition of street.

SEMIACTUATED OPERATION: A type of traffic control signal operation in which at least one, but not all, signal phases function on the basis of actuation. (MUTCD)

SIDEWALK: Any public or private pedestrian or bicycle walkway or path.

SIGNAL HEAD. An assembly of one or more signal faces together with the associated signal housings. (MUTCD)

SIGNAL INDICATION: The illumination of a signal lens or equivalent device. (MUTCD)

SIGNAL PHASE: The right-of-way, yellow change, and red clearance intervals in a cycle that are assigned to an independent traffic movement or combination of movements. (MUTCD)

SIGNAL SECTION: The assembly of a signal housing, signal lens, and light source with necessary components to be used for providing one signal indication. (MUTCD)

SIGNAL TIMING: The amount of time allocated for the display of a signal indication. (MUTCD)

SIGNAL WARRANT: A threshold condition that, if found to be satisfied as part of an engineering study, shall result in analysis of other traffic conditions or factors to determine whether a traffic control signal or other Improvement is justified. (MUTCD)

SLOPE EASEMENT: An easement, which is reasonably necessary and incidental to the construction within the adjoining right-of-way of public street or sidewalk, or both, by the City, state, or their contractors. The purposes to which the easement area may be used include cutting, sloping, filling, installation of stormwater drain pipes or other drainage facilities, grading or otherwise changing the natural contour of the easement area in order to support and to accommodate the development of the adjacent street right-of-way, in accord with generally accepted engineering practices. Following the construction of the adjacent street or sidewalk, or both, the area subject to this easement will be graded, stabilized, and restored using conventional engineering and landscaping methods. Thereafter, the landowners with the underlying fee interest may make and enjoy all lawful uses of the property subject to this easement, provided there be no damage to the lateral and subjacent support of the public street, sidewalk, or h or to any stormwater drainage facility.

DRAFT

STATE ROUTE: An arterial highway designated and signed with a route number, which is primarily funded for construction and administered by TDOT. Improvements and maintenance of state routes is under the jurisdiction of TDOT.

STEADY (STEADY MODE): The continuous illumination of a signal indication for the duration of an interval, signal phase, or consecutive signal phases. (MUTCD)

STORMWATER ORDINANCE: Document initiated by the City of Franklin to establish guidelines for dealing with stormwater.

STORMWATER PERMIT: If approaches to handling stormwater are not standard or specified in the stormwater ordinance, a stormwater permit may need to be applied for by the contractor.

STREET BLOCK FACE: The physical characteristics of property and structures adjoining any one side of a street in-between intersections.

STREET SCAPE: Aesthetic additions (trees, decorative lighting) that are placed outside of the traveled way to enhance appearance.

STREET: A public or private roadway, but is not considered a driveway access point.

STREET DEPARTMENT DIRECTOR: City official responsible for directing and overseeing construction, maintenance, traffic control and stormwater implementation for improvements of City streets.

SUBDIVISION REGULATIONS: Documents initiated by the City of Franklin to establish guidelines for subdivision plans.

TACTILE ARROW (ALIGNED IN DIRECTION OF TRAVEL): A raised (tactile) arrow in an APS pushbutton that helps users know which crosswalk is actuated by the pushbutton.

TACTILE MAP: A raised schematic map (located on an APS pushbutton housing) that shows what will be encountered as the pedestrian negotiates the crosswalk controlled by that push button.

TACTILE: An object that can be perceived using the sense of touch.

TDEC: Tennessee Department of Environment and Conservation

TDOT: The Tennessee Department of Transportation

THROUGH STREET: A street, other than a dead-end street or loop street, that connects two perimeter property lines of a development.

TIA: Traffic impact analysis

TN DIVISION OF WATER POLLUTION CONTROL: A regulatory board that monitors pollution.

TRAFFIC CONTROL SIGNAL (TRAFFIC SIGNAL): Any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed. (MUTCD)

TRAFFIC SIGN: A device mounted on a fixed or movable support, conveying a message or symbol to regulate, warn or guide traffic.

TRANSPORTATION ADVISORY COMMITTEE: Committee that reviews transportation related items and makes recommendations to BOMA.

TREE REMOVAL PERMIT: Permit issued by the City of Franklin Codes Department that allows the contractor to clear designated trees.

VIBROTACTILE PEDESTRIAN DEVICE: A device that communicates, by touch, information about pedestrian timing using a vibrating surface. (MUTCD)

VOLUME: The number of vehicles passing a given point during a specified period of time.

WALK INTERVAL: An interval during which the WALKING PERSON (symbolizing WALK) signal indication is displayed. When a verbal message is provided at an accessible pedestrian signal, the verbal message is "walk sign." (MUTCD)

ZONING ORDINANCE: Document that regulates land use for the City of Franklin.

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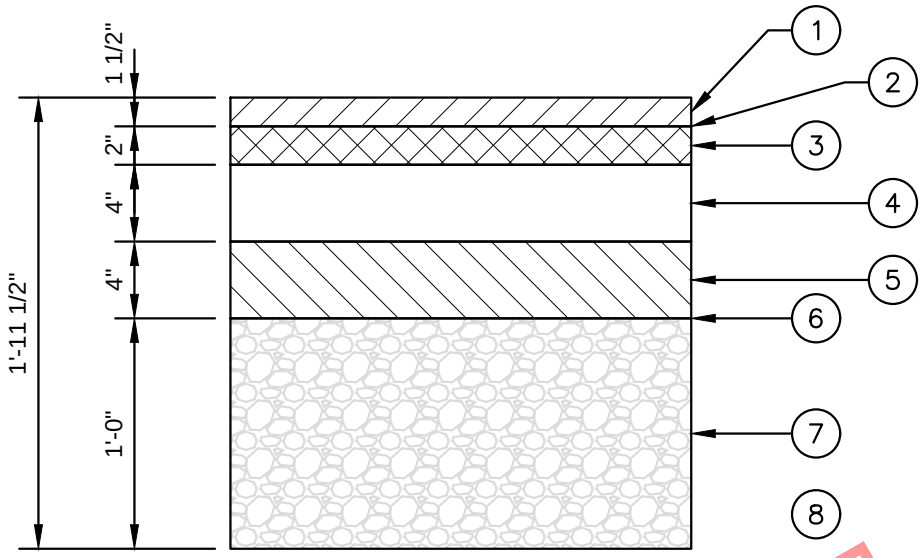


DRAFT

PAVEMENT SCHEDULE

1. 1.5" - BITUMINOUS SURFACE COURSE
   411-02.10 ACS MIX (PG 70-22) GRADING D RDWY
2. TACK COAT
   403-01 BITUMINOUS MATERIAL FOR TACK COAT (TC) @0.07 GAL/SY (@0.10 GAL/SY MILLED SURFACES)
3. 2" - ASPHALT BINDER (226 LB/SY)
   307-02.08 ASPHALT CONCRETE MIX (PG 70-22) (BPMB-HM) GRADING B-M2
4. 4" - ASPHALTIC AGGREGATE BASE BINDER (460 LB/SY)
   307-02.01 ASPHALT CONCRETE MIX (PG 70-22) (BPMB-HM) GRADING A
5. 4" - ASPHALT AGGREGATE BASE (360 LB/SY)
   307-02.02 ASPHALT CONCRETE MIX (PG 70-22) (BPMB-HM) GRADING A-S
   307-02.03 AGGREGATE (BPMB-HM) GRADING A-S
6. PRIME COAT
   402-01 BITUMINOUS MATERIAL FOR PRIME COAT (PC) @0.30-0.35 GAL/SY
   402-02 AGGREGATE FOR COVER MATERIAL (PC) @8-12 LB/SY
7. 12" - MINERAL AGGREGATE BASE
   303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D
8. AGGREGATE UNDERDRAINS WITH PIPE (NOT SHOWN)
   (COORDINATE WITH TDOT STD. DRAWING RD-UD-3)

NOTES

1. THICKNESSES SHOWN ARE MINIMUMS. FINAL DESIGN THICKNESS TO BE DETERMINED BY A GEOTECHNICAL ENGINEER.
2. REFERENCE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" OF THE TENNESSEE DEPARTMENT OF TRANSPORTATION

HISTORIC FRANKLIN TENNESSEE

MAJOR AND MINOR ARTERIAL PAVEMENT SECTION

CITY OF FRANKLIN

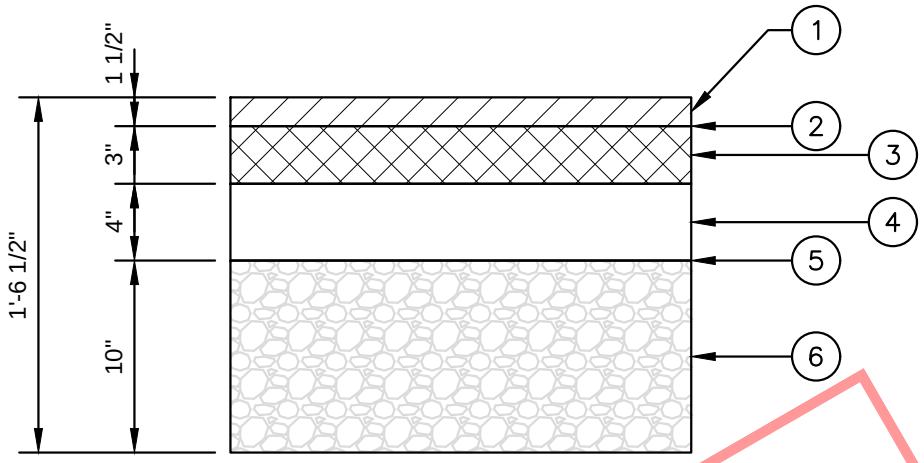
NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

DWG. NO.

RD-1



DRAFT

PAVEMENT SCHEDULE

1. 1.5" - BITUMINOUS SURFACE COURSE
   411-02.10 ACS MIX (PG 70-22) GRADING D RDWY
2. TACK COAT
   403-01 BITUMINOUS MATERIAL FOR TACK COAT (TC) @0.07 GAL/SY (@0.10 GAL/SY MILLED SURFACES)
3. 3" - BITUMINOUS AGGREGATE BASE
   307-02.08 ASPHALT CONCRETE MIX (PG 70-22) (BPMB-HM) GRADING B-M2
4. 4" - BITUMINOUS AGGREGATE BASE (460 LB/SY)
   307-02.01 ASPHALT CONCRETE MIX (PG 70-22) (BPMB-HM) GRADING A
5. PRIME COAT
   402-01 BITUMINOUS MATERIAL FOR PRIME COAT (PC) @0.30-0.35 GAL/SY
   402-02 AGGREGATE FOR COVER MATERIAL (PC) @8-12 LB/SY
6. 10" - MINERAL AGGREGATE BASE
   303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D

NOTES

1. THICKNESSES SHOWN ARE MINIMUMS. FINAL DESIGN THICKNESS TO BE DETERMINED BY A GEOTECHNICAL ENGINEER.
2. REFERENCE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" OF THE TENNESSEE DEPARTMENT OF TRANSPORTATION

HISTORIC FRANKLIN TENNESSEE

MAJOR AND MINOR COLLECTOR PAVEMENT SECTION

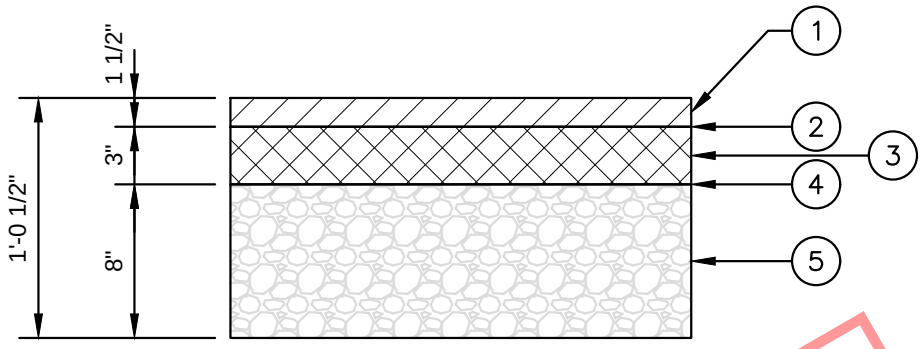
DWG. NO.
RD-2

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

PAVEMENT SCHEDULE

1. 1.5" - BITUMINOUS SURFACE COURSE
   411-01.11 ACS MIX (PG 64-22) GRADING E RDWY
2. TACK COAT
   403-01 BITUMINOUS MATERIAL FOR TACK COAT (TC) @0.07 GAL/SY (@0.10 GAL/SY MILLED SURFACES)
3. 3" - BITUMINOUS AGGREGATE BASE
   307-01.08 ASPHALT CONCRETE MIX (PG 64-22) (BPMB-HM) GRADING B-M2
4. PRIME COAT
   402-01 BITUMINOUS MATERIAL FOR PRIME COAT (PC) @0.30-0.35 GAL/SY
   402-02 AGGREGATE FOR COVER MATERIAL (PC) @8-12 LB/SY
5. 8" - MINERAL AGGREGATE BASE
   303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D

NOTES

1. THICKNESSES SHOWN ARE MINIMUMS. FINAL DESIGN THICKNESS TO BE DETERMINED BY A GEOTECHNICAL ENGINEER.
2. REFERENCE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" OF THE TENNESSEE DEPARTMENT OF TRANSPORTATION

HISTORIC FRANKLIN TENNESSEE

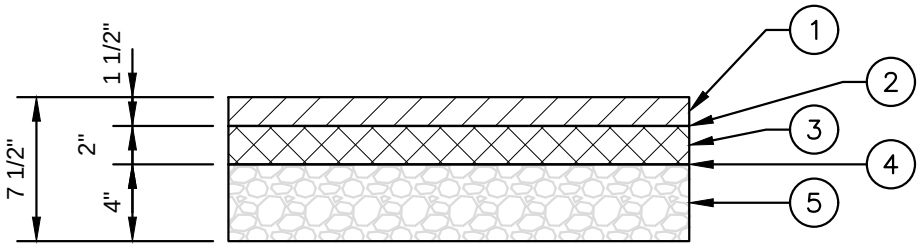
LOCAL, ALLEY, AND MEWS PAVEMENT SECTION

DWG. NO.
RD-3

CITY OF FRANKLIN
NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

PAVEMENT SCHEDULE

1. 1.5" - BITUMINOUS SURFACE COURSE
   411-01.05 ACS MIX (PG 64-22) GRADING E RDWY
2. TACK COAT
   403-01 BITUMINOUS MATERIAL FOR TACK COAT (TC) @0.07 GAL/SY (@0.10 GAL/SY MILLED SURFACES)
3. 2" - BITUMINOUS AGGREGATE BASE
   307-01.08 ASPHALT CONCRETE MIX (PG 64-22) (BPMB-HM) GRADING B-M2
4. PRIME COAT
   402-01 BITUMINOUS MATERIAL FOR PRIME COAT (PC) @0.30-0.35 GAL/SY
   402-02 AGGREGATE FOR COVER MATERIAL (PC) @8-12 LB/SY
5. 4" - MINERAL AGGREGATE BASE
   303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D

NOTES

1. THE ASPHALT PAVEMENT MULTI-USE PATH SHOWN HEREON SHALL ONLY BE USED WHERE SPECIFICALLY PERMITTED BY THE CITY ENGINEER. THE CONCRETE MULTI-USE PATH SECTION ON DWG. NO. RP-9 SHALL BE USED IN ALL OTHER LOCATIONS.
2. MULTI-USE PATH CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAXIMUM
3. THICKNESSES SHOWN ARE MINIMUMS. FINAL DESIGN THICKNESS TO BE DETERMINED BY A GEOTECHNICAL ENGINEER.
4. REFERENCE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" OF THE TENNESSEE DEPARTMENT OF TRANSPORTATION

HISTORIC FRANKLIN TENNESSEE

MULTI-USE PATH PAVEMENT SECTION

DWG. NO.
RD-4

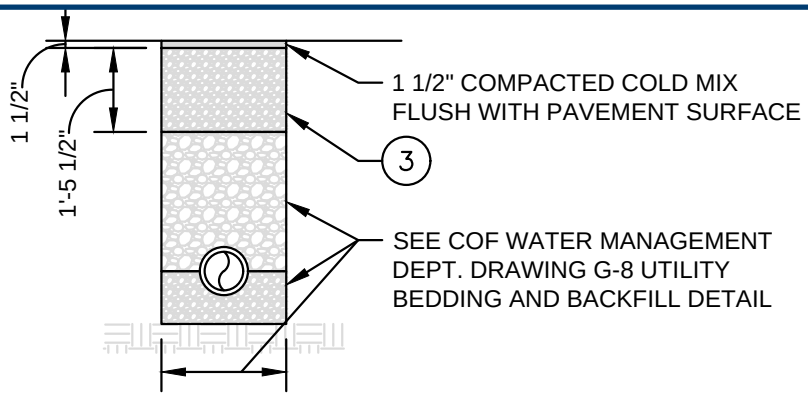
CITY OF FRANKLIN

NOT TO SCALE

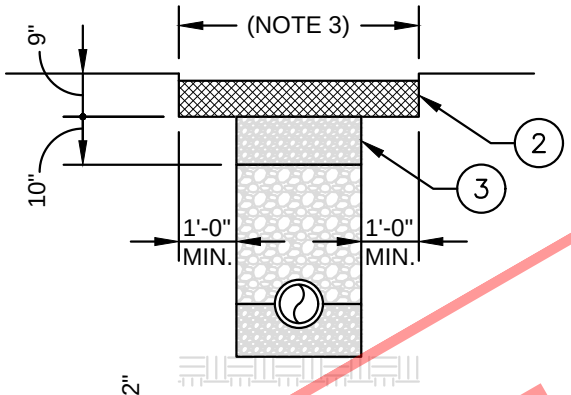
CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

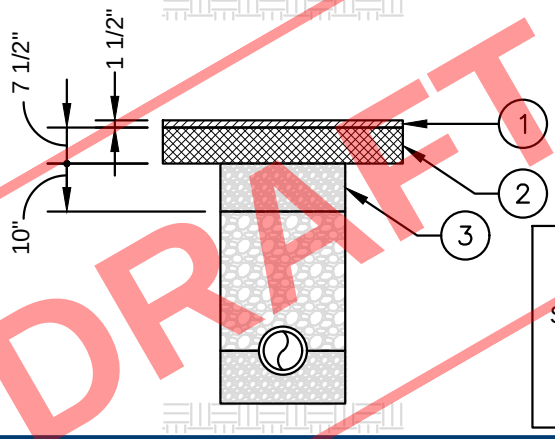
STEP 1
TEMPORARY PATCH



STEP 2
TRENCH REPAIR



STEP 3
FULL WIDTH OVERLAY



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FLOWABLE FILL NOTE

DEPENDING ON FIELD CONDITIONS, SUBSTITUTE FLOWABLE FILL BACKFILL (200 PSI MAX.) FOR THAT SHOWN AS DIRECTED BY THE COF WATER MANAGEMENT OR STREET DEPTS.

PAVEMENT SCHEDULE

1. 1.5" - BITUMINOUS SURFACE COURSE
   411-01.11 ACS MIX (PG 64-22) GRADING E RDWY
2. BITUMINOUS AGGREGATE BASE
   307-01.08 ASPHALT CONCRETE MIX (PG 64-22) (BPMB-HM) GRADING B-M2
3. MINERAL AGGREGATE BASE (PLACED IN LIFTS NOT EXCEEDING 6")
   303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D

TACK AND PRIME COATS NOT SHOWN FOR CLARITY. SEE DRAWING RD-3.

NOTES

1. CONTRACTOR SHALL COORD. TRENCH, BACKFILL, AND PAVEMENT INSPECTIONS WITH THE COF STREET DEPARTMENT.
2. ALL CUTS IN PUBLIC STREETS REQUIRE A STREET CROSSING PERMIT AND APPROVED TRAFFIC CONTROL PLAN.
3. SAWCUT EXISTING PAVEMENTS, BASES, CURB AND GUTTER, AND SIDEWALKS (CUT JOINT TO JOINT) IN NEAT LINES.
4. REPAIR OF ASPHALT PARKING LOTS AND DRIVE AISLES SHOWN. REPAIR OF CONCRETE SURFACES SHALL USE IN-KIND CONCRETE SURFACE COURSE (6" MIN. THICK, 3,000 PSI MIN.) INSTEAD OF BITUMINOUS MATERIALS SHOWN.

HISTORIC FRANKLIN TENNESSEE

ASPHALT PAVEMENT TRENCH REPAIR PARKING LOT AND DRIVE AISLE

CITY OF FRANKLIN

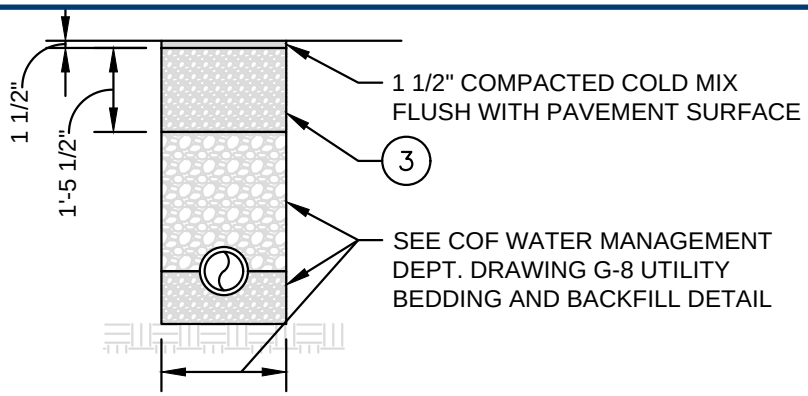
NOT TO SCALE

CITY ENGINEER: Paul P Holzen

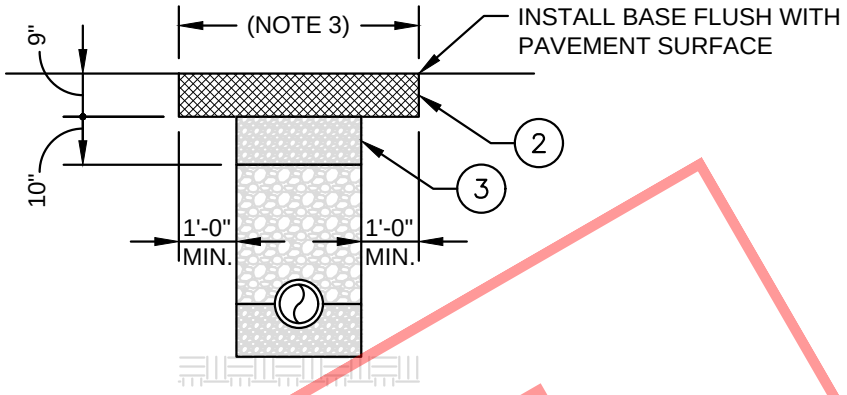
DATE: 7/1/2021

DWG. NO. **RD-5**

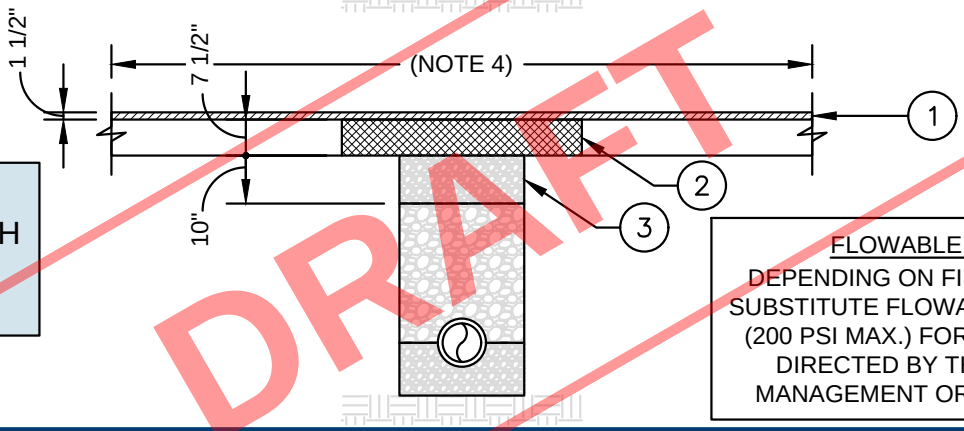
STEP 1
TEMPORARY PATCH



STEP 2
TRENCH REPAIR



STEP 3
FULL WIDTH MILL AND OVERLAY



FLOWABLE FILL NOTE

DEPENDING ON FIELD CONDITIONS, SUBSTITUTE FLOWABLE FILL BACKFILL (200 PSI MAX.) FOR THAT SHOWN AS DIRECTED BY THE COF WATER MANAGEMENT OR STREET DEPTS.

DRAFT

PAVEMENT SCHEDULE

1. 1.5" - BITUMINOUS SURFACE COURSE
   411-01.11 ACS MIX (PG 64-22) GRADING E RDWY
2. BITUMINOUS AGGREGATE BASE
   307-01.08 ASPHALT CONCRETE MIX (PG 64-22) (BPMB-HM) GRADING B-M2
3. MINERAL AGGREGATE BASE (PLACED IN LIFTS NOT EXCEEDING 6")
   303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D

TACK AND PRIME COATS NOT SHOWN FOR CLARITY. SEE DRAWING RD-3.

NOTES

1. CONTRACTOR SHALL COORD. TRENCH, BACKFILL, AND PAVEMENT INSPECTIONS WITH THE COF STREET DEPARTMENT.
2. ALL CUTS IN PUBLIC STREETS REQUIRE A STREET CROSSING PERMIT AND APPROVED TRAFFIC CONTROL PLAN.
3. SAWCUT EXISTING PAVEMENTS, BASES, CURB AND GUTTER, AND SIDEWALKS (CUT JOINT TO JOINT) IN NEAT LINES.
4. AT PERPENDICULAR STREET CUTS, MILL AND OVERLAY SHALL EXTEND A MINIMUM OF 100 FEET CENTERED ON THE TRENCH. AT PARALLEL STREET CUTS, MILL AND OVERLAY SHALL EXTEND A MINIMUM DISTANCE FROM THE EDGE OF PAVEMENT TO THE CENTERLINE OF STREET. FINAL LIMITS SHALL BE DETERMINED BY THE CITY ENGINEER.

HISTORIC FRANKLIN TENNESSEE

ASPHALT PAVEMENT TRENCH REPAIR LOCAL STREET

DWG. NO. **RD-6**

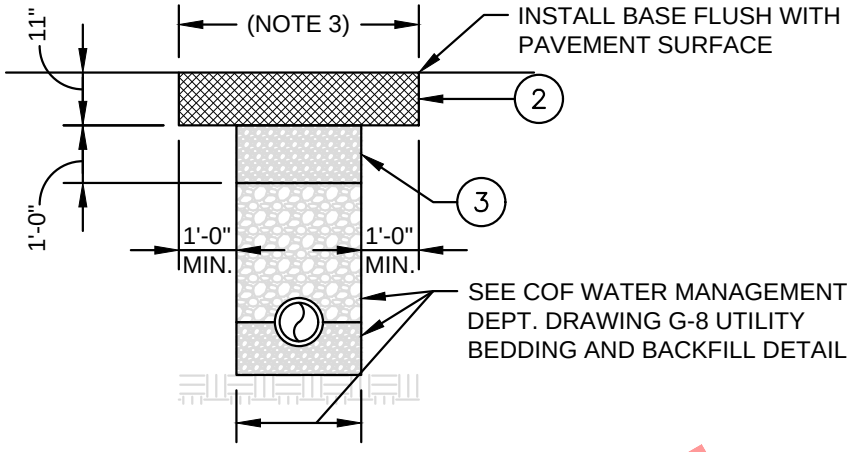
CITY OF FRANKLIN

NOT TO SCALE

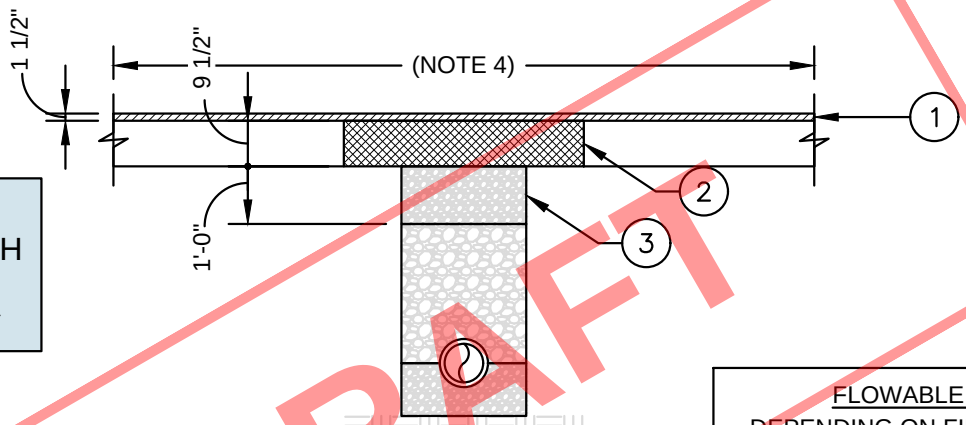
CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

STEP 1
TRENCH REPAIR



STEP 2
FULL WIDTH MILL AND OVERLAY



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FLOWABLE FILL NOTE
DEPENDING ON FIELD CONDITIONS, SUBSTITUTE FLOWABLE FILL BACKFILL (200 PSI MAX.) FOR THAT SHOWN AS DIRECTED BY THE COF WATER MANAGEMENT OR STREET DEPTS.

PAVEMENT SCHEDULE

1. 1.5" - BITUMINOUS SURFACE COURSE
   411-02.10 ACS MIX (PG 70-22) GRADING D RDWY
2. BITUMINOUS AGGREGATE BASE
   307-02.08 ASPHALT CONCRETE MIX (PG 70-22) (BPMB-HM) GRADING B-M2
3. MINERAL AGGREGATE BASE (PLACED IN LIFTS NOT EXCEEDING 6")
   303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D

TACK AND PRIME COATS NOT SHOWN FOR CLARITY. SEE DRAWINGS RD-1 AND RD-2.

NOTES

1. CONTRACTOR SHALL COORD. TRENCH, BACKFILL, AND PAVEMENT INSPECTIONS WITH THE COF STREET DEPARTMENT.
2. ALL CUTS IN PUBLIC STREETS REQUIRE A STREET CROSSING PERMIT AND APPROVED TRAFFIC CONTROL PLAN.
3. SAWCUT EXISTING PAVEMENTS, BASES, CURB AND GUTTER, AND SIDEWALKS (CUT JOINT TO JOINT) IN NEAT LINES.
4. AT PERPENDICULAR STREET CUTS, MILL AND OVERLAY SHALL EXTEND A MINIMUM OF 100 FEET CENTERED ON THE TRENCH. AT PARALLEL STREET CUTS, MILL AND OVERLAY SHALL EXTEND A MINIMUM DISTANCE FROM THE EDGE OF PAVEMENT TO THE CENTERLINE OF STREET. FINAL LIMITS SHALL BE DETERMINED BY THE CITY ENGINEER.

HISTORIC FRANKLIN TENNESSEE

ASPHALT PAVEMENT TRENCH REPAIR ARTERIAL AND COLLECTOR STREET

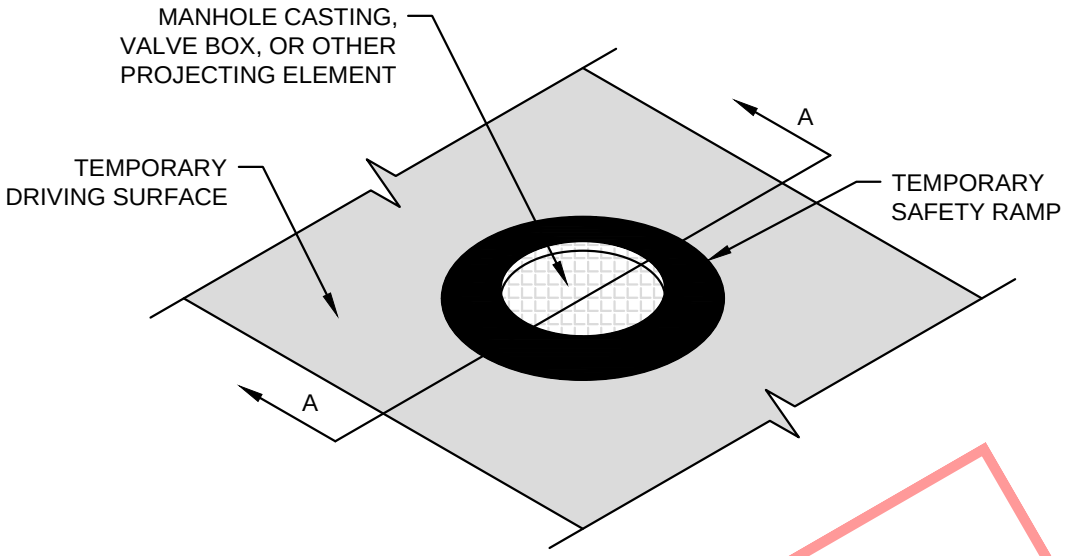
DWG. NO. **RD-7**

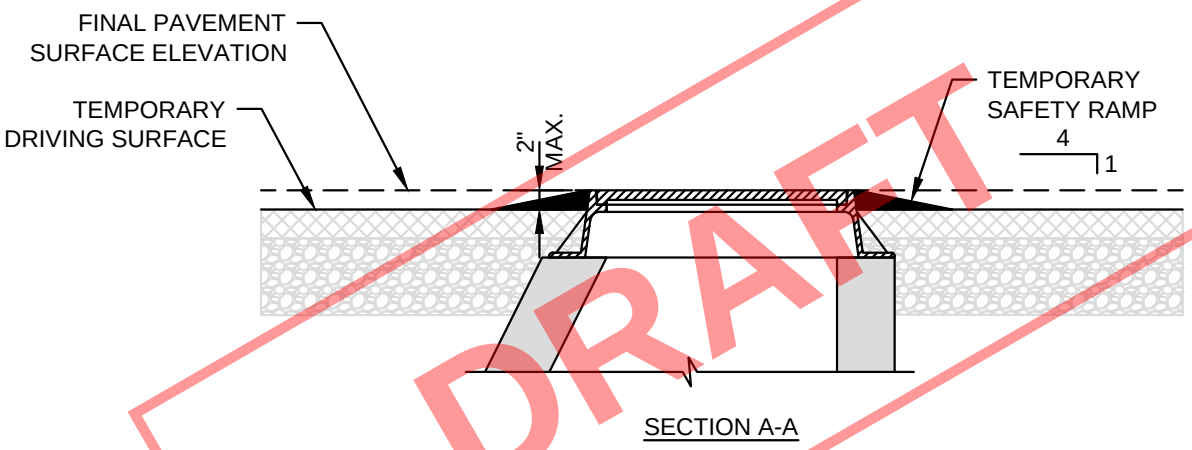
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021





SECTION A-A

DRAFT

NOTES

1. PROVIDE AND MAINTAIN TEMPORARY SAFETY RAMPS AT ALL ROADWAY ELEMENTS PROJECTING GREATER THAN 3/4 INCH ABOVE TEMPORARY DRIVING SURFACES.
2. TEMPORARY SAFETY RAMP:
   A. RUBBER MANHOLE SAFETY RAMP BY AMERICAN HIGHWAY PRODUCTS OR EQUAL
   B. ASPHALT RING, ADEQUATELY COMPACTED TO PROVIDE A FIRM DRIVING SURFACE
3. TEMPORARY SAFETY RAMPS SHALL BE FULLY REMOVED PRIOR TO PLACEMENT OF SURFACE COURSE.

HISTORIC FRANKLIN TENNESSEE

TEMPORARY SAFETY RAMP AT ROADWAY PROJECTIONS

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

DWG. NO.

RD-8

DRAINAGE STRUCTURES, MANHOLES, GRATES, PIPE CULVERTS, AND ENDWALLS

TYPE	TDOT STANDARD DRAWINGS
CATCH BASINS	TDOT CATCH BASINS 10, 12, 13, 14, 16, AND 17 TYPE (SEE NOTE 3)
CATCH BASIN GRATES	SEE CITY OF FRANKLIN DRAWINGS RP-1 THRU RP-4
AREA DRAINS - 1 GRATE	D-CB-42 SERIES
AREA DRAINS - 2 GRATES	D-CB-43 SERIES
AREA DRAIN GRATES	D-CBB-42
JUNCTION BOX	D-JBS-1 THRU D-JBS-5
MANHOLES	D-MH-2 THRU DRF-1
TRENCH DRAINS	D-TD-1
PROTECTED ENDWALLS	D-PE1 THRU D-PE-9F
PIPE CULVERTS AND FLUMES	D-FLU-1, D-PB-1 THRU D-PB-3
PIPE CULVERT INSTALLATION	D-PB-1, D-PB-2

DRAFT

NOTES

1. STRUCTURES NOTED IN TABLE ABOVE TO BE CONSTRUCTED IN ACCORDANCE WITH THE APPLICABLE TENNESSEE DEPARTMENT OF TRANSPORTATION STANDARD DRAWINGS.
2. REFERENCE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" OF THE TENNESSEE DEPARTMENT OF TRANSPORTATION.
3. MODIFY TDOT STRUCTURES ABOVE AS NEEDED TO PROVIDE FULL BEARING FOR INLET CASTINGS NOTED ON CITY OF FRANKLIN DRAWINGS RP-1 THRU RP-4.

HISTORIC FRANKLIN TENNESSEE

DRAINAGE STRUCTURES, MANHOLES, GRATES, PIPE CULVERTS AND END WALLS

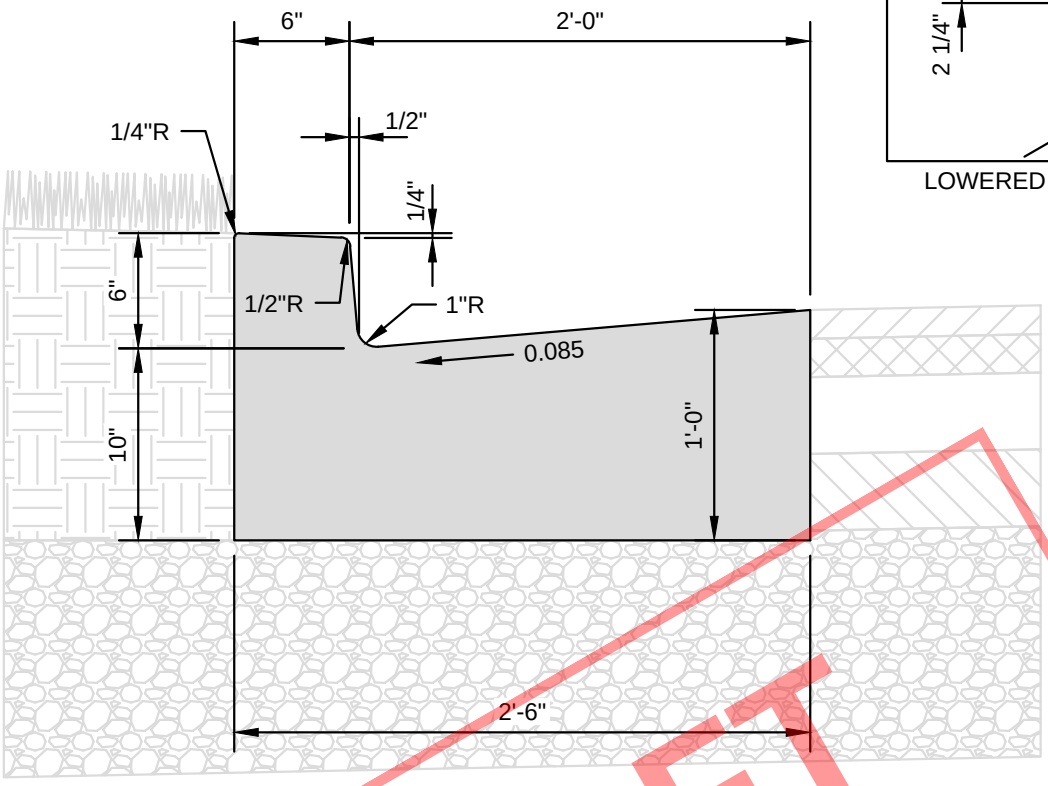
DWG. NO. **D-1**

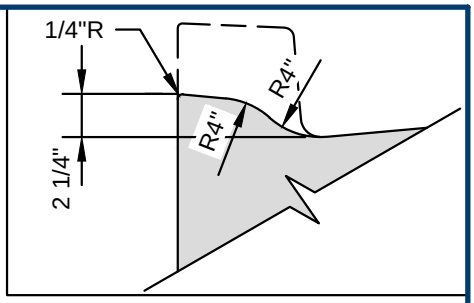
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021





LOWERED CURB AT DRIVEWAYS

DRAFT

NOTES

1. REFERENCE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" OF THE TENNESSEE DEPARTMENT OF TRANSPORTATION, SECTION 702 - CEMENT CONCRETE CURB, GUTTER, AND COMBINED CURB AND GUTTER
2. THE FRONT FACE OF THE CONCRETE CURBS FOR ALL DEGREES OF CURVATURE SHALL CONFORM TO THE CONTOUR OF THE CURVE. NO CHORD SECTIONS WILL BE PERMITTED.
3. CONCRETE: CLASS A (3,000 PSI, 6% AIR)
4. EXPANSION JOINTS: 1/2" THICK U.N.O. (SEE ALSO DRAWING RP-10)
   A. RUBBERIZED EXPANSION JOINT FILLER (AASHTO M153, TYPE 1)
   B. POLYPROPYLENE FOAM JOINT FILLER (ASTM D8139)
5. EXPANSION JOINTS SHALL BE PLACED AS FOLLOWS:
   A. AT TANGENT POINTS OF CIRCULAR CURBS
   B. BETWEEN CURBS AND ABUTTING RIGID OBJECTS
   C. AT OTHER PLACES WHERE STRESSES MAY DEVELOP
   D. TO LINE UP WITH PAVEMENT JOINTS WHERE THE ADJACENT PAVEMENT IS CONCRETE.
   E. AT A MAXIMUM SPACING OF 100 FEET
6. CONTRACTION JOINTS: SPACED AT 10 FEET. SPACING MAY BE REDUCED FOR CLOSURES, BUT NOT LESS THAN 6 FEET.
7. COMBINED CURB AND GUTTER BASED ON TDOT STD. DRAWING RP-VC-10
8. INLET CASTING: JBS 3300-V OR APPROVED EQUAL WITH DIRECTIONAL VANE GRATES AND SURFACE MOUNT ENVIRONOTICE PLATES STATING "DUMP NO WASTE DRAINS TO RIVER". MODIFY TDOT STRUCTURES AS NEEDED TO PROVIDE FULL BEARING AT CASTING.

HISTORIC FRANKLIN TENNESSEE

ARTERIAL AND COLLECTOR CURB AND GUTTER

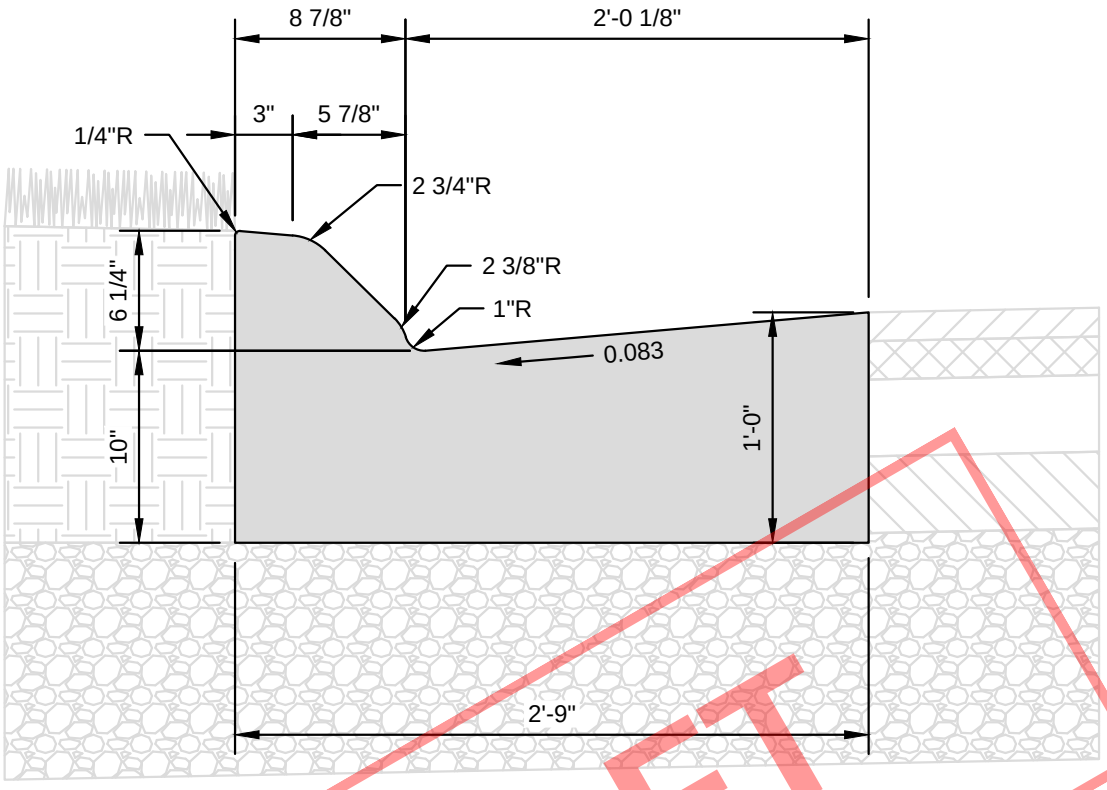
DWG. NO. **RP-1**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

NOTES

1. REFERENCE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" OF THE TENNESSEE DEPARTMENT OF TRANSPORTATION, SECTION 702 - CEMENT CONCRETE CURB, GUTTER, AND COMBINED CURB AND GUTTER
2. THE FRONT FACE OF THE CONCRETE CURBS FOR ALL DEGREES OF CURVATURE SHALL CONFORM TO THE CONTOUR OF THE CURVE. NO CHORD SECTIONS WILL BE PERMITTED.
3. CONCRETE: CLASS A (3,000 PSI, 6% AIR)
4. EXPANSION JOINTS: 1/2" THICK U.N.O. (SEE ALSO DRAWING RP-10)
   A. RUBBERIZED EXPANSION JOINT FILLER (AASHTO M153, TYPE 1)
   B. POLYPROPYLENE FOAM JOINT FILLER (ASTM D8139)
5. EXPANSION JOINTS SHALL BE PLACED AS FOLLOWS:
   A. AT TANGENT POINTS OF CIRCULAR CURBS
   B. BETWEEN CURBS AND ABUTTING RIGID OBJECTS
   C. AT OTHER PLACES WHERE STRESSES MAY DEVELOP
   D. TO LINE UP WITH PAVEMENT JOINTS WHERE THE ADJACENT PAVEMENT IS CONCRETE.
   E. AT A MAXIMUM SPACING OF 100 FEET
6. CONTRACTION JOINTS: SPACED AT 10 FEET. SPACING MAY BE REDUCED FOR CLOSURES, BUT NOT LESS THAN 6 FEET.
7. COMBINED CURB AND GUTTER BASED ON TDOT STD. DRAWING RP-SC-1

HISTORIC FRANKLIN TENNESSEE

ARTERIAL AND COLLECTOR CURB AND GUTTER (SLOPING CURB)

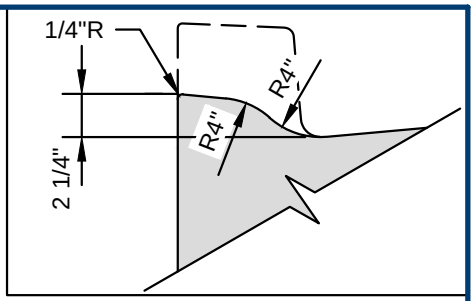
DWG. NO. **RP-2**

CITY OF FRANKLIN

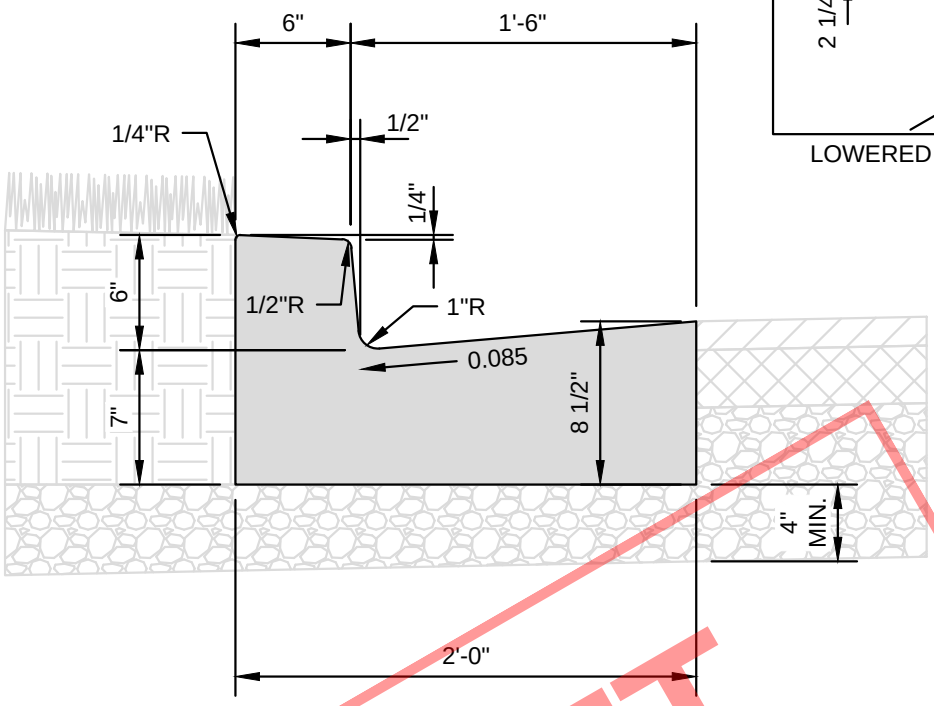
NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



LOWERED CURB AT DRIVEWAYS



DRAFT

NOTES

1. REFERENCE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" OF THE TENNESSEE DEPARTMENT OF TRANSPORTATION, SECTION 702 - CEMENT CONCRETE CURB, GUTTER, AND COMBINED CURB AND GUTTER
2. THE FRONT FACE OF THE CONCRETE CURBS FOR ALL DEGREES OF CURVATURE SHALL CONFORM TO THE CONTOUR OF THE CURVE. NO CHORD SECTIONS WILL BE PERMITTED.
3. CONCRETE: CLASS A (3,000 PSI, 6% AIR)
4. EXPANSION JOINTS: 1/2" THICK U.N.O. (SEE ALSO DRAWING RP-10)
   - A. RUBBERIZED EXPANSION JOINT FILLER (AASHTO M153, TYPE 1)
   - B. POLYPROPYLENE FOAM JOINT FILLER (ASTM D8139)
5. EXPANSION JOINTS SHALL BE PLACED AS FOLLOWS:
   - A. AT TANGENT POINTS OF CIRCULAR CURBS
   - B. BETWEEN CURBS AND ABUTTING RIGID OBJECTS
   - C. AT OTHER PLACES WHERE STRESSES MAY DEVELOP
   - D. TO LINE UP WITH PAVEMENT JOINTS WHERE THE ADJACENT PAVEMENT IS CONCRETE.
   - E. AT A MAXIMUM SPACING OF 100 FEET
6. CONTRACTION JOINTS: SPACED AT 10 FEET. SPACING MAY BE REDUCED FOR CLOSURES, BUT NOT LESS THAN 6 FEET.
7. INLET CASTING: JBS 3080-V OR APPROVED EQUAL WITH DIRECTIONAL VANE GRATES AND SURFACE MOUNT ENVIRONOTICE PLATES STATING "DUMP NO WASTE DRAINS TO RIVER". MODIFY TDOT STRUCTURES AS NEEDED TO PROVIDE FULL BEARING AT CASTING.

HISTORIC FRANKLIN TENNESSEE

LOCAL STREET CURB AND GUTTER

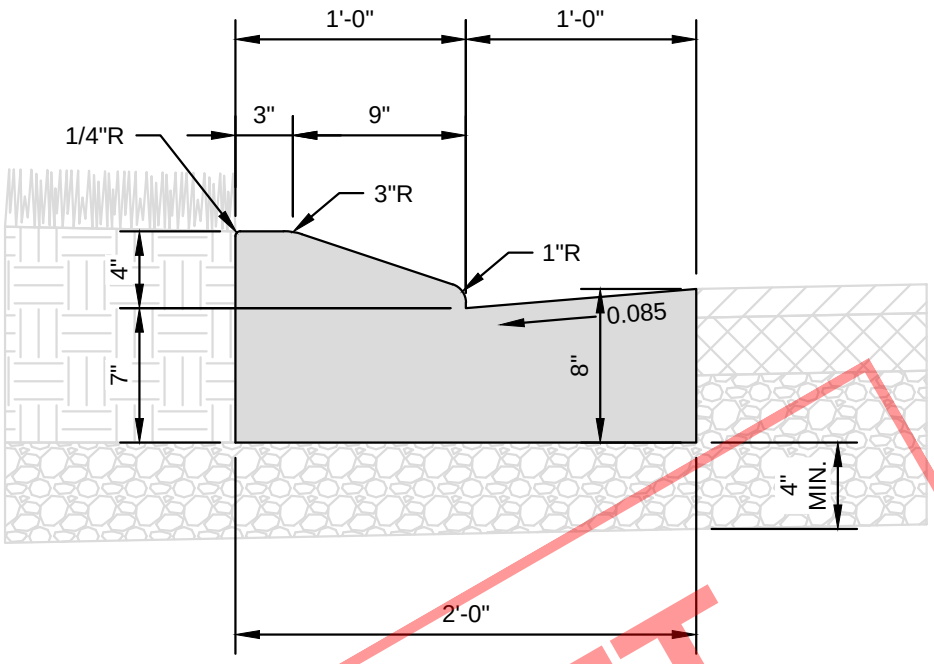
DWG. NO. **RP-3**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

NOTES

1. REFERENCE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" OF THE TENNESSEE DEPARTMENT OF TRANSPORTATION, SECTION 702 - CEMENT CONCRETE CURB, GUTTER, AND COMBINED CURB AND GUTTER
2. THE FRONT FACE OF THE CONCRETE CURBS FOR ALL DEGREES OF CURVATURE SHALL CONFORM TO THE CONTOUR OF THE CURVE. NO CHORD SECTIONS WILL BE PERMITTED.
3. CONCRETE: CLASS A (3,000 PSI, 6% AIR)
4. EXPANSION JOINTS: 1/2" THICK U.N.O. (SEE ALSO DRAWING RP-10)
   A. RUBBERIZED EXPANSION JOINT FILLER (AASHTO M153, TYPE 1)
   B. POLYPROPYLENE FOAM JOINT FILLER (ASTM D8139)
5. EXPANSION JOINTS SHALL BE PLACED AS FOLLOWS:
   A. AT TANGENT POINTS OF CIRCULAR CURBS
   B. BETWEEN CURBS AND ABUTTING RIGID OBJECTS
   C. AT OTHER PLACES WHERE STRESSES MAY DEVELOP
   D. TO LINE UP WITH PAVEMENT JOINTS WHERE THE ADJACENT PAVEMENT IS CONCRETE.
   E. AT A MAXIMUM SPACING OF 100 FEET
6. CONTRACTION JOINTS: SPACED AT 10 FEET. SPACING MAY BE REDUCED FOR CLOSURES, BUT NOT LESS THAN 6 FEET.
7. INLET CASTING: NEENAH R-3501-TR / R-3501-TL OR APPROVED EQUAL WITH TYPE L GRATES. MODIFY TDOT STRUCTURES AS NEEDED TO PROVIDE FULL BEARING AT CASTING.

HISTORIC FRANKLIN TENNESSEE

LOCAL STREET ROLLOVER CURB AND GUTTER (RESIDENTIAL AREAS ONLY)

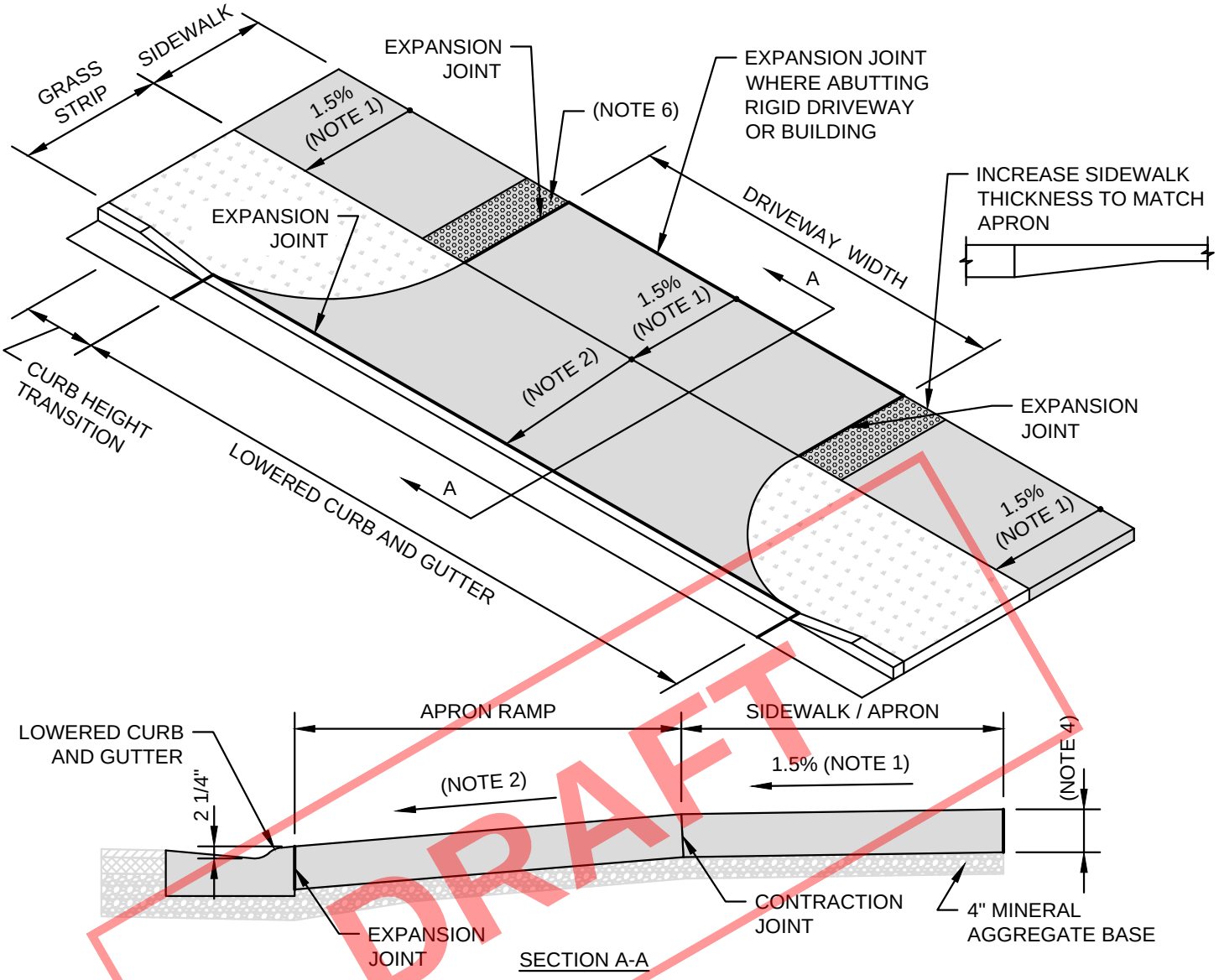
DWG. NO. **RP-4**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. APRON RAMP SLOPE:
   - A. 8% MAX., 1.5% MIN. AT RESIDENTIAL DRIVEWAYS, EXCEPT MULTI-FAMILY RESIDENTIAL
   - B. 6% MAX., 1.5% MIN. AT ALL OTHER DRIVEWAYS
3. MINERAL AGGREGATE BASE: 4" MIN. THICK 303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D
4. CONCRETE: CLASS A (3,000 PSI, 6% AIR) WITH SYNTHETIC FIBER REINFORCEMENT
   - A. 6" MIN. THICK AT RESIDENTIAL DRIVEWAYS, EXCEPT MULTI-FAMILY
   - B. 8" MIN. THICK AT NONRESIDENTIAL, MIXED-USE, AND MULTI-FAMILY RESIDENTIAL DRIVEWAYS
5. EXPANSION JOINTS: 1/2" THICK U.N.O. (SEE ALSO DRAWING RP-10)
   - A. RUBBERIZED EXPANSION JOINT FILLER (AASHTO M153, TYPE 1)
   - B. POLYPROPYLENE FOAM JOINT FILLER (ASTM D8139)
6. DETECTABLE WARNING SURFACE: BRICK RED, CAST-IN-PLACE (ADA SOLUTIONS, INC. OR APPROVED EQUAL)
   - A. PROVIDE AT DRIVEWAYS WITH YIELD OR STOP CONTROL ONLY

HISTORIC FRANKLIN TENNESSEE

STANDARD CONCRETE DRIVEWAY APRON WITH GRASS STRIP

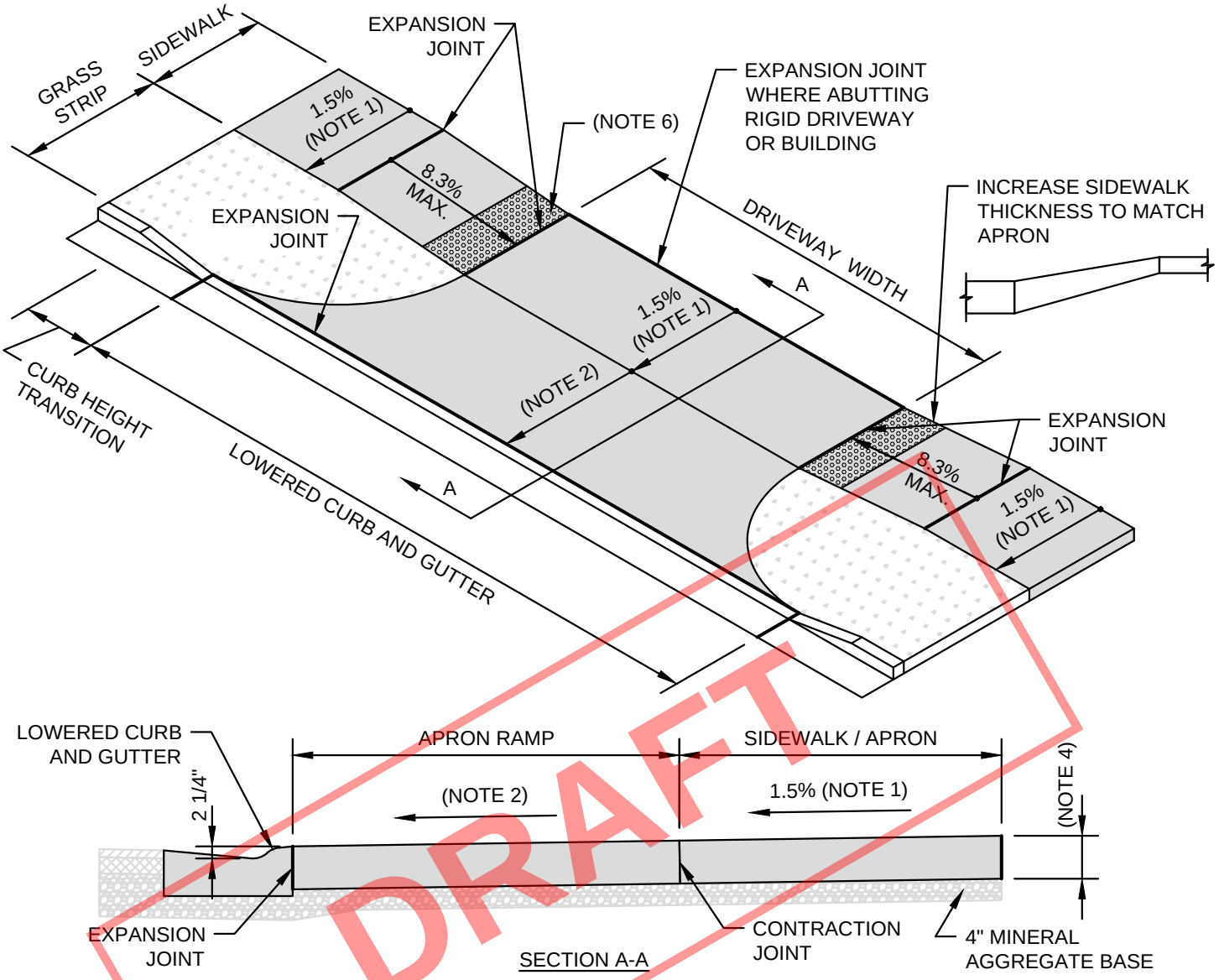
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

DWG. NO. **RP-5**



DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. APRON RAMP SLOPE:
   - A. 8% MAX., 1.5% MIN. AT RESIDENTIAL DRIVEWAYS, EXCEPT MULTI-FAMILY RESIDENTIAL
   - B. 6% MAX., 1.5% MIN. AT ALL OTHER DRIVEWAYS
3. MINERAL AGGREGATE BASE: 4" MIN. THICK 303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D
4. CONCRETE: CLASS A (3,000 PSI, 6% AIR) WITH SYNTHETIC FIBER REINFORCEMENT
   - A. 6" MIN. THICK AT RESIDENTIAL DRIVEWAYS, EXCEPT MULTI-FAMILY
   - B. 8" MIN. THICK AT NONRESIDENTIAL, MIXED-USE, AND MULTI-FAMILY RESIDENTIAL DRIVEWAYS
5. EXPANSION JOINTS: 1/2" THICK U.N.O. (SEE ALSO DRAWING RP-10)
   - A. RUBBERIZED EXPANSION JOINT FILLER (AASHTO M153, TYPE 1)
   - B. POLYPROPYLENE FOAM JOINT FILLER (ASTM D8139)
6. DETECTABLE WARNING SURFACE: BRICK RED, CAST-IN-PLACE (ADA SOLUTIONS, INC. OR APPROVED EQUAL)
   - A. PROVIDE AT DRIVEWAYS WITH YIELD OR STOP CONTROL ONLY

HISTORIC FRANKLIN TENNESSEE

LOWERED CONCRETE DRIVEWAY APRON WITH GRASS STRIP

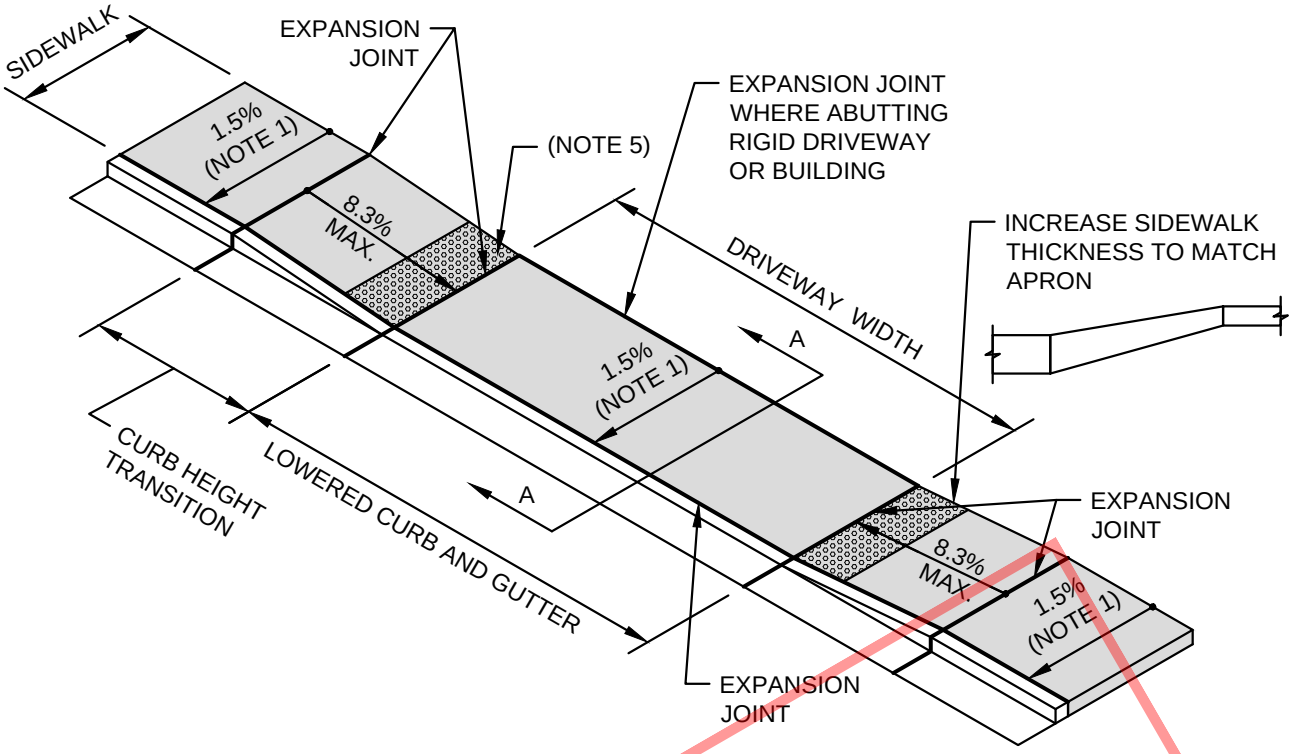
CITY OF FRANKLIN

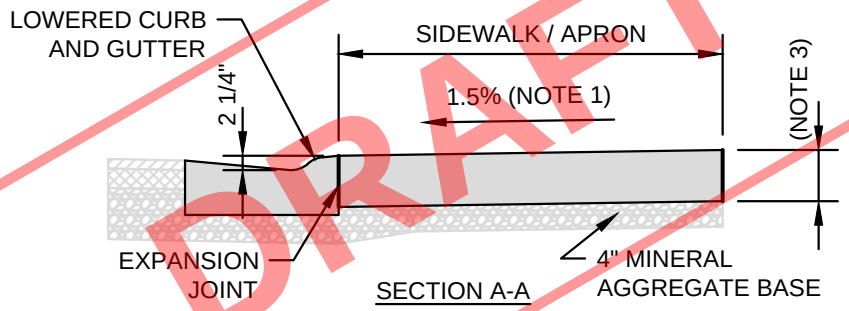
NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

DWG. NO. **RP-6**





DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. MINERAL AGGREGATE BASE: 4" MIN. THICK 303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D
3. CONCRETE: CLASS A (3,000 PSI, 6% AIR) WITH SYNTHETIC FIBER REINFORCEMENT
   - A. 6" MIN. THICK AT RESIDENTIAL DRIVEWAYS, EXCEPT MULTI-FAMILY
   - B. 8" MIN. THICK AT NONRESIDENTIAL, MIXED-USE, AND MULTI-FAMILY RESIDENTIAL DRIVEWAYS
4. EXPANSION JOINTS: 1/2" THICK U.N.O. (SEE ALSO DRAWING RP-10)
   - A. RUBBERIZED EXPANSION JOINT FILLER (AASHTO M153, TYPE 1)
   - B. POLYPROPYLENE FOAM JOINT FILLER (ASTM D8139)
5. DETECTABLE WARNING SURFACE: BRICK RED, CAST-IN-PLACE (ADA SOLUTIONS, INC. OR APPROVED EQUAL)
   - A. PROVIDE AT DRIVEWAYS WITH YIELD OR STOP CONTROL ONLY

HISTORIC FRANKLIN TENNESSEE

LOWERED CONCRETE DRIVEWAY APRON WITHOUT GRASS STRIP

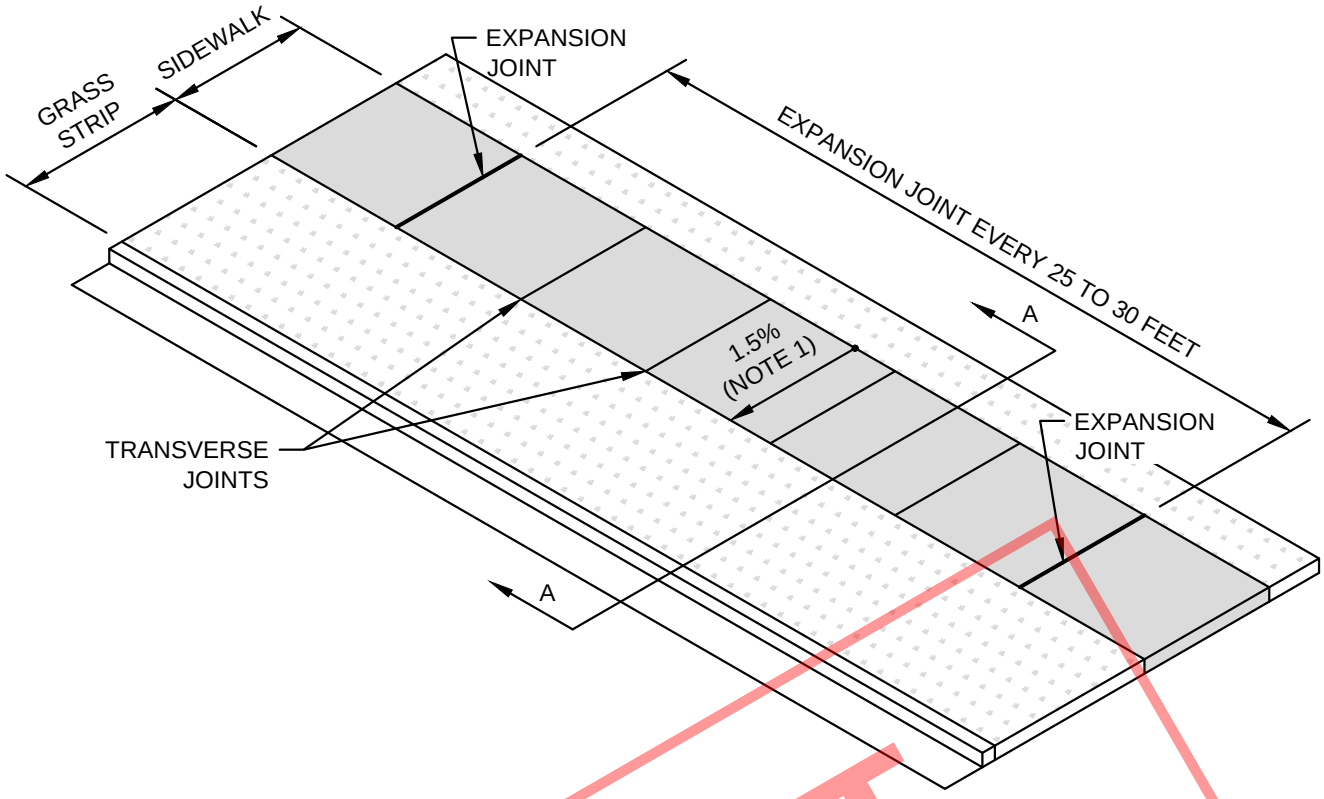
DWG. NO. **RP-7**

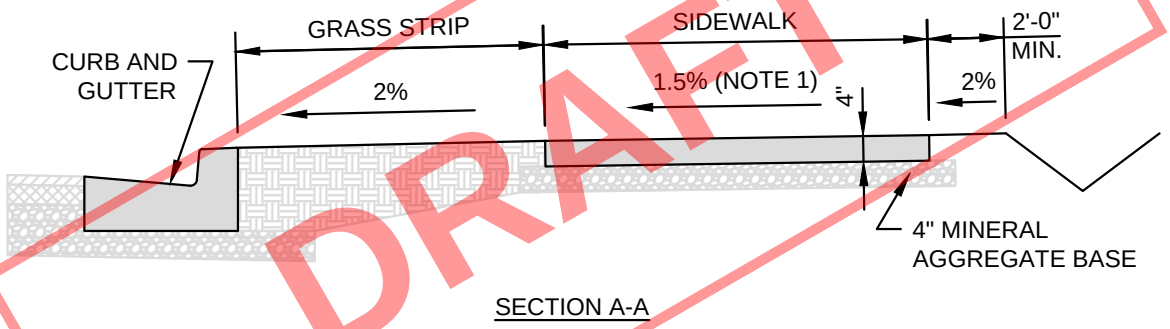
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021





SECTION A-A

DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. MINERAL AGGREGATE BASE: 4" MIN. THICK 303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D
3. CONCRETE: 4" MIN. THICK CLASS A (3,000 PSI, 6% AIR) WITH SYNTHETIC FIBER REINFORCEMENT, BROOM FINISH
4. EXPANSION JOINTS: SEE DRAWING RP-10
5. PROVIDE TRANSVERSE JOINTS FORMING BLOCKS AS NEARLY TO SQUARE AS PRACTICAL
6. PROVIDE A LONGITUDINAL JOINT CENTERED ON WALK WHERE SIDEWALK WIDTH IS 8'-0" OR GREATER

HISTORIC FRANKLIN TENNESSEE

CONCRETE SIDEWALK

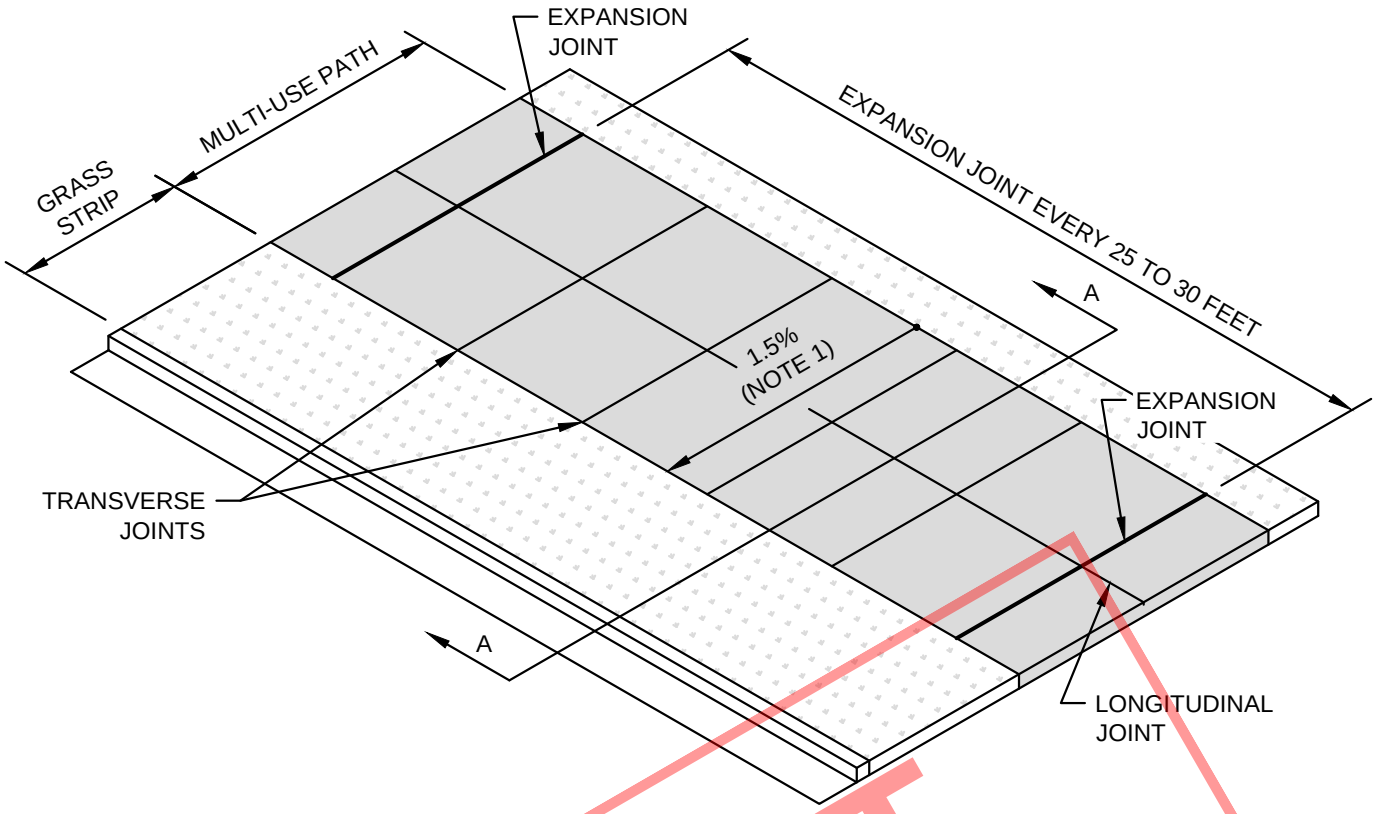
DWG. NO. **RP-8**

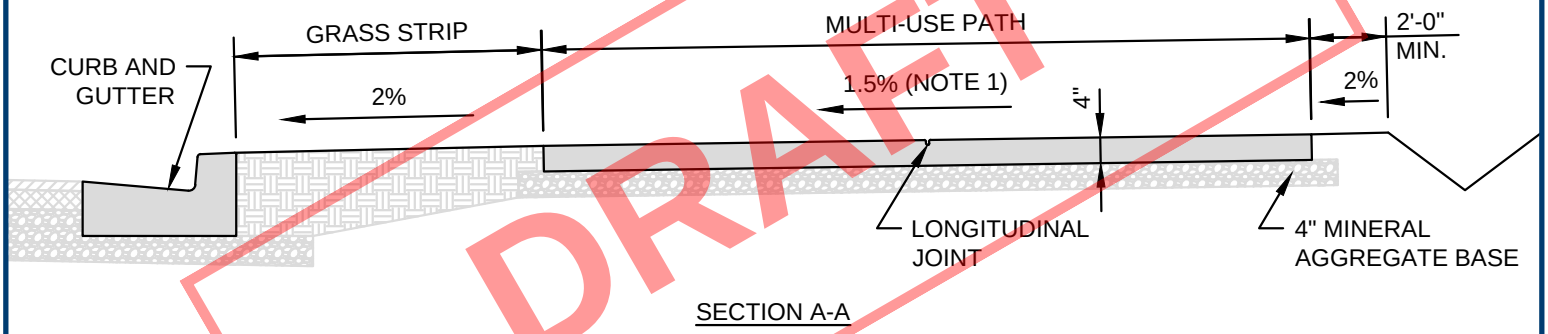
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER:

DATE: 7/1/2021





SECTION A-A

DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. MINERAL AGGREGATE BASE: 4" MIN. THICK 303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D
3. CONCRETE: 4" MIN. THICK CLASS A (3,000 PSI, 6% AIR) WITH SYNTHETIC FIBER REINFORCEMENT, BROOM FINISH
4. EXPANSION JOINTS: SEE DRAWING RP-10
5. PROVIDE TRANSVERSE JOINTS FORMING BLOCKS AS NEARLY TO SQUARE AS PRACTICAL
6. PROVIDE A LONGITUDINAL JOINT CENTERED ON WALK WHERE SIDEWALK WIDTH IS 8'-0" OR GREATER

HISTORIC FRANKLIN TENNESSEE

CONCRETE MULTI-USE PATH

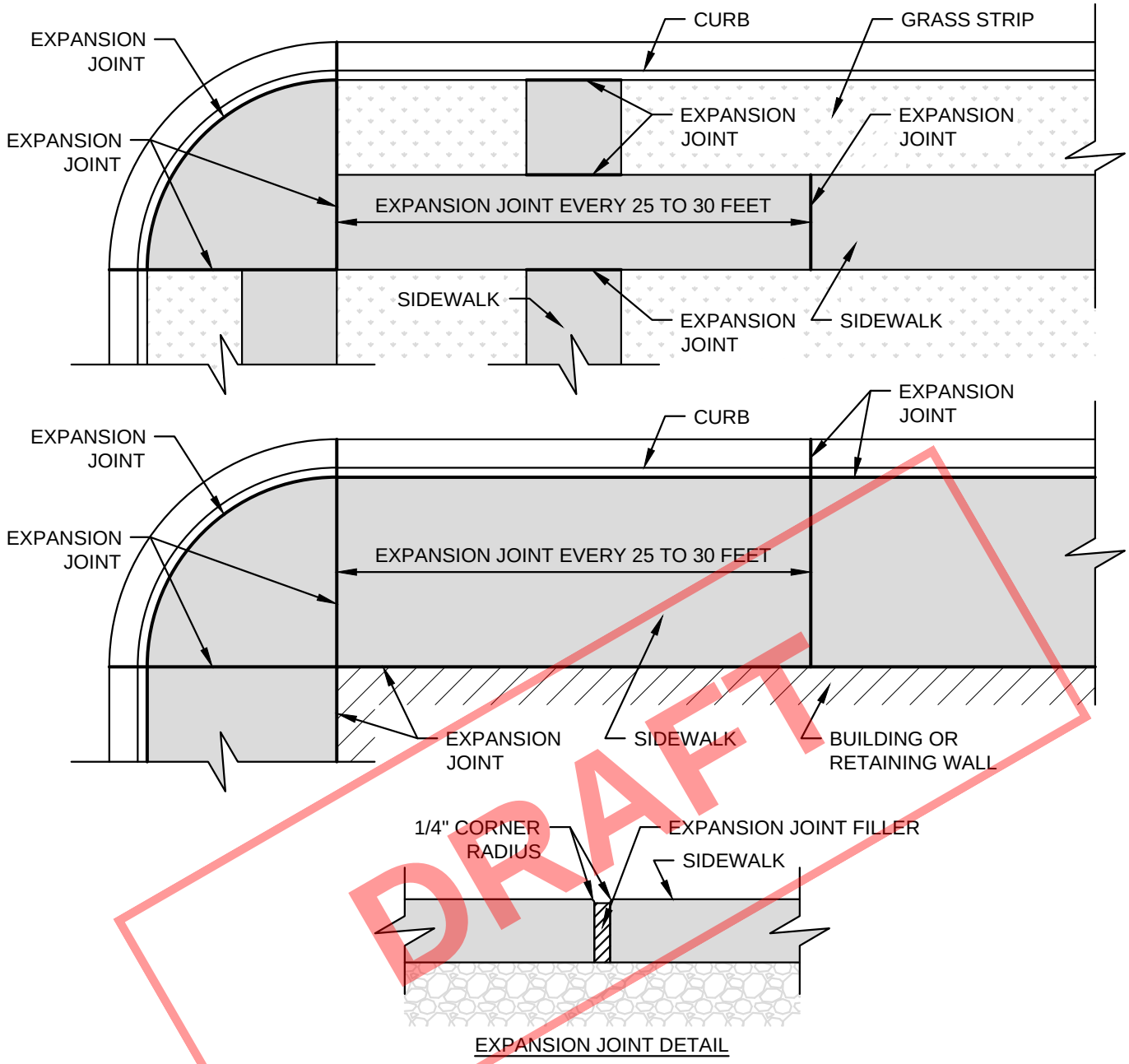
DWG. NO. **RP-9**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



EXPANSION JOINT DETAIL

DRAFT

NOTES

1. EXPANSION JOINTS:
   - A. RUBBERIZED EXPANSION JOINT FILLER (AASHTO M153, TYPE 1)
   - B. POLYPROPYLENE FOAM JOINT FILLER (ASTM D8139)
2. 1/2" THICK EXPANSION JOINTS SHALL BE PLACED AS FOLLOWS:
   - A. TRANSVERSE TO SIDEWALK AT 25 TO 30 FEET APART DEPENDING ON TRANSVERSE JOINT MARKINGS
   - B. TRANSVERSE TO SIDEWALK AT CURB EXPANSION JOINTS WHERE SIDEWALK IS BUILT DIRECTLY AGAINST CURB
   - C. BETWEEN CURB AND SIDEWALK WHERE SIDEWALK IS BUILT DIRECTLY AGAINST CURB
   - D. AT ABUTTING RIGID DRIVEWAYS OR OTHER SIDEWALKS
   - E. AT CHANGES IN SIDEWALK DIRECTION, INCLUDING AT STREET CORNERS AND AT CURVED SECTIONS
   - F. AT OTHER PLACES WHERE STRESSES MAY DEVELOP
3. 1" THICK EXPANSION JOINTS SHALL BE PLACED WHERE SIDEWALK ABUTS CIRCULAR CURBS, BUILDINGS, AND WALLS.

HISTORIC FRANKLIN TENNESSEE

SIDEWALK EXPANSION JOINT

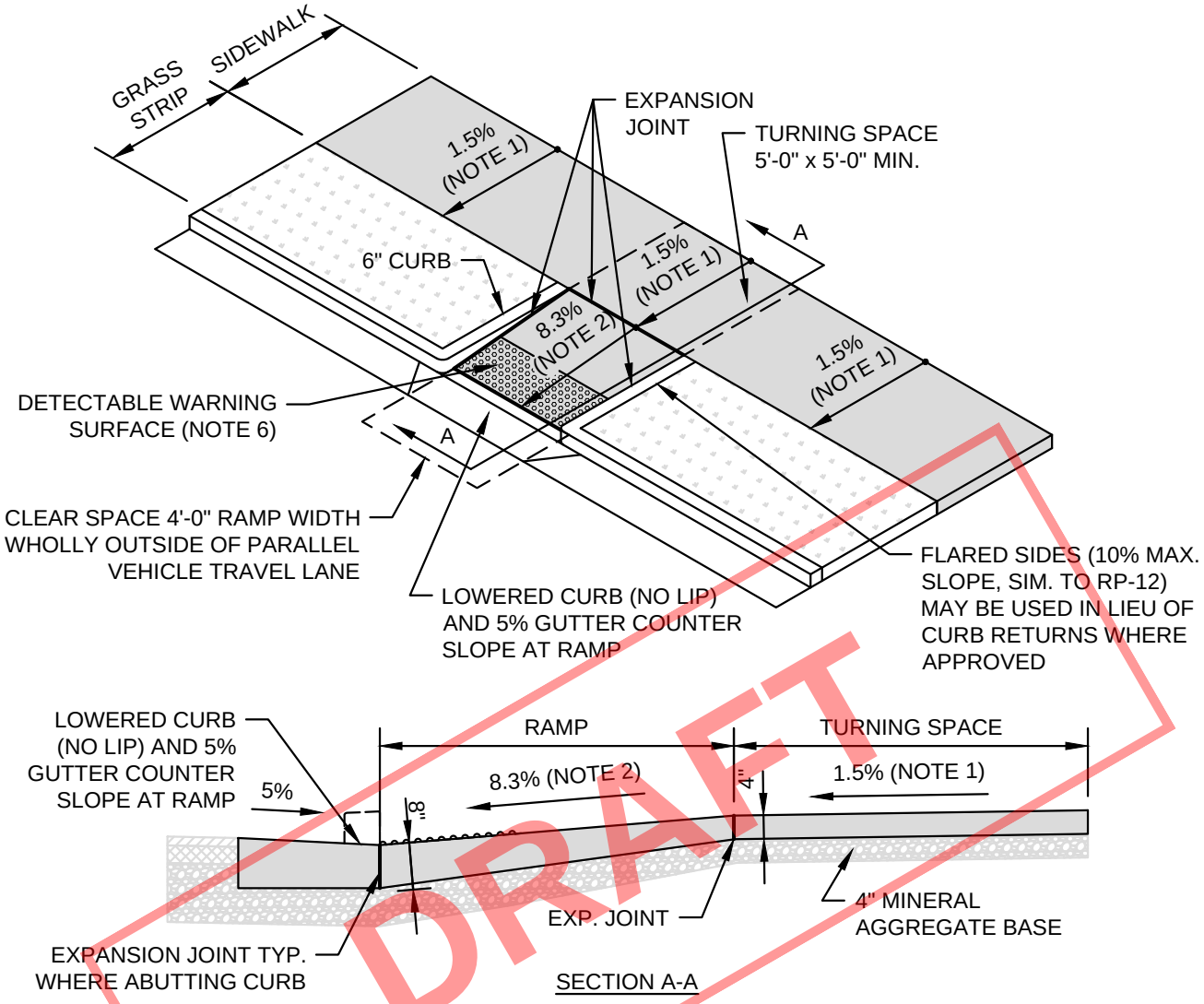
DWG. NO. **RP-10**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



SECTION A-A

DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. RAMP SLOPE: 8.3% MAX., 5% MIN. SLOPE SHALL NOT REQUIRE RAMP LENGTH TO EXCEED 15 FEET.
3. MINERAL AGGREGATE BASE: 4" MIN. THICK 303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D
4. CONCRETE: CLASS A (3,000 PSI, 6% AIR) WITH SYNTHETIC FIBER REINFORCEMENT
   A. 8" MIN. THICK AT RAMP CONNECTION TO STREET.
   B. 4" MIN. THICK AWAY FROM RAMP CONNECTION TO STREET. TAPER THICKNESS ACCORDINGLY.
5. EXPANSION JOINTS: 1/2" THICK U.N.O. (SEE ALSO DRAWING RP-10)
6. DETECTABLE WARNING: BRICK RED (YELLOW IN TDOT ROW), CAST-IN-PLACE (ADA SOLUTIONS OR APPROVED EQUAL)
   A. EXTEND SURFACE FULL WIDTH OF RAMP (EXCLUDING FLARED SIDES) AND 2'-0" IN THE DIRECTION OF TRAVEL
7. RAMP FINISH: COARSE BROOM FINISH TRANSVERSE TO SLOPE
8. RAMPS SHALL BE PROVIDED AT ALL STREET INTERSECTIONS, WALK LOCATIONS, AND MID-BLOCK CROSSINGS AND COMPLY WITH THE PROPOSED ACCESSIBILITY GUIDELINES FOR PEDESTRIAN FACILITIES IN THE PUBLIC RIGHT-OF-WAY.
9. POSITIVE DRAINAGE SHALL BE PROVIDED ACROSS ALL ELEMENTS SUCH THAT WATER DOES NOT ACCUMULATE.

HISTORIC FRANKLIN TENNESSEE

PERPENDICULAR CURB RAMP

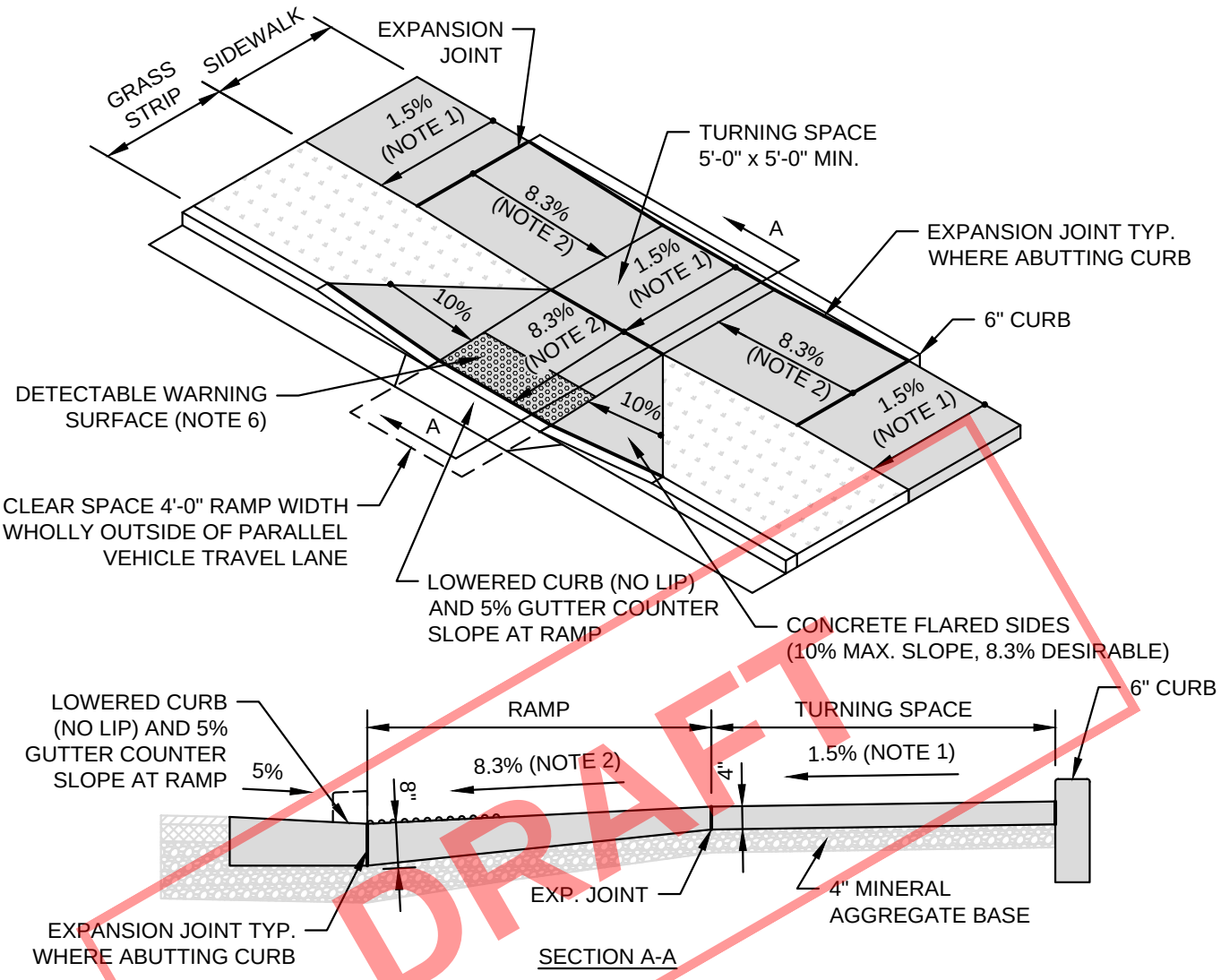
DWG. NO. **RP-11**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. RAMP SLOPE: 8.3% MAX., 5% MIN. SLOPE SHALL NOT REQUIRE RAMP LENGTH TO EXCEED 15 FEET.
3. MINERAL AGGREGATE BASE: 4" MIN. THICK 303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D
4. CONCRETE: CLASS A (3,000 PSI, 6% AIR) WITH SYNTHETIC FIBER REINFORCEMENT
   A. 8" MIN. THICK AT RAMP CONNECTION TO STREET.
   B. 4" MIN. THICK AWAY FROM RAMP CONNECTION TO STREET. TAPER THICKNESS ACCORDINGLY.
5. EXPANSION JOINTS: 1/2" THICK U.N.O. (SEE ALSO DRAWING RP-10)
6. DETECTABLE WARNING: BRICK RED (YELLOW IN TDOT ROW), CAST-IN-PLACE (ADA SOLUTIONS OR APPROVED EQUAL)
   A. EXTEND SURFACE FULL WIDTH OF RAMP (EXCLUDING FLARED SIDES) AND 2'-0" IN THE DIRECTION OF TRAVEL
7. RAMP FINISH: COARSE BROOM FINISH TRANSVERSE TO SLOPE
8. RAMPS SHALL BE PROVIDED AT ALL STREET INTERSECTIONS, WALK LOCATIONS, AND MID-BLOCK CROSSINGS AND COMPLY WITH THE PROPOSED ACCESSIBILITY GUIDELINES FOR PEDESTRIAN FACILITIES IN THE PUBLIC RIGHT-OF-WAY.
9. POSITIVE DRAINAGE SHALL BE PROVIDED ACROSS ALL ELEMENTS SUCH THAT WATER DOES NOT ACCUMULATE.

HISTORIC FRANKLIN TENNESSEE

COMBINATION CURB RAMP - FLARED SIDES

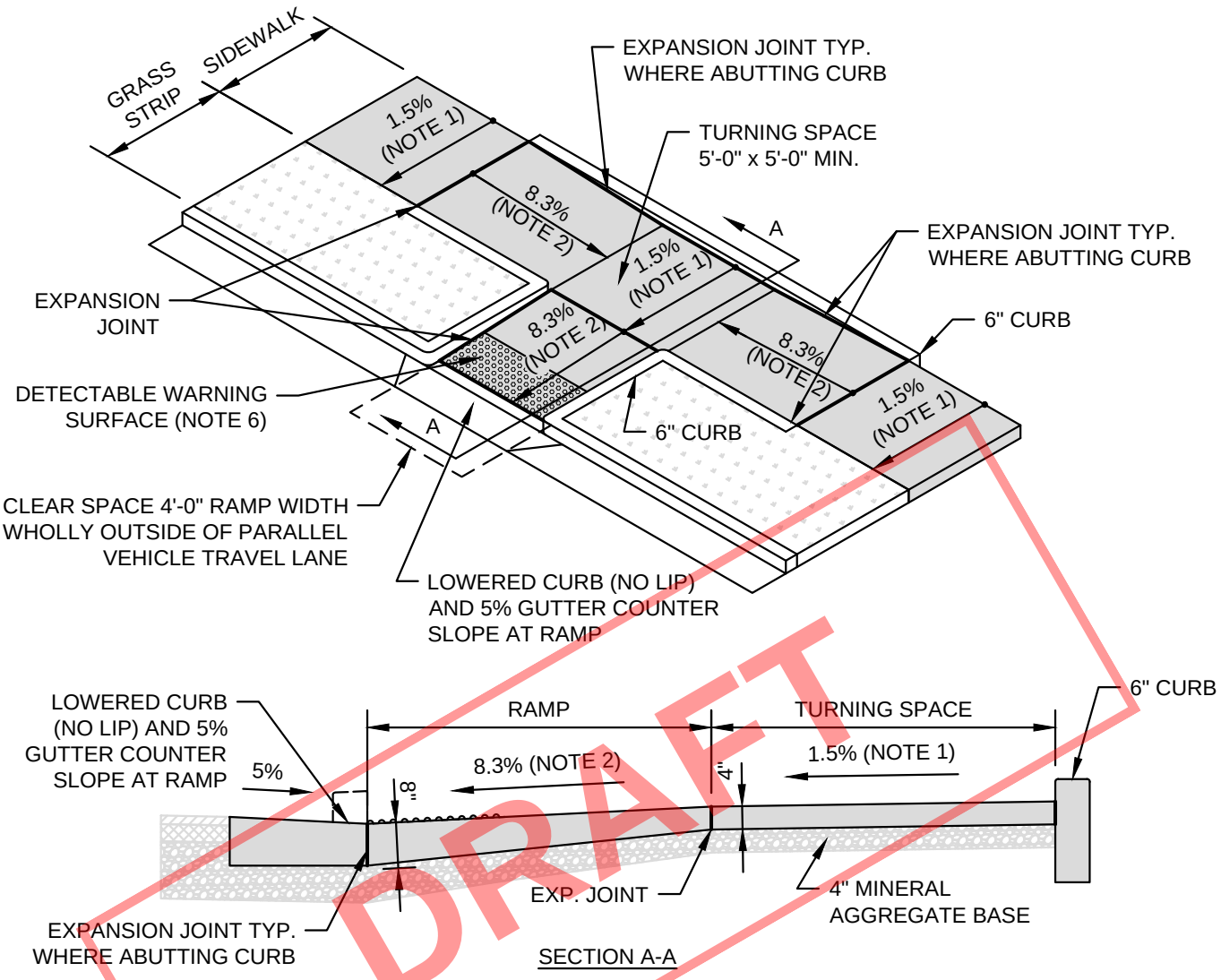
DWG. NO. **RP-12**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. RAMP SLOPE: 8.3% MAX., 5% MIN. SLOPE SHALL NOT REQUIRE RAMP LENGTH TO EXCEED 15 FEET.
3. MINERAL AGGREGATE BASE: 4" MIN. THICK 303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D
4. CONCRETE: CLASS A (3,000 PSI, 6% AIR) WITH SYNTHETIC FIBER REINFORCEMENT
   A. 8" MIN. THICK AT RAMP CONNECTION TO STREET.
   B. 4" MIN. THICK AWAY FROM RAMP CONNECTION TO STREET. TAPER THICKNESS ACCORDINGLY.
5. EXPANSION JOINTS: 1/2" THICK U.N.O. (SEE ALSO DRAWING RP-10)
6. DETECTABLE WARNING: BRICK RED (YELLOW IN TDOT ROW), CAST-IN-PLACE (ADA SOLUTIONS OR APPROVED EQUAL)
   A. EXTEND SURFACE FULL WIDTH OF RAMP (EXCLUDING FLARED SIDES) AND 2'-0" IN THE DIRECTION OF TRAVEL
7. RAMP FINISH: COARSE BROOM FINISH TRANSVERSE TO SLOPE
8. RAMPS SHALL BE PROVIDED AT ALL STREET INTERSECTIONS, WALK LOCATIONS, AND MID-BLOCK CROSSINGS AND COMPLY WITH THE PROPOSED ACCESSIBILITY GUIDELINES FOR PEDESTRIAN FACILITIES IN THE PUBLIC RIGHT-OF-WAY.
9. POSITIVE DRAINAGE SHALL BE PROVIDED ACROSS ALL ELEMENTS SUCH THAT WATER DOES NOT ACCUMULATE.

HISTORIC FRANKLIN TENNESSEE

COMBINATION CURB RAMP - 6" CURB

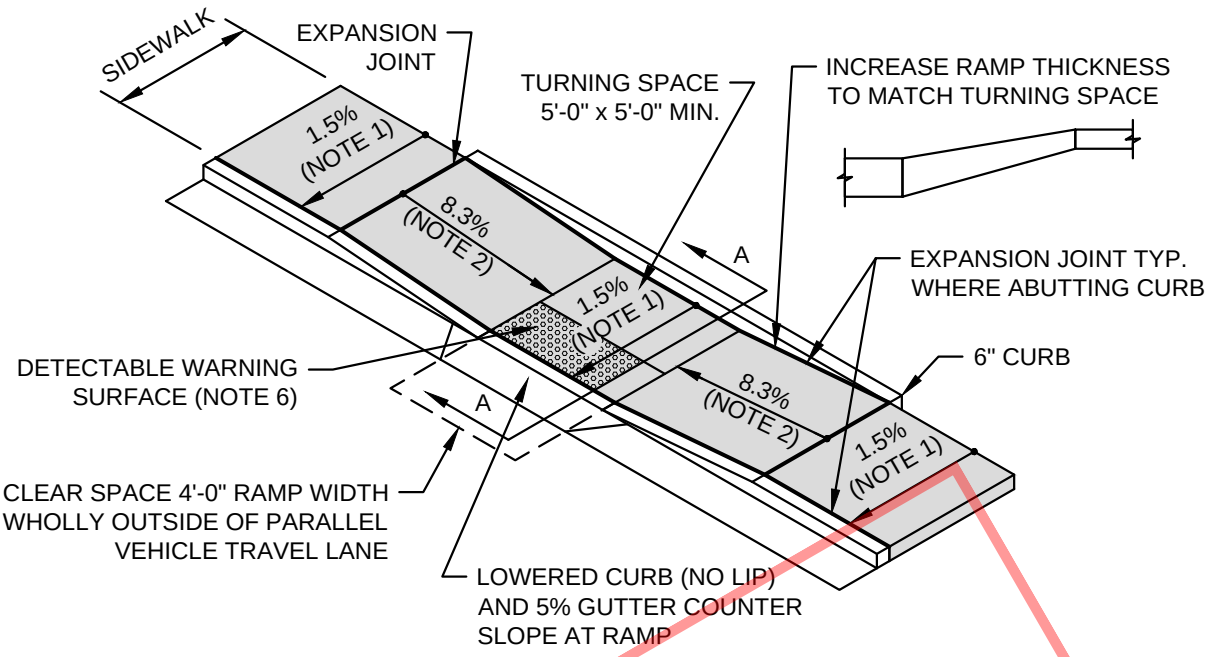
DWG. NO. **RP-13**

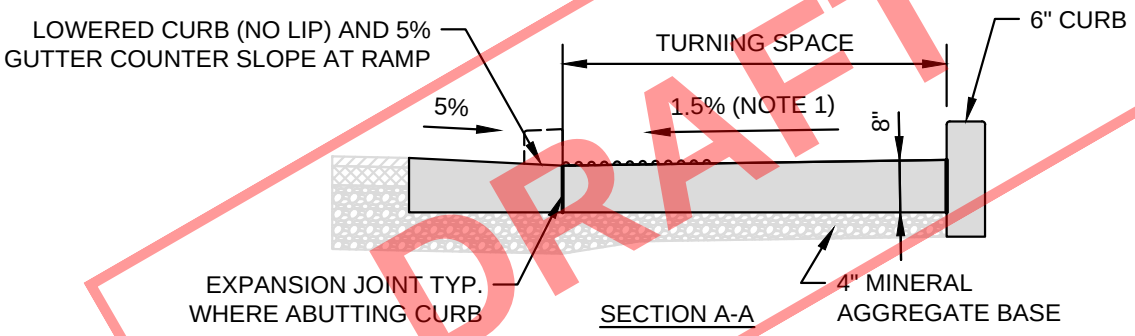
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021





DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. RAMP SLOPE: 8.3% MAX., 5% MIN. SLOPE SHALL NOT REQUIRE RAMP LENGTH TO EXCEED 15 FEET.
3. MINERAL AGGREGATE BASE: 4" MIN. THICK 303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D
4. CONCRETE: CLASS A (3,000 PSI, 6% AIR) WITH SYNTHETIC FIBER REINFORCEMENT
   A. 8" MIN. THICK AT RAMP CONNECTION TO STREET.
   B. 4" MIN. THICK AWAY FROM RAMP CONNECTION TO STREET. TAPER THICKNESS ACCORDINGLY.
5. EXPANSION JOINTS: 1/2" THICK U.N.O. (SEE ALSO DRAWING RP-10)
6. DETECTABLE WARNING: BRICK RED (YELLOW IN TDOT ROW), CAST-IN-PLACE (ADA SOLUTIONS OR APPROVED EQUAL)
   A. EXTEND SURFACE FULL WIDTH OF RAMP (EXCLUDING FLARED SIDES) AND 2'-0" IN THE DIRECTION OF TRAVEL
7. RAMP FINISH: COARSE BROOM FINISH TRANSVERSE TO SLOPE
8. RAMPS SHALL BE PROVIDED AT ALL STREET INTERSECTIONS, WALK LOCATIONS, AND MID-BLOCK CROSSINGS AND COMPLY WITH THE PROPOSED ACCESSIBILITY GUIDELINES FOR PEDESTRIAN FACILITIES IN THE PUBLIC RIGHT-OF-WAY.
9. POSITIVE DRAINAGE SHALL BE PROVIDED ACROSS ALL ELEMENTS SUCH THAT WATER DOES NOT ACCUMULATE.

HISTORIC FRANKLIN TENNESSEE

PARALLEL CURB RAMP

DWG. NO. **RP-14**

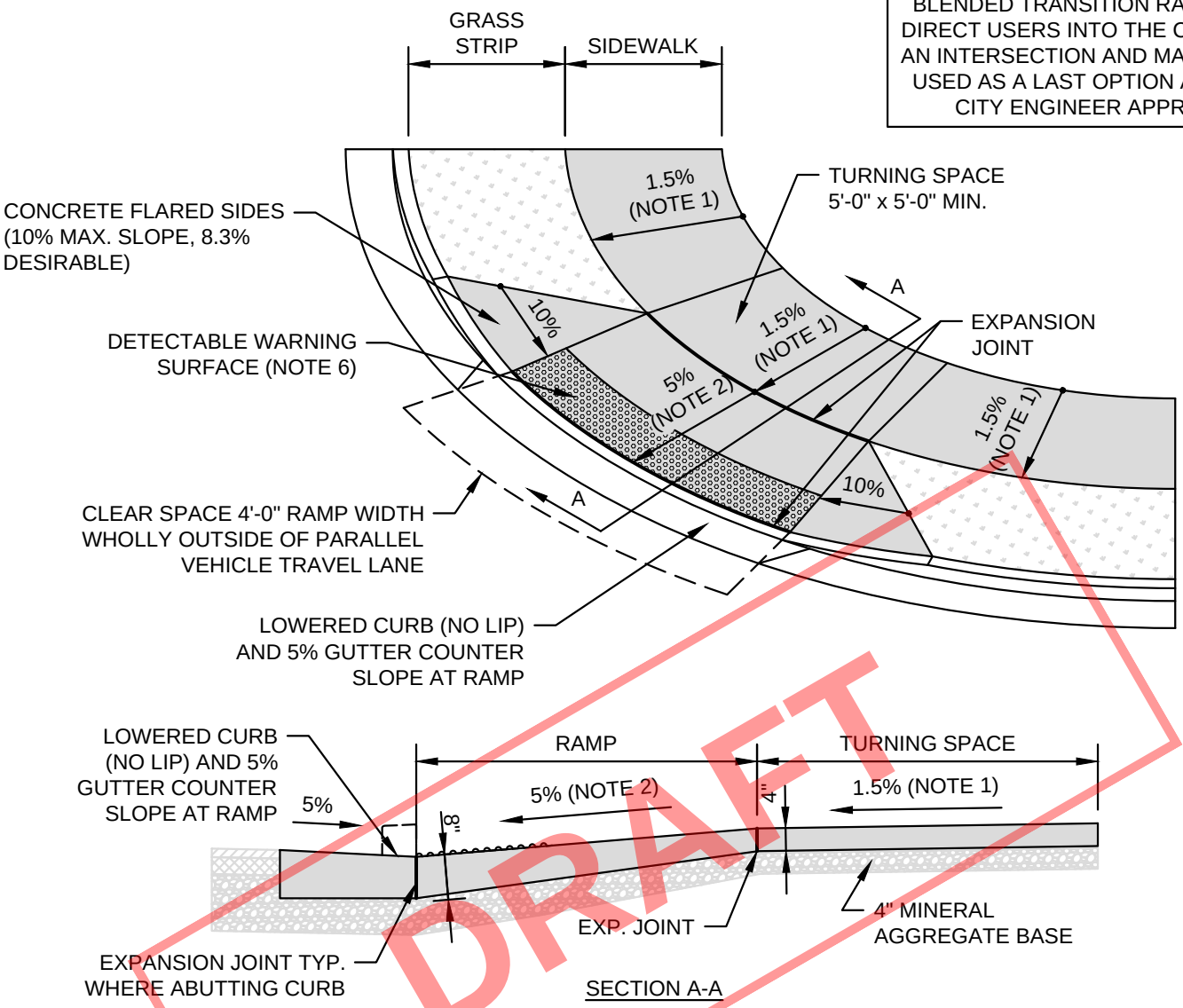
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

BLENDED TRANSITION RAMPS MAY DIRECT USERS INTO THE CENTER OF AN INTERSECTION AND MAY ONLY BE USED AS A LAST OPTION AND WITH CITY ENGINEER APPROVAL



DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. RAMP SLOPE: 5% MAX.
3. MINERAL AGGREGATE BASE: 4" MIN. THICK 303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D
4. CONCRETE: CLASS A (3,000 PSI, 6% AIR) WITH SYNTHETIC FIBER REINFORCEMENT
   A. 8" MIN. THICK AT RAMP CONNECTION TO STREET.
   B. 4" MIN. THICK AWAY FROM RAMP CONNECTION TO STREET. TAPER THICKNESS ACCORDINGLY.
5. EXPANSION JOINTS: 1/2" THICK U.N.O. (SEE ALSO DRAWING RP-10)
6. DETECTABLE WARNING: BRICK RED (YELLOW IN TDOT ROW), CAST-IN-PLACE (ADA SOLUTIONS OR APPROVED EQUAL)
   A. EXTEND SURFACE FULL WIDTH OF RAMP (EXCLUDING FLARED SIDES) AND 2'-0" IN THE DIRECTION OF TRAVEL
7. RAMP FINISH: COARSE BROOM FINISH TRANSVERSE TO SLOPE
8. RAMPS SHALL BE PROVIDED AT ALL STREET INTERSECTIONS, WALK LOCATIONS, AND MID-BLOCK CROSSINGS AND COMPLY WITH THE PROPOSED ACCESSIBILITY GUIDELINES FOR PEDESTRIAN FACILITIES IN THE PUBLIC RIGHT-OF-WAY.
9. POSITIVE DRAINAGE SHALL BE PROVIDED ACROSS ALL ELEMENTS SUCH THAT WATER DOES NOT ACCUMULATE.

HISTORIC FRANKLIN TENNESSEE

BLENDED TRANSITION RAMP

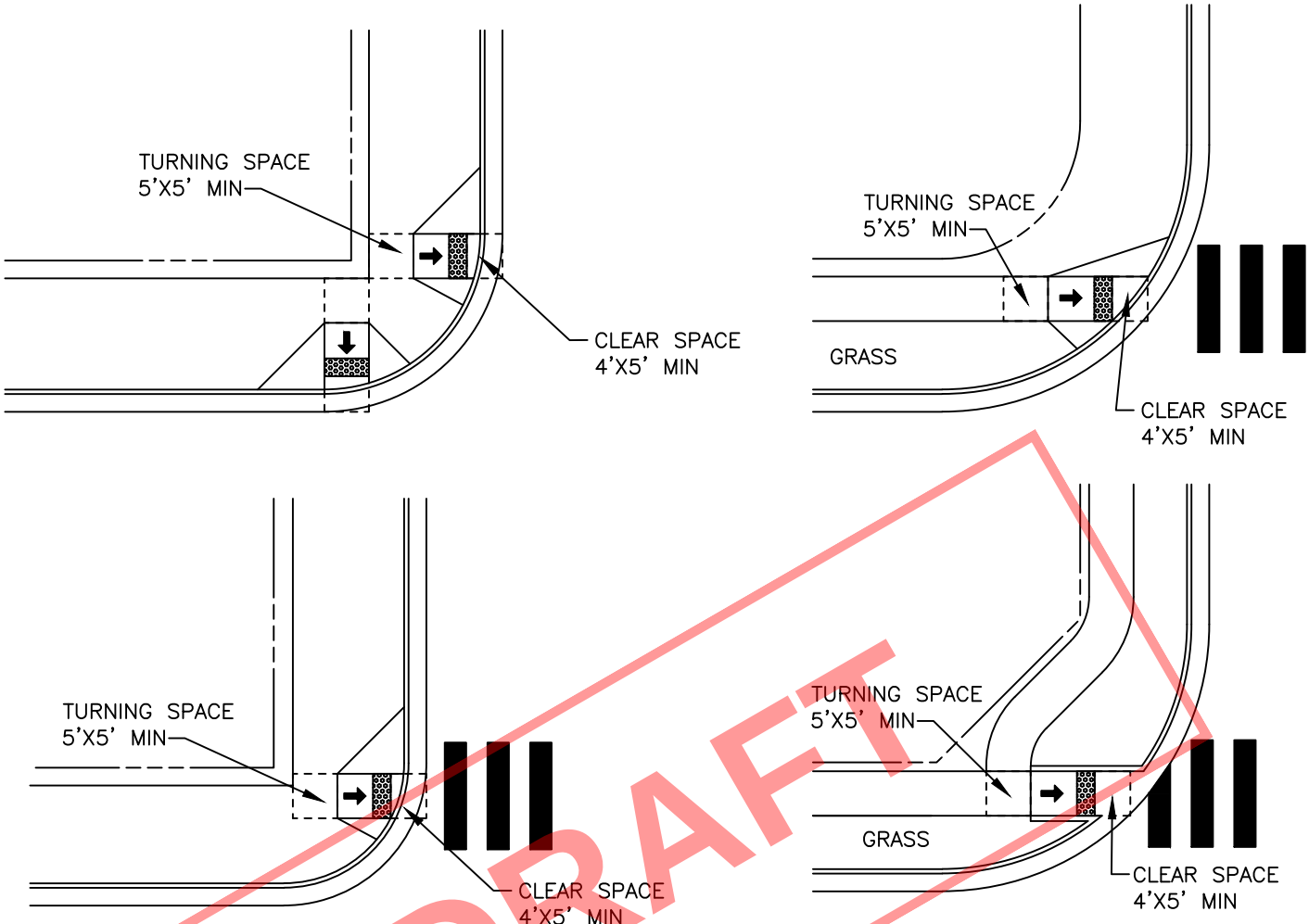
DWG. NO. **RP-15**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER:

DATE: 7/1/2021



DRAFT

SLOPE 8.3% MAX (1.5% CROSS SLOPE)

TRUNCATED DOME DETECTABLE WARNING SURFACE

GENERAL NOTES

1. TURNING SPACE SHALL BE 5'X5'.
2. THE RUNNING SLOPE OF THE CURB RAMP SHALL CUT THROUGH OR SHALL BE BUILT UP TO THE CURB AT RIGHT ANGLES OR SHALL MEET THE GUTTER GRADE BREAK AT RIGHT ANGLES WHERE THE CURB IS CURVED. THE RUNNING SLOPE OF THE CURB RAMP SHALL BE 5% MIN AND 8.3% MAX BUT SHALL NOT REQUIRE THE RAMP LENGTH TO EXCEED 15'. THE RUNNING SLOPE OF THE TURNING SPACE SHALL BE 1.5%.
3. WHERE A PEDESTRIAN CIRCULATION PATH CROSSES THE CURB RAMP, FLARED SIDES SHALL BE SLOPED 10% MAX, MEASURED PARALLEL TO THE CURB LINE.
4. GRADE BREAKS AT THE TOP AND BOTTOM OF CURB RAMP RUNS SHALL BE PERPENDICULAR TO THE DIRECTION OF THE RAMP RUN. GRADE BREAKS SHALL NOT BE PERMITTED ON THE SURFACE OF RAMP RUNS AND TURNING SPACES. SURFACE SLOPE THAT MEET AT GRADE BREAKS SHALL BE FLUSH.
5. CLEAR SPACE BEYOND THE BOTTOM GRADE BREAK SHALL BE 4'X5' IN WIDTH AND AND WHOLLY OUTSIDE THE PARALLEL VEHICLE TRAVEL LANE.
6. THE COUNTER SLOPE OF THE GUTTER OR STREET AT THE FOOT OF CURB RAMP RUNS SHALL BE 5% MAX.

N.T.S

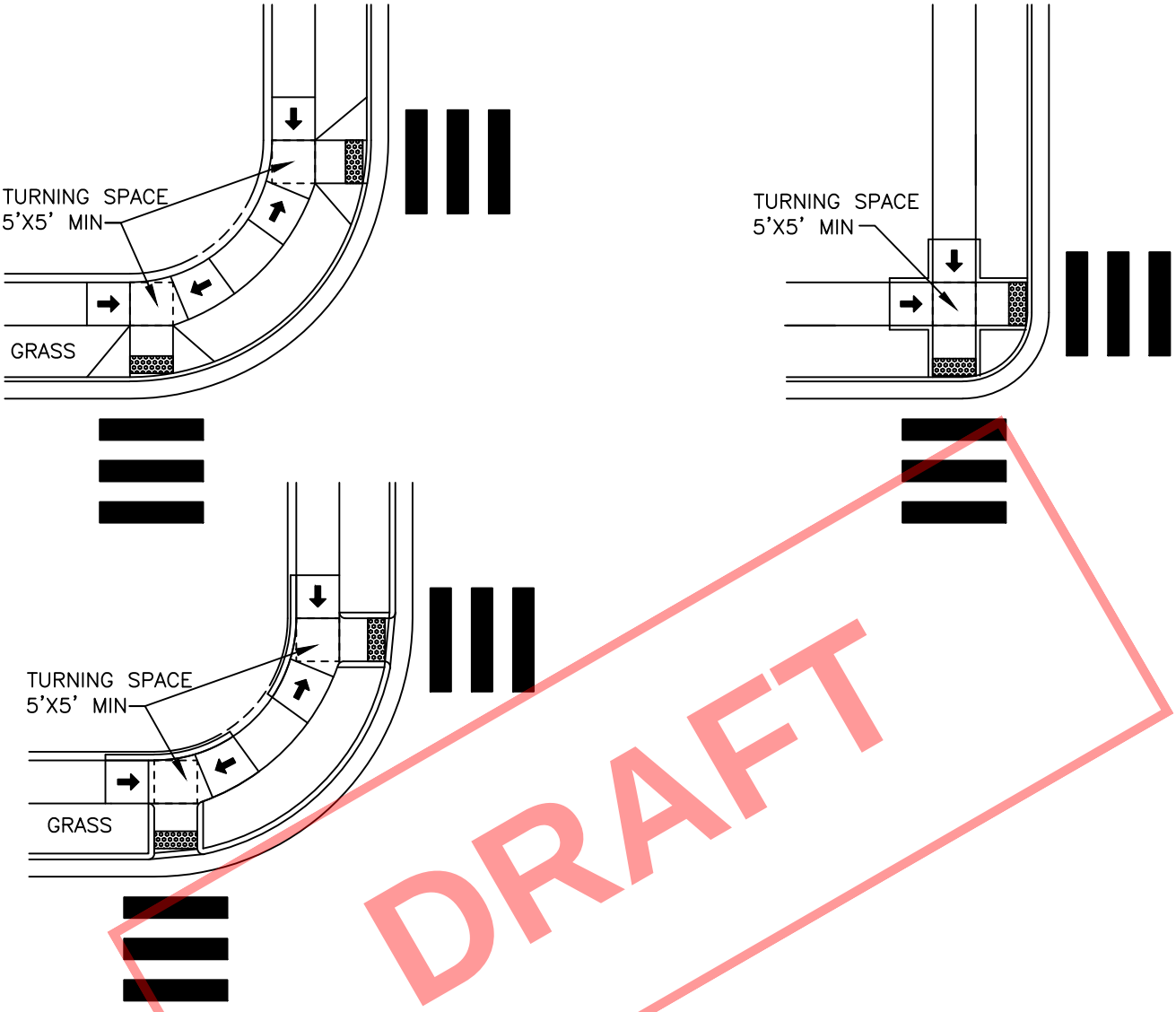
HISTORIC FRANKLIN TENNESSEE

PERPENDICULAR RAMP LAYOUT

DWG. NO.

RP-16

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021
NOT TO SCALE		



DRAFT

SLOPE 8.3% MAX (1.5% CROSS SLOPE)

TRUNCATED DOME DETECTABLE WARNING SURFACE

GENERAL NOTES

1. TURNING SPACE SHALL BE 5'X5'.
2. THE RUNNING SLOPE OF THE CURB RAMP SHALL CUT THROUGH OR SHALL BE BUILT UP TO THE CURB AT RIGHT ANGLES OR SHALL MEET THE GUTTER GRADE BREAK AT RIGHT ANGLES WHERE THE CURB IS CURVED. THE RUNNING SLOPE OF THE CURB RAMP SHALL BE 5% MIN AND 8.3% MAX BUT SHALL NOT REQUIRE THE RAMP LENGTH TO EXCEED 15'. THE RUNNING SLOPE OF THE TURNING SPACE SHALL BE 1.5%.
3. WHERE A PEDESTRIAN CIRCULATION PATH CROSSES THE CURB RAMP, FLARED SIDES SHALL BE SLOPED 10% MAX, MEASURED PARALLEL TO THE CURB LINE.
4. GRADE BREAKS AT THE TOP AND BOTTOM OF CURB RAMP RUNS SHALL BE PERPENDICULAR TO THE DIRECTION OF THE RAMP RUN. GRADE BREAKS SHALL NOT BE PERMITTED ON THE SURFACE OF RAMP RUNS AND TURNING SPACES. SURFACE SLOPE THAT MEET AT GRADE BREAKS SHALL BE FLUSH.
5. CLEAR SPACE BEYOND THE BOTTOM GRADE BREAK SHALL BE 4'X5' IN WIDTH AND AND WHOLLY OUTSIDE THE PARALLEL VEHICLE TRAVEL LANE.
6. THE COUNTER SLOPE OF THE GUTTER OR STREET AT THE FOOT OF CURB RAMP RUNS SHALL BE 5% MAX.

N.T.S

HISTORIC FRANKLIN TENNESSEE

COMBINATION PERPENDICULAR SIDEWALK RAMP LAYOUT

DWG. NO.

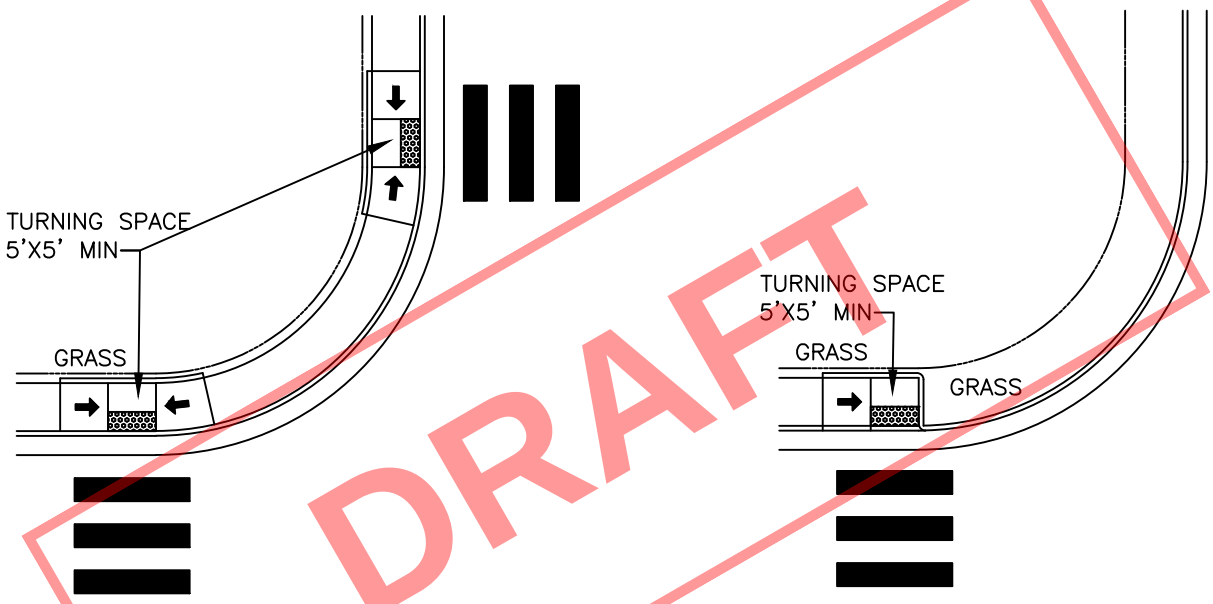
RP-17

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

SLOPE 8.3% MAX (1.5% CROSS SLOPE)
TRUNCATED DOME DETECTABLE WARNING SURFACE

GENERAL NOTES

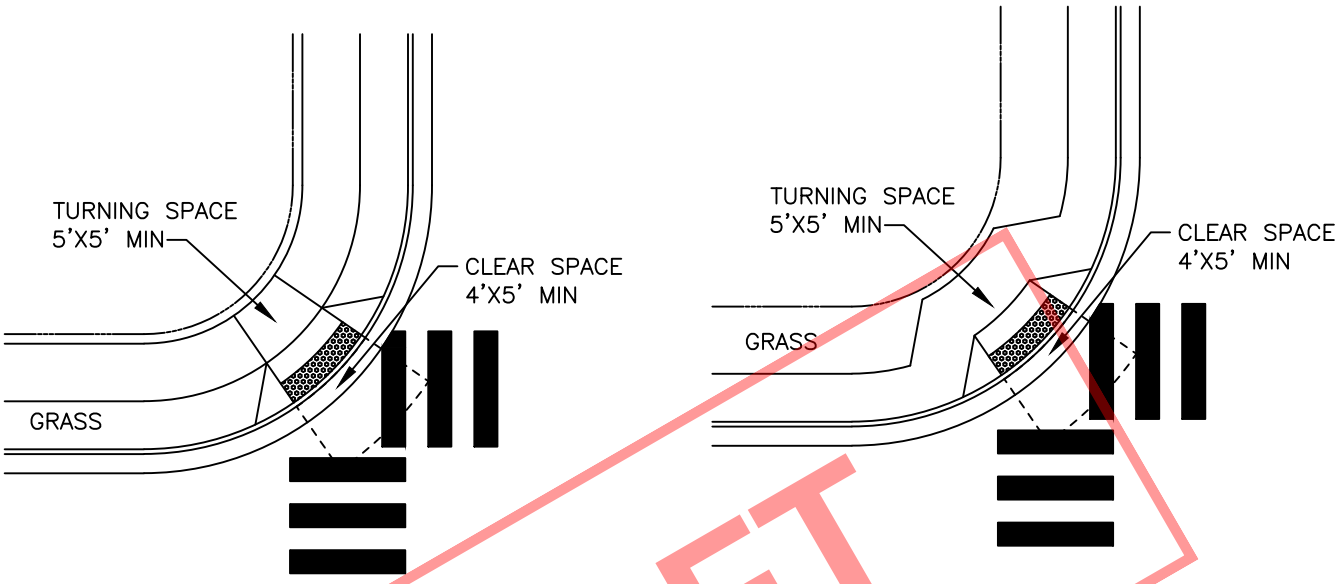
1. TURNING SPACE SHALL BE 5'X5'.
2. THE RUNNING SLOPE OF THE CURB RAMP SHALL BE IN-LINE WITH THE DIRECTION OF SIDEWALK TRAVEL. THE RUNNING SLOPE OF THE CURB RAMP SHALL BE 5% MIN AND 8.3% MAX BUT SHALL NOT REQUIRE THE RAMP LENGTH TO EXCEED 15' MIN. THE RUNNING SLOPE OF THE TURNING SPACE SHALL BE 1.5%
3. THE COUNTER SLOPE OF THE GUTTER OR STREET AT THE FOOT OF CURB RAMPS RUNS SHALL BE 5% MAX.
4. GRADE BREAKS AT THE TOP AND BOTTOM OF CURB RAMP RUNS SHALL BE PERPENDICULAR TO THE DIRECTION OF THE RAMP RUN. GRADE BREAKS SHALL NOT BE PERMITTED ON THE SURFACE OF RAMP RUNS AND TURNING SPACES. SURFACE SLOPES THAT MEET AT GRADE BREAKS SHALL BE FLUSH

N.T.S

HISTORIC FRANKLIN TENNESSEE

PARALLEL CURB RAMP LAYOUT

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021	DWG. NO. RP-18
NOT TO SCALE			



DRAFT

NOTE:
BLENDED TRANSITION RAMP LAYOUT, LOCATED AT THE APEX OF THE CORNER, MAY DIRECT USERS INTO THE CENTER OF THE INTERSECTION, RATHER THAN THE CROSS WALK, AND SHOULD BE USED AS THE LAST OPTION IN CURB RAMP DESIGN. CITY ENGINEER APPROVAL SHALL BE REQUIRED FOR THIS TYPE OF LAYOUT.

← SLOPE 8.3% MAX (1.5% CROSS SLOPE)
TRUNCATED DOME DETECTABLE WARNING SURFACE

GENERAL NOTES

1. TURNING SPACE SHALL BE 5'X5' AND CLEAR SPACE SHALL BE 4'X5' MIN.
2. THE CROSS SLOPE OF CURB RAMPS, BLENDED TRANSITIONS AND TURNING SPACE SHALL BE 1.5%.
3. THE RUNNING SLOPE OF THE CURB RAMP SHALL BE IN-LINE WITH THE DIRECTION OF SIDEWALK TRAVEL. THE RUNNING SLOPE OF THE CURB RAMP SHALL BE 5%. THE RUNNING SLOPE OF THE TURNING SPACE SHALL BE 1.5%
4. THE COUNTER SLOPE OF THE GUTTER OR STREET AT THE FOOT OF CURB RAMPS RUNS SHALL BE 5% MAX.
5. GRADE BREAKS AT THE TOP AND BOTTOM OF CURB RAMP RUNS SHALL BE PERPENDICULAR TO THE DIRECTION OF THE RAMP RUN. GRADE BREAKS SHALL NOT BE PERMITTED ON THE SURFACE OF RAMP RUNS AND TURNING SPACES. SURFACE SLOPES THAT MEET AT GRADE BREAKS SHALL BE FLUSH.
6. DETECTABLE WARNING SHALL BE INSTALLED ALONG ENTIRE WIDTH OF RAMP BASE.

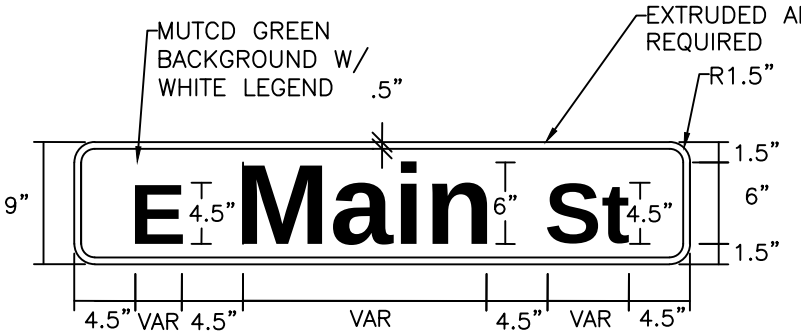
N.T.S

HISTORIC FRANKLIN TENNESSEE

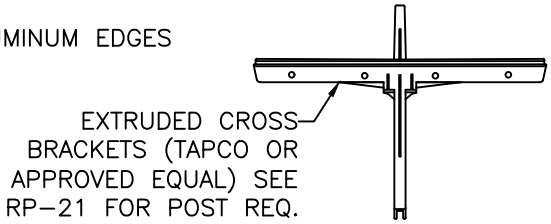
BLENDED TRANSITION RAMP LAYOUT

DWG. NO.
RP-19

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021
NOT TO SCALE		

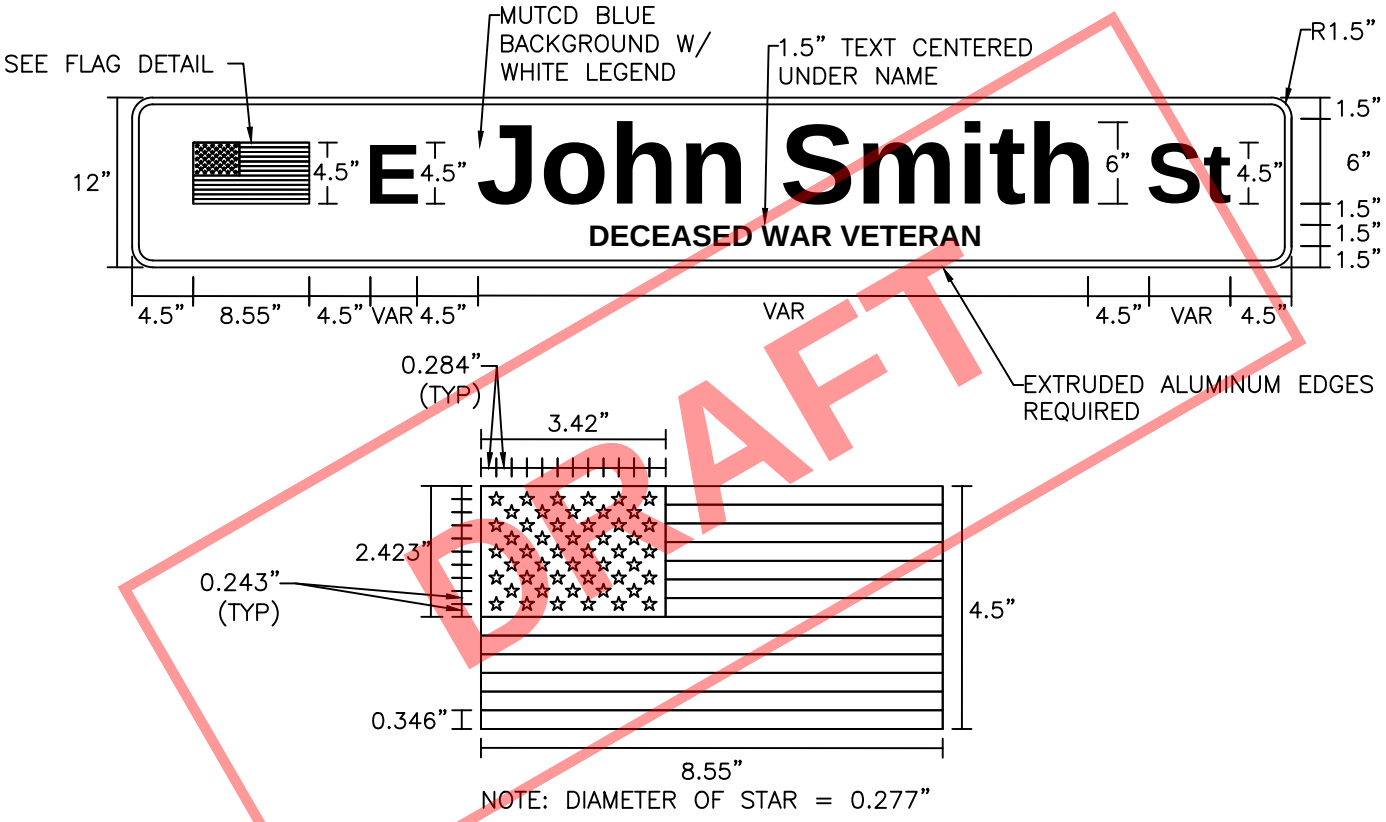


STANDARD STREET NAME SIGN



SIGN LENGTH	CROSS BRACKET LENGTH
≤ 30"	18"
30"≥42"	24"

STREET SIGN CROSS BRACKET



DECEASED WAR VETERAN STREET NAME SIGN

DRAFT

GENERAL NOTES

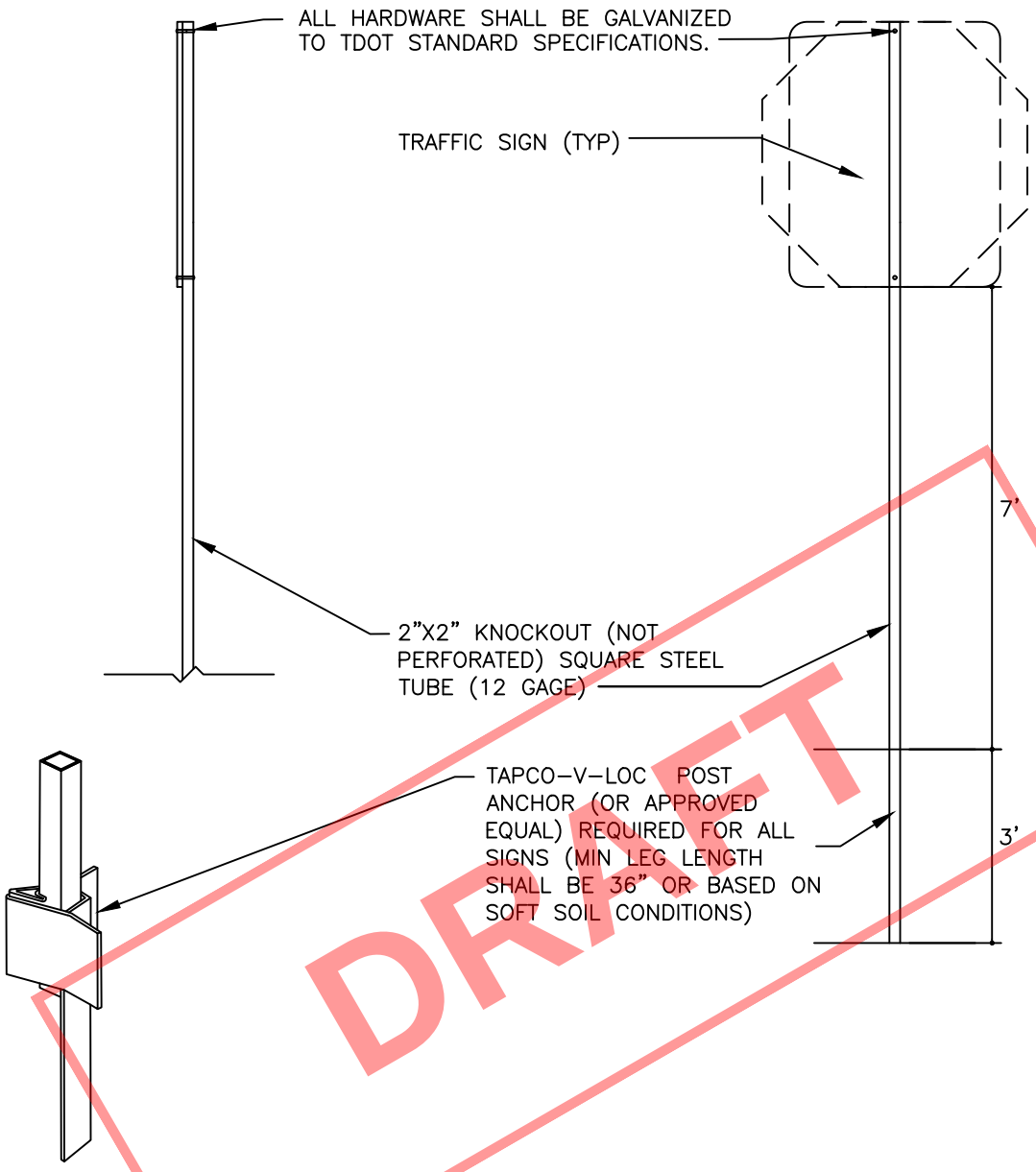
1. ALL STREET SIGNS SHALL BE EXTRUDED AND DOUBLE FACED.
2. ALL STREET SIGNS MUST BE FABRICATED WITH REFLECTIVE MATERIALS. ALL REFLECTIVE MATERIALS MUST QUALIFY AS HIGH INTENSITY PRISMATIC GRADE. ALL SIGNS MUST HAVE A MINIMUM 7–YEAR MATERIALS WARRANTY.
3. ALUMINUM BLANKS SHALL HAVE A MINIMUM GAGE OF 0.80.
4. ALL TEXT SHALL BE STANDARD US FEDERAL HIGHWAY ADMINISTRATION SERIES B FONTS. FONT WIDTH SHALL BE ADJUSTED TO AVOID SIGNS LONGER THAN 42" IN LENGTH.
5. SHOP DRAWINGS SHALL BE SUBMITTED TO STREET DEPARTMENT FOR REVIEW AND APPROVAL PRIOR TO ORDERING/INSTALLATION.
6. DECORATIVE POST AND ALTERNATE SIGN MOUNTING BRACKETS ARE ALLOWED ONLY WHEN MAINTAINED BY A HOMEOWNERS OR BUSINESS ASSOCIATION. SHOP DRAWINGS SHALL BE SUBMITTED TO THE STREET DEPARTMENT FOR REVIEW AND APPROVAL.

N.T.S

HISTORIC FRANKLIN TENNESSEE

LOCAL RESIDENTIAL STREET NAME SIGN (MUTCD D3-1)

CITY OF FRANKLIN	CITY ENGINEER:	DATE: 7/1/2021	DWG. NO. RP-20
NOT TO SCALE			



DRAFT

GENERAL NOTES

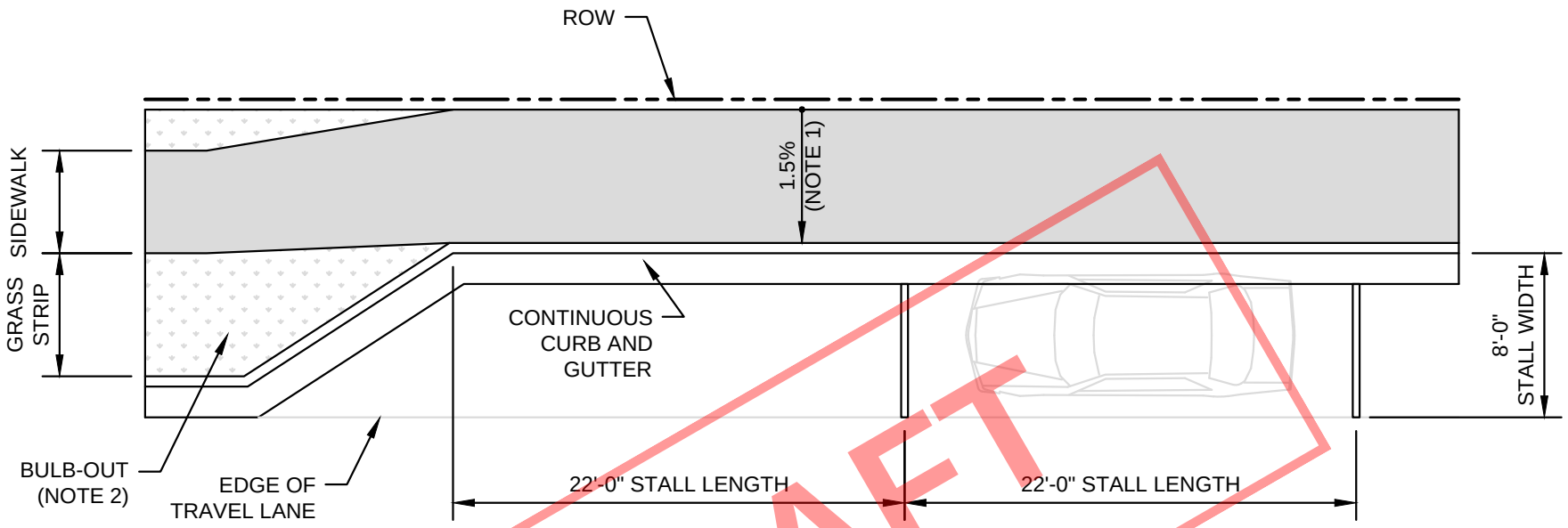
1. ALL SIGNS MUST BE FABRICATED WITH REFLECTIVE MATERIALS. ALL REFLECTIVE MATERIALS MUST QUALIFY AS HIGH INTENSITY PRISMATIC GRADE. ALL SIGNS MUST HAVE A MINIMUM 7-YEAR MATERIALS WARRANTY.
2. ALL SIGNS SHALL BE MUTCD COMPLIANT.
3. SHOP DRAWINGS SHALL BE SUBMITTED TO STREET DEPARTMENT FOR REVIEW AND APPROVAL PRIOR TO ORDERING/INSTALLATION.
4. DECORATIVE AND POWDER COATED POST ARE ALLOWED BUT SHALL BE MAINTAINED BY THE HOMEOWNERS OR BUSINESS ASSOCIATION WITHIN DEVELOPMENTS. ALL NON-STANDARD DECORATIVE POST AND BREAKAWAY MOUNTING DETAILS SHALL BE SUBMITTED TO THE STREET DEPARTMENT FOR REVIEW AND APPROVAL.
5. THE MINIMUM HEIGHT, MEASURED VERTICALLY FROM THE BOTTOM OF THE SIGN TO THE TOP OF THE CURB IN BUSINESS, COMMERCIAL OR RESIDENTIAL AREAS WHERE PARKING OR PEDESTRIAN MOVEMENTS ARE LIKELY TO OCCUR SHALL BE 7 FEET. THE HEIGHT TO THE BOTTOM OF A SECONDARY SIGN MOUNTED BELOW ANOTHER SIGN MAY BE 1 FOOT LESS. SEE FIGURE 2A-2 AND SECTION 2A.18 OF THE MUTCD FOR ADDITIONAL INFORMATION.

N.T.S

HISTORIC FRANKLIN TENNESSEE

LOCAL STREET SIGN

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021	DWG. NO. RP-21
NOT TO SCALE			



DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. BULB-OUTS TO THE EDGE OF TRAVEL LANE ARE REQUIRED AT EACH END OF AN ON-STREET PARKING SPACE OR SERIES OF SPACES.
3. ON-STREET PARKING SPACES SHALL BE LOCATED OUTSIDE OF STREET INTERSECTION SIGHT DISTANCE TRIANGLES.

HISTORIC FRANKLIN TENNESSEE

ON-STREET PARKING

CITY OF FRANKLIN

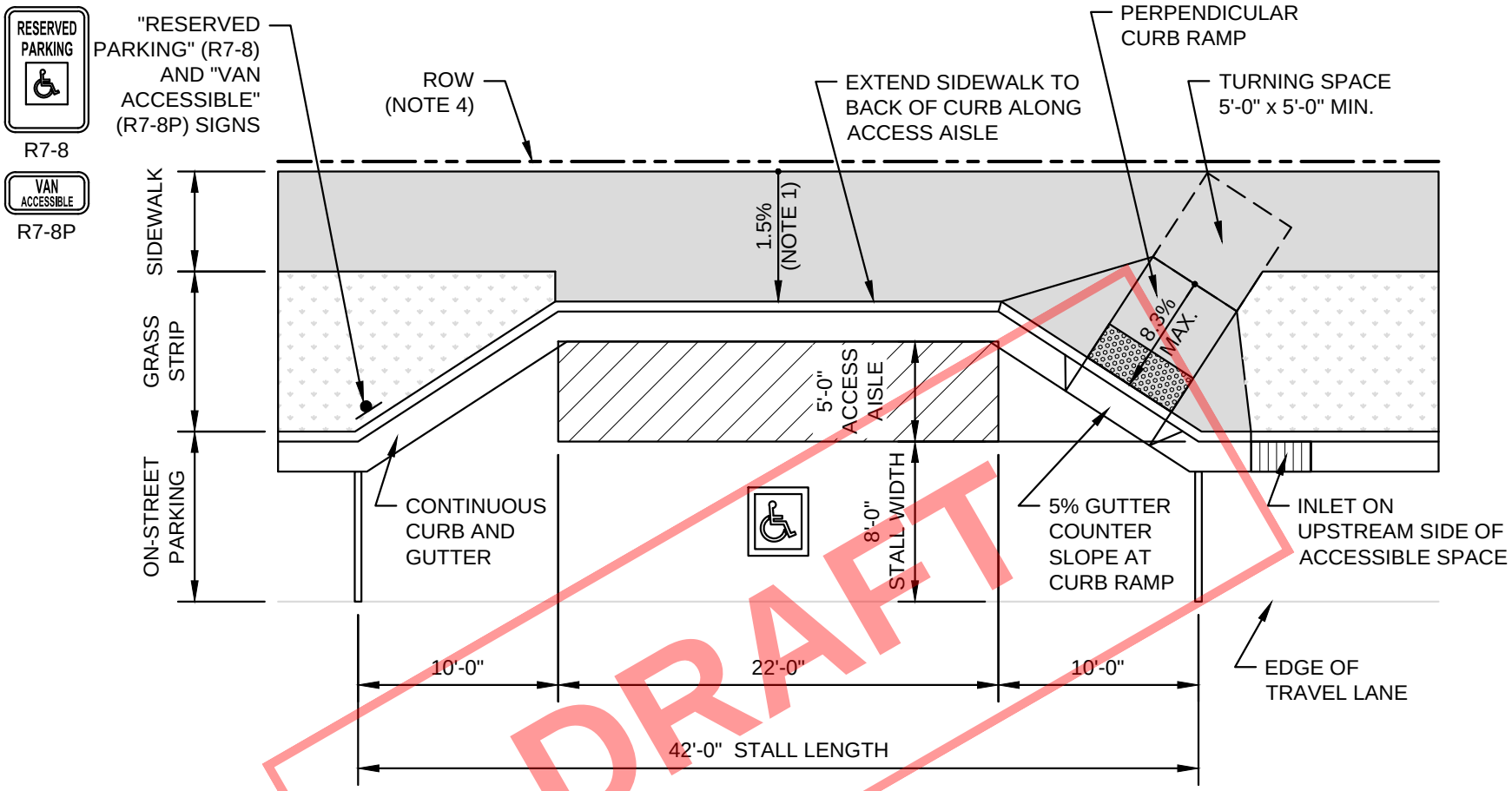
NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

DWG. NO.

RP-22



DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. ACCESSIBLE ON-STREET PARKING SPACES SHALL BE PROVIDED AT ALL NEW PUBLIC AND PRIVATE STREETS WITH MARKED OR METERED ON-STREET PARKING.
3. QUANTITY OF ACCESSIBLE ON-STREET PARKING SPACES SHALL MEET THAT REQUIRED IN TABLE R214 OF THE "PROPOSED ACCESSIBILITY GUIDELINES FOR PEDESTRIAN FACILITIES IN THE PUBLIC RIGHT-OF-WAY" BY THE UNITED STATES ACCESS BOARD.
4. ADDITIONAL ROW SHALL BE DEDICATED AS NECESSARY TO ACCOMMODATE THE ACCESSIBLE PARKING SPACE, ACCESS AISLE, AND SIDEWALK BEYOND.
5. THE 5'-0" ACCESS AISLE IS REQUIRED REGARDLESS OF THE PARKING SPACE LOCATION ALONG THE BLOCK FACE AND IS EXCLUSIVE OF THE GUTTER.
6. INTERNATIONAL SYMBOL OF ACCESSIBILITY MARKING: 36" X 41" BLUE BACKGROUND WITH WHITE BORDER, THERMOPLASTIC
7. A BULB-OUT TO THE EDGE OF TRAVEL LANE IS REQUIRED AT EACH END OF AN ON-STREET PARKING SPACE OR SERIES OF SPACES (NOT SHOWN).

HISTORIC FRANKLIN TENNESSEE

ACCESSIBLE ON-STREET PARKING (STANDARD)

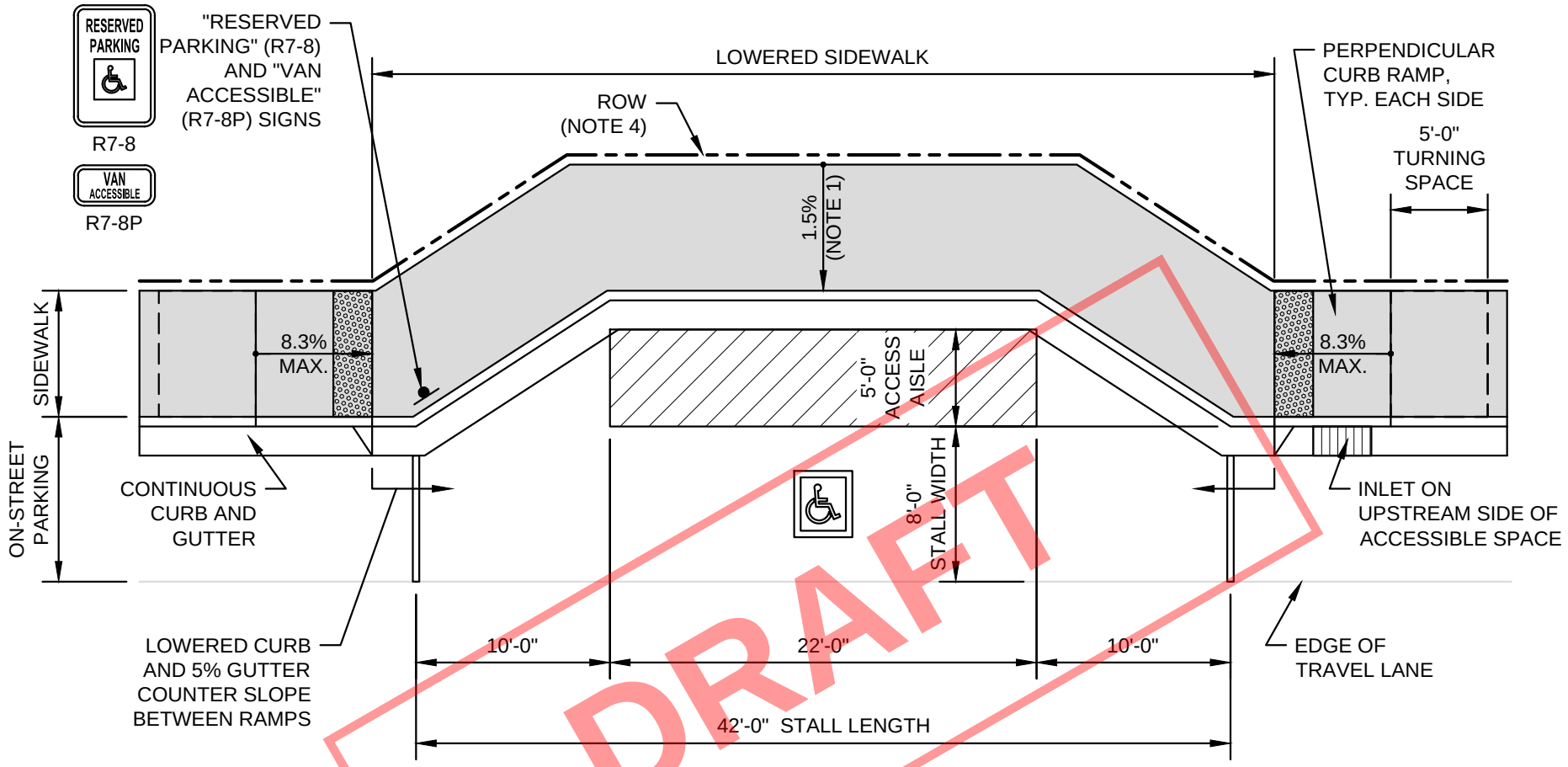
DWG. NO. **RP-23**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. ACCESSIBLE ON-STREET PARKING SPACES SHALL BE PROVIDED AT ALL NEW PUBLIC AND PRIVATE STREETS WITH MARKED OR METERED ON-STREET PARKING.
3. QUANTITY OF ACCESSIBLE ON-STREET PARKING SPACES SHALL MEET THAT REQUIRED IN TABLE R214 OF THE "PROPOSED ACCESSIBILITY GUIDELINES FOR PEDESTRIAN FACILITIES IN THE PUBLIC RIGHT-OF-WAY" BY THE UNITED STATES ACCESS BOARD.
4. ADDITIONAL ROW SHALL BE DEDICATED AS NECESSARY TO ACCOMMODATE THE ACCESSIBLE PARKING SPACE, ACCESS AISLE, AND SIDEWALK BEYOND.
5. THE 5'-0" ACCESS AISLE IS REQUIRED REGARDLESS OF THE PARKING SPACE LOCATION ALONG THE BLOCK FACE AND IS EXCLUSIVE OF THE GUTTER.
6. INTERNATIONAL SYMBOL OF ACCESSIBILITY MARKING: 36" X 41" BLUE BACKGROUND WITH WHITE BORDER, THERMOPLASTIC
7. A BULB-OUT TO THE EDGE OF TRAVEL LANE IS REQUIRED AT EACH END OF AN ON-STREET PARKING SPACE OR SERIES OF SPACES (NOT SHOWN).

HISTORIC FRANKLIN TENNESSEE

ACCESSIBLE ON-STREET PARKING (LOWERED SIDEWALK)

DWG. NO. **RP-24**

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021
NOT TO SCALE		

DRAFT

DESCRIPTION

COLOR:	BLACK ON ORANGE
SIZE:	4" DIAMETER
CONSTRUCTION:	0.010" WHITE RIGID VINYL

W. FRICK & COMPANY PART# CFT-CM-4
OR APPROVED EQUAL

NOTES

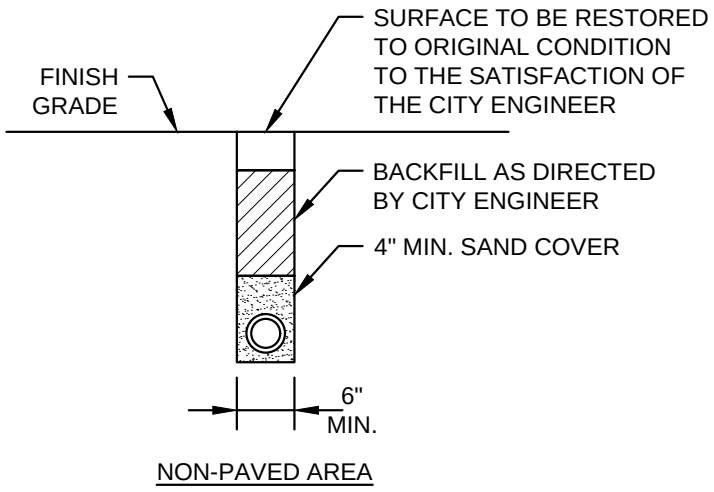
1. MARKERS SHALL BE INSTALLED EVERY 200 FEET OR AT LOCATIONS WHERE FIBER OPTIC CABLE RUN CHANGES DIRECTION.
2. ONLY APPROVED MARKERS AND ADHESIVE SHALL BE USED.
3. ADHESIVE: METALBOND SB-12 HIGH STRENGTH SEALANT ADHESIVE OR APPROVED EQUAL
4. PLACE MARKER ON TOP OF CURB WITH ARROW POINTED IN THE DIRECTION THE FIBER OPTIC CABLE LINES IN REFERENCE TO THE MARKER LOCATION.
5. IF NO CURB IS PRESENT, PLACE MARKER AT EDGE OF PAVEMENT NEAREST THE CABLE RUN WITH ARROW POINTED IN THE DIRECTION THE FIBER OPTIC CABLE LIES IN REFERENCE TO THE MARKER LOCATION.

HISTORIC FRANKLIN TENNESSEE

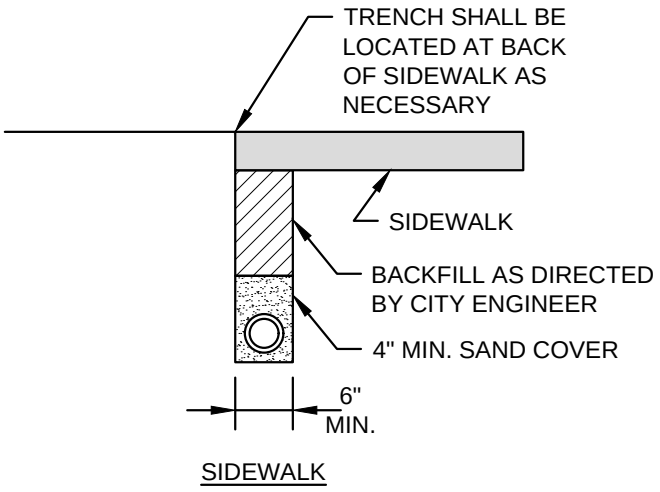
CITY OF FRANKLIN FIBER OPTIC EMBLEM

DWG. NO. **ITS-1**

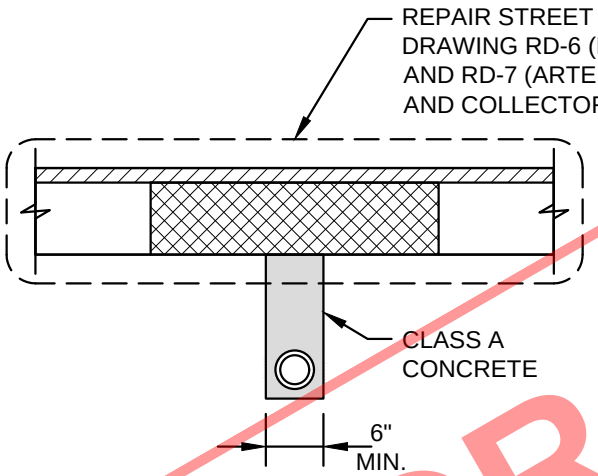
CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021
NOT TO SCALE		



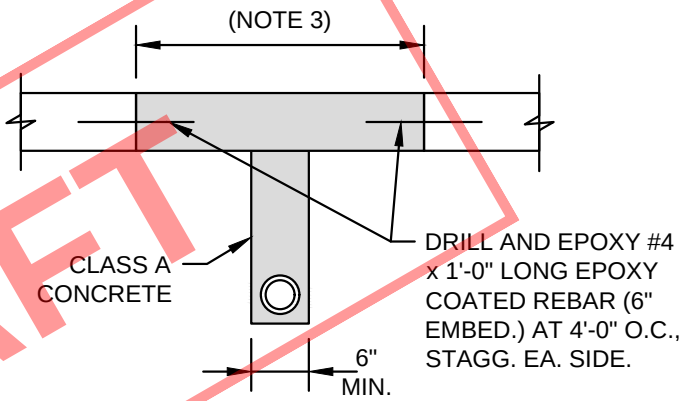
NON-PAVED AREA



SIDEWALK



ASPHALT



CONCRETE

DRAFT

NOTES

1. CONTRACTOR SHALL COORD. TRENCH, BACKFILL, AND PAVEMENT INSPECTIONS WITH THE COF STREET DEPARTMENT.
2. ALL CUTS IN PUBLIC STREETS REQUIRE A STREET CROSSING PERMIT AND APPROVED TRAFFIC CONTROL PLAN.
3. SAWCUT EXISTING PAVEMENTS, BASES, CURB AND GUTTER, AND SIDEWALKS (CUT JOINT TO JOINT) IN NEAT LINES.
4. TRENCH DEPTH SHALL BE 2'-0" MIN. SHOULD THE COF STREET DEPARTMENT ALLOW A LESSER DEPTH DUE TO FIELD CONDITIONS, THE CONDUIT SHALL BE CONCRETE-ENCASED IN ALL APPLICATIONS.
5. CONDUIT, PULL BOXES, AND POLES ARE TO BE INSTALLED AND LEVEL TO FINAL GRADE PRIOR TO POURING SIDEWALKS.
6. WARNING TAPE: TYPE 2 TAPE INSTALLED AT 12" BELOW FINISH GRADE (ALL TRENCHES)
7. TRACER WIRE: COPPER CLAD, 12 GA. MIN. WITH COLOR-CODED 30 MIL. HDPE INSULATED JACKET (ALL TRENCHES)
8. CONCRETE: CLASS A (3,000 PSI, 6% AIR)
9. CONDUIT:
   - A. SEE PLANS FOR NUMBER AND SIZE.
   - B. ALL CONDUIT SHALL BE SCHEDULE 40 PVC.
   - C. ALL CONDUIT SHALL USE LONG SWEEP RADII (MINIMUM 6" RADIUS).
   - D. PROVIDE JET LINE OR EQUAL PULL STRING.

HISTORIC FRANKLIN TENNESSEE

CONDUIT TRENCH BACKFILL

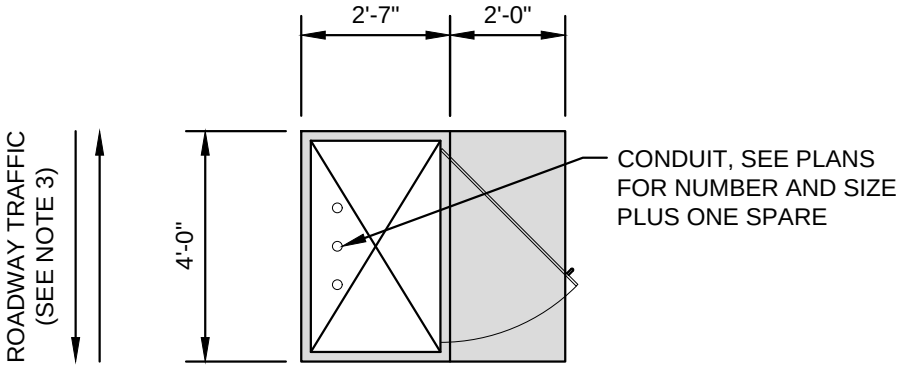
DWG. NO. **ITS-2**

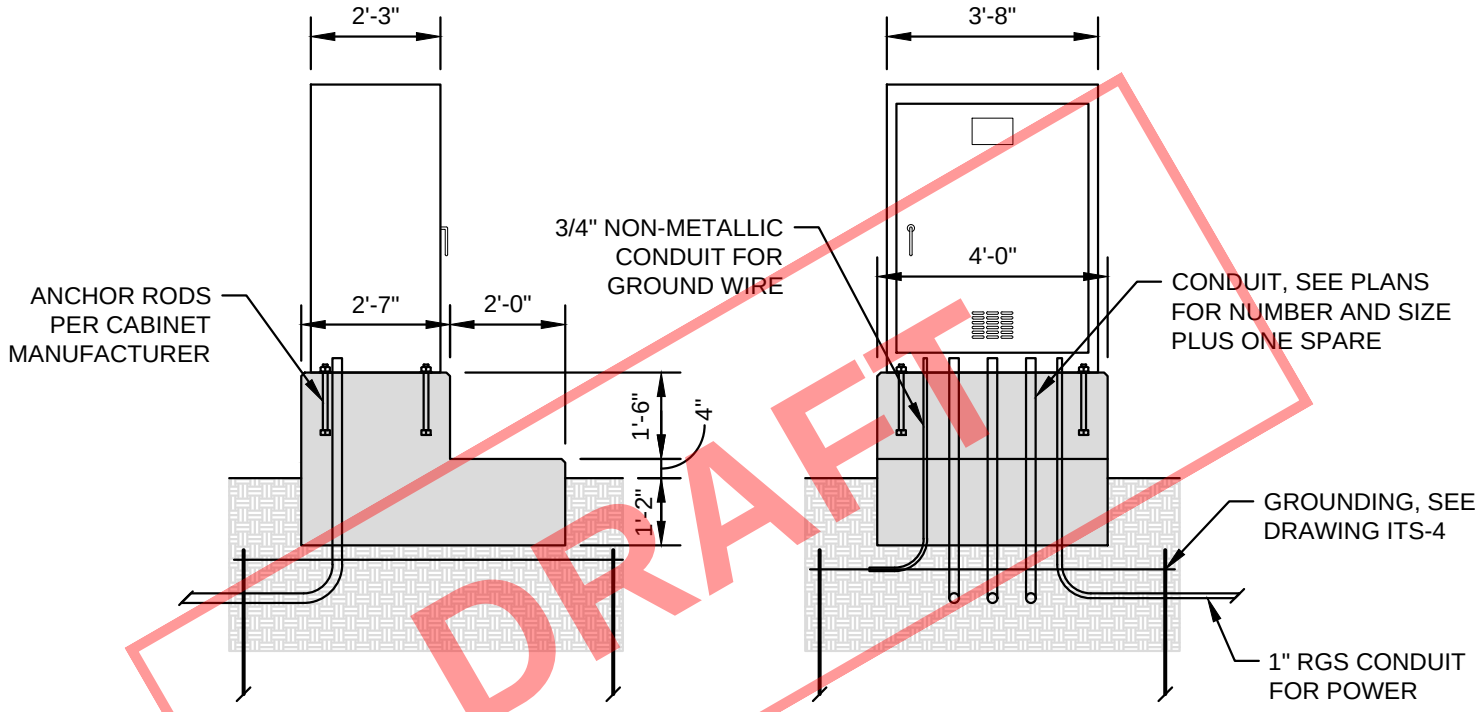
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021





DRAFT

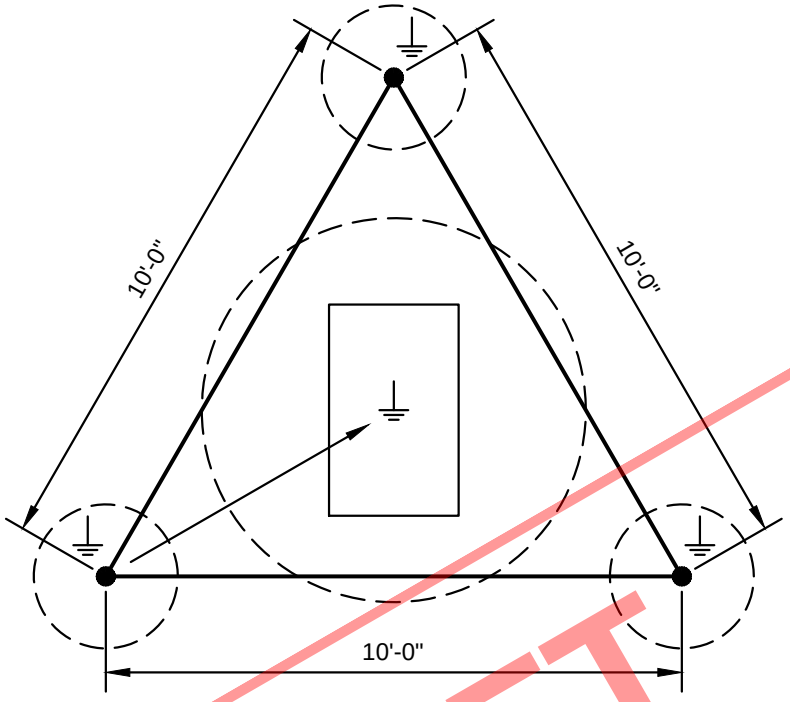
NOTES

1. DETAIL TO BE USED WITH COF 730FR TS-2 TYPE 1 CABINET.
2. FINISH SHALL BE POWDER COATED TO MATCH SHERWIN-WILLIAMS #PGS4-1059-FC (FRANKLIN GREEN) WHEN LOCATED IN HISTORIC DOWNTOWN FRANKLIN AREA OR VINYL WRAP AS APPROVED BY THE COF ENGINEERING DEPARTMENT.
3. BASE MOUNTED CABINET SHALL BE SITUATED IN THE OPTIMUM POSITION FOR VIEWING THE CONTROLLER OPERATION AND THE ON-STREET SIGNAL DISPLAYS SIMULTANEOUSLY.
4. CONCRETE: CLASS A (3,000 PSI, 6% AIR)
5. GROUNDING: SEE DRAWING ITS-4
6. CONDUIT:
   - A. SEE PLANS FOR NUMBER AND SIZE.
   - B. PROVIDE ADDITIONAL 2" SPARE CONDUIT.
   - C. PROVIDE 1" RGS CONDUIT FOR POWER.
   - D. PROVIDE 3/4" NON-METALLIC CONDUIT FOR GROUND WIRE.
   - E. ALL CONDUIT SHALL USE LONG SWEEP RADII (MINIMUM 6" RADIUS).

HISTORIC FRANKLIN TENNESSEE

TRAFFIC SIGNAL CABINET FOUNDATION

CITY OF FRANKLIN	CITY ENGINEER:	DATE: 7/1/2021	DWG. NO. ITS-3
NOT TO SCALE			



DRAFT

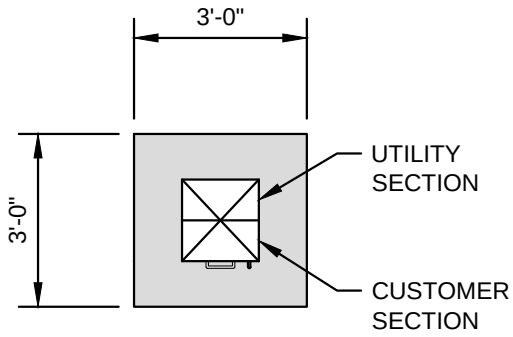
NOTES

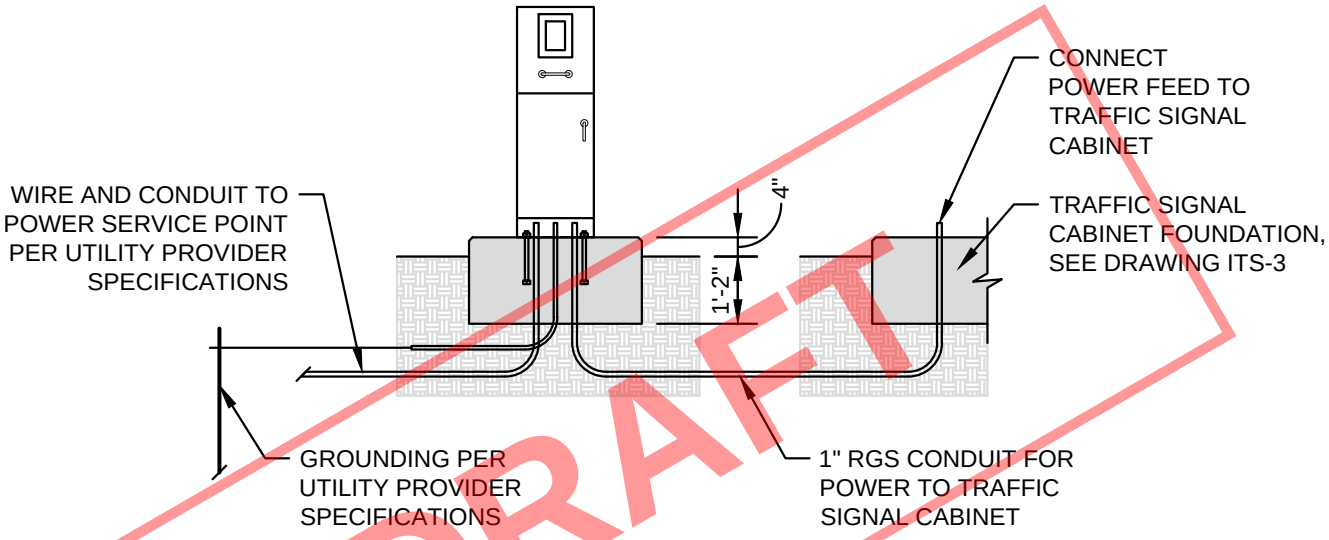
1. ALL GROUNDING POINTS SHALL BE TIED TOGETHER.
2. GROUND RODS: 5/8" x 8'-0" COPPER CLAD STEEL WITH 25 OHM OR LESS RESISTANCE (3 MIN. REQUIRED)
3. GROUND WIRE: NO. 6 BARE SOLID COPPER WIRE
4. CONTRACTOR SHALL PROVIDE GROUNDING TEST RESULTS TO THE CITY.

HISTORIC FRANKLIN TENNESSEE

TRAFFIC SIGNAL CABINET GROUNDING

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021	DWG. NO. ITS-4
NOT TO SCALE			





DRAFT

NOTES

1. DETAIL TO BE USED WITH MILBANK SERVICE PEDESTAL MODEL NUMBER CP3B71110A22BKSL1 OR APPROVED EQUAL.
2. FINISH SHALL BE POWDER COATED TO MATCH SHERWIN-WILLIAMS #PGS4-1059-FC (FRANKLIN GREEN) WHEN LOCATED IN HISTORIC DOWNTOWN FRANKLIN AREA.
3. AT THE DIRECTION OF THE OF ENGINEERING DEPARTMENT, THE PEDESTAL FOUNDATION MAY BE POURED INTEGRALLY WITH THE TRAFFIC SIGNAL CABINET FOUNDATION. LOCATION DEPENDENT ON CABINET PHOTOCELL PLACEMENT. PHOTOCELL TO BE POSITIONED FACING SOUTH TO SOUTHEAST.
4. CONCRETE: CLASS A (3,000 PSI, 6% AIR)
5. GROUNDING: PER UTILITY PROVIDER SPECIFICATIONS
6. CONDUIT:
   - A. PROVIDE 1" RGS CONDUIT FOR POWER TO TRAFFIC SIGNAL CABINET.
   - B. PROVIDE CONDUIT PER UTILITY PROVIDER SPECIFICATIONS FOR GROUNDING AND TO POWER SOURCE.
   - C. ALL CONDUIT SHALL USE LONG SWEEP RADII (MINIMUM 6" RADIUS).

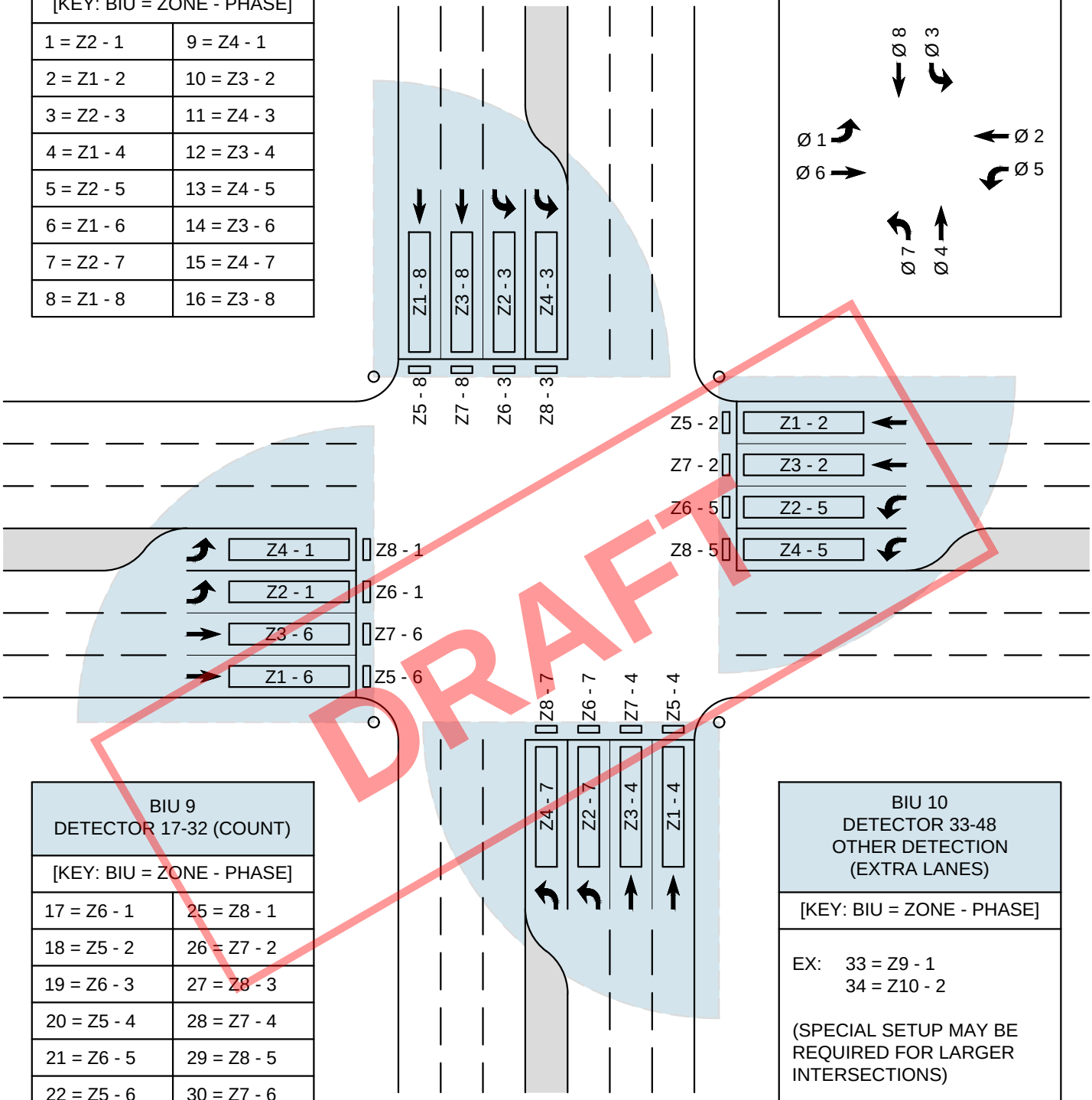
HISTORIC FRANKLIN TENNESSEE

ELECTRICAL SERVICE DETAILS FOR TRAFFIC SIGNAL

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021	DWG. NO. ITS-5
NOT TO SCALE			

BIU 8 DETECTOR 1-16 (STOP BAR)	
[KEY: BIU = ZONE - PHASE]	
1 = Z2 - 1	9 = Z4 - 1
2 = Z1 - 2	10 = Z3 - 2
3 = Z2 - 3	11 = Z4 - 3
4 = Z1 - 4	12 = Z3 - 4
5 = Z2 - 5	13 = Z4 - 5
6 = Z1 - 6	14 = Z3 - 6
7 = Z2 - 7	15 = Z4 - 7
8 = Z1 - 8	16 = Z3 - 8

PHASING CONVENTION



DRAFT

BIU 9 DETECTOR 17-32 (COUNT)	
[KEY: BIU = ZONE - PHASE]	
17 = Z6 - 1	25 = Z8 - 1
18 = Z5 - 2	26 = Z7 - 2
19 = Z6 - 3	27 = Z8 - 3
20 = Z5 - 4	28 = Z7 - 4
21 = Z6 - 5	29 = Z8 - 5
22 = Z5 - 6	30 = Z7 - 6
23 = Z6 - 7	31 = Z8 - 7
24 = Z5 - 8	32 = Z7 - 8

BIU 10
DETECTOR 33-48
OTHER DETECTION
(EXTRA LANES)

[KEY: BIU = ZONE - PHASE]

EX: 33 = Z9 - 1
34 = Z10 - 2

(SPECIAL SETUP MAY BE REQUIRED FOR LARGER INTERSECTIONS)

HISTORIC FRANKLIN TENNESSEE

TS2 DETECTOR LOCATIONS / ASSIGNMENTS

CITY OF FRANKLIN

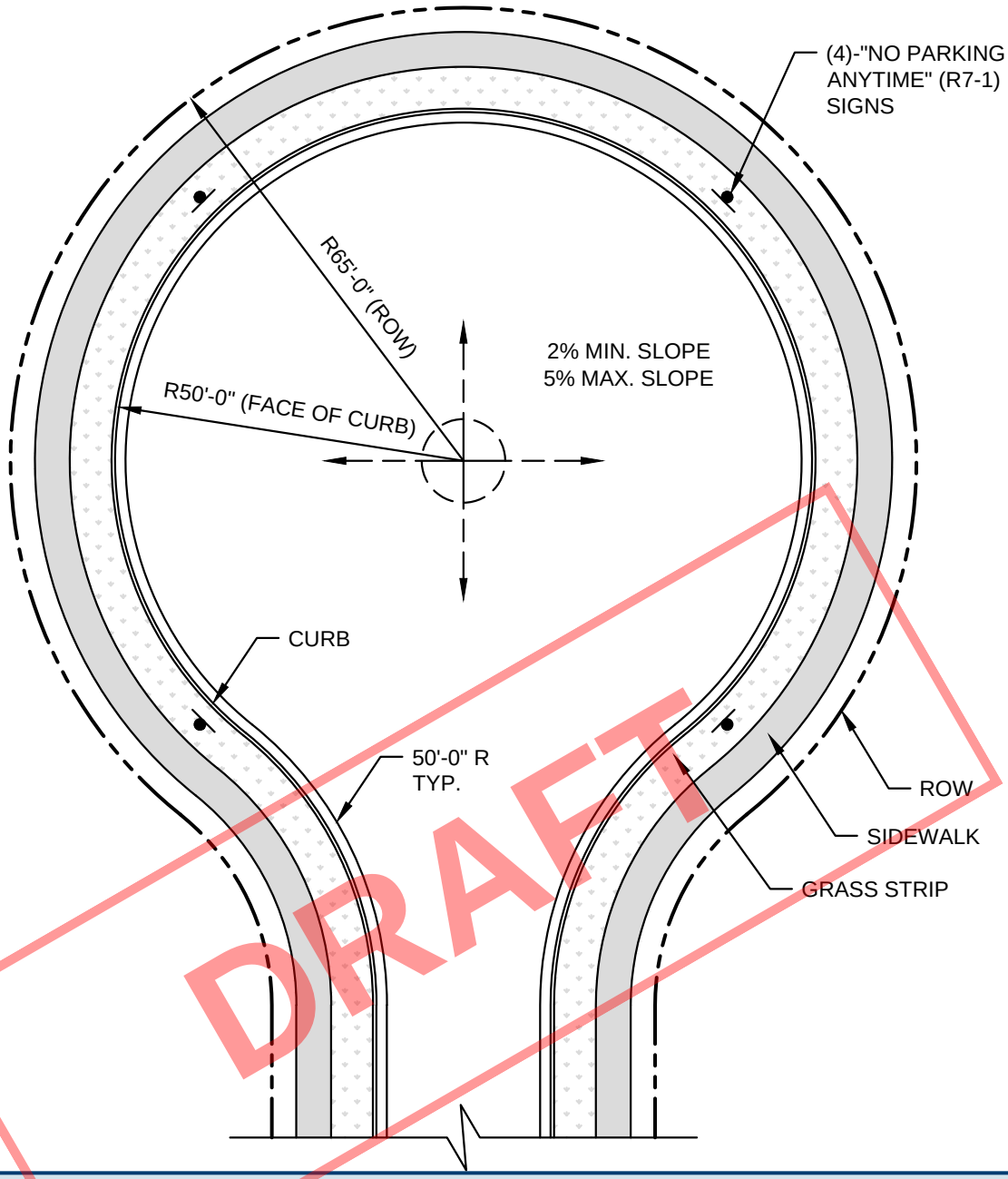
NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

DWG. NO.

ITS-6



DRAFT

NOTES

1. (4) - "NO PARKING ANYTIME" SIGNS SHALL BE PLACED AROUND PERIMETER OF CUL-DE-SAC.
2. PAVEMENT SLOPE WITHIN CUL-DE-SAC SHALL NOT BE LESS THAN 2% OR GREATER THAN 5%.

HISTORIC FRANKLIN TENNESSEE

CUL-DE-SAC

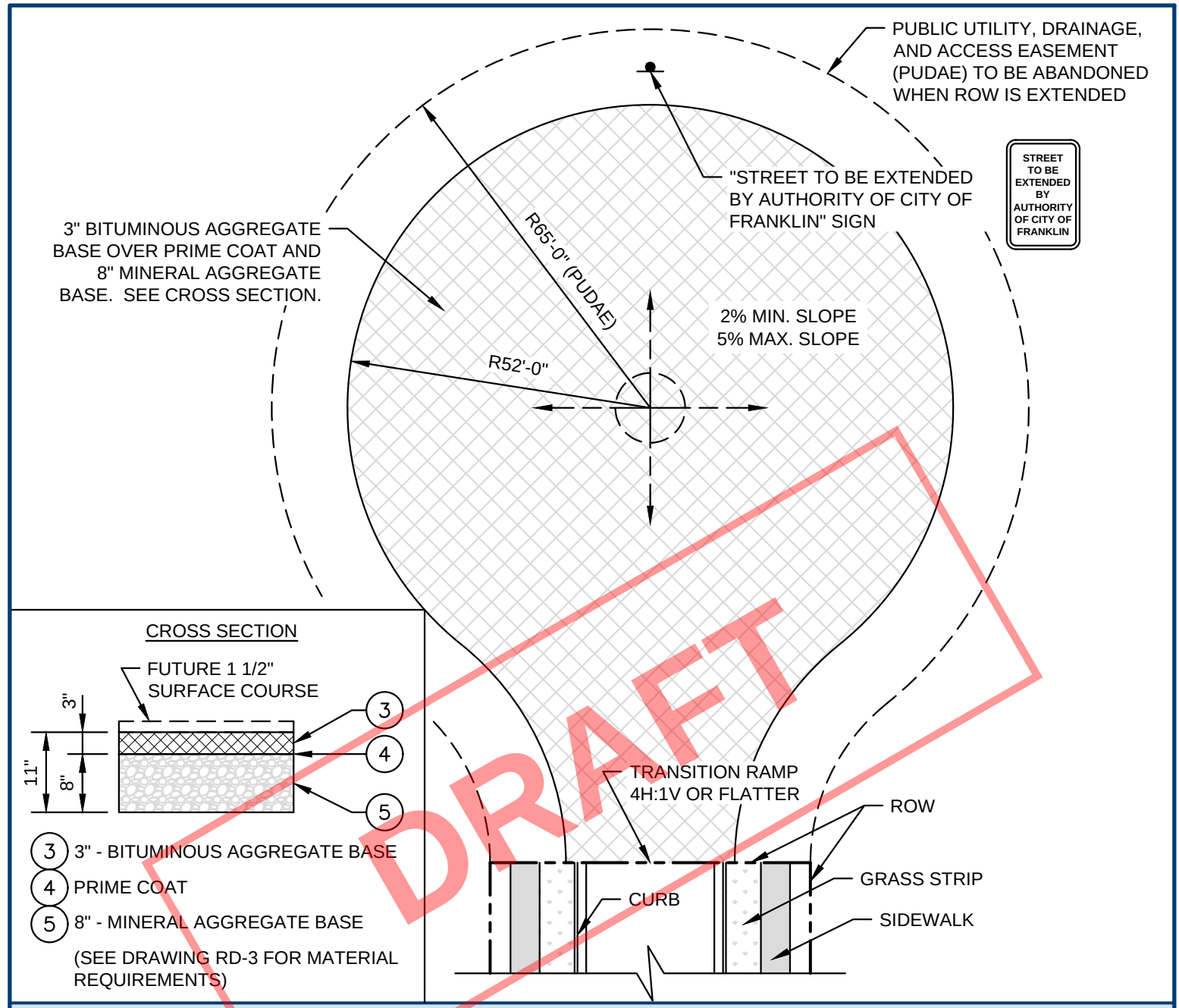
DWG. NO. **SD-1**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

NOTES

1. TEMPORARY CUL-DE-SACS SHALL ONLY BE USED INTERNAL TO DEVELOPMENTS FOR CONSTRUCTION PHASING PURPOSES WHERE THE FINAL BUILD-OUT OF THE OVERALL DEVELOPMENT ALLOWS THE TEMPORARY CUL-DE-SAC TO BE ELIMINATED.
2. TEMPORARY CUL-DE-SACS SHALL NOT BE USED AT THE PERIMETER OF DEVELOPMENTS WHERE ELIMINATION OF THE TEMPORARY CUL-DE-SAC REQUIRES IMPROVEMENTS IN ADJACENT DEVELOPMENTS.
3. TEMPORARY CUL-DE-SACS SHALL BE REMOVED WITHIN 3 YEARS FROM THE DATE CONSTRUCTION STARTS, UNLESS OTHERWISE APPROVED BY THE FIRE MARSHAL.
4. PAVEMENT SLOPE WITHIN CUL-DE-SAC SHALL NOT BE LESS THAN 2% OR GREATER THAN 5%.
5. TEMPORARY CUL-DE-SAC MATERIALS SHALL MATCH THOSE REQUIRED FOR A LOCAL STREET MINUS THE SURFACE COURSE. SEE DRAWING RD-3.

HISTORIC FRANKLIN TENNESSEE

TEMPORARY CUL-DE-SAC

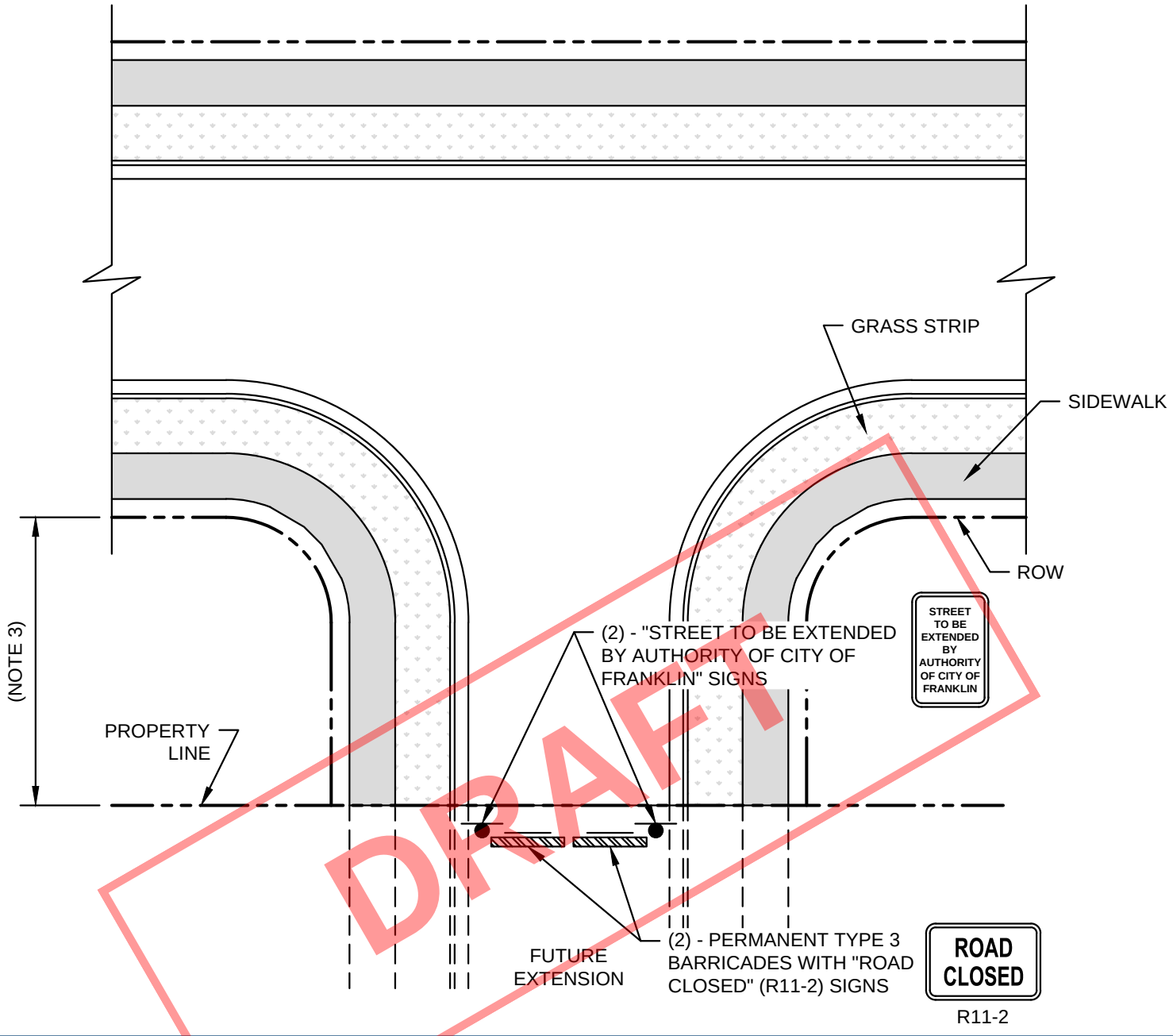
DWG. NO. **SD-2**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

NOTES

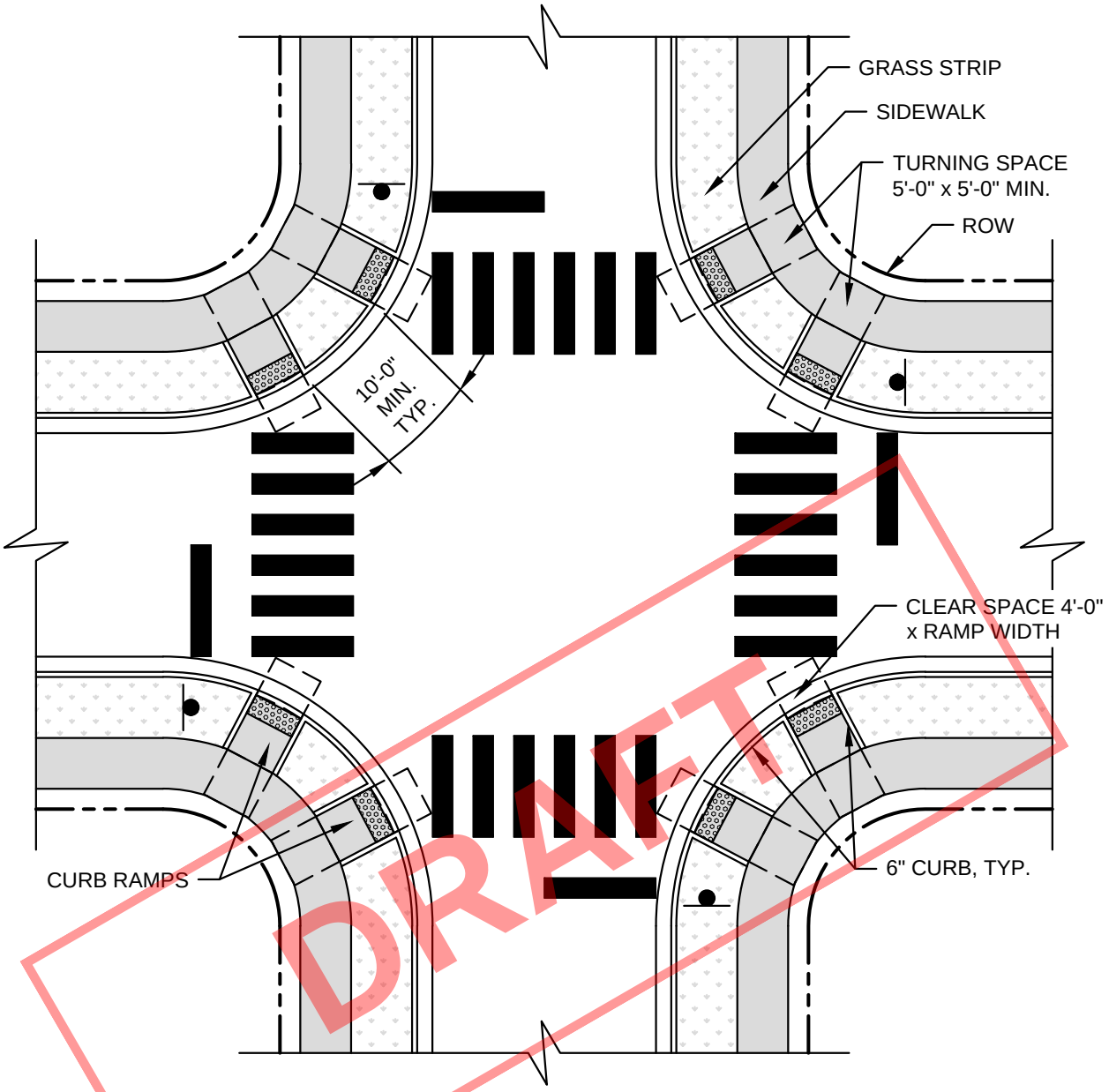
1. TEMPORARY DEAD END STREET STUBS ARE ALLOWED FOR LOCAL STREETS ONLY.
2. TEMPORARY DEAD END STREET STUBS ARE NOT ALLOWED FOR ALLEYS OR MEWS.
3. TEMPORARY DEAD END STREET STUBS SHALL EXTEND A MAXIMUM OF ONE SINGLE-FAMILY RESIDENTIAL LOT.
4. TYPE 3 BARRICADES SHALL BE ANCHORED USING PERMANENT INSTALLATION METHODS.

HISTORIC FRANKLIN TENNESSEE

TEMPORARY DEAD END STREET STUB

DWG. NO. **SD-3**

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021
NOT TO SCALE		



DRAFT

NOTES

1. SEE CURB RAMP STANDARD DRAWINGS FOR CONSTRUCTION DETAILS.
2. CROSSWALKS TO BE MARKED WHEN REQUIRED BY THE CITY ENGINEER.
3. CLEAR SPACE AT BASE OF CURB RAMPS SHALL BE WHOLLY OUTSIDE OF THE PARALLEL VEHICLE TRAVEL LANE.
4. STOP LINE TO BE MARKED AT ALL LOCATIONS WHERE STOP SIGNS ARE APPROVED.
5. ALL PAVEMENT MARKINGS SHALL CONFORM TO THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES.
6. ALL PAVEMENT MARKINGS TO BE THERMOPLASTIC.

HISTORIC FRANKLIN TENNESSEE

GEOMETRIC LAYOUT OF INTERSECTIONS WITH CURB RETURN RADII OF 30' OR LESS

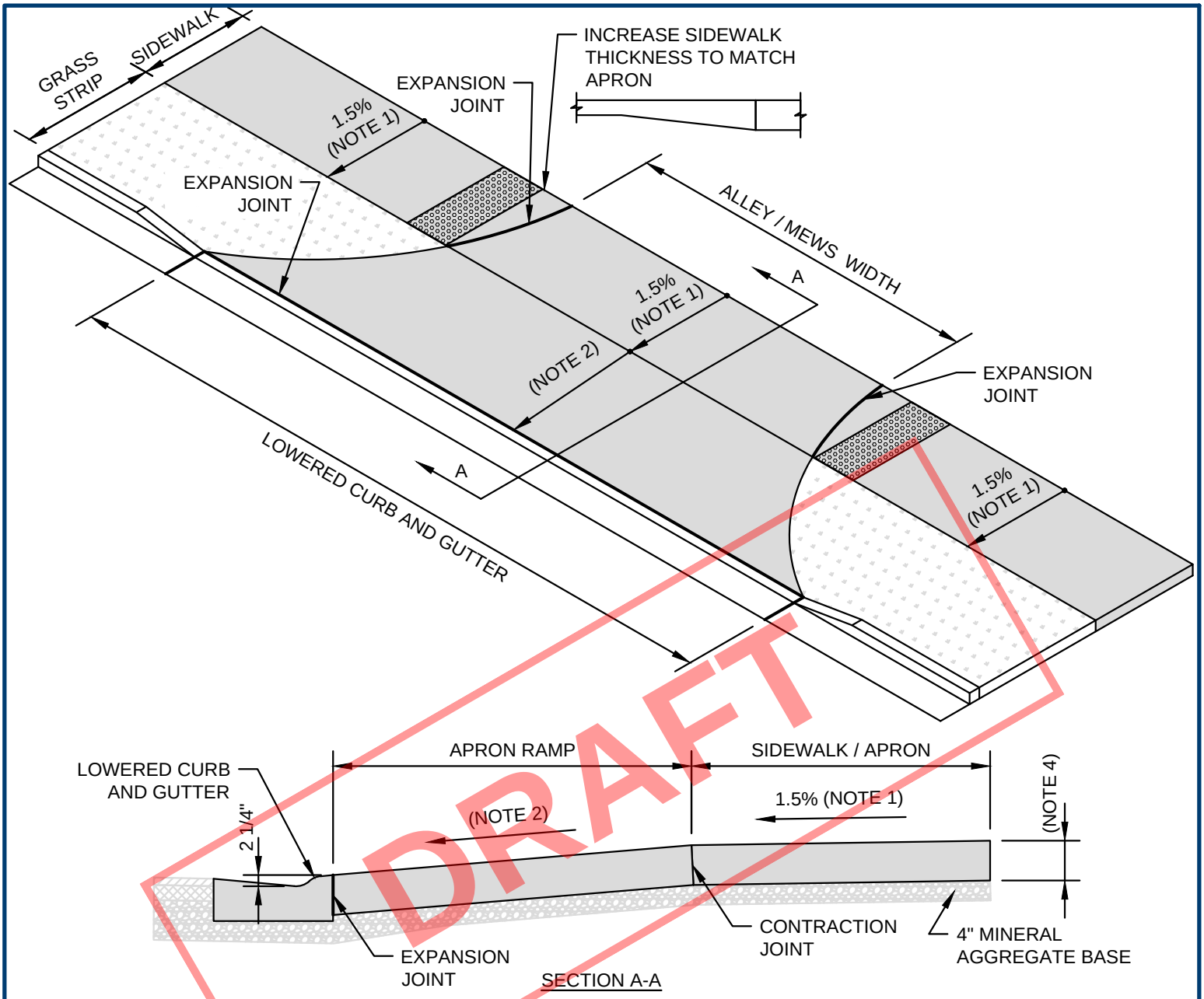
DWG. NO. **SD-4**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



SECTION A-A

DRAFT

NOTES

1. SIDEWALK CROSS SLOPE: 1.5% DESIRABLE, 2.0% MAX.
2. APRON RAMP SLOPE: 8% MAX., 1.5% MIN.
3. MINERAL AGGREGATE BASE: 4" MIN. THICK 303-01 MINERAL AGGREGATE, TYPE A BASE, GRADING D
4. CONCRETE: 8" MIN. THICK CLASS A (3,000 PSI, 6% AIR) WITH SYNTHETIC FIBER REINFORCEMENT
5. EXPANSION JOINTS: 1/2" THICK U.N.O. (SEE ALSO DRAWING RP-10)
   A. RUBBERIZED EXPANSION JOINT FILLER (AASHTO M153, TYPE 1)
   B. POLYPROPYLENE FOAM JOINT FILLER (ASTM D8139)
6. DETECTABLE WARNING SURFACE: BRICK RED, CAST-IN-PLACE (ADA SOLUTIONS, INC. OR APPROVED EQUAL)
7. APRON RADIUS:
   A. 15'-0" MIN. AT ALLEYS
   B. 25'-0" MIN. AT MEWS

HISTORIC FRANKLIN TENNESSEE

ALLEY / MEWS APPROACH APRON

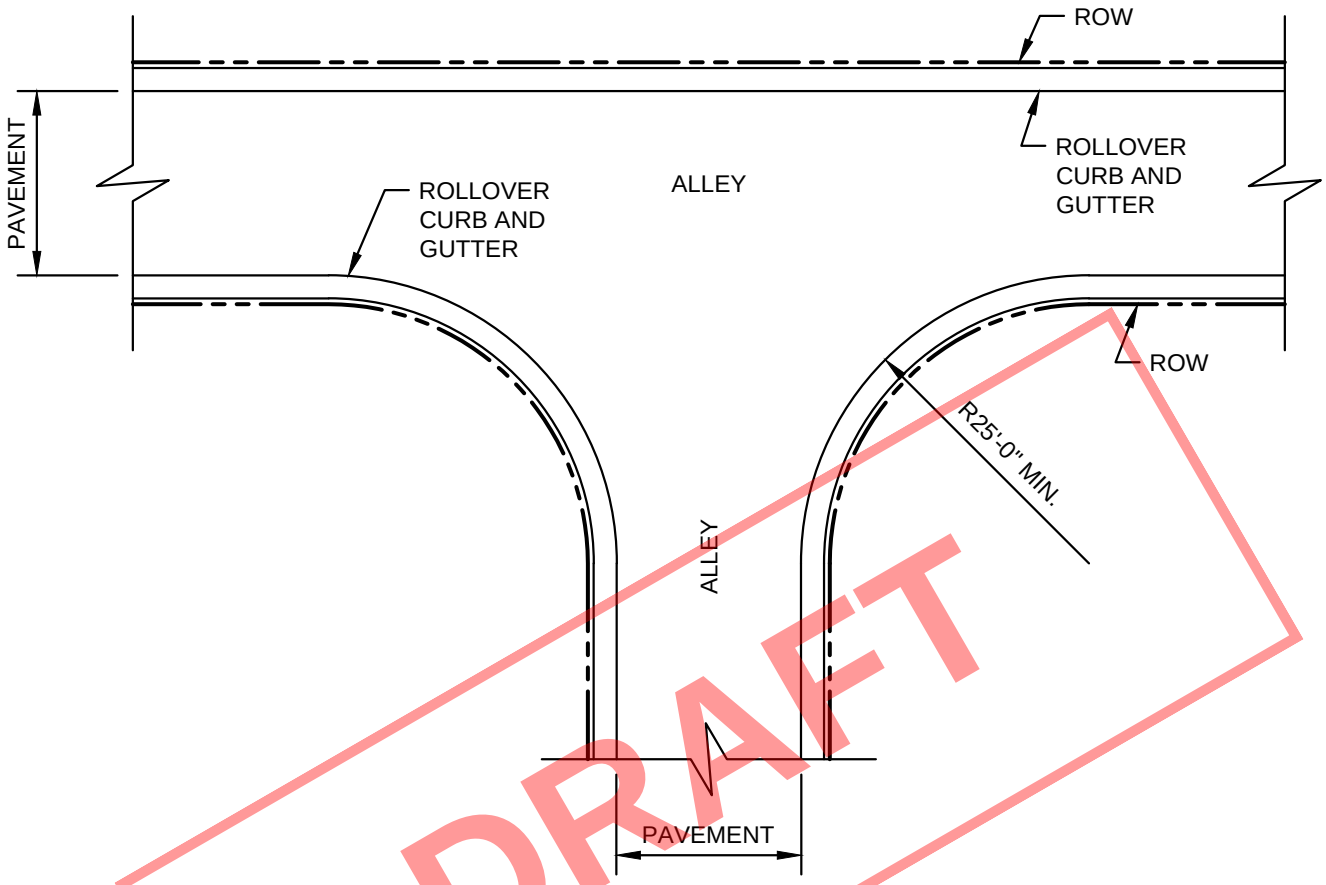
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

DWG. NO. **SD-5**



DRAFT

NOTES

1. AN ALLEY INTERSECTION WITH ANOTHER ALLEY SHALL HAVE THE GEOMETRIC LAYOUT SHOWN ABOVE.
2. A MEWS INTERSECTION WITH ANOTHER MEWS OR ALLEY IS NOT PERMITTED.

HISTORIC FRANKLIN TENNESSEE

T-ALLEY INTERSECTIONS

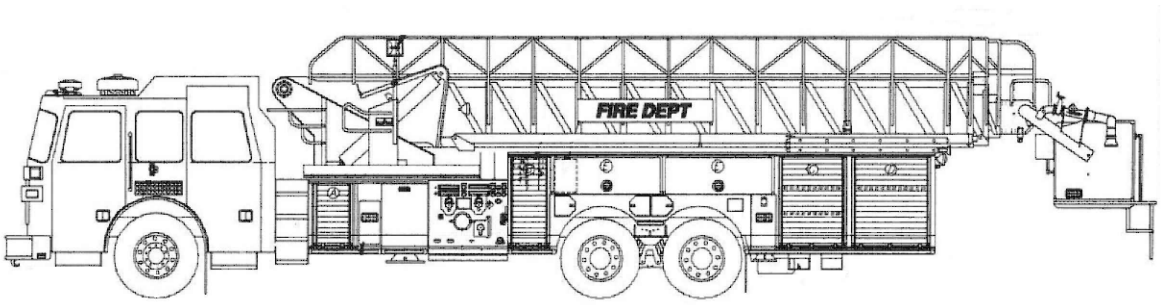
DWG. NO. **SD-6**

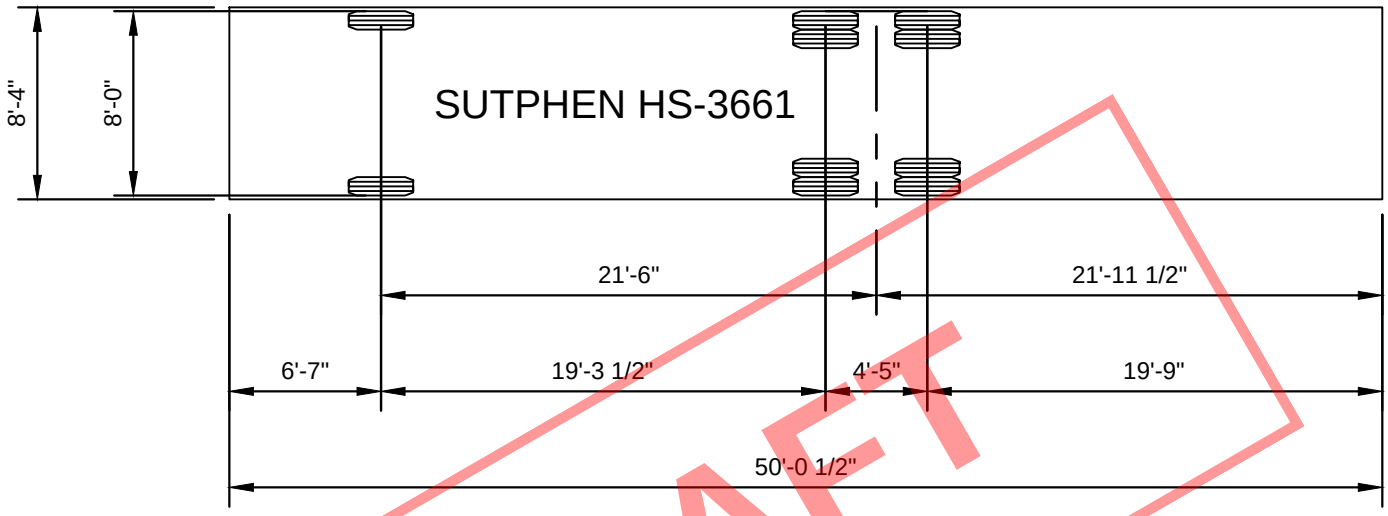
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

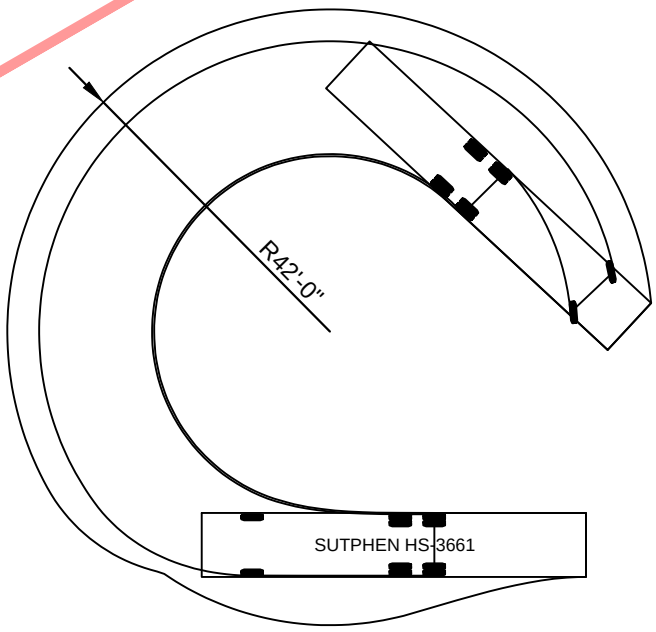




DRAFT

APPARATUS AND TURNING INFORMATION

1. NUMBER OF FRONT AXLES = 1
2. FRONT TRACK WIDTH = 8.000 FT
3. WHEELS ON EACH FRONT AXLE = 2
4. NUMBER OF REAR AXLES = 2
5. REAR TRACK WITH = 8.000 FT
6. WHEELS ON EACH REAR AXLE = 4
7. WHEELBASE = 19.292 FT
8. REAR AXLE SPACING = 4.417 FT
9. LOCK-TO-LOCK TIME = 6 SEC
10. TURNING RADIUS WALL TO WALL = 42 FT
11. BODY LENGTH = 50.042 FT
12. BODY WIDTH = 8.333 FT
13. REAR OVERHANG = 24.167 FT
14. MINIMUM DESIGN SPEED = 5 MPH



HISTORIC FRANKLIN TENNESSEE

FIRE APPARATUS TURNING TEMPLATE

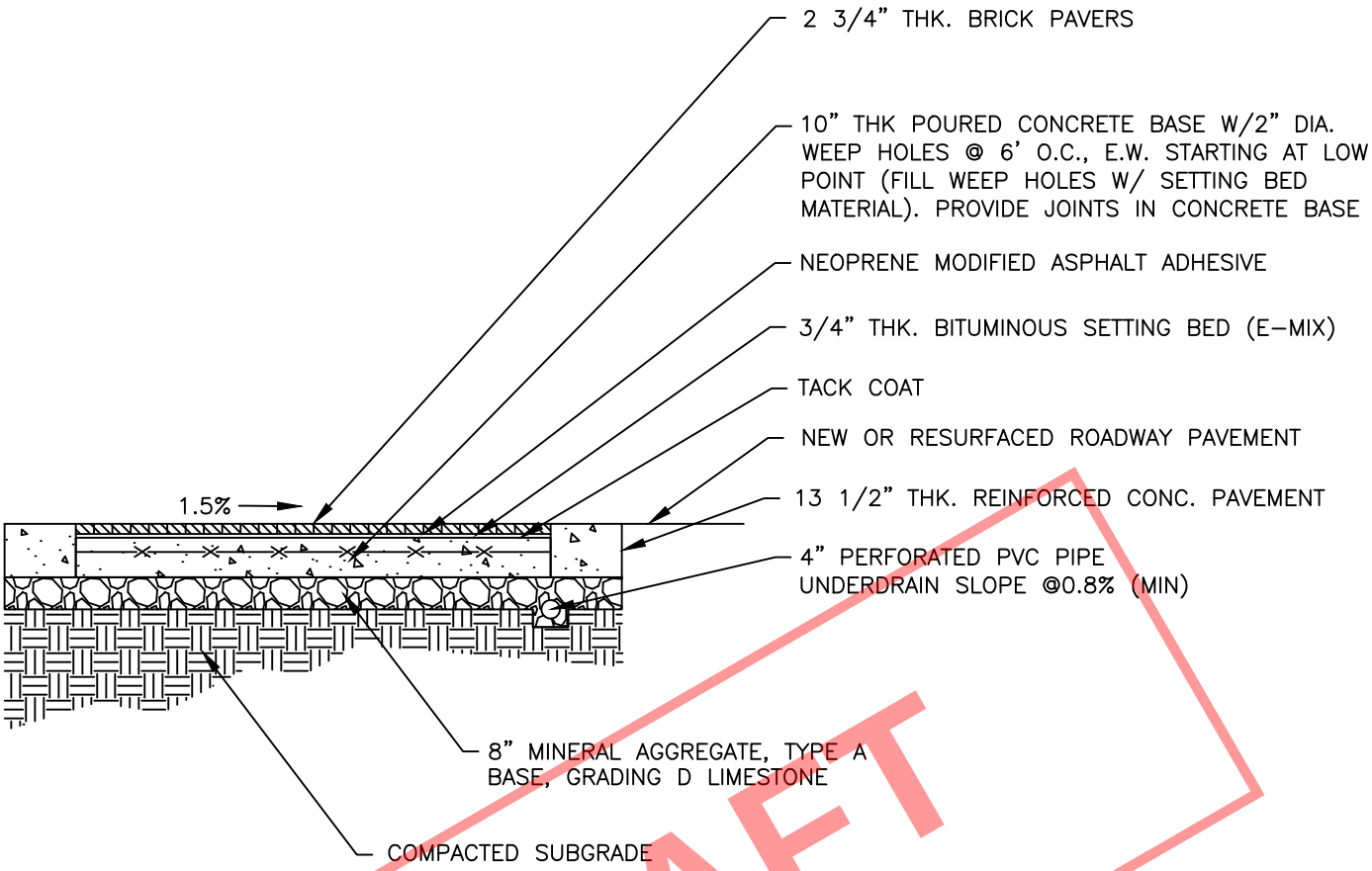
DWG. NO. **SD-7**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER:

DATE: 7/1/2021



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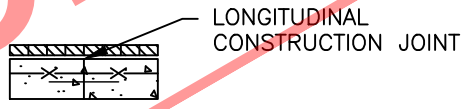


SECTION A–A

GENERAL NOTES

1. PLACE PAVERS IN PATTERNS PER CITY OF FRANKLIN STREETSCAPE PLANS. PLACE PAVERS WITH HAND TIGHT JOINTS (MAX 1/16". USE 4" X 8" PAVERS AS SHOWN. SAW CUT PERIMETER PAVERS ABUTTING CONCRETE PAVEMENT ONLY AS NEEDED TO FILL VOIDS. SEE CITY OF FRANKLIN PAVER SPECIFICATIONS FOR INSTALLATION.
2. DO NOT USE FILLERS TO FILL JOINT VOIDS OF EXCESSIVE WIDTH BETWEEN THE BRICK PAVERS AND THE ABUTTING CONCRETE PAVEMENT. CUT PAVERS TO FIT.
3. INSTALL CONCRETE PAVEMENT JOINTS AND REINFORCMENT BARS IN ACCORDANCE WITH LANS AND DETAILS AND SECTION A–A
4. THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.

N.T.S

HISTORIC FRANKLIN TENNESSEE

CROSSWALK 2 3/4" THICK BRICK PAVERS ON CONCRETE BASE

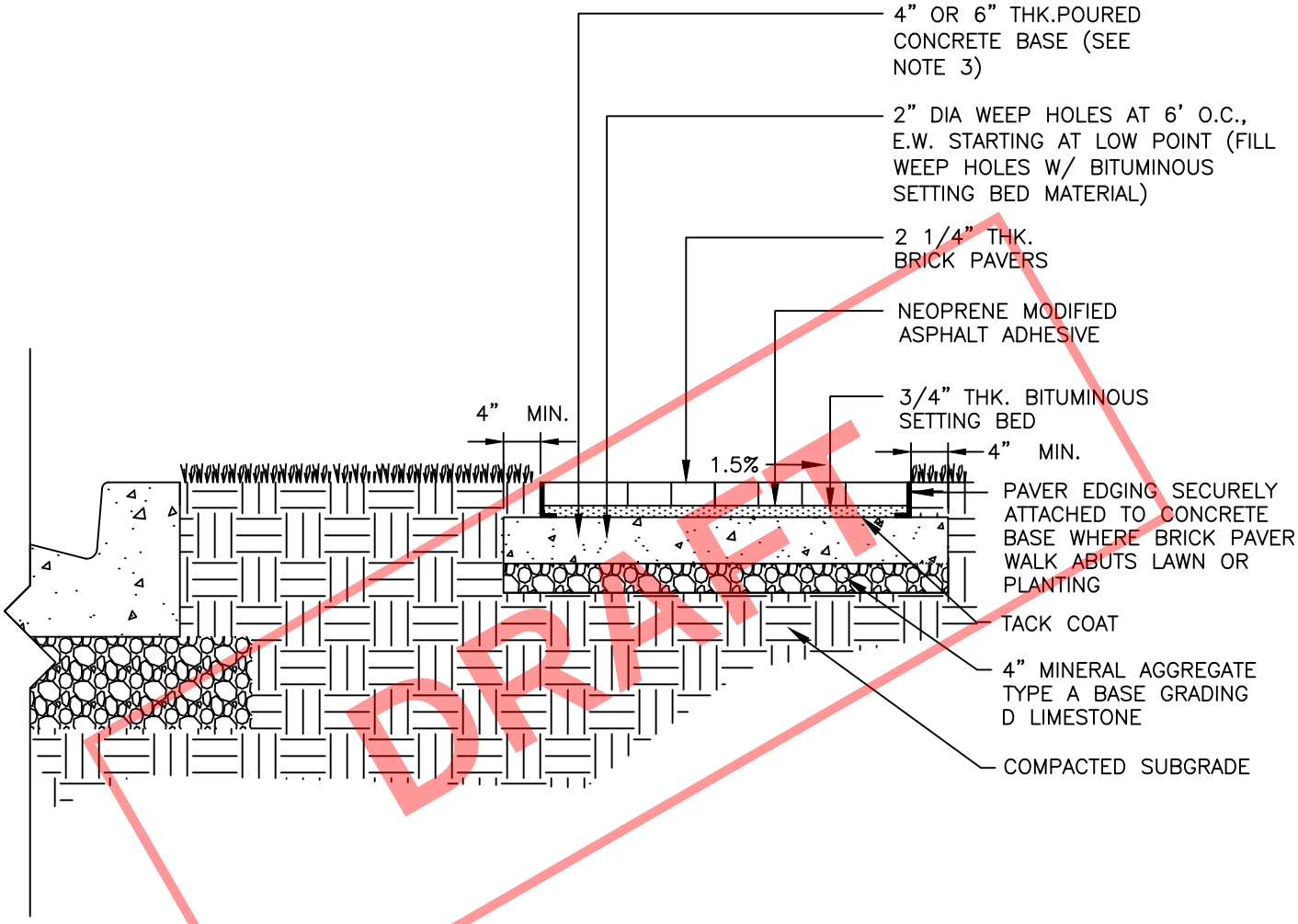
DWG. NO. **SS-1**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

GENERAL NOTES

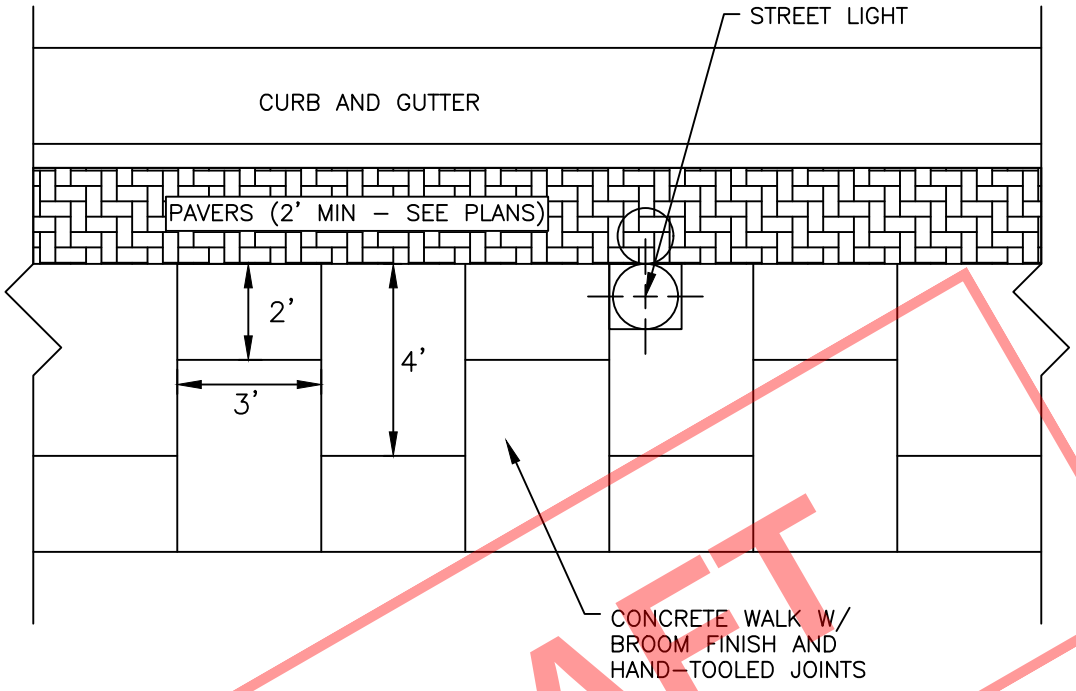
1. PLACE PAVERS IN PATTERNS PER CITY OF FRANKLIN STREETSCAPE PLANS. PLACE PAVERS WITH HAND TIGHT JOINTS NOT TO EXCEED 1/8" (MIN 1/16"). SAW CUT PAVERS AS NEEDED TO MAINTAIN ABOVE JOINT TOLERANCES.
2. DO NOT USE FILLERS TO FILL JOINT VOIDS OF EXCESSIVE WIDTH. RESET AND SAW CUT PAVERS AS REQUIRED TO ELIMINATE EXCESSIVE JOINT WIDTHS.
3. 4" THK POURED CONCRETE BASE ON ALL SIDEWALKS AND 6" THK PURED CONCRETE BASE ON ALL DRIVEWAYS.
4. THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.

N.T.S

HISTORIC FRANKLIN TENNESSEE

2 1/4" THICK BRICK PAVERS ON CONCRETE BASE

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021	DWG. NO. SS-2
NOT TO SCALE			



DRAFT

GENERAL NOTES

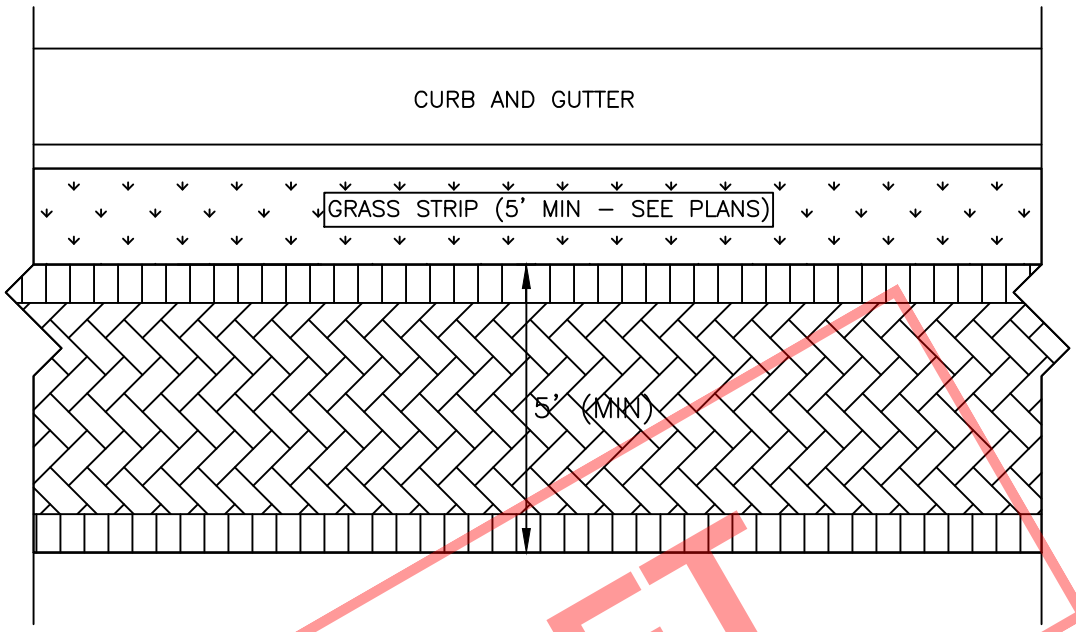
1. AFTER INSTALLATION OF HAND TOOLED JOINTS (AND CONCRETE SETUP):
   - A. SAW CUT (2/3 CONCRETE DEPTH) ALL HAND TOOLED JOINTS RUNNING PERPENDICULAR TO STREET CURB
   - B. SAW CUT (FULL DEPTH) ALL HAND TOOLED JOINTS AT THE INTERSECTION POINT OF THE STAGGERED JOINT
   - C. INSTEAD OF A AND B ABOVE, CONTRACTOR HAS THE OPTION TO INSTALL COLD JOINTS AT THESE LOCATIONS
   - D. THE PUPOSE OF A THROUGH C ABOVE IS TO PREVENT REFLECTIVE CRACKING AT THE INTERSECTION POINTS OF THE STAGGERED JOINTS. CONTRACTOR SHALL ENSURE NO REFLECTIVE CRACKING OCCURS AT THESE INTERSECTION POINTS.
   - E. COSTS OF JOINTS SPECIFIED ABOVE ARE INCIDENTAL TO CONCRETE WALK AND DRIVE ITEMS
2. THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.

N.T.S

HISTORIC FRANKLIN TENNESSEE

CONCRETE PAVEMENT WITH STAGGERED JOINT PATTERN

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021	DWG. NO. SS-3
NOT TO SCALE			



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NOTE: THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.

N.T.S

HISTORIC FRANKLIN TENNESSEE

TYPICAL 2 1/4" THICK BRICK PAVERS PATTERN

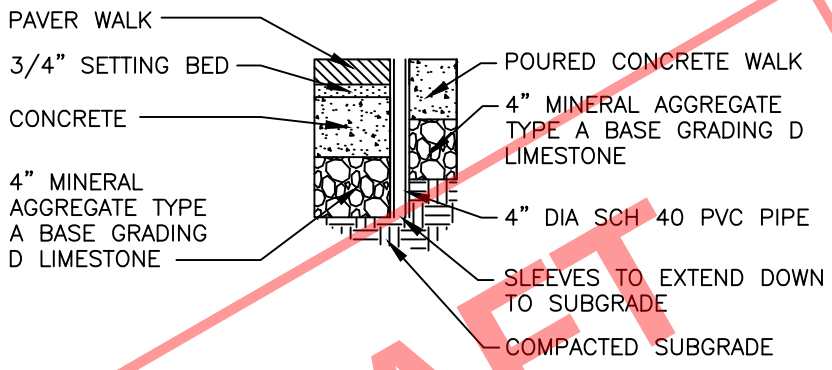
DWG. NO. **SS-4**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



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NOTE: THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.

N.T.S

HISTORIC FRANKLIN TENNESSEE

SIGN SLEEVES

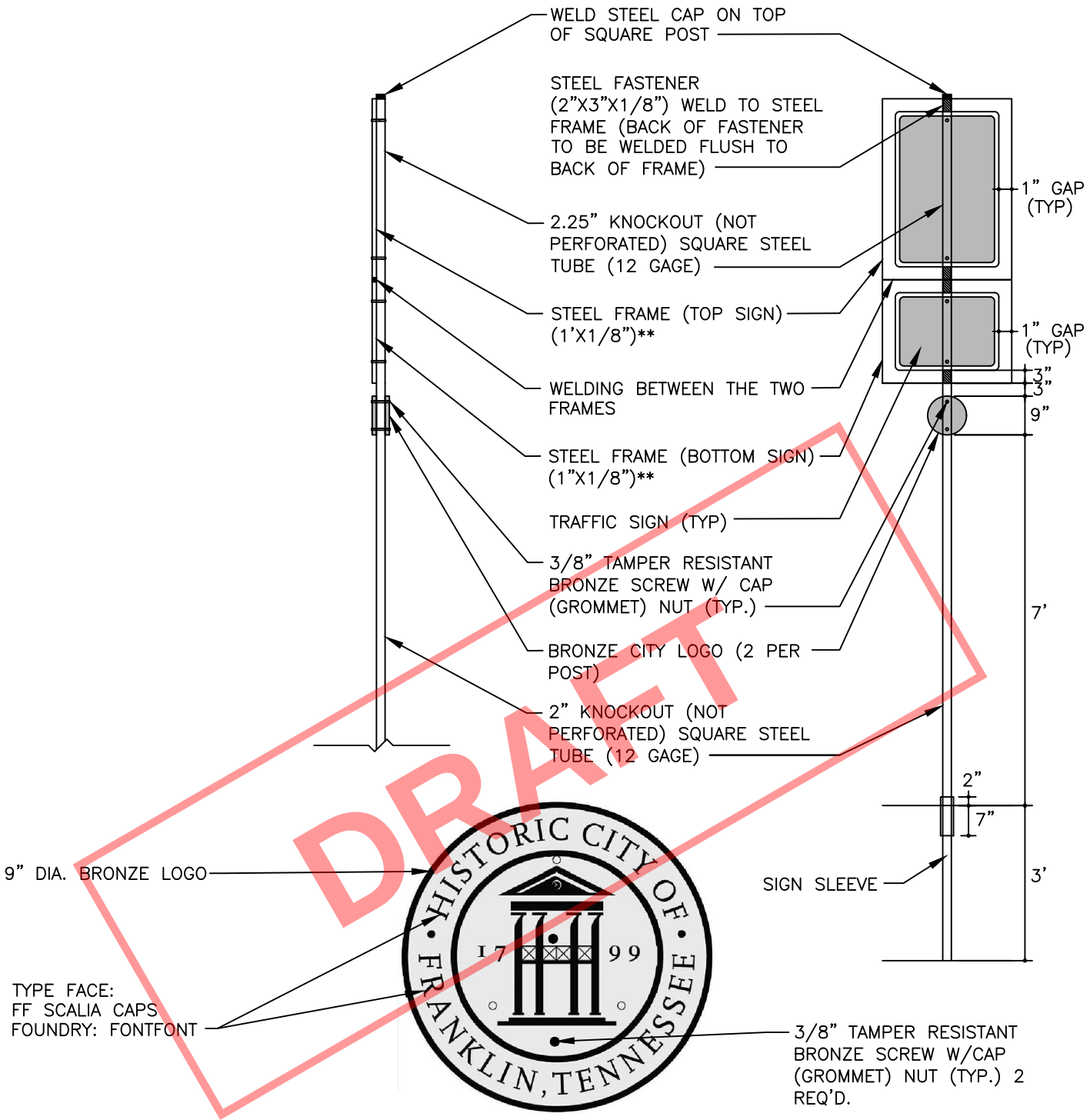
DWG. NO. **SS-5**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

GENERAL NOTES

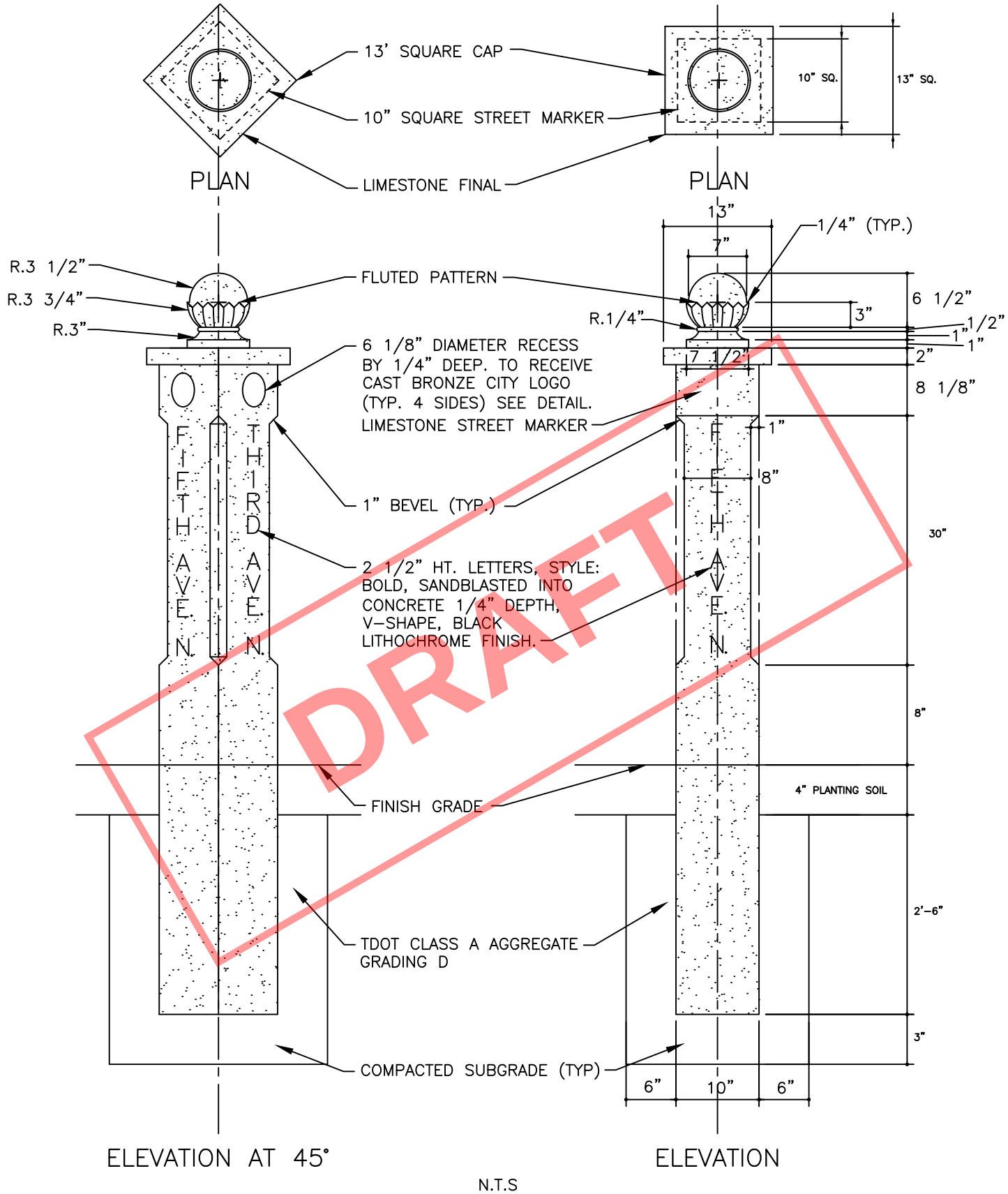
1. ALL BLACK ART SHALL BE RAISED FROM THE BACKGROUND TO CREATE A SUBSTANTIAL EMBOSSED APPEARANCE AND SHALL BE NATURAL BRONZE COLOR/FINISH
2. SUBMIT SHOP DRAWINGS TO CITY FOR APPROVAL PRIOR TO FABRICATION
3. FINISH FRAME AND POST PER SPECS. FINISH COLOR OF STEEL FRAME, 2" AND 2.25" KNOCKOUT SQ. STEEL TUBE TO MATCH SHERWIN WILLIAMS #PGS8-90245 (80% GLOSS) (FRANKLIN GREEN)
4. GRIND ALL WELDS SMOOTH
5. FINISH BACKS OF ALL TRAFFIC SIGNS PER CITY STREET SPECS. FINISH COLOR TO MATCH SHERWIN WILLIAMS #PGS8-90245 (80% GLOSS) (FRANKLIN GREEN).
6. THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.

N.T.S

HISTORIC FRANKLIN TENNESSEE

TYPICAL STREET SIGN

CITY OF FRANKLIN	CITY ENGINEER:	DATE: 7/1/2021	DWG. NO. SS-6
NOT TO SCALE			



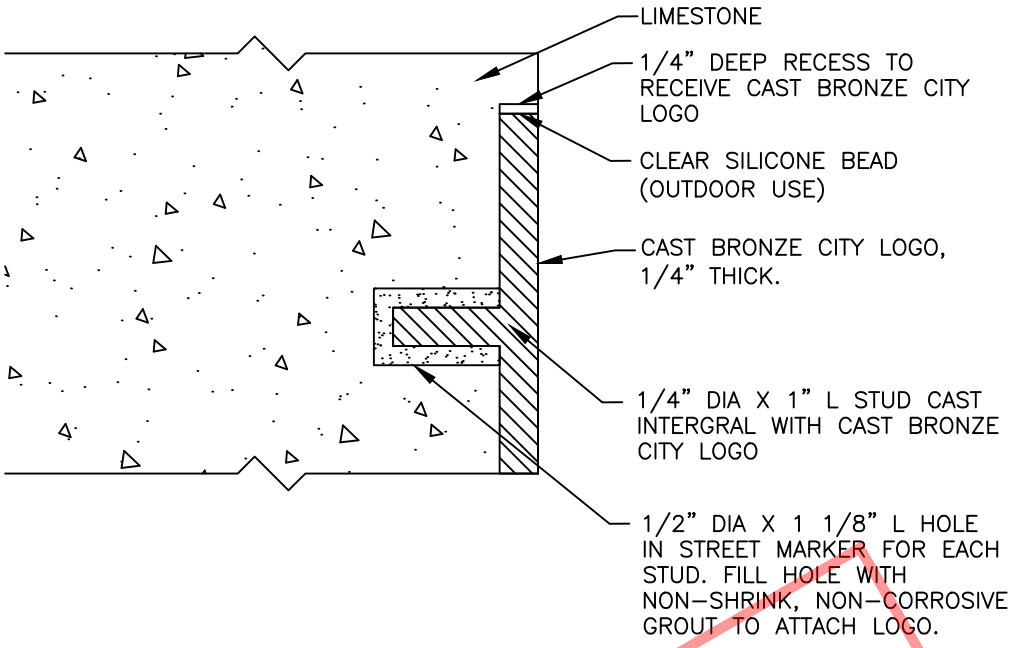
DRAFT

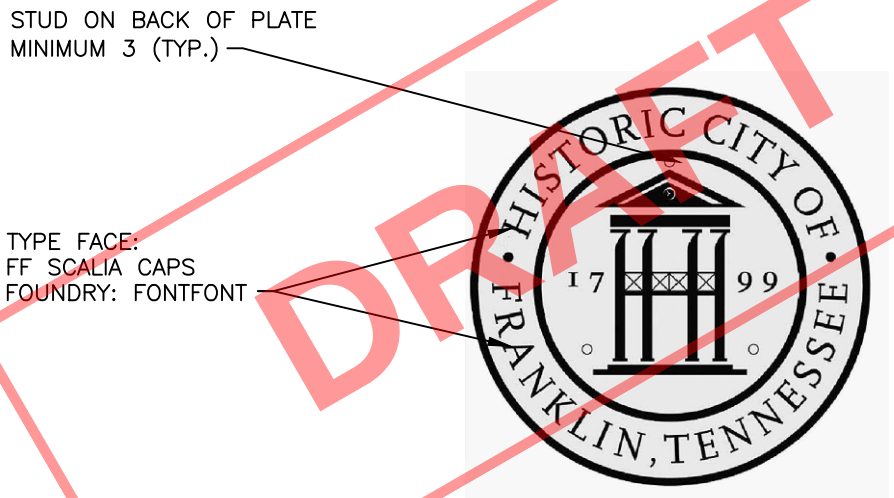
HISTORIC FRANKLIN TENNESSEE

LIMESTONE STREET MARKER PG 1 OF 2

DWG. NO. **SS-7**

CITY OF FRANKLIN	CITY ENGINEER:	DATE: 7/1/2021
NOT TO SCALE		





DRAFT

GENERAL NOTES

1. ALL BLACK ART SHALL BE RAISED FROM THE BACKGROUND TO CREATE A SUBSTANTIAL EMBOSSED APPEARANCE AND SHALL BE NATURAL BRONZE COLOR/FINISH
2. ALL RECESSED AREAS TO BE FINISH PAINTED TO MATCH SHERWIN WILLIAMS #PG58-90245 SHEEN "FRANKLIN GREEN" GLOSS POWDER COAT.
3. SUBMIT SHOP DRAWINGS, AND STONE SAMPLES TO CITY FOR APPROVAL PRIOR TO FABRICATION
4. BRONZE CITY LOGO SHALL MATCH THOSE INSTALLED ALONG 3RD AVE N. AND 5TH AVE. N.
5. LIMESTONE SHALL BE INDIANA LIMESTONE, GREY COLOR / SMOOTH FINISH
6. SEAL STREET MARKERS PER CITY SPECS.
7. THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.

N.T.S

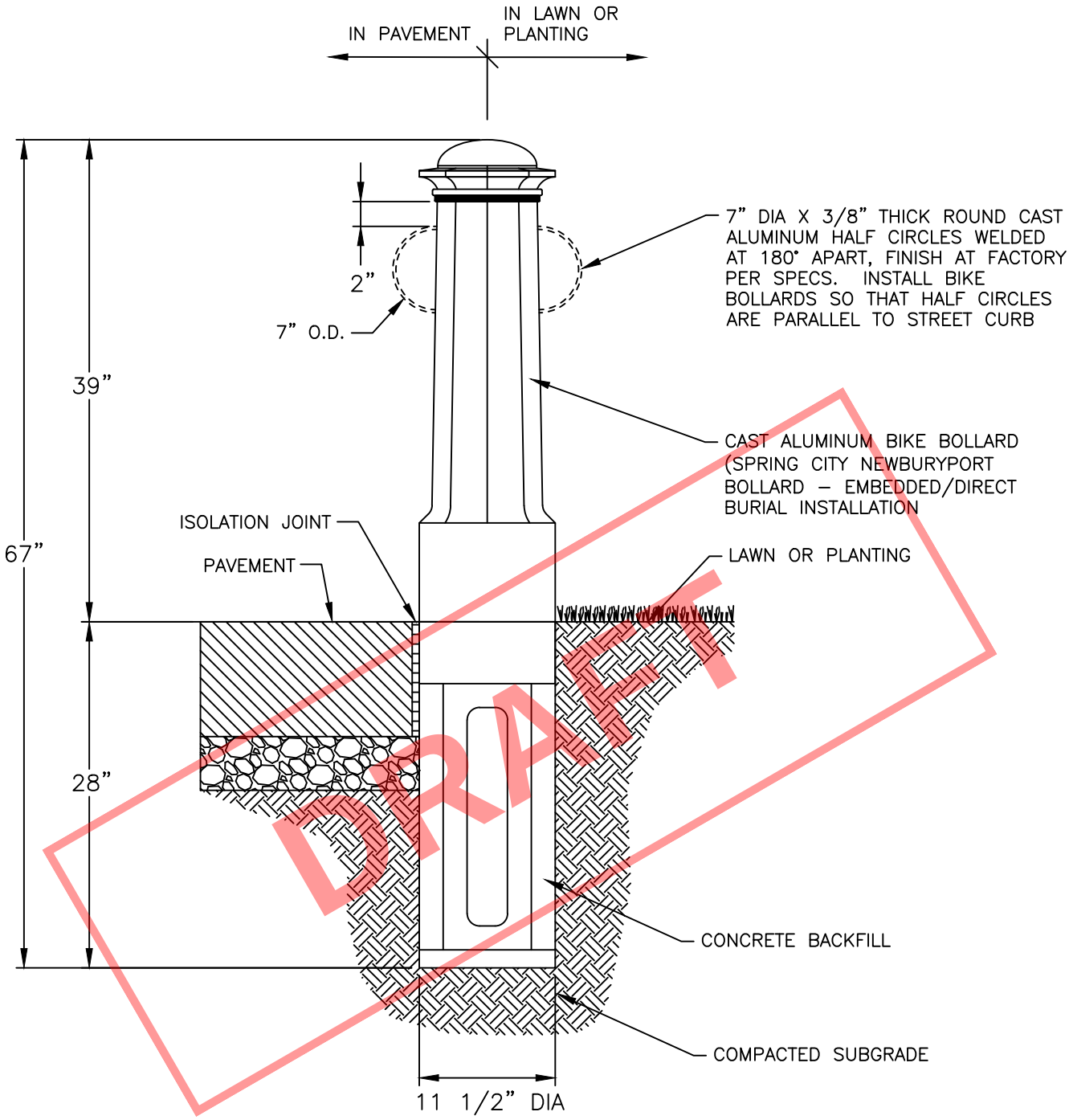
HISTORIC FRANKLIN TENNESSEE

LIMESTONE STREET MARKER PG 2 OF 2

DWG. NO.

SS-7

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021
NOT TO SCALE		



DRAFT

GENERAL NOTES

1. BIKE BOLLARD PART NO.: ABDNPBP–13–3.3–DD–XX–CW
   XX = TWO ALUMINUM 7" DIAMETER (OUTSIDE DIAMETER) HALF CIRCLES WELDED @ 180° ON EACH SIDE OF THE BOLLARD
   CW = RAL Y0331 HEAVY DUTY ACROLON SYSTEM BY SHERWIN WILLIAMS
2. THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.

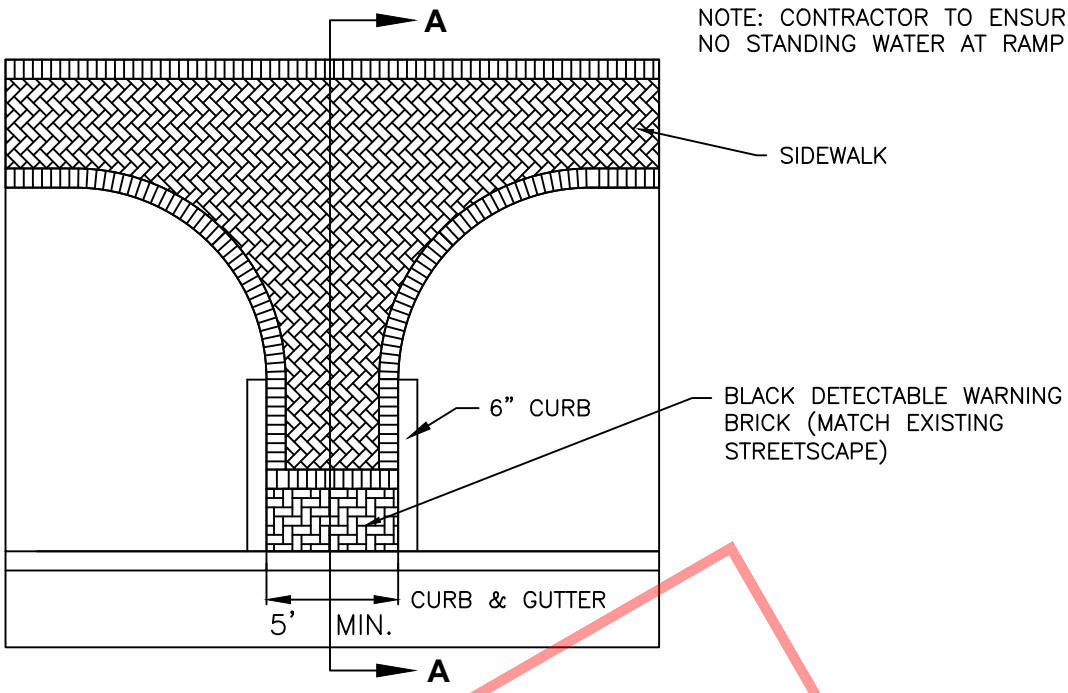
N.T.S

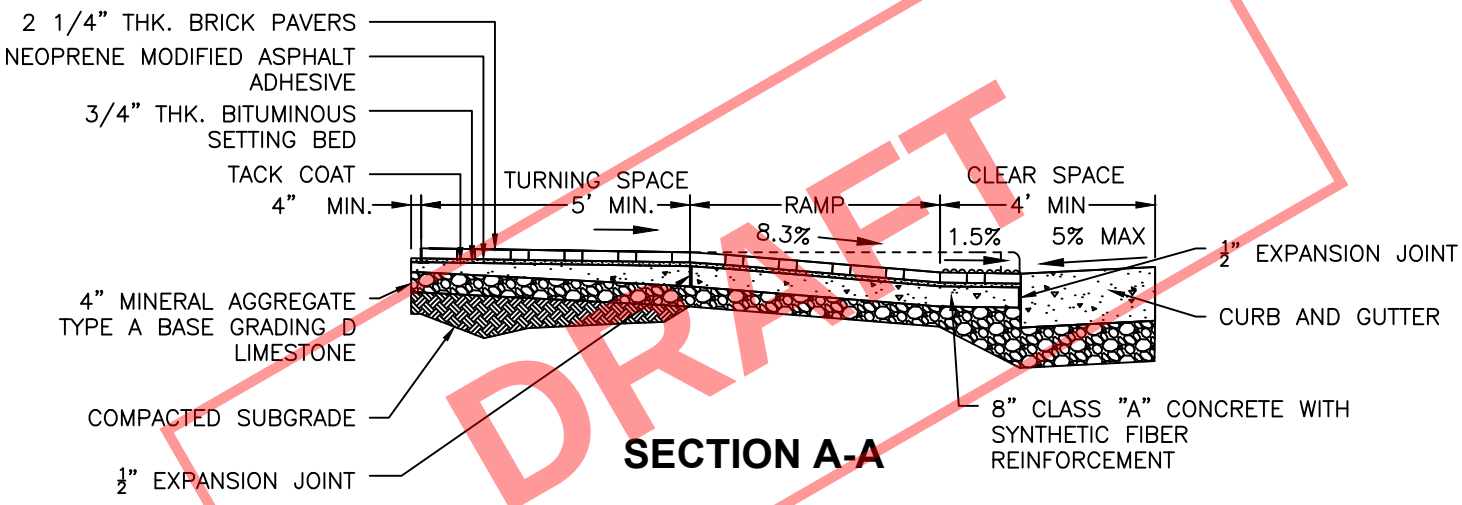
HISTORIC FRANKLIN TENNESSEE

CAST ALUMINUM BIKE BOLLARD

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021	DWG. NO. SS-8
NOT TO SCALE			

NOTE: CONTRACTOR TO ENSURE NO STANDING WATER AT RAMP





SECTION A-A

DRAFT

GENERAL NOTES

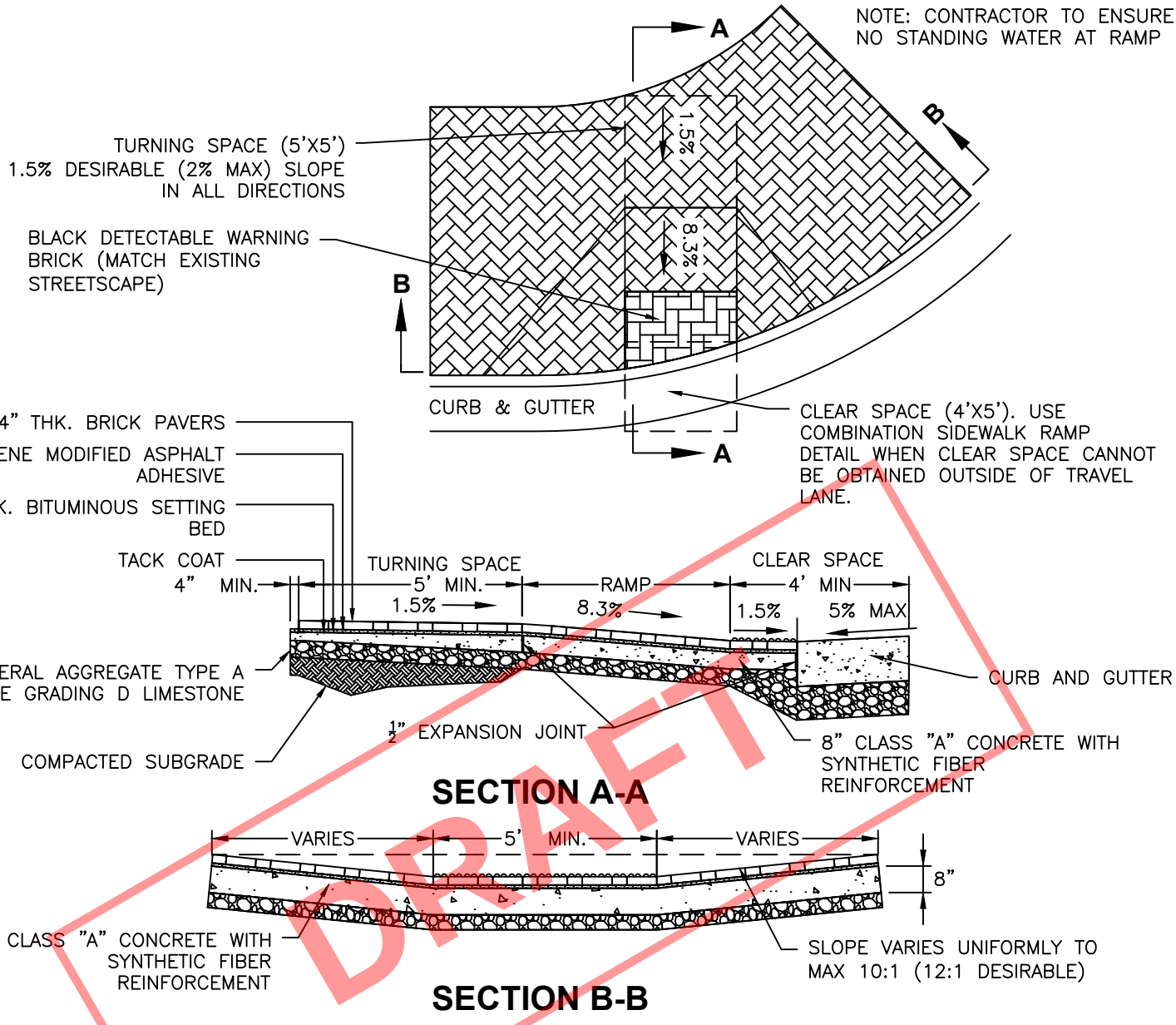
1. THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.
2. PLACE PAVERS IN PATTERNS PER CITY OF FRANKLIN STREETSCAPE PLANS. PLACE PAVERS WITH HAND TIGHT JOINTS NOT TO EXCEED $\frac{1}{8}$" (MIN $\frac{1}{16}$"). SAW CUT PAVERS AS NEEDED TO MAINTAIN ABOVE JOINT TOLERANCES.
3. DO NOT USE FILLERS TO FILL JOINT VOIDS OF EXCESSIVE WIDTH. RESET AND SAW CUT PAVERS AS REQUIRED TO ELIMINATE EXCESSIVE JOINT WIDTHS.
4. CONCRETE UNDER BRICK PAVERS SHALL BE A MIN THICKNESS OF: 4" UNDER ALL SIDEWALKS, 6" UNDER ALL DRIVEWAYS AND 8" UNDER ALL RAMPS.
5. A VARIATION OF THE RAMP MAY BE USED IN CERTAIN CIRCUMSTANCES BUT MUST COMPLY WITH PROPOSED ACCESSIBILITY GUIDELINES FOR PEDESTRIAN FACILITIES IN THE PUBLIC RIGHT-OF-WAY
6. DESIRABLE SLOPE TO BE USED UNLESS OTHERWISE DIRECTED BY THE CITY OF FRANKLIN.
7. MINIMUM TURNING SPACE IS 5'X5' AND MIN CLEAR SPACE 4'X5' OUTSIDE TRAVEL WAY.
8. GRADE BREAKS AT THE TOP AND BOTTOM OF CURB RAMP RUNS SHALL BE PERPENDICULAR TO THE DIRECTION OF THE RAMP RUN. GRADE BREAKS SHALL NOT BE PERMITTED ON THE SURFACE OF RAMP RUNS AND TURNING SPACES. SURFACE SLOPE THAT MEET AT GRADE BREAKS SHALL BE FLUSH.
9. 4" MIN BASE STONE (303-01 MINERAL AGGREGATE, TYPE "A" BASE, GRADING "D" REQUIRED UNDER ALL SIDEWALKS AND CURB.

N.T.S

HISTORIC FRANKLIN TENNESSEE

BRICK CURB RAMP AND DETECTABLE WARNING

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021	DWG. NO. SS-9
NOT TO SCALE			



DRAFT

GENERAL NOTES

1. THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.
2. PLACE PAVERS IN PATTERNS PER CITY OF FRANKLIN STREETSCAPE PLANS. PLACE PAVERS WITH HAND TIGHT JOINTS NOT TO EXCEED $\frac{1}{8}$" (MIN $\frac{1}{16}$"). SAW CUT PAVERS AS NEEDED TO MAINTAIN ABOVE JOINT TOLERANCES.
3. DO NOT USE FILLERS TO FILL JOINT VOIDS OF EXCESSIVE WIDTH. RESET AND SAW CUT PAVERS AS REQUIRED TO ELIMINATE EXCESSIVE JOINT WIDTHS.
4. CONCRETE UNDER BRICK PAVERS SHALL BE A MIN THICKNESS OF: 4" UNDER ALL SIDEWALKS, 6" UNDER ALL DRIVEWAYS AND 8" UNDER ALL RAMPS.
5. A VARIATION OF THE RAMP MAY BE USED IN CERTAIN CIRCUMSTANCES BUT MUST COMPLY WITH PROPOSED ACCESSIBILITY GUIDELINES FOR PEDESTRIAN FACILITIES IN THE PUBLIC RIGHT-OF-WAY
6. DESIRABLE SLOPE TO BE USED UNLESS OTHERWISE DIRECTED BY THE CITY OF FRANKLIN.
7. MINIMUM TURNING SPACE IS 5'X5' AND MIN CLEAR SPACE 4'X5' OUTSIDE TRAVEL WAY.
8. GRADE BREAKS AT THE TOP AND BOTTOM OF CURB RAMP RUNS SHALL BE PERPENDICULAR TO THE DIRECTION OF THE RAMP RUN. GRADE BREAKS SHALL NOT BE PERMITTED ON THE SURFACE OF RAMP RUNS AND TURNING SPACES. SURFACE SLOPE THAT MEET AT GRADE BREAKS SHALL BE FLUSH.
9. 4" MIN BASE STONE (303-01 MINERAL AGGREGATE, TYPE "A" BASE, GRADING "D" REQUIRED UNDER ALL SIDEWALKS AND CURB.

N.T.S

HISTORIC FRANKLIN TENNESSEE

BRICK PERPENDICULAR CURB RAMP

DWG. NO.

SS-10

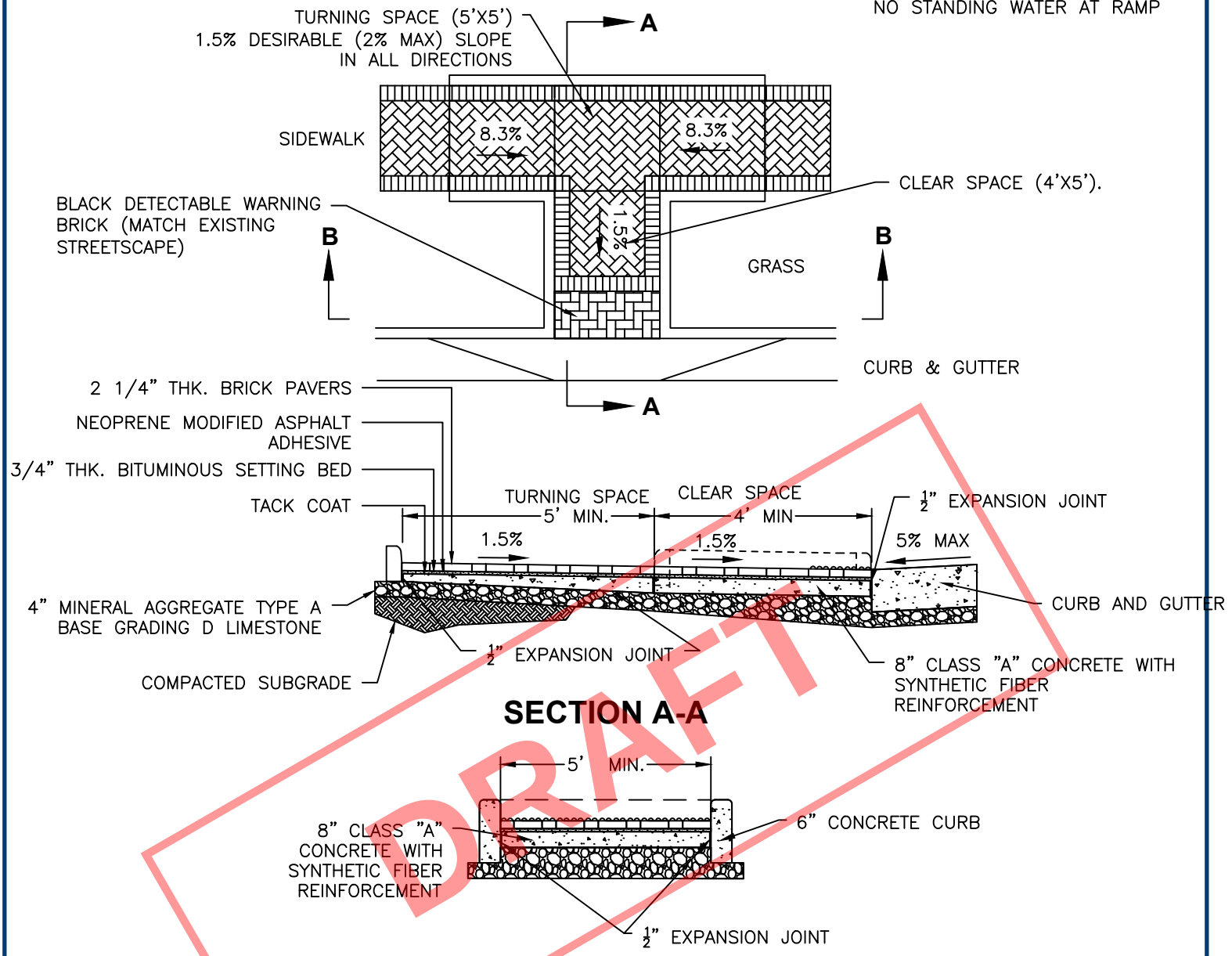
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

NOTE: CONTRACTOR TO ENSURE NO STANDING WATER AT RAMP



SECTION A-A

SECTION B-B

DRAFT

GENERAL NOTES

1. THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.
2. PLACE PAVERS IN PATTERNS PER CITY OF FRANKLIN STREETSCAPE PLANS. PLACE PAVERS WITH HAND TIGHT JOINTS NOT TO EXCEED 1/8" (MIN 1/16"). SAW CUT PAVERS AS NEEDED TO MAINTAIN ABOVE JOINT TOLERANCES.
3. DO NOT USE FILLERS TO FILL JOINT VOIDS OF EXCESSIVE WIDTH. RESET AND SAW CUT PAVERS AS REQUIRED TO ELIMINATE EXCESSIVE JOINT WIDTHS.
4. CONCRETE UNDER BRICK PAVERS SHALL BE A MIN THICKNESS OF: 4" UNDER ALL SIDEWALKS, 6" UNDER ALL DRIVEWAYS AND 8" UNDER ALL RAMPS.
5. A VARIATION OF THE RAMP MAY BE USED IN CERTAIN CIRCUMSTANCES BUT MUST COMPLY WITH PROPOSED ACCESSIBILITY GUIDELINES FOR PEDESTRIAN FACILITIES IN THE PUBLIC RIGHT-OF-WAY
6. DESIRABLE SLOPE TO BE USED UNLESS OTHERWISE DIRECTED BY THE CITY OF FRANKLIN.
7. MINIMUM TURNING SPACE IS 5'X5' AND MIN CLEAR SPACE 4'X5' OUTSIDE TRAVEL WAY.
8. GRADE BREAKS AT THE TOP AND BOTTOM OF CURB RAMP RUNS SHALL BE PERPENDICULAR TO THE DIRECTION OF THE RAMP RUN. GRADE BREAKS SHALL NOT BE PERMITTED ON THE SURFACE OF RAMP RUNS AND TURNING SPACES. SURFACE SLOPE THAT MEET AT GRADE BREAKS SHALL BE FLUSH.
9. 4" MIN BASE STONE (303-01 MINERAL AGGREGATE, TYPE "A" BASE, GRADING "D" REQUIRED UNDER ALL SIDEWALKS AND CURB.

N.T.S

HISTORIC FRANKLIN TENNESSEE

BRICK COMBINATION CURB RAMP

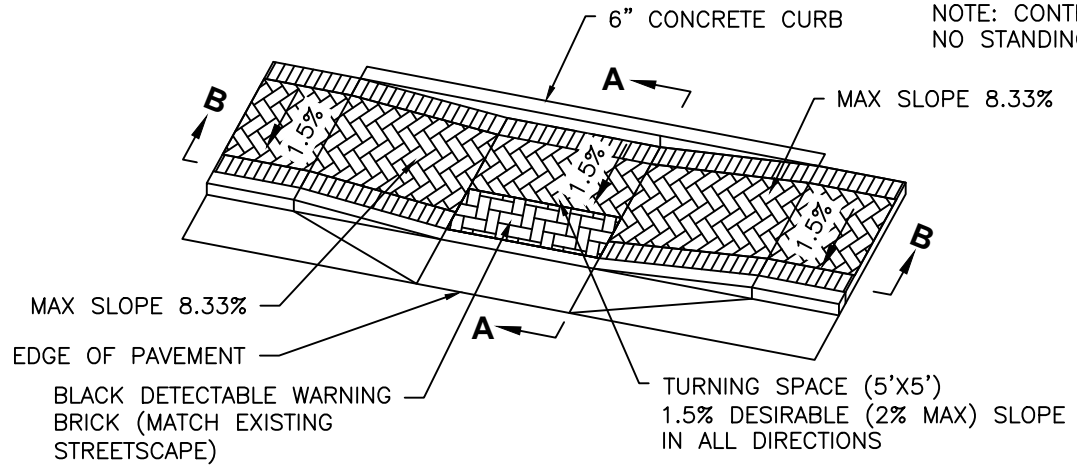
DWG. NO. **SS-11**

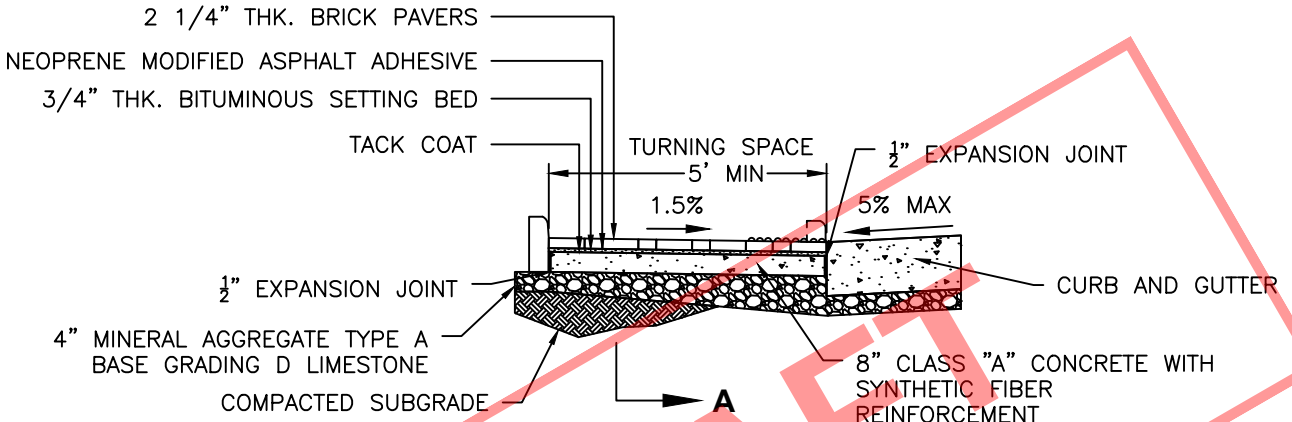
CITY OF FRANKLIN

NOT TO SCALE

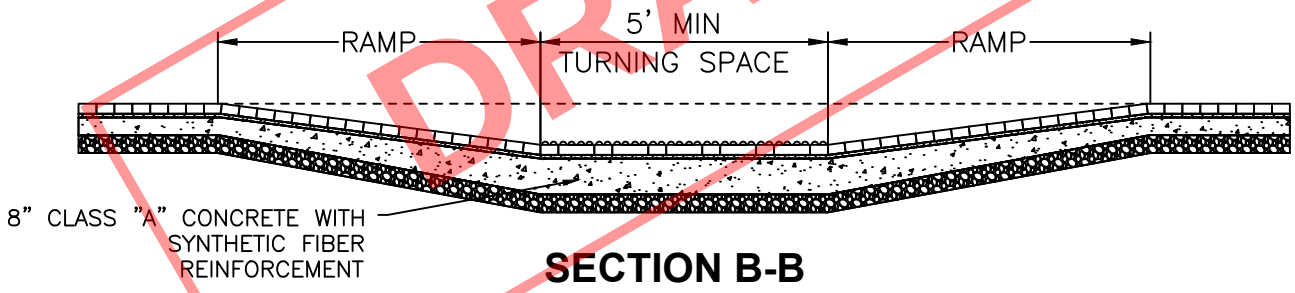
CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021





SECTION A-A



SECTION B-B

DRAFT

GENERAL NOTES

1. THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.
2. PLACE PAVERS IN PATTERNS PER CITY OF FRANKLIN STREETSCAPE PLANS. PLACE PAVERS WITH HAND TIGHT JOINTS NOT TO EXCEED $\frac{1}{8}$" (MIN $\frac{1}{16}$"). SAW CUT PAVERS AS NEEDED TO MAINTAIN ABOVE JOINT TOLERANCES.
3. DO NOT USE FILLERS TO FILL JOINT VOIDS OF EXCESSIVE WIDTH. RESET AND SAW CUT PAVERS AS REQUIRED TO ELIMINATE EXCESSIVE JOINT WIDTHS.
4. CONCRETE UNDER BRICK PAVERS SHALL BE A MIN THICKNESS OF: 4" UNDER ALL SIDEWALKS, 6" UNDER ALL DRIVEWAYS AND 8" UNDER ALL RAMPS.
5. A VARIATION OF THE RAMP MAY BE USED IN CERTAIN CIRCUMSTANCES BUT MUST COMPLY WITH PROPOSED ACCESSIBILITY GUIDELINES FOR PEDESTRIAN FACILITIES IN THE PUBLIC RIGHT-OF-WAY
6. DESIRABLE SLOPE TO BE USED UNLESS OTHERWISE DIRECTED BY THE CITY OF FRANKLIN.
7. MINIMUM TURNING SPACE IS 5'X5' AND MIN CLEAR SPACE 4'X5' OUTSIDE TRAVEL WAY.
8. GRADE BREAKS AT THE TOP AND BOTTOM OF CURB RAMP RUNS SHALL BE PERPENDICULAR TO THE DIRECTION OF THE RAMP RUN. GRADE BREAKS SHALL NOT BE PERMITTED ON THE SURFACE OF RAMP RUNS AND TURNING SPACES. SURFACE SLOPE THAT MEET AT GRADE BREAKS SHALL BE FLUSH.
9. 4" MIN BASE STONE (303-01 MINERAL AGGREGATE, TYPE "A" BASE, GRADING "D" REQUIRED UNDER ALL SIDEWALKS AND CURB.

N.T.S

HISTORIC FRANKLIN TENNESSEE

BRICK PARALLEL CURB RAMP

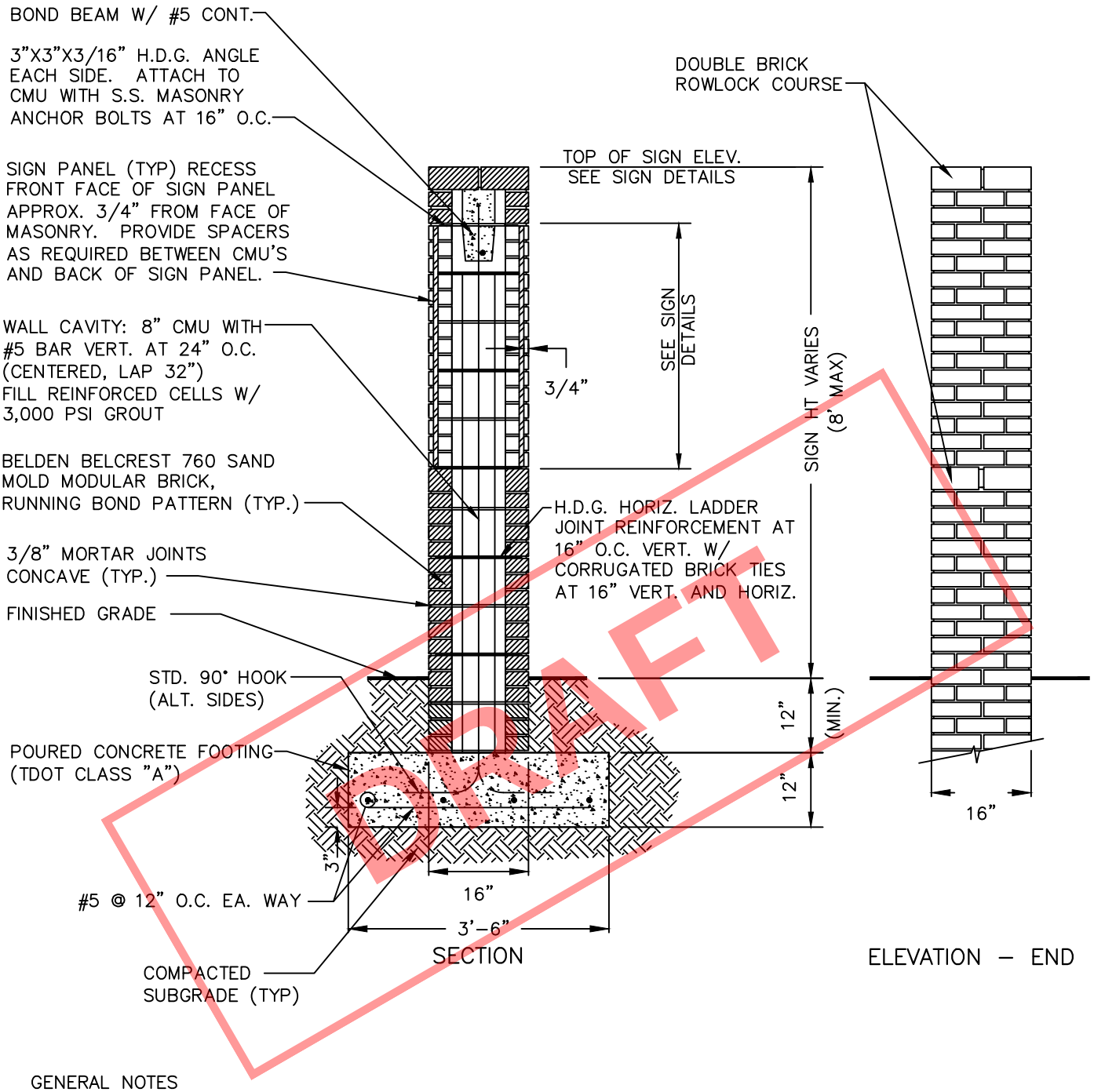
DWG. NO. **SS-12**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

GENERAL NOTES

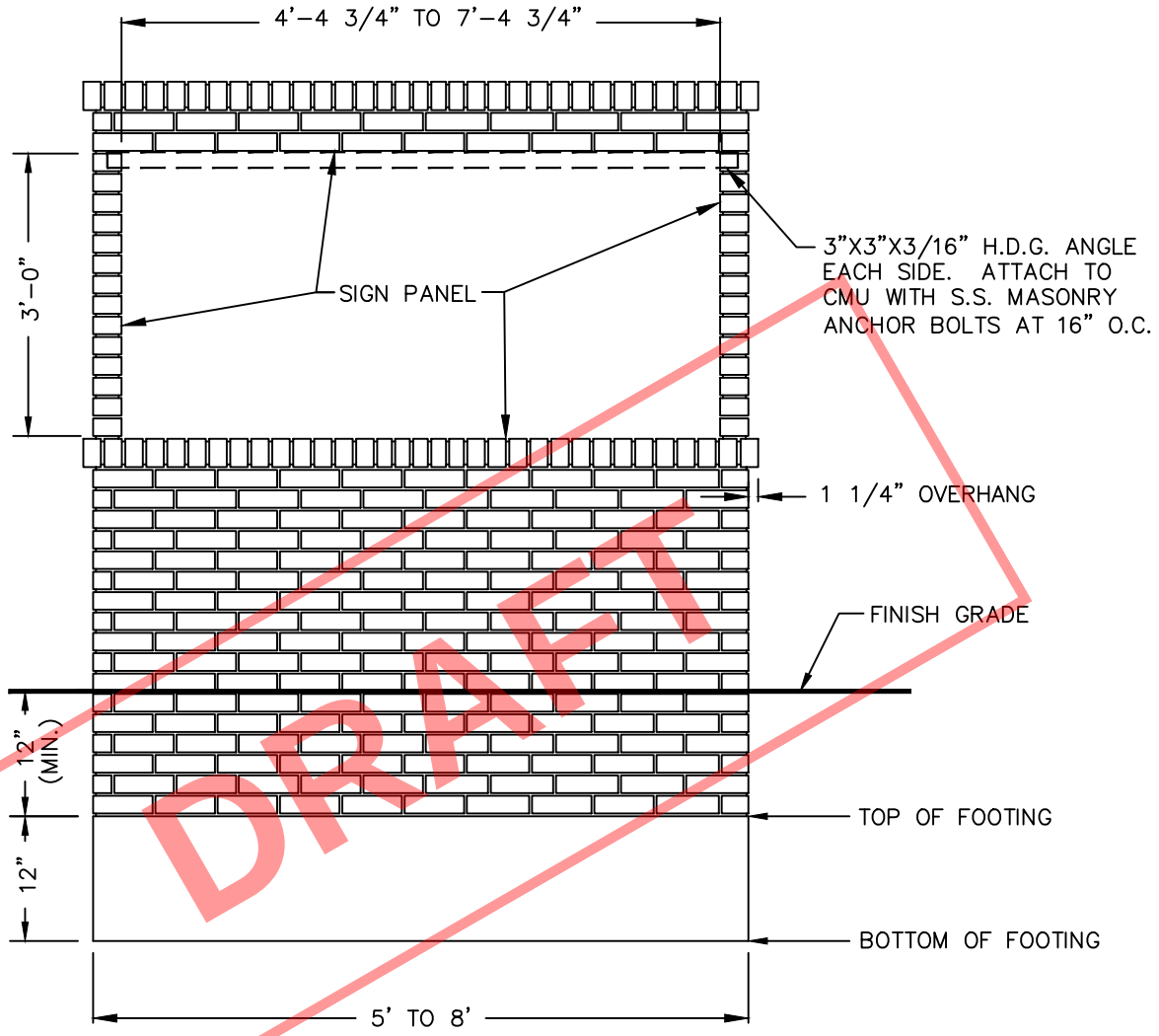
1. CONTRACTOR IS REQUIRED TO UTILIZE A SPECIALTY SIGNAGE DESIGN/FABRICATION SUBCONTRACTOR. SIGNS SHALL BE APPROVED BY THE PROPERTY OWNER AND CITY OF FRANKLIN. SIGNS ARE DOUBLE SIDED; 2 PANELS ARE REQUIRED FOR EACH SIGN. THE SIGN PANELS ARE REQUIRED TO FIT ONTO THE DESIGNATED MASONRY BASES. CONTRACTOR IS RESPONSIBLE FOR PROPER FIT OF SIGN PANELS ONTO MASONRY BASES.
2. SIGN PANELS SHALL BE EXTERNALLY ILLUMINATED. REFER TO ELECTRICAL DRAWINGS FOR SIGN PANEL LIGHTING.
3. THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.

N.T.S

HISTORIC FRANKLIN TENNESSEE

STREETSCAPE SIGN PG 1 OF 2

CITY OF FRANKLIN	CITY ENGINEER:	DATE: 7/1/2021	DWG. NO. SS-13A
NOT TO SCALE			



DRAFT

NOTE: THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.

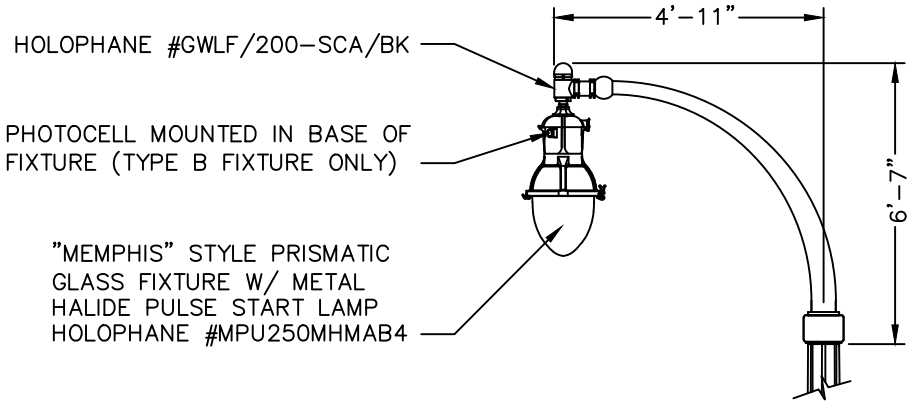
N.T.S

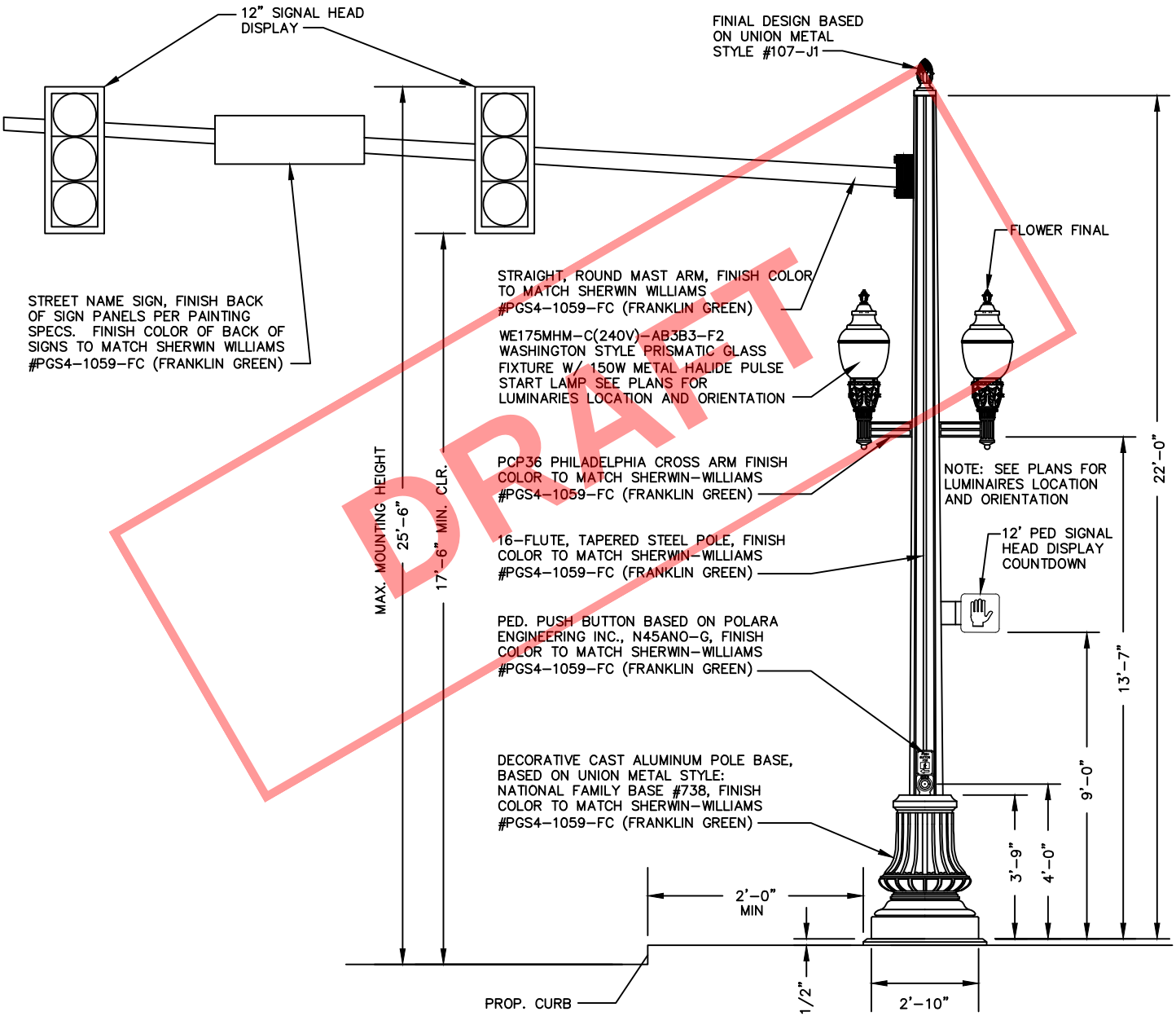
HISTORIC FRANKLIN TENNESSEE

STREETSCAPE SIGN PG 2 OF 2

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021	DWG. NO. SS-13B
NOT TO SCALE			

NOTE: LUMINAIRE ON TOP OF TRAFFIC POLE. SEE PLANS FOR LUMINAIRES LOCATION AND ORIENTATION.





DRAFT

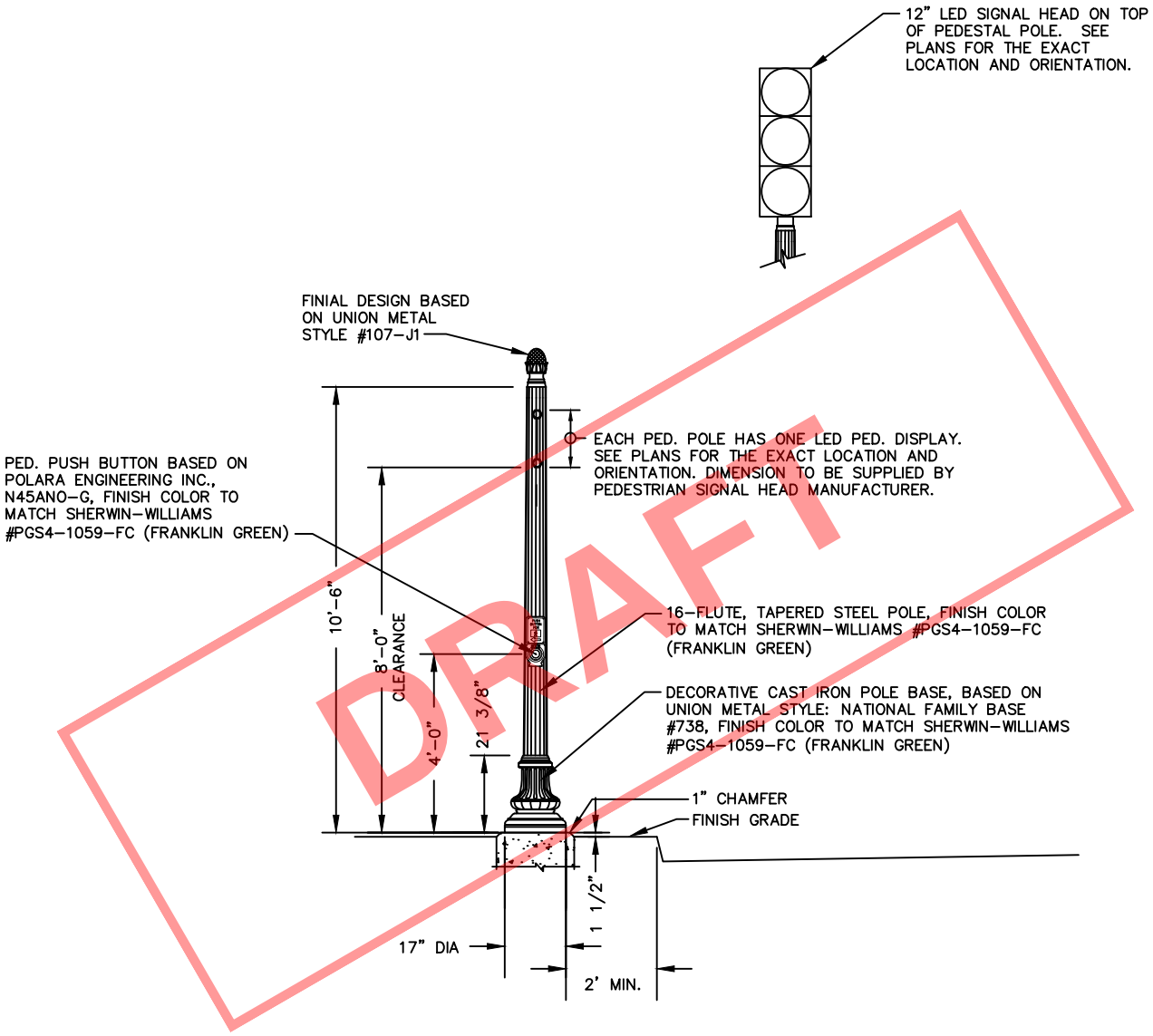
NOTE: THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.
N.T.S

HISTORIC FRANKLIN TENNESSEE

STREETSCAPE TRAFFIC SIGNAL MAST ARM POLE

DWG. NO. **SS-14**

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021
NOT TO SCALE		



DRAFT

NOTE: THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.

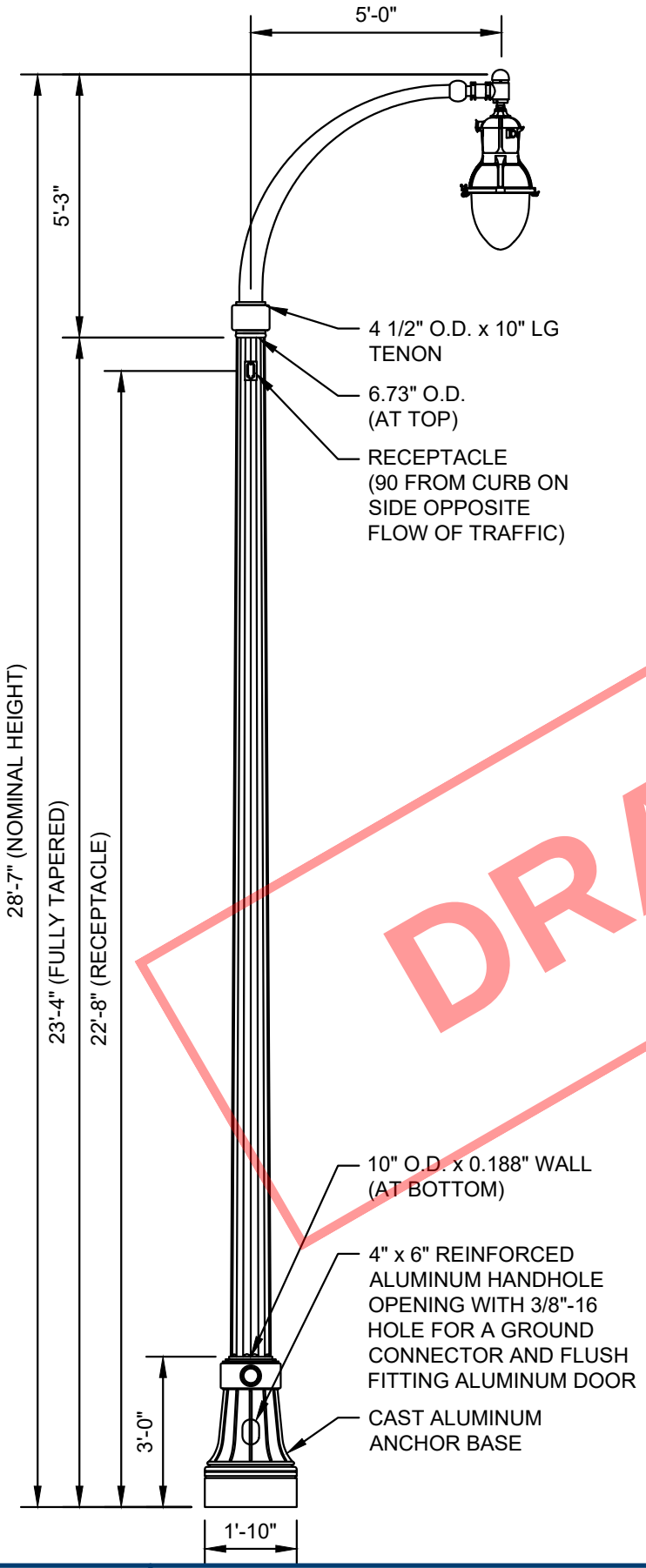
N.T.S

HISTORIC FRANKLIN TENNESSEE

STREETSCAPE PEDESTAL POLE

DWG. NO. **SS-15**

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021
NOT TO SCALE		



DRAFT

APPLICABILITY

1. DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS, EXCEPT ALONG MAIN STREET

POLE AND APPURTENANCES

1. ALUMINUM 6064-T4 ROUND FLUTED TAPERED POLE (16 SHARP) (TREATED TO T6 CONDITION AFTER WELDING)
2. TENON: Ø4.5" x 10"
3. (1) GFI RECEPTACLE, w/ IN-USE WEATHERPROOF COVER
4. ATLANTA SERIES CAST ALUMINUM CLAMSHELL BASE, 22" DIAMETER
5. REYNOLDSBURG STYLE ROADWAY ARM, 51" LONG FOR MOUNTING A SINGLE FIXTURE
6. LEVELING FITTER (BHLF WLF), GLASWERKS DECORATIVE ARM FITTER SLIPFIT 2 INCH NOMINAL PIPE, SWIVEL, CAST ALUMINUM
7. FINISH: RP99P024 FRANKLIN GREEN 80% GLOSS
8. (1) SET 1" x 36" ANCHOR BOLTS (HOT-DIP GALV.)

FIXTURE

1. MEMPHIS TEARDROP LED 2 (MPL2)
2. 13,000 LUMENS
3. 3 COBs
4. 4000K SERIES CCT
5. AUTO-SENSING 120-277V 50/60 Hz
6. TEAR DROP GLASS AND DOOR
7. TYPE 3 ASYMMETRIC DISTRIBUTION
8. THREADED TOP OPENING, 1.5" NPT

CATALOG #'s

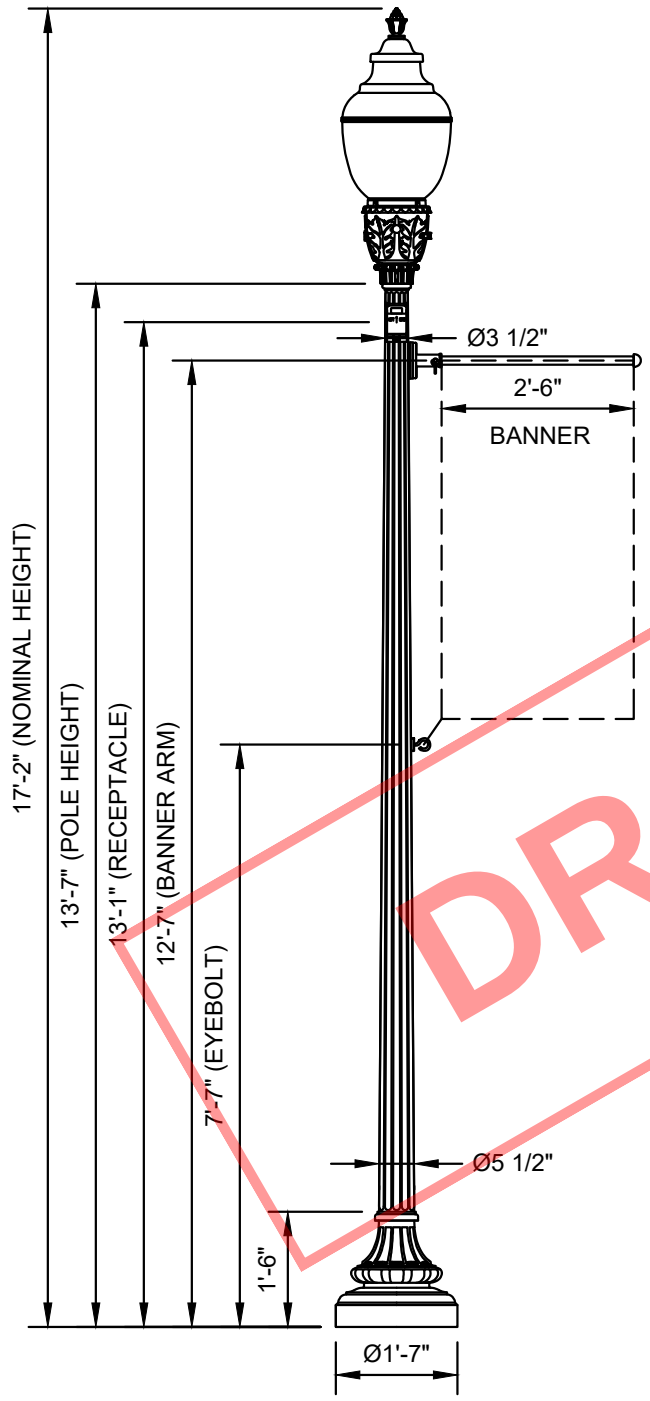
1. RFD214665
2. POLE: RFTA2310-3DR12520G-EA-RP99P024
3. BASE COVER: AT22CACSB-RP99P024
4. ARM: RBC51/1-CA/RP99P024
5. ANCHOR BOLTS: AB-27-4
6. FITTER: GWLF200SCACMC
7. FIXTURE (TYPE A): MPL2P30S40KASCMCTG3P
8. FIXTURE (TYPE B): MPL2P30S40KASCMCTG3PRPCS

HISTORIC FRANKLIN TENNESSEE

STREETSCAPE LIGHT POLE (TYPE A AND B)

DWG. NO. **L-1**

CITY OF FRANKLIN	CITY ENGINEER: Paul P Holzen	DATE: 7/1/2021
NOT TO SCALE		



APPLICABILITY

1. DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS, EXCEPT ALONG MAIN STREET

POLE AND APPURTENANCES

1. WADSWORTH SERIES POLE
2. ALUMINUM, FLUTED TAPERED FTJ SHAFT
3. TENON: Ø3" x 3"
4. (1) GFI RECEPTACLE, w/ SMALL IN-USE WEATHERPROOF COVER
5. (1) BOLT-ON 30" BANNER ARM, Ø1" PIPE, HALF SPHERE FINIAL
6. (1) BOLT-ON EYEBOLT
7. FINISH: RP99P024 FRANKLIN GREEN 80% GLOSS
8. (1) SET 3/4" x 18" ANCHOR BOLTS (HOT-DIP GALV.)

	ORIENTATION	HEIGHT
RECEPTACLE	90°	13'-1"
BANNER ARM	180°	12'-7"
EYEBOLT	180°	7'-7"

FIXTURE

1. GLASS WASHINGTON POSTLITE LED (WAE3)
2. P30 LED PERFORMANCE PKG
3. 4000K SERIES CCT
4. AUTO-SENSING 120-277V 50/60 Hz
5. ENHANCED STYLE HOUSING
6. TYPE III OPTICS, CMC FINISH
7. BUD FINIAL, CMC FINISH
8. FIELD ADJUSTABLE OUTPUT
9. 7-PIN DIMMING PHOTOCONTROL RECEPTACLE
10. SHORTING CAP

CATALOG #'s

1. POLE: WDA14FTJ19P07RP99P024-PROVS RFD214670
2. RECEPTACLE: FGIUS-SRP99P024 RFD214670
3. BANNER ARM: BAD30H4RP99P024 RFD214670
4. EYEBOLT: EBBRP99P024 RFD214670
5. ANCHOR BOLTS: AB-31-4
6. FIXTURE (TYPE C): WAE3P3040KMVOLTENGL3CMCBDTCMCAOPR7SH
7. FIXTURE (TYPE D): WAE3P3040KMVOLTENGL3CMCBDTCMCAOPR7SHRPCS

DRAFT

HISTORIC FRANKLIN TENNESSEE

STREETSCAPE LIGHT POLE (TYPE C AND D)

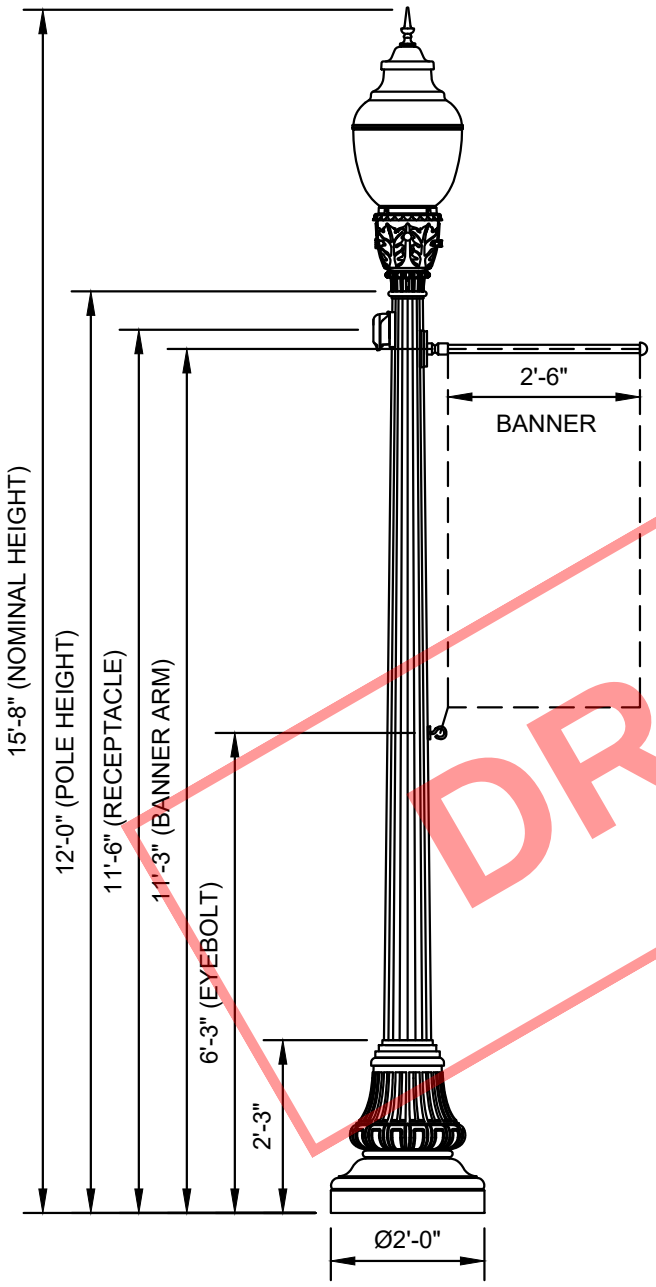
DWG. NO. **L-2**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



APPLICABILITY

1. DETAIL TO BE USED IN DOWNTOWN FRANKLIN IN MAIN STREET CORRIDOR

POLE AND APPURTENANCES

1. ROUND TAPERED POLE
2. STEEL, 16-SHARP FLUTED SHAFT
3. TENON: Ø3" x 3"
4. (1) COLUMBIA SERIES Ø24" CAST IRON CLAMSHELL BASE, 2 HAND HOLES @ 180° FROM EACH OTHER
5. (1) GFI RECEPTACLE, w/ SMALL IN-USE WEATHERPROOF COVER
6. (1) 50A/240V RECEPTACLE w/ WEATHERPROOF COVER
7. (1) BOLT-ON 30" BANNER ARM, Ø1" PIPE, HALF SPHERE FINIAL
8. (1) BOLT-ON EYEBOLT
9. (1) 4" x 6" HANDHOLE, LESS ANCHOR BOLTS
10. FINISH: RP99P024 FRANKLIN GREEN 80% GLOSS
11. (1) SET 3/4" x 18" ANCHOR BOLTS (HOT-DIP GALV.)

	ORIENTATION	HEIGHT
RECEPTACLE	270°	11'-6"
RECEPTACLE	180°	1'-6"
BANNER ARM	90°	11'-3"
EYEBOLT	90°	6'-3"

FIXTURE

1. GLASS WASHINGTON POSTLITE LED (WAE3)
2. P30 LED PERFORMANCE PKG
3. 4000K SERIES CCT
4. AUTO-SENSING 120-277V 50/60 Hz
5. ENHANCED STYLE HOUSING
6. TYPE III OPTICS, CMC FINISH
7. SPIKE FINIAL, CMC FINISH
8. FIELD ADJUSTABLE OUTPUT
9. 7-PIN DIMMING PHOTOCONTROL RECEPTACLE
10. SHORTING CAP

CATALOG #'s

1. POLE: RTFS12T3-MODHH-RP99P024 RFD214418
2. BASE: C24CSBCIU246E
3. RECEPTACLES: FGIUS-SRP99P024 RFD214418, FG-SPCU246E
4. BANNER ARM: BBD30H4U246E-SPCL RFD214418
5. EYEBOLT: EBBRP99P024
6. ANCHOR BOLTS: AB-31-4
7. FIXTURE: WAE3P3040KMVOLTENGL3CMCSKTCMCAOPR7SH

DRAFT

HISTORIC FRANKLIN TENNESSEE

STREETSCAPE LIGHT POLE (MAIN STREET - SINGLE)

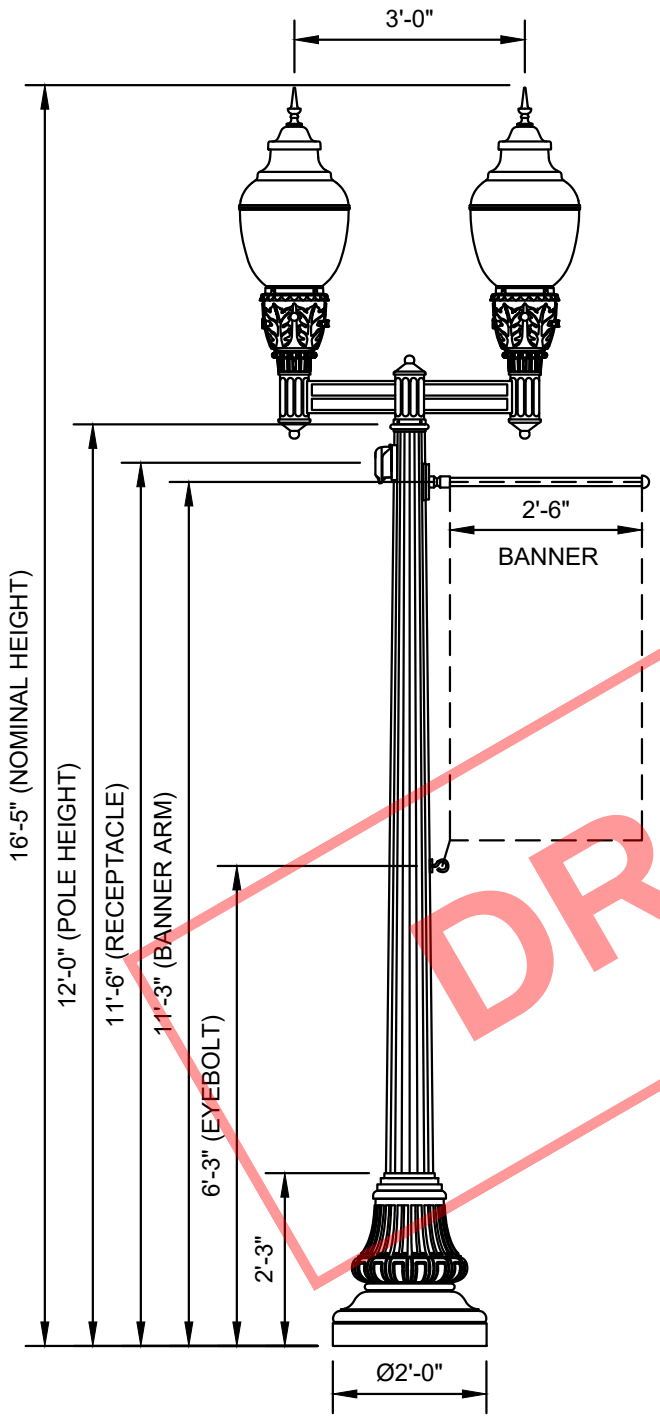
DWG. NO. **L-3**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



APPLICABILITY

1. DETAIL TO BE USED IN DOWNTOWN FRANKLIN IN MAIN STREET CORRIDOR

POLE AND APPURTENANCES

1. ROUND TAPERED POLE
2. STEEL, 16-SHARP FLUTED SHAFT
3. TENON: Ø3" x 5"
4. (1) COLUMBIA SERIES Ø24" CAST IRON CLAMSHELL BASE, 2 HAND HOLES @ 180° FROM EACH OTHER
5. (1) GFI RECEPTACLE, w/ SMALL IN-USE WEATHERPROOF COVER
6. (1) 50A/240V RECEPTACLE w/ WEATHERPROOF COVER
7. (1) BOLT-ON 30" BANNER ARM, Ø1" PIPE, HALF SPHERE FINIAL
8. (1) BOLT-ON EYEBOLT
9. (1) 4" x 6" HANDHOLE, LESS ANCHOR BOLTS
10. PHILADELPHIA SERIES CROSSARM, 36" LONG FOR 2@180° FIXTURES
11. FINISH: RP99P024 FRANKLIN GREEN 80% GLOSS
12. (1) SET 3/4" x 18" ANCHOR BOLTS (HOT-DIP GALV.)

	ORIENTATION	HEIGHT
RECEPTACLE	270°	11'-6"
RECEPTACLE	180°	1'-6"
BANNER ARM	90°	11'-3"
EYEBOLT	90°	6'-3"

FIXTURE

1. GLASS WASHINGTON POSTLITE LED (WAE3)
2. P30 LED PERFORMANCE PKG
3. 4000K SERIES CCT
4. AUTO-SENSING 120-277V 50/60 Hz
5. ENHANCED STYLE HOUSING
6. TYPE III OPTICS, CMC FINISH
7. SPIKE FINIAL, CMC FINISH
8. FIELD ADJUSTABLE OUTPUT
9. 7-PIN DIMMING PHOTOCONTROL RECEPTACLE
10. SHORTING CAP

CATALOG #'s

1. POLE: RTFS12T5-MODHH-RP99P024 RFD214417
2. ARM: PCP36CARP99P024
3. BASE: C24CSBCIU246E
4. RECEPTACLES: FGIUS-SRP99P024 RFD214417, FG-SPCU246E
5. BANNER ARM: BBD30H4U246E-SPCL RFD214417
6. EYEBOLT: EBBRP99P024
7. ANCHOR BOLTS: AB-31-4
8. FIXTURE: (2) WAE3P3040KMVOLTENGL3CMCSKTCMCAOPR7SH

DRAFT

HISTORIC FRANKLIN TENNESSEE

STREETSCAPE LIGHT POLE (MAIN STREET - DOUBLE)

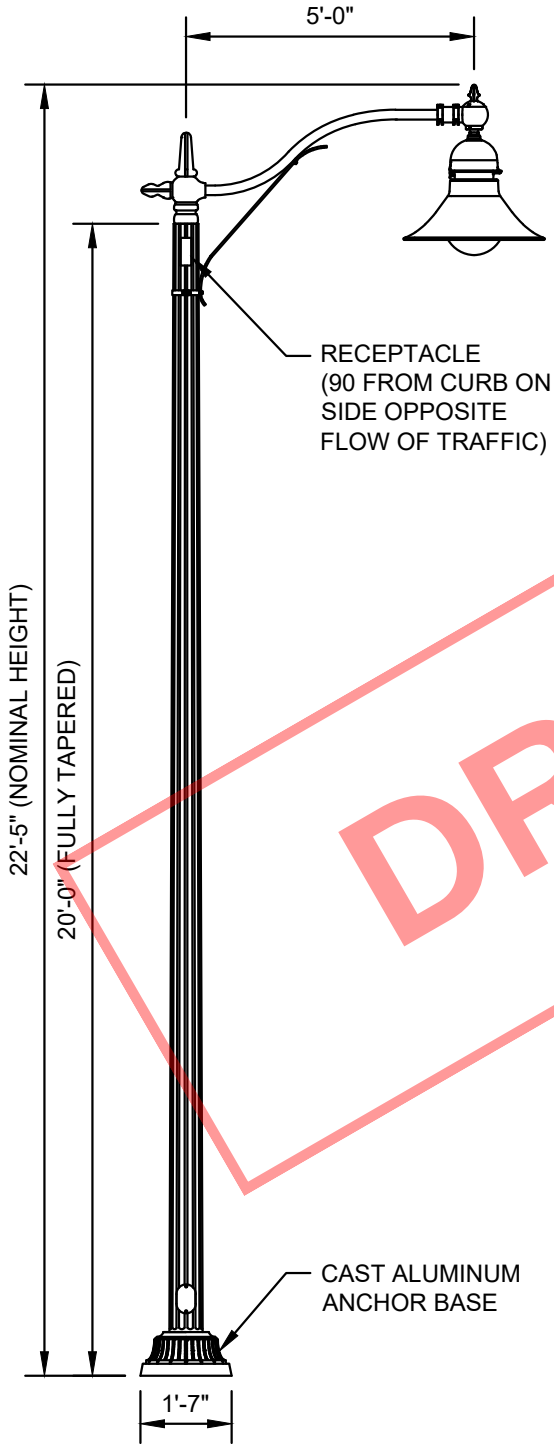
DWG. NO. **L-4**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



APPLICABILITY

1. DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS, EXCEPT ALONG MAIN STREET

POLE AND APPURTENANCES

1. ALUMINUM ROUND FLUTED TAPERED POLE
2. (1) GFI RECEPTACLE, w/ IN-USE WEATHERPROOF COVER
3. ATLANTA SERIES CAST ALUMINUM CLAMSHELL BASE, 19" DIAMETER, HOLOPHANE SANTA ROSA STYLE
4. HOLOPHANE BHC SERIES BOSTON HARBOUR STYLE CURVED ARM w/ DECORATIVE SUPPORT STRAP AND FINIAL
5. FINISH: SHERWIN-WILLIAMS #PGS8-90245 (FRANKLIN GREEN) 80% GLOSS

DRAFT

FIXTURE

1. PRAGUE STYLE FIXTURE
2. PRISMATIC GLASS BOWL LENS
3. PULSE START METAL START LAMP

CATALOG #'s

1. FIXTURE : GP175WPM241AS73N

HISTORIC FRANKLIN TENNESSEE

RURAL STYLE STREET LIGHT

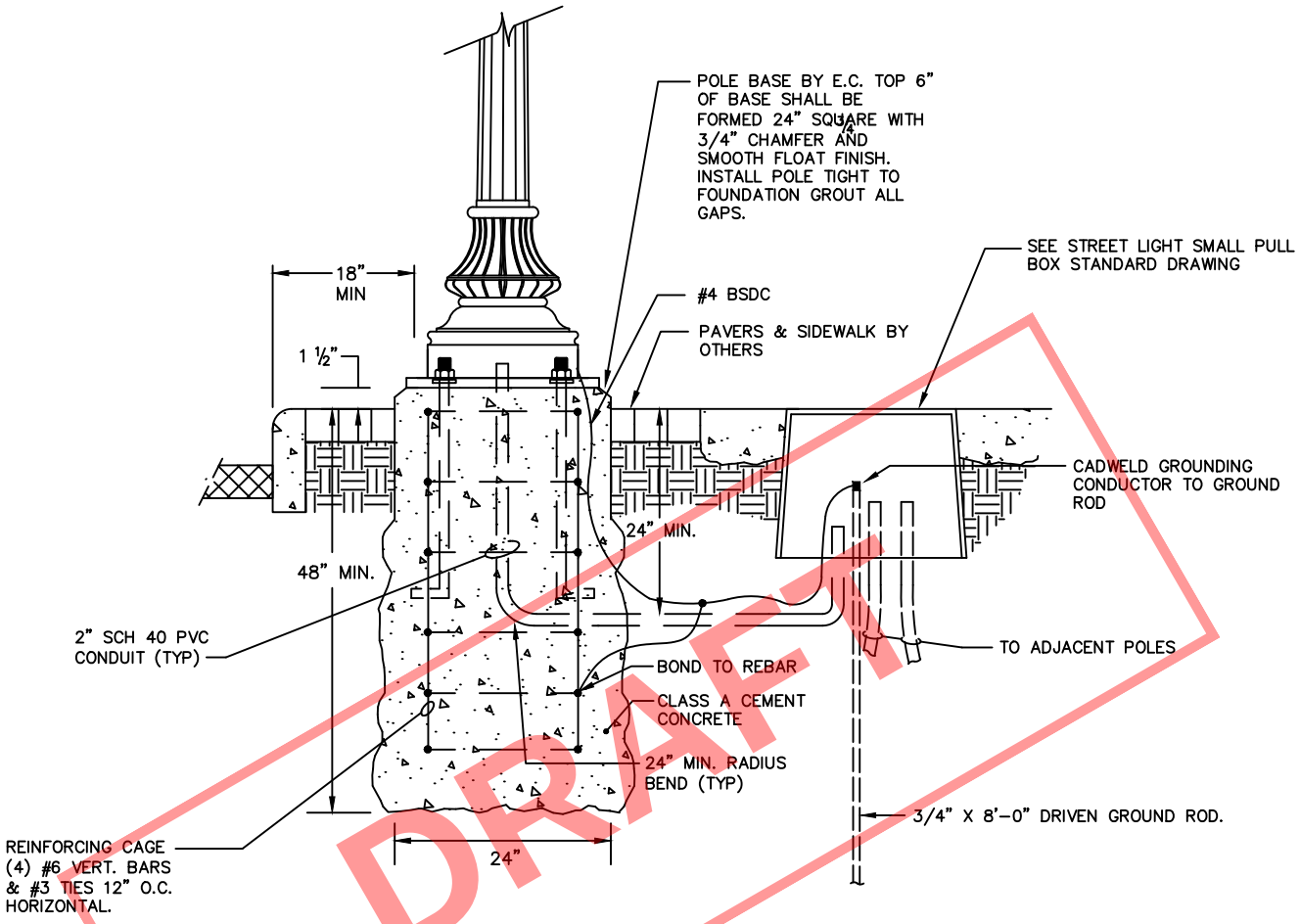
DWG. NO. **L-5**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

NOTES:

1. THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREET.
2. PROVIDE POLE LENGTH REQUIRED BY SOIL CONDITIONS AND POLE / LUMINAIRE (INCLUDING WIND LOADING.)
3. WHERE REQUIRED BY SITE CONDITIONS, PROVIDE SPREAD–TYPE FOOTING.
4. FOUNDITIONS SHALL BE DESIGNED BY LICENSED ENGINEER

N.T.S

HISTORIC FRANKLIN TENNESSEE

STREETSCAPE LIGHT POLE BASE DETAIL

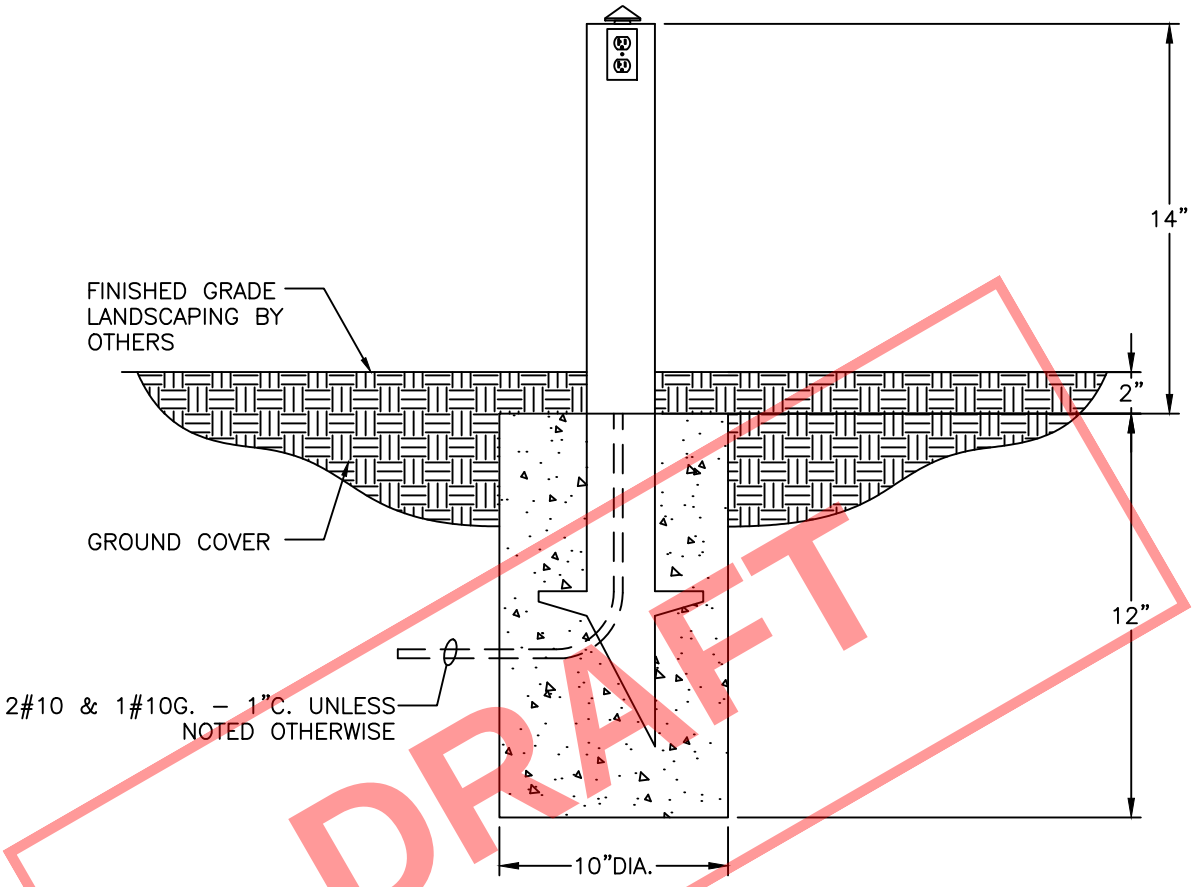
DWG. NO. **L-6**

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



DRAFT

NOTES:

1. PROVIDE A ”FRANKLIN GREEN 80% GLOSS” RECEPTACLE POST (ARLINGTON INDUSTRIES #GP26B OR APPROVED EQUAL) WITH BLACK GROUND FAULT INTERUPTING RECEPTACLE (HUBBELL GF5362 OR APPROVED EQUAL) AND IN–USE WEATHER PROOF COVER (ARLINGTON INDUSTRIES #60VC OR APPROVED EQUAL)

NOTE:

THIS DETAIL TO BE USED IN DOWNTOWN FRANKLIN GATEWAY CORRIDORS AND CONNECTOR STREETS.

N.T.S

HISTORIC FRANKLIN TENNESSEE

PLANTER RECEPTACLE DETAIL

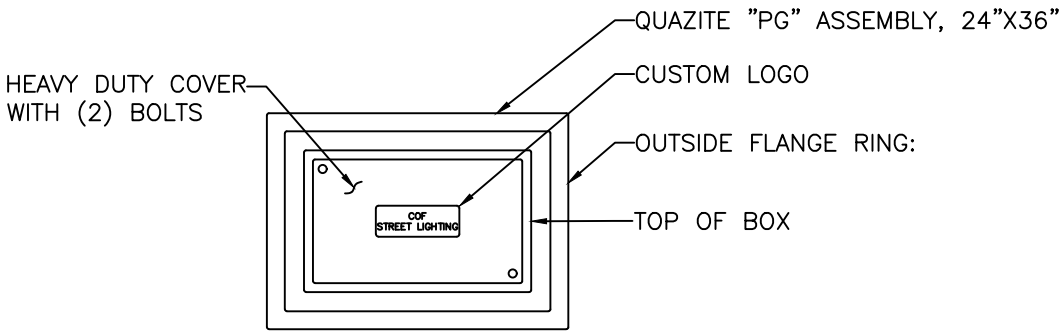
DWG. NO. **L-7**

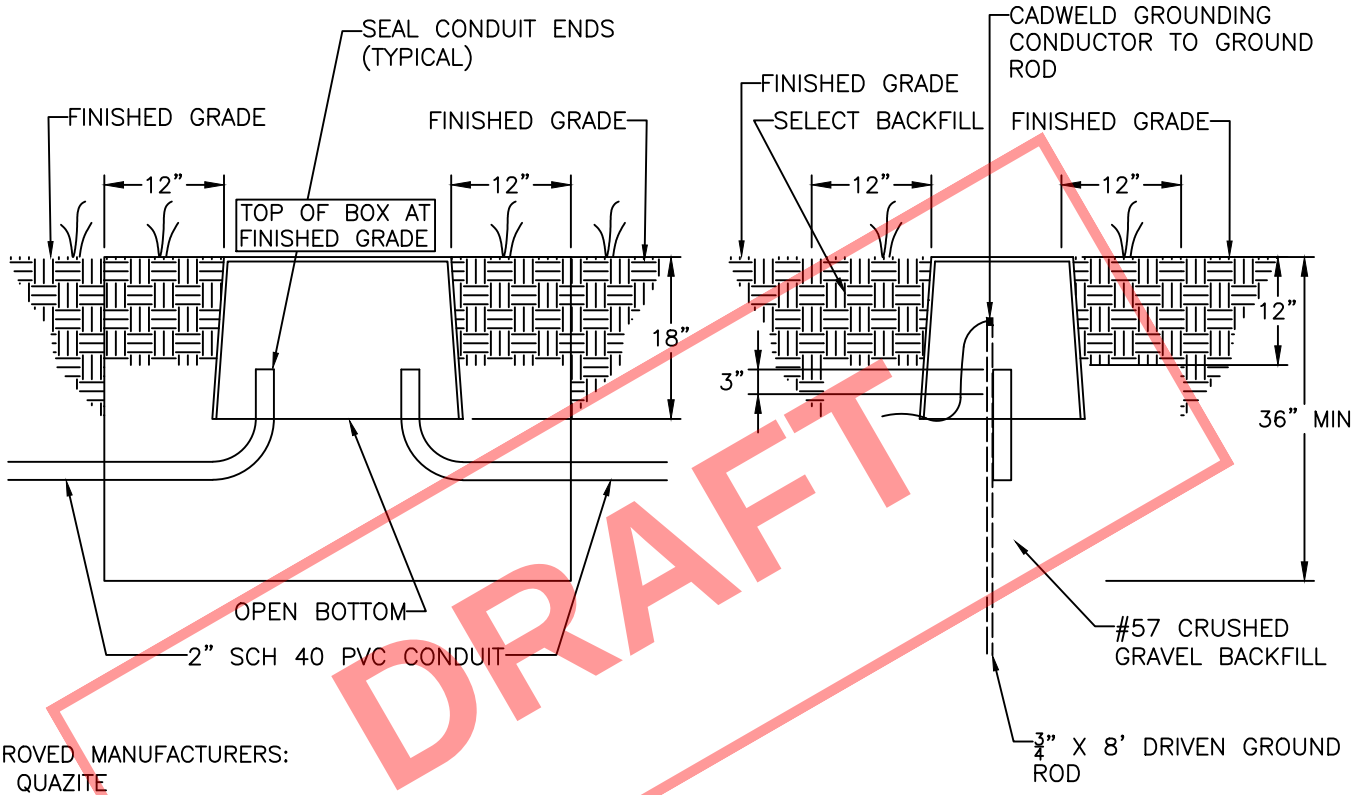
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021





DRAFT

APPROVED MANUFACTURERS:
1. QUAZITE
2. MARTIN ENTERPRISES
3. ARMORCAST

NOTES:
1) EXCAVATE AND BACKFILL WITH MINIMUM EIGHTEEN INCH (18") THICK LAYER OF #57 CRUSHED GRAVEL.
2) INSTALL BOX AND BACKFILL TO WITHIN TWELVE INCHES (12") OF FINISHED GRADE WITH #57 CRUSHED GRAVEL.
3) BACKFILL INSIDE BOX WITHIN THREE INCHES (3") OF THE TOP OF THE CONDUIT WITH #57 CRUSHED GRAVEL.
4) THE TOP OF THE PULL–BOX MUST BE FLUSH WITH FINISHED GRADE.
5) PULL–BOX TO BE FURNISHED AND INSTALLED BY CUSTOMER.
6) SCHEDULE INSPECTION OF PULL–BOX INSTALLATION WITH CITY OF FRANKLIN STREET DEPARTMENT A MINIMUM OF THREE BUSINESS DAYS PRIOR TO INSPECTION.
7) CITY OF FRANKLIN RESERVES THE RIGHT TO REQUIRE A LARGER PULL–BOX. IF LARGER PULL–BOX IS REQUIRED, THE CITY WILL ISSUE SPECIFICATIONS AND INSTALLATION REQURIEMENTS FOR THE LARGER PULL–BOX.
8) PULL–BOXES ARE REQUIRED TO BE INSTALLED AT THE MIDPOINT OF ANY CIRCUIT RUN THAT EXCEED 300 FEET
9) PULL–BOXES ARE NOT TO BE INSTALLED IN THE PATH OF VEHICLAR TRAVEL.
10) PULL–BOXES SHALL BE UL LISTED.

N.T.S

HISTORIC FRANKLIN TENNESSEE

STREET LIGHT LARGE PULL BOX INSTALLATION DETAIL

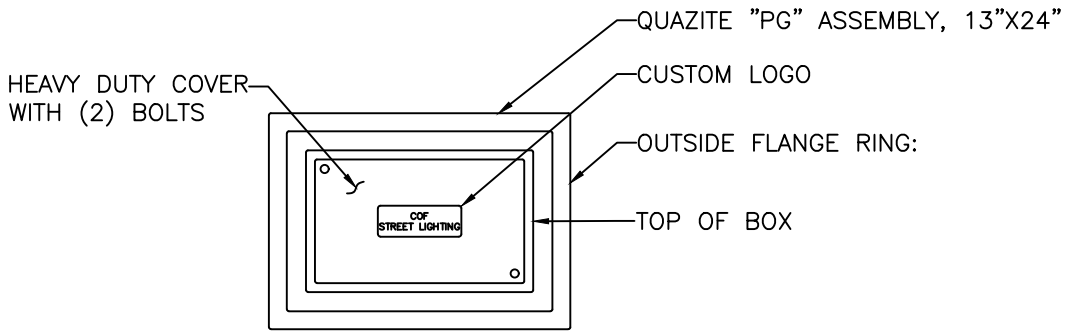
DWG. NO. **L-8**

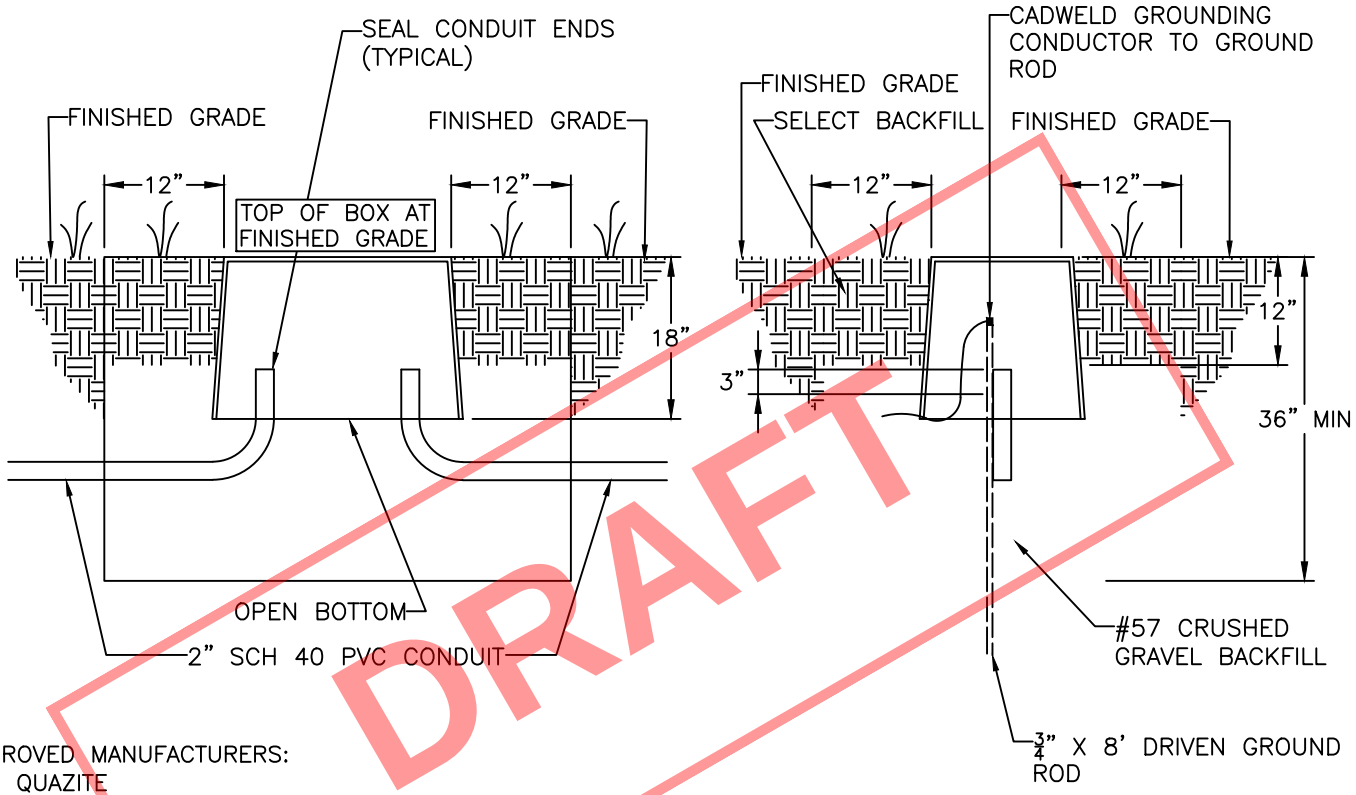
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021





DRAFT

APPROVED MANUFACTURERS:
1. QUAZITE
2. MARTIN ENTERPRISES
3. ARMORCAST

NOTES:
1) EXCAVATE AND BACKFILL WITH MINIMUM EIGHTEEN INCH (18") THICK LAYER OF #57 CRUSHED GRAVEL.
2) INSTALL BOX AND BACKFILL TO WITHIN TWELVE INCHES (12") OF FINISHED GRADE WITH #57 CRUSHED GRAVEL.
3) BACKFILL INSIDE BOX WITHIN THREE INCHES (3") OF THE TOP OF THE CONDUIT WITH #57 CRUSHED GRAVEL.
4) THE TOP OF THE PULL–BOX MUST BE FLUSH WITH FINISHED GRADE.
5) PULL–BOX TO BE FURNISHED AND INSTALLED BY CUSTOMER.
6) SCHEDULE INSPECTION OF PULL–BOX INSTALLATION WITH CITY OF FRANKLIN STREET DEPARTMENT A MINIMUM OF THREE BUSINESS DAYS PRIOR TO INSPECTION.
7) CITY OF FRANKLIN RESERVES THE RIGHT TO REQUIRE A LARGER PULL–BOX. IF LARGER PULL–BOX IS REQUIRED, THE CITY WILL ISSUE SPECIFICATIONS AND INSTALLATION REQURIEMENTS FOR THE LARGER PULL–BOX.
8) PULL–BOXES ARE REQUIRED TO BE INSTALLED AT THE MIDPOINT OF ANY CIRCUIT RUN THAT EXCEED 300 FEET
9) PULL–BOXES ARE NOT TO BE INSTALLED IN THE PATH OF VEHICLAR TRAVEL
10) PULL–BOXES SHALL BE UL LISTED.

N.T.S

HISTORIC FRANKLIN TENNESSEE

STREET LIGHT SMALL PULL BOX INSTALLATION DETAIL

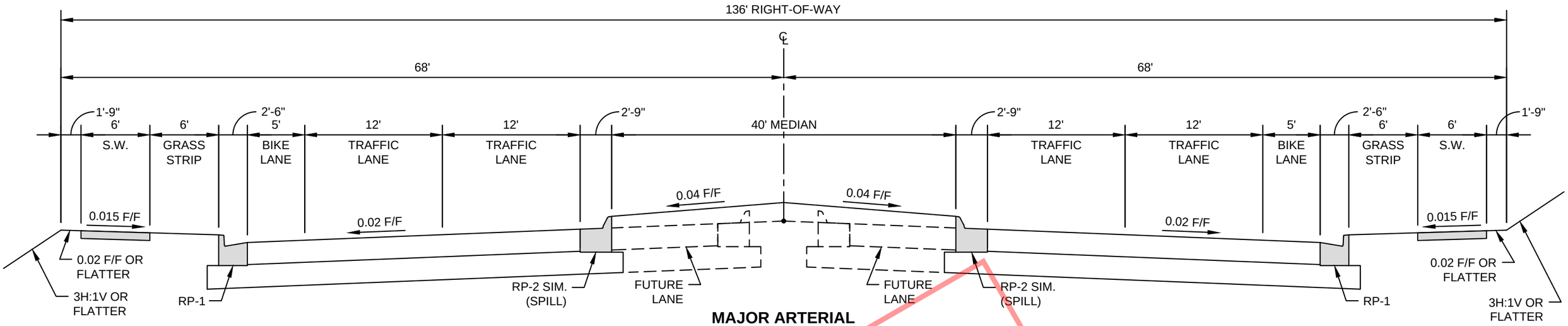
DWG. NO. **L-9**

CITY OF FRANKLIN

NOT TO SCALE

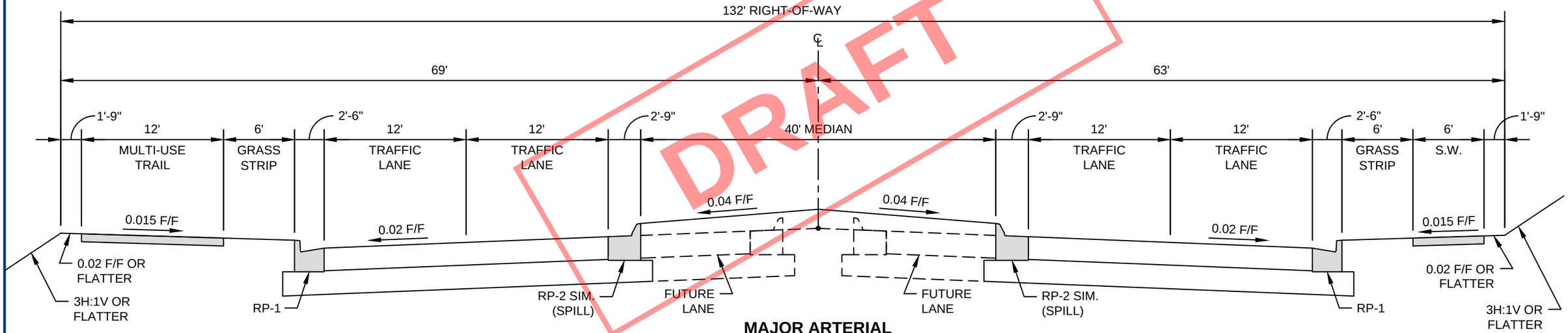
CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



MAJOR ARTERIAL

(WITH BIKE LANES)



MAJOR ARTERIAL

(WITH MULTI-USE TRAIL)

DRAFT

DESIGN NOTES

HISTORIC FRANKLIN TENNESSEE

MAJOR ARTERIAL STREET SECTIONS

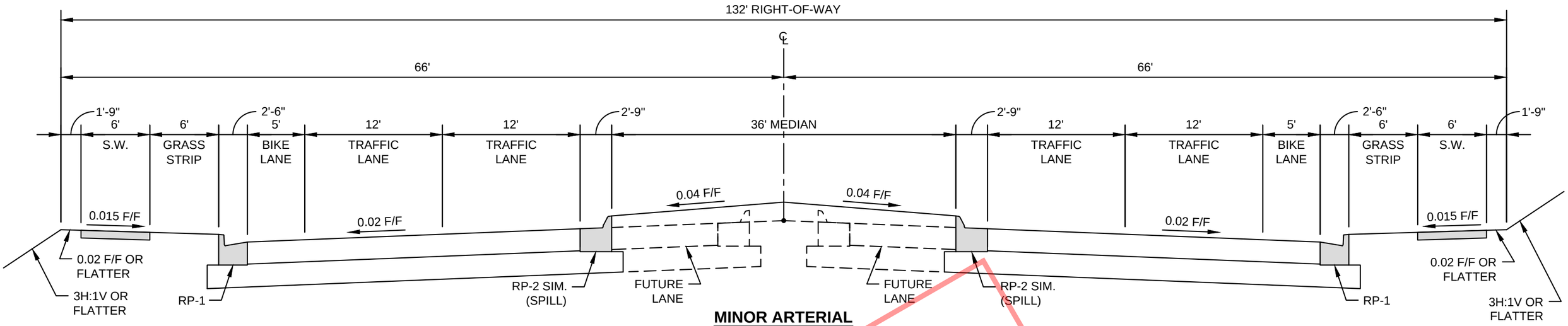
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

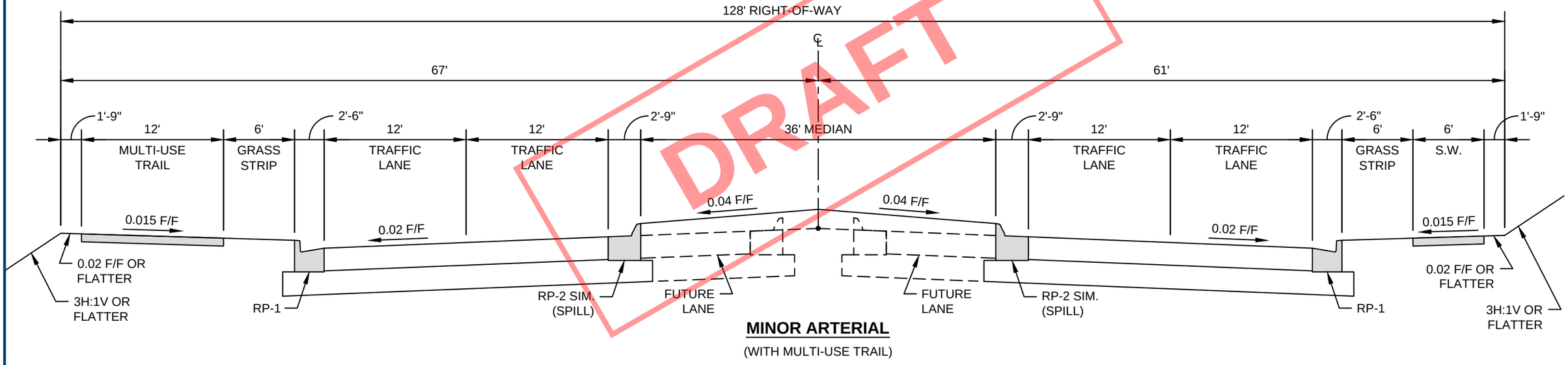
DATE: 7/1/2021

DWG. NO. **TS-1**



MINOR ARTERIAL

(WITH BIKE LANES)



MINOR ARTERIAL

(WITH MULTI-USE TRAIL)

DRAFT

DESIGN NOTES

HISTORIC FRANKLIN TENNESSEE

MINOR ARTERIAL STREET SECTIONS

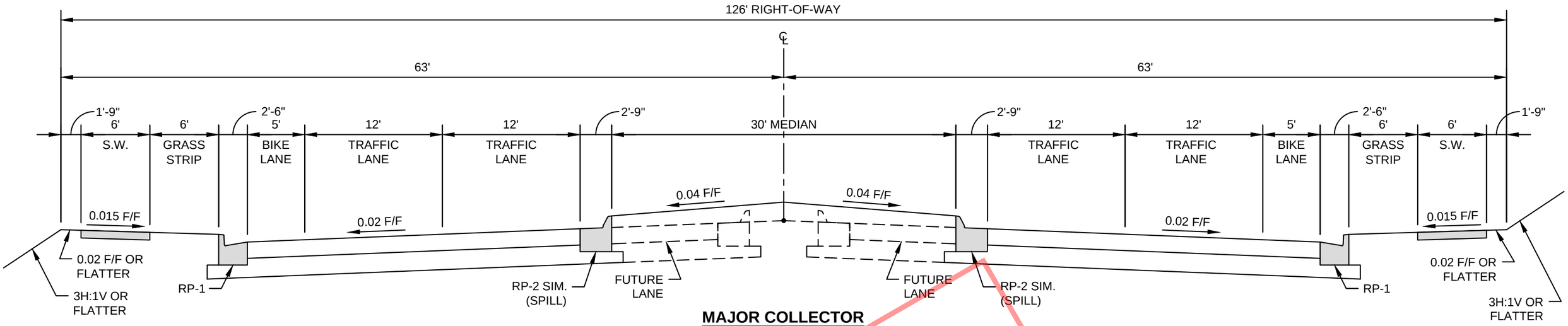
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

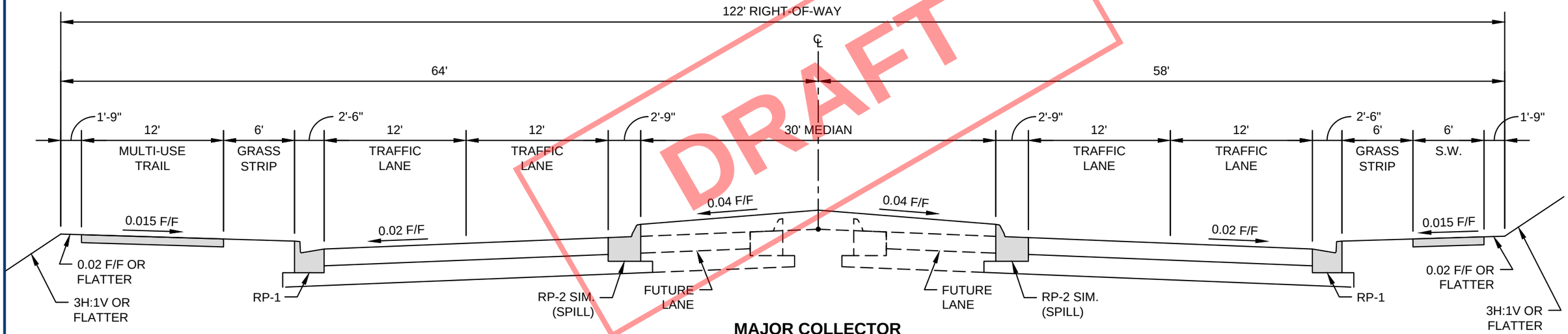
DATE: 7/1/2021

DWG. NO. **TS-2**



MAJOR COLLECTOR

(WITH BIKE LANES)



MAJOR COLLECTOR

(WITH MULTI-USE TRAIL)

DRAFT

DESIGN NOTES

HISTORIC FRANKLIN TENNESSEE

MAJOR COLLECTOR STREET SECTIONS

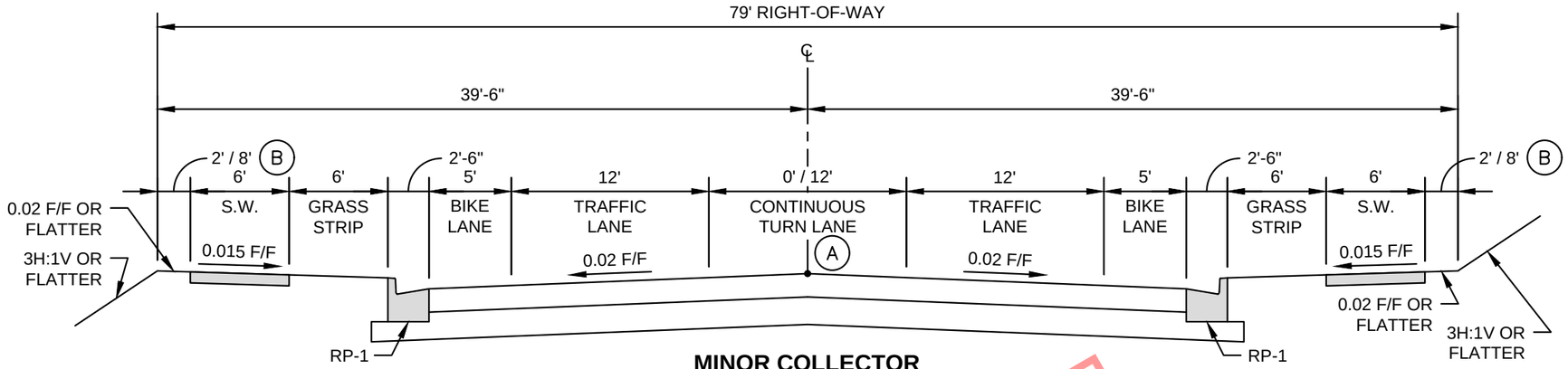
CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

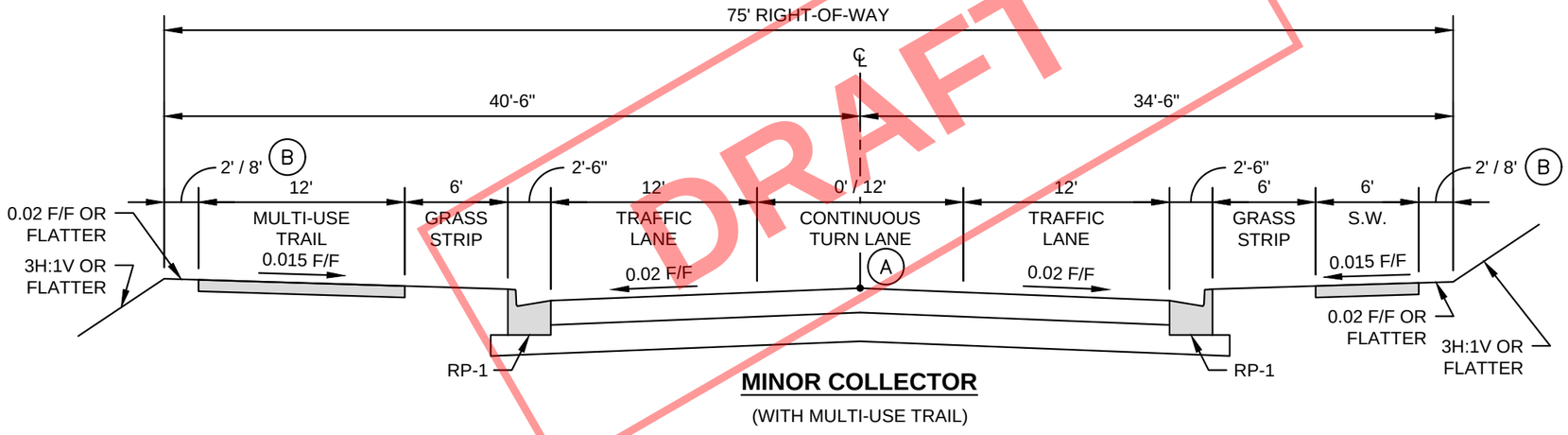
DATE: 7/1/2021

DWG. NO. **TS-3**



MINOR COLLECTOR

(WITH BIKE LANES)



MINOR COLLECTOR

(WITH MULTI-USE TRAIL)

DRAFT

DESIGN NOTES
(A) CONSTRUCT CONTINUOUS TURN LANE (3-LANE SECTION) WHERE REQUIRED BY *CONNECT FRANKLIN*
(B) 2' WHERE A CONTINUOUS TURN LANE IS PROVIDED 8' WHERE A CONTINUOUS TURN LANE IS NOT PROVIDED

HISTORIC FRANKLIN TENNESSEE

MINOR COLLECTOR STREET SECTIONS

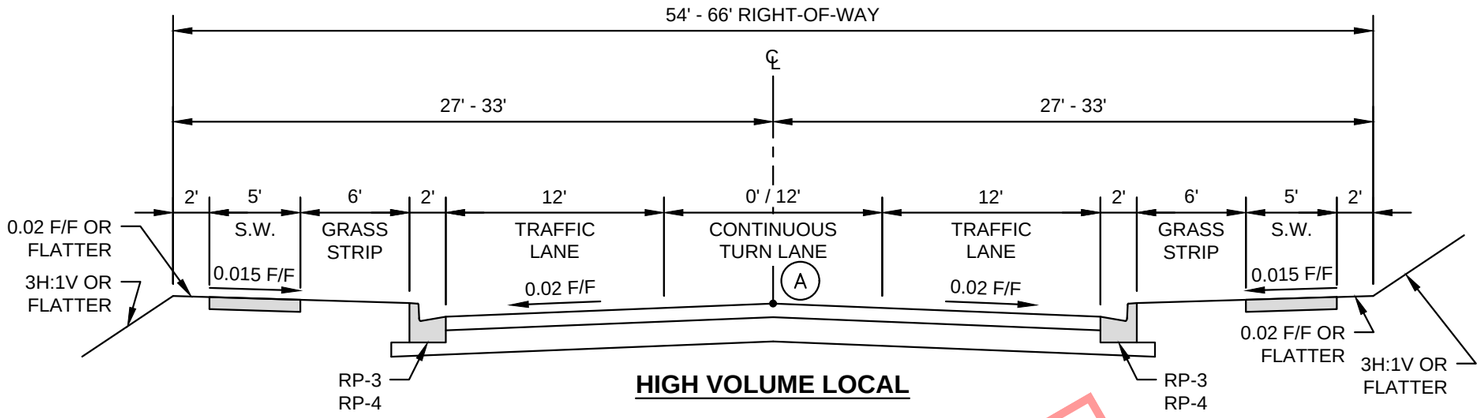
CITY OF FRANKLIN

NOT TO SCALE

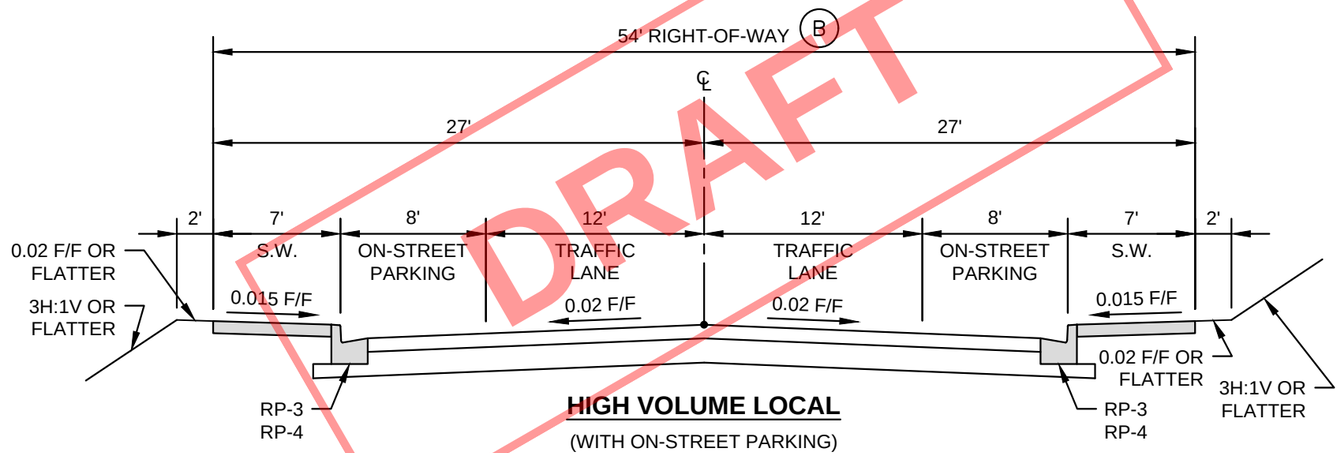
CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

DWG. NO. **TS-4**



HIGH VOLUME LOCAL



HIGH VOLUME LOCAL
(WITH ON-STREET PARKING)

DRAFT

DESIGN NOTES	
A	CONSTRUCT CONTINUOUS TURN LANE (3-LANE SECTION) WHERE REQUIRED BY CITY ENGINEER
B	ADDITIONAL RIGHT-OF-WAY OR PUBLIC ACCESS EASEMENT WIDTH SHALL BE PROVIDED AS NEEDED TO ACCOMMODATE ACCESSIBLE ON-STREET PARKING.

HISTORIC FRANKLIN TENNESSEE

HIGH VOLUME LOCAL STREET SECTIONS

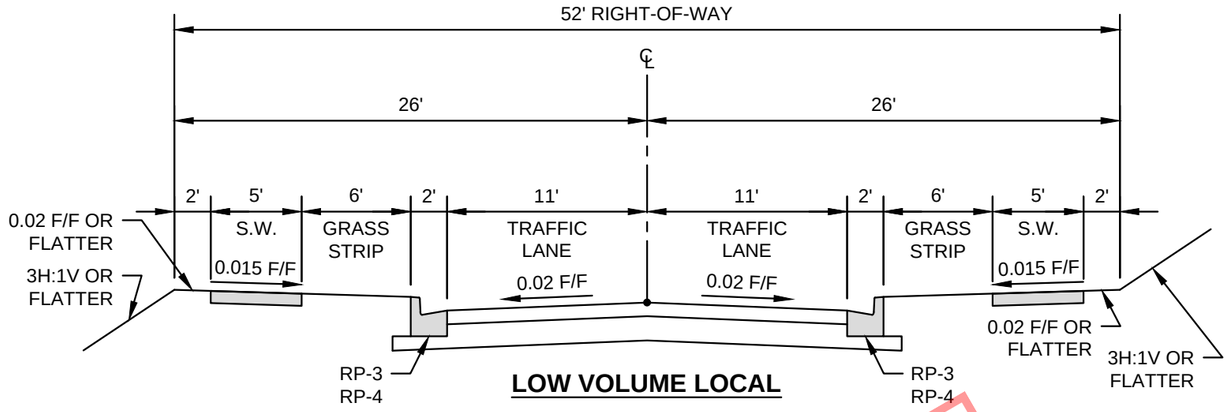
CITY OF FRANKLIN

NOT TO SCALE

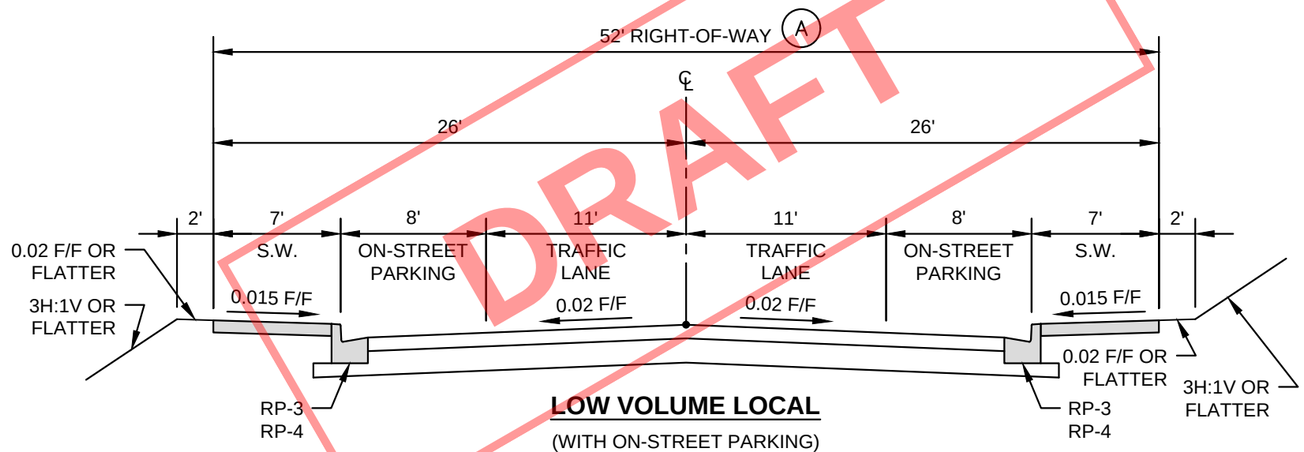
CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

DWG. NO. **TS-5**



LOW VOLUME LOCAL



LOW VOLUME LOCAL

(WITH ON-STREET PARKING)

DRAFT

DESIGN NOTES
(A) ADDITIONAL RIGHT-OF-WAY OR PUBLIC ACCESS EASEMENT WIDTH SHALL BE PROVIDED AS NEEDED TO ACCOMMODATE ACCESSIBLE ON-STREET PARKING.

HISTORIC FRANKLIN TENNESSEE

LOW VOLUME LOCAL STREET SECTIONS

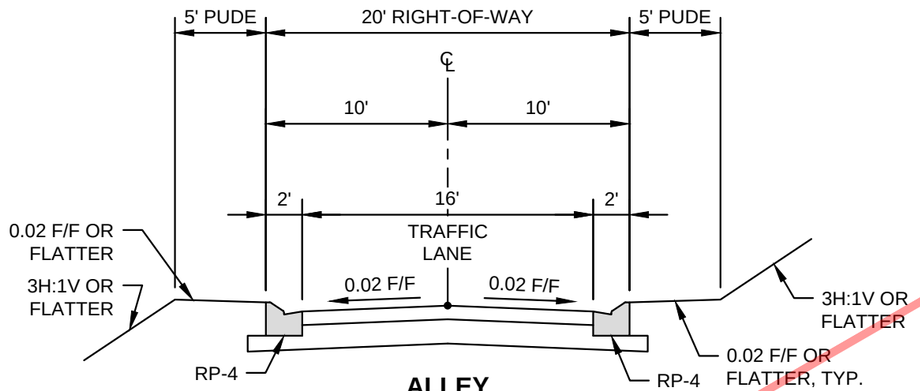
DWG. NO. **TS-6**

CITY OF FRANKLIN

NOT TO SCALE

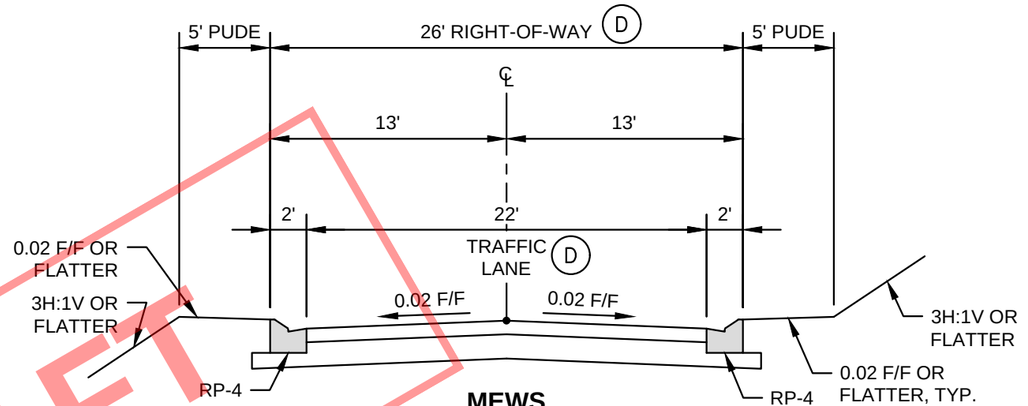
CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021



ALLEY

(B)(C)



MEWS

(A)(C)

DRAFT

GENERAL NOTES
1. UTILITY SEPARATIONS SHALL MEET WATER MANAGEMENT DEPARTMENT GENERAL REQUIREMENTS AND TECHNICAL SPECIFICATIONS.
2. 'PUDE' DENOTES A PUBLIC UTILITY AND DRAINAGE EASEMENT

SIGNAGE		
	ALLEY	MEWS
NO PARKING SIGNS (EACH SIDE)	YES	YES
STOP SIGN AT INTERSECTION	NO	YES
STREET NAME SIGN AT INTERSECTION	NO	YES

DESIGN NOTES	
(A)	NO UTILITIES OTHER THAN STORM, WATER, AND SANITARY SEWER PERMITTED WITHIN MEWS R.O.W.
(B)	NO UTILITIES OTHER THAN STORM AND EITHER WATER OR SANITARY SEWER PERMITTED WITHIN ALLEY R.O.W.
(C)	MAXIMUM SANITARY SEWER DEPTH WITHIN MEWS AND ALLEY R.O.W. MAY BE LIMITED BASED ON SURROUNDING CONDITIONS. COORDINATE WITH WATER MANAGEMENT DEPARTMENT.
(D)	WHERE AN APPROVED AUTOMATIC SPRINKLER SYSTEM IS PROVIDED TO ALL HOMES SERVED BY THE MEWS, THE MEWS TRAFFIC LANE MAY BE REDUCED TO 18 FEET AND MEWS ROW MAY BE REDUCED TO 22 FEET.

HISTORIC FRANKLIN TENNESSEE

ALLEY AND MEWS SECTIONS

CITY OF FRANKLIN

NOT TO SCALE

CITY ENGINEER: Paul P Holzen

DATE: 7/1/2021

DWG. NO. **TS-7**

FRANKLIN TRANSPORTATION & STREET TECHNICAL STANDARDS

HISTORIC FRANKLIN TENNESSEE

City of Franklin, TN
Transportation & Street Technical Standards, 2021 Edition

Chapter	Chapter Title	Pg.
1	General Provisions and Requirements	1-1
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CHAPTER 1

GENERAL PROVISIONS AND REQUIREMENTS

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1.1 Title

These standards shall be known as the "Franklin Transportation and Street Technical Standards", referred to throughout this document as "these Standards."

1.2 Purpose

The purpose of these Standards is to provide reasonable design and construction guidelines for transportation infrastructure within the City of Franklin that promote economical and durable designs and allow for safe and efficient traffic movement.

1.3 Authority

These Standards were adopted by the Board of Mayor and Aldermen (BOMA) and became effective on XXX, 2021 by Ordinance XXXX-XX.

1.4 Applicability

Except as may otherwise be required by law, these rules and regulations govern the construction of new streets, existing streets requiring improvement or rehabilitation, and all associated improvements and appurtenances, both public and private, installed in the City of Franklin, Tennessee ("the City").

1.5 Compatibility

If any provision of these Standards and any other provisions of law impose overlapping or contradictory requirements, or contain any restrictions covering any of the same subject matter, that provision which is more restrictive or imposes higher standards or requirements shall govern unless otherwise specified.

These Standards do not relieve the applicant from provisions of any other applicable code, ordinance, or regulation.

Any conflicts, errors, or omissions in the approval of any application shall not relieve the applicant from compliance with these Standards, or with any other regulatory agency with jurisdiction over the project.

1.6 City Engineer

All places within these Standards that reference the "City Engineer" shall refer to the City of Franklin, Tennessee City Engineer or their designated representative.

1.7Standard Drawings and Typical Street Sections

The Standard Drawings and Typical Street Sections produced by the City of Franklin Engineering Department and available online on the City of Franklin Engineering webpage are incorporated by reference into these Standards.

1.8 Specifications and Resources

Infrastructure within the City shall be designed and constructed per the latest edition of the following documents:

- "*A Policy on Geometric Design of Highways and Streets*", latest edition, American Association of State Highway and Transportation Officials; AASHTO. (Hereinafter referred to as the "*Green Book*").

- "*Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400)*", latest edition, American Association of State Highway and Transportation Officials; AASHTO.

- "*Guide for the Development of Bicycle Facilities*", latest edition, American Association of State Highway and Transportation Officials; AASHTO.

- "*AASHTO Roadside Design Guide*", latest edition, American Association of State Highway and Transportation Officials; AASHTO.

- "*Traffic Engineering Handbook*", latest edition, Institute of Transportation Engineers

- "*Trip Generation Manual*", latest edition, Institute of Transportation Engineers.

- "*Manual on Uniform Traffic Control Devices for Streets and Highways*", latest edition, U.S. Department of Transportation, Federal Highway Administration; FHWA. (Hereinafter referred to as the "*MUTCD*").

- "*Roundabouts: An Informational Guide*", latest edition, U.S. Department of Transportation, Federal Highway Administration; FHWA.

- "*Public Right of Way Accessibility Guidelines*" latest edition, United States Access Board. (Hereinafter referred to as the "*PROWAG*").

- "*AASHTO LRFD Bridge Design Specifications*", latest edition, American Association of State Highway and Transportation Officials; AASHTO.

- "*Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting, ANSI/IES RP-8*", latest edition, American National Standards Institute, ANSI, and Illuminating Engineering Society, IES.

- The following Publications of the Tennessee Department of Transportation, latest editions. (Hereinafter referred to as "*TDOT Standard Specifications*")
  - "*TDOT Standard Specifications for Road and Bridge Construction*"
  - "*TDOT Survey Manual*"
  - "*TDOT Roadway Design Guidelines*"
  - "*TDOT Standard Drawings*"
  - "*TDOT Traffic Design Manual*"

- The City of Franklin Supplemental Specifications To: The Tennessee Department of Transportation Specifications for Road and Bridge Construction, March 1, 2015 as amended.

- The City of Franklin Corridor and Connector Streets Economic Development Projects; Zoning Ordinance; Stormwater Ordinance; Subdivision Regulations; Major Thoroughfare Plan; Land Use Plan, and Administrative Manual, latest editions.

In the case of a conflict between the documents above and provisions elsewhere in these Standards, the provisions in these Standards shall govern, unless the construction is within State of Tennessee right-of-way.

1.9 Plan Standards

In order to provide consistency and maintain accuracies, the following criteria are to be adopted for the roadway plans.

Plans submitted must be submitted in PDF and AutoCAD format. Each plan submittal shall be completed digitally through the City's Electronic Plan Submittal Process.

Exemptions to these standards may be granted by the City Engineer upon request, based on project scope and location.

1.9.1 Survey

Survey information in the form of point data files must be included at the time of plan submission. All survey data gathering shall adhere to "TDOT Standard Specifications".

Survey procedures require that all surveys shall be tied to the State Plane Coordinate System using the Tennessee Geodetic Reference Network (TGRN). All surveyed coordinate values will be based on the North American Datum 1983 (NAD/83) (1995 adjustment) coordinates and appropriate notes indicating such shall appear on the topography plot.

All design computations shall be based on these adjusted coordinate values. This will ensure that all computed points on the project will have coordinate values tied to the State Plane System. Assumed coordinates will not be used.

Coordinate values for all PI's shall be shown on present and proposed (if any are shown) layout sheets within each curve data table. Coordinate values shall also be listed for the beginning and ending points of the project. A notation near the title block in lower right hand corner for each sheet on which coordinates appear shall read, *"Coordinates are NAD/83 (1995), are datum adjusted by the factor of 1.000XXX"* and tied to the TGRN. The "1995" refers to the year of the most recent adjustment of coordinate values in Tennessee and 1.000XXX refers to the actual datum adjustment factor used for the project.

1.9.2 Construction Plan Submittal

The plan submittal shall consist of neat, scaled drawings with specifications and any other pertinent supportive data as required for review approval. These drawings shall include all aspects of the street, grading and drainage, including documentation or supporting evidence that proves sufficient engineering calculations have been performed in accordance with the approved project. The construction drawings and drainage calculations shall bear the stamp of a Registered Tennessee Professional Engineer. Other submittals for approval which are necessary and to be done by the Developer may include, but are not limited to the Franklin Planning Commission; the Tennessee Department of Transportation, the Tennessee Department of Environment and Conservation, and the Tennessee Division of Water Pollution Control, Natural Resources Section.

As a general guideline, the *supporting calculations shall include any engineering information that is pertinent to the project*. These may include, but are not limited to the following:

- Drainage calculations including culvert and bridge analysis, drainage areas, runoff values, energy dissipators
- Intersection sight distance calculations
- Quantity calculations (City projects)
- Structural calculations

The designer is encouraged to add notes on the plans explaining special situations or items which are not readily apparent and that would influence the proposed design. The following sheets and information will be reviewed for quality assurance at this submission:

Title Sheet – Information on the title sheet shall include the following:

- Project numbers
- Project location map including north arrow and scale
- Description of project work type
- Reference points at the beginning and end of the project
- Project lengths, including incidental construction
- Design data including design speed, design criteria, functional classification, terrain, traffic data, etc.
- Signature block

Index and General Notes Sheet – Provide a list of utility owners and addresses that will be affected by the project. The index blocks shall be completed to indicate the sheet numbers for the plans.

Typical Cross Sections – These should show basic configuration and design features. This will typically include the following:

- Lane and shoulder widths tied to centerline
- Construction centerline
- Profile Grade Line
- Cross slopes
- Pavement Design
- Station ranges/limits
- Curbs
- Sidewalk locations and widths
- Bicycle facilities
- Side slopes
- Shoulder configurations if warranted
- Retaining walls, culverts, and bridges if warranted
- Ditches, Seed/Sod areas

Plat Sheet/Property Map – (if required) shall be included for projects that require acquisition of right-of-way.

Plan and Profile Sheets - Elevations and grades of special ditches shall be shown so that accurate right-of-way requirements can be determined. Typically, the plan view and profile shall be shown on the same sheet. In addition to the criteria required for the previous submittal, the plan and profile sheets shall include the following:

- Horizontal alignment (e.g., horizontal curve data, PC, PI, PT, bearings)
- Vertical alignment and its relationship to grade controlling features
- All alignment controlling features (e.g., high-water levels, existing cross roads and bridges, regulated drains, drainage structures, railroads, under drain criteria, traffic maintenance considerations, cemeteries, historical buildings, parks, ADA requirements, etc.)
- Preliminary drainage details, e.g., bridges and mainline culverts.
- Project limits
- Drainage features (e.g. pipe structures, ditch grades, preliminary inlet spacing for storm-sewer trunk line designs, etc.) and proposed drainage notes
- Public road approach and drive locations
- Construction limits
- Proposed right-of-way
- Approximate roadside barrier locations
- Permanent erosion protection
- Index and general notes sheet shall be up-to-date and accurate.
- The plan and profile sheets shall reflect correct structure notations, sodding, rip-rap and paved sodded ditch locations shall be indicated; earthwork balances are shown for City projects; and removal items are noted.
- If the project is to be funded by the City, tabulated values shall be included in the plan sheets that show quantities of all needed items.
- North Arrow and Scale for each sheet

Cross Sections – The cross sections shall include the following:

- Profile grade line
- Templates of the typical section placed on the existing cross sections
- Drainage structures
- Approaches and drives
- Clearance to buildings
- Final structure notation and final earthwork areas and volumes

Detail Sheets – The proposed layouts shall be included as follows:

- Turning movements and turn lanes
- Pavement markings
- Signals
- Signs, including sign structures
- Lighting
- Retaining walls
- Special drainage structures
- Superelevation transition diagrams
- Plans for temporary erosion control, traffic maintenance details, and traffic design elements (e.g., intersections, signals, signing and lighting).

Traffic Maintenance Details – The proposed traffic maintenance scheme and phasing shall be outlined and may be accompanied with "TDOT Standard Specifications".

Structure/Drainage Data Table – The preliminary information to be included in the structure data table is as follows:

- Location
- Size
- Type
- Approximate elevations and grades where necessary for clarity
- Type of headwall

Design Information - In addition to the plans, the designer shall include copies of the hydraulic analysis for mainline culverts and bridges, if applicable, and results of any economic analysis that may have been completed for alternative grade lines.

Cost Estimate – A construction cost estimate is required for City funded projects only. Quantities for all major items shall be included in the cost estimate. Miscellaneous pay items previously accounted for as a percentage of the cost estimate and which are not required to complete tables in the plans do not need to be quantified.

1.9.3 Revision of Plans

Should, prior to, or during construction, necessary changes be anticipated that would in the opinion of the City staff constitute significant revision of the plans already approved by the City, said plans shall be revised with said changes shown and resubmitted along with a letter stating why such changes are believed necessary. Changes deemed to be minor in nature by the Street Department Director may be made during construction with the changes noted for inclusion in the "as-built" drawings to be submitted to the City prior to final acceptance.

The City Engineer shall have the right to re-review the entire set of Plans should a revision of the plans be required.

1.10 Plan Review Procedure / Fees

After receiving approval of the Preliminary Plat, Final Plat, Development Plan, and/or Site Plan, the Developer or Developer's Engineer shall submit construction drawings for approval.

1.10.1 Submittal Requirements and Fees.

Submittal Requirements and Fees can be found in the Municipal Code and the Administrative Manual.

1.10.2 Approval of Drawings and Fees, On-site Approved Drawings Required

The City Engineer must approve plans, calculations and fees prior to the start of any work on the project. A complete set of approved Plans shall be available at the construction site at all times. Plans will not be deemed approved until the City Engineer and Street Department's stamps of approval have been affixed to the cover sheet of the drawings and specifications.

1.10.3 Expiration of Construction Drawings

Expiration of the construction drawings shall coincide with expiration of the Site Plan as per the applicable Franklin Zoning Ordinance.

1.11 Utility Coordination

Locating and coordination for the relocation of existing utilities within the City's right-of-way is the responsibility of the contractor. Tennessee's One-Call shall be utilized in addition to coordination with local

utility owners. The contractor shall at all times protect existing utilities and will be responsible for costs due to damage caused to any utility lines.

1.12 Historical Research Resources

It is the responsibility of the contractor and designer to identify historic properties and to submit and follow plans that take these into account. Record searches can be performed at the Tennessee Historical Commission (THC), which houses the Tennessee State Historic Preservation Office. THC is located in Nashville and is the central repository for information on architectural surveys for the state of Tennessee. Their records can assist the contractor and designer in determining properties along the project corridor that have been listed in the National Register of Historic Places or if they have been inventoried in past surveys. Any records of historic properties shall be noted on the construction plan as measures taken to avoid such properties.

1.13 Permits

Prior to beginning any construction, the Developer and/or Contractor, shall obtain all necessary permits as required by law. Such permits may include, but are not limited to, those required by State of Tennessee, Williamson County and the City.

Prior to beginning any construction activities, the Developer shall obtain all necessary City permits as outlined in Franklin Municipal Code, which may include, but are not limited to, Stormwater Management & Grading Permit, Excavation/Road Bore Permit, Demolition Permit, Building Permit, etc.

1.14 Notification of Construction

In addition to any other notices required by law (e.g., TN One Call, notices to non-participating utilities), before commencing any street construction operations, a 72 hour notice must be given during regular business hours to the Engineering Department (Traffic Operations Center) and Streets Department.

1.15 Quality Control Testing

Construction materials, including aggregate base stone, asphalt, concrete, and roadway sub-grades shall be fully tested in accordance with the designations and requirements within the referenced "TDOT Standard Specifications" sections. Unless otherwise noted within the "Standard Specifications" section, the type and number of tests called for by the referenced standards shall be performed.

Testing shall be done by an independent testing laboratory whose qualifications are approved by the City. Testing results will be submitted to and approved by the City Engineer. The City reserves the right to require industry standard certifications of testing and inspections by the testing laboratory, mills, shops and factories. Such certifications required shall be submitted in duplicate.

The Developer shall provide the necessary labor and supervision required to support field testing by the independent testing firm and inspections by City officials at no cost to the City. Test reports of field testing if applicable shall be submitted directly to the City Engineer. Defects disclosed by tests shall be rectified at no cost to the City. The Developer is required to have the design engineer or a certified quality control inspector present during all phases of construction. A daily log of work performed shall be kept by this individual and submitted to the City upon request.

1.16 Inspection

All projects shall be subject to inspection during and upon completion of construction by an authorized representative(s) of the City. Presence or absence of an inspector during construction does not relieve the Developer and/or Contractor from adherence to approved plans and material contained in these Standards or from liability. Materials and/or workmanship found not meeting requirements of approved plans and specifications shall be immediately brought into conformity with said plans and specifications.

An authorized representative of the City shall make a final inspection of the project after completion to determine acceptability of the work and for release of performance bonds if required. Before this final inspection can be made, the Engineer responsible for the project shall certify in writing to the City Engineer that the work has been completed in accordance with approved plans and specifications.

The cost for inspection during construction is calculated and paid as part of the Grading and Stormwater Permit. Additional inspection fees will be required only when an inspection requiring City approval fails and requires subsequent re-inspections. The Inspection Fee (current prices can be found in the City of Franklin Municipal Code) shall be paid to the City before issuance of Permits.

Drainage facilities including, but not limited to, culverts, detention basins and ditches, as well as the roadway sub-grade, base stone and binder & surface coarse shall be inspected, tested and given approval at each stage of installation prior to proceeding to the next stage of construction. Final construction inspection for approval and acceptance of streets and drainage systems will not be granted until all work has been completed in accordance with the approved plans.

1.17 As-Built Plan Submittal

Final as-built plans shall be submitted immediately following completion of construction activities. If the project is developed in phases, as-built plans for each phase shall be submitted once the work is complete in that phase. Acceptance of Facilities will not be issued until satisfactory as-built plans have been approved by the Street Department Director and the City Engineer.

All aspects of the project that have been affected by construction shall be verified and appear on the as-built plans. This would include, but is not limited to the following items:

- All property lines and easements
- Existing structures (Include patio covers, decks, trellises, sheds, pools, fences, poles, etc.)
- Location of all "as-built" work with station and offsets
- Height and location of all fences, walls, screens, tress and hedges over 42" tall
- All commercial driveways, paved areas, and required parking spaces
- All concealed components with station and offsets (include known buried cables, utilities, drainage structures, etc.)
- Video documentation of storm drainage
- Stormwater BMP'S (Detention/ Retention ponds, Bioretention Areas, etc.)
- All Utilities

Public or private stormwater infrastructure with nominal size of 12 inches or greater shall be video-inspected to verify proper installation, and the video recording and associated inspection report shall be submitted as part of the as-built record. The professional preparing the video shall be certified by the Pipeline Assessment and Certification Program (PACP). Video documentation shall be prepared in

conjunction with the preparation of drainage as-builts and shall be provided no more than 90 calendar days prior to a performance release request submittal. Additional testing may be required if warranted by the video inspection.

Other concealed components shall require documented proof to be submitted with the as-built plans in the form of a certified construction log that has been generated by the design engineer or a certified quality control inspector as detailed in Section 1.10 of these Standards.

As-built plans are required to be *endorsed by a Tennessee registered professional engineer and or a registered land surveyor.*

1.18 Acceptance of Facilities

After construction has been completed, a final inspection will take place by the City. City acceptance occurs when the Franklin Municipal Planning Commission releases performance bonds. Acceptance will occur once all contractual agreements have been met and construction meets the extents considered satisfactory under these Standards and deemed as such by the City.

Acceptance will only be issued after As-Built plans that adhere to requirements listed in these Standards have been submitted and approved by the City Engineer.

In the event of requests for acceptance of streets meeting development build-out requirements, but fronting a remaining vacant building lot, the developer shall post a Lot Bond for the vacant lot to insure protection of the as-built street improvements. Such bonds shall meet the requirements of Franklin Municipal Code, regarding Lot Bonds.

1.19 Existing Streets

Existing streets serving a proposed development shall make offsite safety improvements in accordance with these Standards as determined by the City Engineer.

1.20 Modification of Engineering Standards

The purpose of a modification of engineering standards is to provide limited relief from requirements of these Standards in cases where strict application of a particular requirement would create an exceptional hardship prohibiting the use of land in a manner otherwise allowed under these Standards. Self-imposed hardships, or actions taken by the applicant rather than conditions unique to the land in question, shall not be grounds for a modification of engineering standards.

A modification of engineering standards is not intended to remove inconveniences or financial burdens that the requirements of these Standards may impose of property owners in general.

A request for modification of engineering standards shall be made to the City Engineer in the form of a letter prepared by a licensed professional engineer. Each request shall include the following information. Incomplete requests shall be grounds for denial.

1) Documentation of the exceptional hardship and justification for the request;
2) Identification of the standard to be modified;
3) Identification of the alternative design or construction standard proposed;

4) Cost impacts to the City, including maintenance and replacement costs; and
5) Seal of the licensed professional engineering preparing the request.

The modification of engineering standards shall be considered by the City Engineer on a case-by-case basis and a determination shall be made using the following criteria:

1) Demonstration of an exceptional hardship due to unique physical surroundings, property shape, or topographical conditions of the property involved;
2) The granting of the modification shall not be detrimental to the safety, health, or welfare of the public, or injurious to other property or improvements;
3) The modification complies with acceptable engineering standards; and
4) The modification shall not place an undue financial burden on the City.

1) In approving modifications of engineering standards, the City Engineer may impose such conditions as in his or her judgement, shall secure substantially the objectives, standards, and requirements of these Standards.

1.21 Appeal of City Engineer Order or Decision

Any person aggrieved by any order or determination of the City Engineer may appeal said order or decision to the Building and Street Standards Board of Appeals, established in Franklin Municipal Code, and have such order or determination reviewed by the Building and Street Standards Board of Appeals. A written notice of Appeal shall be filed with the City Engineer, and such notice shall set forth with particularity the decision, action or inaction of the City Engineer complained of and the relief sought by the person filing said Appeal. See City of Franklin Municipal Code for additional details.

1.22 Revisions to these Standards

Per the Franklin Municipal Code Chapter 11, Title 16, Section 16-1101, major revisions to these Standards shall be adopted by ordinance of the City Board of Mayor and Aldermen; however, the City Engineer shall have the authority to issue minor revisions to the adopted standards for such items as administrative changes, error corrections, and clarifications that do not substantially alter the content or intent of the street specifications.

STREET DESIGN

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2.1 Standards for Design

The purpose of this chapter is to present the City criteria and guidelines for the design of streets and other related elements in the street right-of-way. It is to be used by the City, developers and their engineers in the design of public and private streets for which approval by the City Engineer is required. This chapter is not intended to address streets in the downtown urban core of the City, or streets in designated historic districts, however, certain criteria and guidelines in this chapter may be determined to be applicable to streets in these areas in order to preserve the public health, safety and welfare, as determined by the City Engineer.

2.1.1 General

All design drawings and support data submitted to the City Engineer for approval must be sealed by a registered Professional Engineer, licensed to practice in the State of Tennessee.

The design criteria, as presented, are intended to aid in preparation of plans and specifications, and include minimum standards where applicable. These design criteria are considered minimum and a complete design will usually require more than is presented in this document. Design of streets shall follow *"TDOT Standard Specifications"* unless otherwise noted in these Standards. For items not addressed in *"TDOT Standard Specifications"*, AASHTO's *"Green Book"* and other relevant AASHTO design documents shall be consulted for guidance. Where conflicts exist or interpretations are required, the City Engineer shall make the final determination in consultation with the designer.

2.1.2 Location and Layout of New Streets

The location and layout of new streets shall be as identified in the Major Thoroughfare Plan, Subdivision Regulations and Zoning Ordinance. Streets not identified in the Major Thoroughfare Plan shall meet the needs of the specific development and satisfy all other specific requirements of this chapter. The City Engineer retains the authority to designate collector and arterial streets as needed for circulation and emergency access and retains authority for approval of the overall street layout.

All streets shall have a logical relationship to the existing topography and to the location of existing, platted or planned streets within adjacent properties. In instances where a proposed street is not indicated on the Major Thoroughfare Plan, it should support a rectangular grid or modified grid street network to the maximum extent practicable. Curvilinear street networks shall only be used when topographic or environmental constraints make use of the grid pattern undesirable, or when established development patterns on adjacent lands make the grid pattern infeasible.

The street layout for all subdivisions shall be designed to ensure connectivity, enhance general circulation and to provide secondary points for emergency access. They shall also provide safe, efficient, and convenient vehicular, bicycle, and pedestrian access within and between developments. Certain streets may need to be extended to property boundaries to provide for the future logical extension of the street through adjacent properties. If an arterial or collector street is located within or adjacent to a development, the development shall continue the street to a logical termination point as determined by the City Engineer.

A major component in street layout is neighborhood traffic safety. This is an essential transportation issue in the City. Streets shall be designed to limit excessive traffic speeds and volumes in neighborhoods and provide for safe travel for all modes of transportation including pedestrian, bicycle, and vehicles. In addition, new streets in neighborhoods shall be laid out to minimize opportunities for cut-through traffic.

2.1.3 Traffic Impact Analysis

The City Engineer or his/her designee may require that a transportation impact analysis (TIA) be prepared for developments or projects meeting the criteria specified in this Subsection. The TIA shall consider traffic capacity and service, traffic controls, intelligent transportation systems (ITS), multi-modal accommodations and safety issues in accordance with the following standards:

(1) When Required

A TIA shall be required to assess the transportation impacts of a proposed development or project when:

(a) The expected number of primary trips generated by a proposed land use exceeds an estimated 1,000 vehicle trips per day or 100 peak hour vehicle trips per day; or

(b) A proposed land use generates less than 1,000 vehicle trips per day, or 100 peak hour vehicle trips per day when:

i. The use is on a site located at or near existing or planned signalized intersections; or
ii. The proposed land use may constitute a threat or danger to the safe and efficient flow of traffic, as determined by the City Engineer or his/her designee.

(c) The City Engineer or his/her designee may waive this provision if a recent, valid traffic study has been completed from which needed traffic impacts and mitigations can be extrapolated.

(d) When a development or project is subject to a land use plan amendment and/or rezoning, said land use plan amendment and/or rezoning application shall be accompanied by a new or updated TIA. At a minimum, the TIA shall provide information on both the existing Level of Service and future Level of Service based on the land use plan amendment and/or rezoning being proposed. This information shall be considered by the City of Franklin Board of Mayor and Aldermen when considering a land use plan amendment and/or rezoning. The Board of Mayor and Aldermen, at their discretion, may require system improvements to mitigate the traffic impacts resulting from a proposed land use plan amendment and/or rezoning, and may require said system improvements to be made by the applicant as a condition of approval. Any subsequent Development Plan associated with an approved land use plan amendment and/or rezoning shall be required to update the original TIA.

(2) Preparation of TIA

Reference the City of Franklin Traffic Impact Analysis (TIA) Guidelines on the City of Franklin Engineering webpage for TIA preparation requirements.

2.1.4 Connectivity

Plans shall achieve internal street connectivity by providing multiple connections to the existing city street network and adjacent lots wherever possible, and in accordance with these Street Standards.

(1) Cul-de-sacs

Cul-de-sacs are permitted only where allowed by the Franklin Zoning Ordinance. Where cul-de-sacs are created, at least one eight-foot-wide pedestrian access easement shall be provided, to the maximum extent practicable, between each cul-de-sac head and the sidewalk system of the closest adjacent street or pedestrian sidewalk or pathway.

2.1.5 Private Streets

Private streets serving more than one lot shall be built to the same standards as required for public streets and shall be located in a public utility drainage and access easement (PUDAE).

2.2 Street Classification and Right-of-Way

2.2.1 General

Listed below are the classifications of public streets used in the City. These classifications primarily provide different levels of emphasis in regard to traffic movement versus direct access to property. Transportation improvements developed in accordance with the street classification system will help to discourage through traffic from using local neighborhood streets, and local traffic from congesting regional travel facilities. This will not only improve the efficiency of the transportation system in the City, but will also maintain the livability of its neighborhoods.

The City Major Thoroughfare Plan specifically identifies all streets classified as Freeways, Expressways, Arterials and Collectors in the City. Streets without one of these classifications shall normally be considered a Local street. However, the City Engineer shall have the authority to verify all street classifications for the purpose of applying street design standards.

2.2.2 Street Classifications

(1) Freeways and Expressways

A divided arterial highway designed for the unimpeded flow of large traffic volumes. Access to a freeway is rigorously controlled and intersection grade separations are usually required. All freeways and expressways in the City are anticipated to be owned and designed by the Tennessee Department of Transportation (TDOT).

(2) Arterial Streets

Arterial streets are intended to primarily serve moderate to high traffic speeds and volumes within and through the City. Arterial streets may provide some access to abutting property, but only as it is incidental to the primary functional responsibility of travel service for major traffic movements. Arterial streets are classified as either Major Arterials or Minor Arterials depending upon expected traffic usage and adjoining property access.

(3) Collector Streets

Collector streets are intended to primarily serve slow to moderate traffic speeds and volumes and to distribute traffic from the arterials throughout the City to other collectors, arterials and local streets. Collector streets shall provide both land access service and traffic circulation within residential neighborhoods and commercial and industrial areas. Collector streets will be classified as either Major Collectors (further broken down to commercial/industrial or residential), or Minor Collectors depending upon expected traffic usage and adjoining property access. Major Collector streets may have limited driveway access to maintain the street's ability to achieve a safer and efficient traffic flow.

(4) Local Streets

Local streets are intended to primarily serve slow speeds and volumes and to provide access to abutting lands and connections to the higher street classifications. Local streets are to be planned so that future urban expansion will not require the conversion of local streets to collector or arterial streets. Local streets may be commercial/industrial or residential depending

upon the type and extent of the development and zoning they serve. Local streets may be terminated by a "cul-de-sac" where necessary due to topographic or other constraints.

(5) Alley / Mews

Alleys and mews are intended to primarily serve very slow speeds and volumes associated with the rear access and service functions for residential and commercial properties. Mews are a special type of alley that serves as the only vehicular and emergency access for lots abutting the mews. No vehicle parking area, fence, structure, vegetation, or wall shall be erected, maintained, or planted within the alley / mews right-of-way or within two feet of the edge of the alley / mews pavement/curb, whichever is greater.

(6) Private Streets

Private streets are streets that provide access to more than one lot but are not owned, operated and maintained by the City. Private streets shall be required to meet City design standards as determined by the City Engineer.

(7) Frontage Roads

Frontage roads are streets that normally run parallel to major roadways, usually arterials, to provide access to adjacent properties. Such streets greatly reduce the level of private driveway access to the major streets. Frontage roads are not typically used in the City and must be approved in advance by the City Engineer.

2.2.3 Cross Sections

Typical features and dimensions of standard City streets are illustrated in the Typical Section Drawings. These standard sections may be revised by the City Engineer on a case-by-case basis, to meet specific needs that may exist, or are projected to exist, along a particular street section. The following table summarizes for each standard section the primary design elements and their dimensions.

Table 2.2 (1) Street Typical Cross Section Elements by Classification

STD DWG #	Street Classification	Right-of-Way	Travel Lanes	Median	Bike Lanes	Sidewalks	Multi-Use Path	Parking Lane
TS-1	Major Arterial	136′	Four @ 12′	40′	Two @ 5′	Two @ 6′	No	No
TS-1	Major Arterial	132′	Four @ 12′	40′	No	One @ 6′	One @ 12′	No
TS-2	Minor Arterial	132′	Four @ 12′	36′	Two @ 5′	Two @ 6′	No	No
TS-2	Minor Arterial	128′	Four @ 12′	36′	No	One @ 6′	One @ 12′	No
TS-3	Major Collector	126′	Four @ 12′	30′	Two @ 5′	Two @ 6′	No	No
TS-3	Major Collector	122′	Four @ 12′	30′	No	One @ 6′	One @ 12′	No
TS-4	Minor Collector	79′	Three @ 12′	No	Two @ 5′	Two @ 6′	No	8′ Parking Allowed
TS-4	Minor Collector	75′	Three @ 12′	No	Two @ 5′	Two @ 6′	No	8′ Parking Allowed
TS-5	High Volume Local	54′	Two @ 12′	No	No	Two @ 5′	No	8′ Parking Allowed
TS-6	Low Volume Local	52′	Two @ 11′	No	No	Two @ 5′	No	8′ Parking Allowed
TS-7	Alley / Mews	Varies	Varies	No	No	No	No	No

2.2.4 Right-of-Way and Easements

(1) Right-of-Way
Minimum right-of-way widths shall be as shown in **Table 2.2 (1)** and in the street classification typical cross section drawings at the end of this chapter. Topography, special design features and other factors may require widths greater than these minimums. The City Engineer shall have final review with determination of any additional right-of-way that is required for the design of a specific street segment.

(2) Easements
There are several types of street-related easements allowed in the City.

i. Public Utility, Drainage and Access Easement (PUDAE) that shall be approved for use by the City Engineer on a case-by-case basis.
ii. Public Utility and Drainage Easement (PUDE) that shall be approved for use by the City Engineer on a case-by-case basis.
iii. Public Access Easement (PAE) that allows multiple users of an access to the street.
iv. Public Drainage Easement (PDE) for drainage purposes only.
v. Slope Easement (SE) that provides for slopes between the street right-of-way and adjacent property.
vi. Temporary Construction Easement (TCE) that may be used to provide adequate construction area in the construction of a street project.

(3) Improvements in Right-of-Way
It is the policy of the City to place all permanent public streets, traffic signals, equipment, traffic signs and street-related features in public street right-of-way, with fee simple ownership by the City.

(4) Additional Right-of-Way Widths on Existing Streets
Developments that adjoin existing streets shall dedicate additional fee simple right-of-way, where necessary, to meet the minimum requirements for the functional street classification of the existing street, or other dimensions as required by the City Engineer. This dedication shall be as follows:

i. The entire right-of-way shall be provided where any part of the development is on both sides of the existing street.
ii. When the development is located on only one side of the existing street, one half (1/2) of the required width of the right-of-way, measured from the center line of the existing roadway, shall be provided. If the development provides improvements to the existing roadway that shifts the centerline of the roadway, then the one half (1/2) of the required width of the right-of-way shall be measured from the new center line of the roadway.
iii. When required by the City Engineer, additional right-of-way shall be required to accommodate future roadway improvements.

(5) Dedication Process
The dedication of right-of-way and easements for street purposes shall normally occur through the platting process. When dedications are required outside the platting process, they shall be dedicated in a manner and format approved by the City Engineer and City Attorney.

2.3 Design Criteria

The design criteria presented in this section apply to all roadways that are required to be designed and constructed to City standards and specifications. The design criteria presented below shall be used as minimum requirements for new developments and may be increased at the direction of the City Engineer if warranted by safety hazards or traffic operations.

The City Engineer, in consultation with other City departments and State agencies, may allow modifications to the design criteria set forth in this chapter. Modifications may be necessary to allow private or public construction to be compatible with in-place improvements or to address unusual circumstances that justify an alternative design or criteria. Modifications to design criteria may be allowed provided that an investigation by the City Engineer concludes that all of the following criteria can be satisfied.

- The modification to the design criteria is based on sound engineering principles and practices.
- The modification to the design criteria will not create an unsafe or hazardous situation to occur.
- The modification to the design criteria will be equivalent to the minimum criteria set forth herein in terms of functionality, efficiency, durability, structural integrity and long term maintenance.
- The modification to the design criteria will not adversely impact adjacent properties or individual property owners, provided that safety is not compromised.

The City Engineer is authorized to require studies or other pertinent information to be provided by the petitioner to help support or validate the modification request at no cost to the City. See **Chapter 1** for additional information on the variance process.

All streets are to be designed in accordance with the design speeds specified for each street classification in this chapter, or as amended by the City Engineer, and as summarized in **Table 2.3 (1) and Table 2.3 (2)**.

2.3.1 Desired Operating Levels of Service

Reference the Traffic Impact Analysis (TIA) Guidelines on the City of Franklin Engineering Development webpage for Level of Service requirements.

2.3.2 Design Traffic Level

Streets shall generally be designed to accommodate projected future traffic conditions a minimum of twenty (20) years (or another target year agreed to in the Traffic Impact Analysis Memorandum of Understanding (MOU)) after the street is opened to traffic. These projected traffic conditions shall address total daily traffic loads along with directional distribution of the peak-hour loads. These loads shall address typical weekday conditions as well as off-peaks and weekend periods when applicable. Seasonal and special event conditions shall also be considered where appropriate as determined by the City Engineer.

2.3.3 Design Vehicle

All streets shall be designed to accommodate the predominant type and composition of vehicles that can be reasonably expected to travel through them. At a minimum, for streets and intersections designed in the City, the vehicle types in **Table 2.3 (3)** shall be fully accommodated in the design process. For special circumstances other design vehicles may be required by the City Engineer.

TABLE 2.3 (1) STREET STANDARDS – GENERAL PARAMETERS

Design Feature or Characteristic	Street Classification and Typical Section									
	4-Lane Major Arterial TS-1	4-Lane Major Arterial TS-1	4-Lane Minor Arterial TS-2	4-Lane Minor Arterial TS-2	4-Lane Major Collector TS-3	4-Lane Major Collector TS-3	2-Lane Minor Collector TS-4	2-Lane Minor Collector TS-4	2-Lane High Volume Local TS-5	2-Lane Low Volume Local TS-6
Right of Way (ROW) Width	136'	132'	132'	128'	126'	122'	79'	75'	54'	52'
No. of Travel Lanes	4	4	4	4	4	4	3	3	2	2
Minimum Lane Width	12'	12'	12'	12'	12'	12'	12'	12'	12'	11'
Minimum Lane Width (total)	48'	48'	48'	48'	48'	48'	36'	36'	24'	22'
Median Width	40'	40'	36'	36'	30'	30'	n/a	n/a	n/a	n/a
Curb & Gutter: Vertical or Mountable	V	V	V	V	V	V	V	V	V	V or M
Designated Bike Lanes?	Yes	No	Yes	No	Yes	No	Yes	No	No	No
Bike Lane Width per side	5'	n/a	5'	n/a	5'	n/a	5'	n/a	n/a	n/a
Parking Lane Width	n/a	n/a	n/a	n/a	n/a	n/a	8'	8'	8'	8'
Minimum Sidewalk Width	6'	6' (1 side)	6'	6' (1 side)	6'	6' (1 side)	6'	6' (1 side)	5'	5'
Multi-Use Path	No	12' (1 side)	No	12' (1 side)	No	12' (1 side)	No	12' (1 side)	No	No
Grass Strip Width	6'	6'	6'	6'	6'	6'	6'	6'	6'	6'
Left Turn Lanes Req'd?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[c]	No
Right Turn Lanes Req'd?	Yes	Yes	Yes	Yes	Maybe	Maybe	Maybe	Maybe	No	No
Traffic Volume Capacity (1000 veh/day)	>35	>35	25-35	20-25	15-20	15-20	10-15	10-15	2-5	<2
Speed Limit, MPH [note a]	45	45	40	40	35	35	30	30	25	25 or 20
Driveway & Street Access	Very Ltd	Very Ltd	Limited	Limited	Limited	Limited	Frequent	Frequent	Frequent	Unlimited
Continuity of Travel	Very High	Very High	High	High	Moderate	Moderate	Moderate	Low	Very Low	Very Low
Street Lights	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Partial	Partial
Traffic Calming	None	None	None	None	None	None	None	None	Possible	Possible

NOTES: a. Design speed shall be a minimum of 5mph above the posted speed limit.
b. Vertical curb requires shoulder separation from travel lane on posted speeds of 50 mph or greater.
c. Separate Left Turn Lanes required in Commercial or Mixed-Use developments and at all traffic signals.

TABLE 2.3 (2) STREET STANDARDS – TECHNICAL DESIGN CRITERIA

Design Element		Arterial		Collector		Local		Alley / Mews
		Major	Minor	Major	Minor	High Volume	Low Volume	
Overall Design Parameters								
Design Speed/Posted Speed		50 / 45	45 / 40	40 / 35	35 / 30	30 / 25	25 / 25 or 20	15 / 15
Min Stopping Sight Distance [Note a]		425’	360’	305’	250’	200’	115’	80’
Passing Sight Distance		1,835’	1,625’	1,470’	1,280’	n/a	n/a	n/a
Horizontal Alignment [Note b]								
Minimum centerline radius: with no super-elevation (NC) with 0.02 super-elevation with 0.04 super-elevation		1,391’ 1011’ 905’	1,039’ 794’ 711’	762’ 593’ 533’	510’ 408’ 371’	333’ Not Allowed Not Allowed	70’ Not Allowed Not Allowed	55’ Not Allowed Not Allowed
Maximum super-elevation		0.04 ft/ft	0.04 ft/ft	0.04 ft/ft	0.04 ft/ft	n/a	n/a	n/a
Minimum tangent between curves or at intersections		200’	150’	150’	100’	100’	0	0
Vertical Alignment								
Maximum Centerline Grade %		6	7	8 [note c]	8 [note c]	8 [note c]	10 [note c]	8
Minimum Gutter Flow-line Grade %		0.5	0.5	0.5	0.5	0.5	0.5-1.0	1.0
Min. K-values for Vertical Curves (Stopping Sight Distance)	Crest	84	61	44	29	19	7	7
	Sag	96	79	64	49	37	17	17
Intersection Design								
Minimum sight distance at driveways and intersections (street and topographic features may increase these minimums)		See AASHTO *“Green Book”*						
Access Management								
Distance Between Intersections	Signalized	2,640’		1,320’	1,320’	n/a	n/a	n/a
	Non-signalized	1,200’	600’	300’	300’	200’ [note d]	200’ [note d]	n/a
Minimum distance between high volume driveways / alleys / mews & street or other high volume intersections [note e]		800’	600’	300’	300’	200’	200’	n/a
Minimum distance between low volume driveways & street intersections [note e]		250’	250’	230’	230’	125’	50’	40’
Minimum distance between low volume driveways [note e]		250’	250’	150’	150’	50’	20’	10’

NOTE: a. AASHTO **“***Green Book”* latest standards supersede these requirements and shall be adjusted based on roadway grades.
b. AASHTO *“Green Book”* latest standards supersede these requirements. Requirements based on Low-Speed Urban Streets.
c. These dimensions may be increased or amended by the City Engineer as deemed necessary for safe and efficient street operations.
d. These distances may be reduced to 125 feet when both intersecting streets are cul-de-sacs.
e. Measured from the nearest points of radius returns

Table 2.3 (3) Design Vehicle Requirements	
Street Classification	Vehicles Accommodated
Alley / Mews	Passenger cars and single-unit trucks.
Local	Passenger cars, single-unit trucks (SU-30), and conventional school buses must be able to turn easily from one street to the next and remain in the correct lane for each street. Combination trucks (WB-50) shall be able to physically traverse local streets by using the full width of the traveled way if necessary, including intersection turns, and without tracking onto the curb at corners.
Minor Collector	Passenger cars, single-unit trucks and conventional school buses must be able to turn easily from one street to the next and remain in the correct lane for each street. Combination trucks (WB-50) shall be able to physically traverse the street by using the full width of the traveled way if necessary, including intersection turns, and without tracking onto the curb at corners.
Major Collector	Passenger cars, transit buses (S-40), single-unit trucks, conventional school buses and combination trucks (WB-62) must be able to turn easily from one street to the next and remain in the correct lane for each street, and without tracking onto the curb at corners.
Major and Minor Arterial	Passenger cars, transit buses (S-40), single-unit trucks, conventional school buses and combination trucks (WB-67) must be able to turn easily from one street to the next and remain in the correct lane for each street, and without tracking onto the curb at corners.
Freeway / Expressway	All approved vehicle types must be able to turn easily onto and off of Freeway/Expressway Ramps from adjacent streets and remain in the correct lane for each ramp/street. These are typically State of Tennessee roadways and shall meet all TDOT design vehicle requirements.

2.3.4 Minimum Turning Paths of Design Vehicles

All street and intersection geometric designs shall be evaluated to ensure that the minimum turning paths for the selected design vehicles can be safely and efficiently accommodated by the proposed street and intersection geometry.

2.3.5 Design Speed

There are two primary types of speeds that must be considered in the street design process. The first is "design" speed, which is the selected speed used to determine the various minimum geometric design features of the street. The second type is "operating" speed, which is the speed at which drivers operate their vehicles in free-flow conditions. The "85th percentile speed" (the speed at which 85 percent of the vehicles travel at or less) is generally assumed to be the operating (and typically posted) speed of a street.

The design speed selected for street design purposes shall take into consideration several factors including street classification, adjacent land use, topography and sight distance, pedestrian and bicycle activity, and the desired operating speed of the facility. The design speed used in street design shall be approved by the City Engineer and shall generally be in accordance with **Table 2.3 (2)** for desirable design speed by street classification.

2.3.6 Street and Lane Widths

(1) Street Widths

The minimum width of a street pavement section shall be determined by (1) its functional classification as identified in the Major Thoroughfare Plan, and (2) typical cross-sections as shown in the Standard Drawings. Other elements such as topography and Traffic Impact Analysis (such as turn lanes and deceleration/acceleration lanes), and unique street design features may necessitate a change in the minimum street section width. The City Engineer will approve the final required street width.

(2) Lane Widths

The minimum and desirable widths of different types of lanes based on the street classification are provided in **Table 2.3 (1),** and as shown in the Typical Section Drawings. These widths may be modified by the City Engineer based on the specific requirements of a street section.

2.3.7 Special Street Configurations

(1) Cul-de-Sacs

(a) Where Allowed: Cul-de-sacs are permitted only on Local Street classifications and shall not extend for more than five-hundred (500) feet (unless necessitated by topography and approved by the City Engineer) as measured from the center of the cul-de-sac turn around to the nearest right-of way boundary of the adjoining street right-of-way intersection. If adjoining properties, commercial or residential, install fire sprinkler systems, this length may be extended to 1000 feet in accordance with the adopted fire code. In no case shall a cul-de-sac or temporary dead end street serve more than twenty (20) single-family residential lots.

Typical Street Cul-de-Sac

(b) Secondary Access: Any Local Street with a cul-de-sac that exceeds the maximum lengths above shall be provided with a secondary access point.

(c) Design Requirements: Cul-de-sac streets shall terminate in a circular turn around having a right-of-way radius of at least sixty-five (65) feet, and a paved radius of at least fifty (50) feet at its outside edge. These and other minimum requirements are illustrated in the Standard Drawings.

(d) Prohibited Designs: All cul-de-sac designs must allow for automobiles and typical service vehicles to turn around without requiring backing maneuvers.

(e) Temporary Cul-de-Sac: Where a development is being implemented by sections, a temporary cul-de-sac may be used if the overall development plan allows the cul-de-sac to be eliminated at final build out of the development. Temporary cul-de-sacs shall be replaced with a street connection within three (3) years or less from the date construction starts unless otherwise approved by the Fire Marshall. The cul-de-sac shall be provided with an asphalt turn-around having a radius of at least fifty (50) feet. No designs requiring backing maneuvers will be allowed. The easement radius shall be a minimum of sixty-five (65) feet in areas where there is no adjacent public utility and access easement, and a minimum of sixty (60) feet where public utility and access easements are required and/or provided.

All temporary cul-de-sacs shall be constructed within dedicated street right-of-way or a dedicated Public Utility, Drainage and Access Easement for those areas outside the tangent street right-of-way section. The Easement outside the tangent right-of-way section shall be vacated by the City when the Easement is no longer necessary. Application for vacation of the easement must be initiated and paid for by the Developer or property owner.

A sign must be provided at the end of the temporary cul-de-sac noting that the street will be extended in the future. Signing for temporary, dead-end streets shall be in accordance with the requirements of the Standard Drawings.

(f) Cul-de-Sac Medians: Center median islands in cul-de-sacs are prohibited.

(g) Cul-de-Sac Parking: Parking in a cul-de-sac is prohibited. Four (4) "No Parking" street signs shall be evenly spaced around the perimeter of new cul-de-sacs.

(2) Eyebrows

(a) Where Allowed: Eyebrows shall be permitted only on Local Streets. They may only be used in tangent sections or at intersection corners. Design of eyebrows shall be as shown in **Figure 2.3 (1).**

(b) Design Requirements: Eyebrows shall be a minimum of twenty-five (25) feet in length and a maximum of fifty (50) feet measured along the flow-line. Lengths exceeding fifty (50) feet shall incorporate an island as approved by the City Engineer. Designs that require backing maneuvers for typical use vehicles are prohibited.

Typical Eyebrow

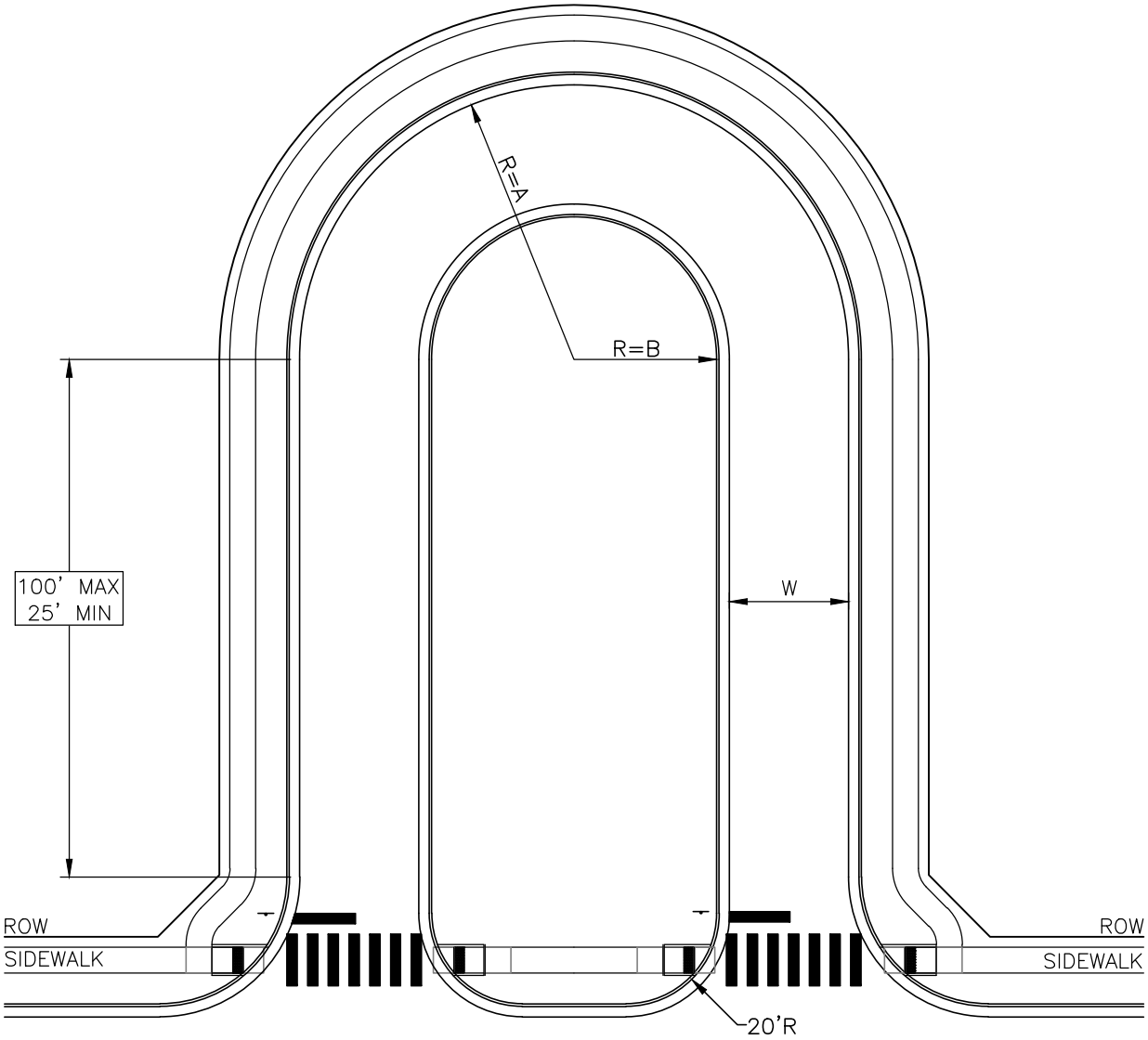
(c) Location: The location of the eyebrow shall be in conformance with intersection spacing requirements as provided in **Access Management Section**.

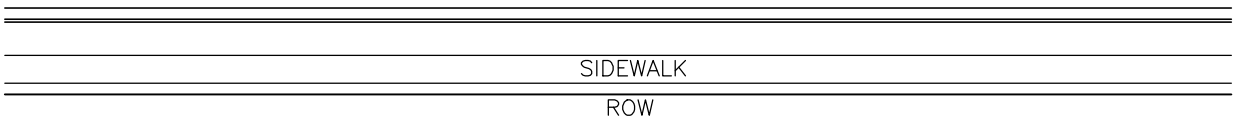
(3) Dead-End Streets and Alleys / Mews

(a) Where Allowed: Permanent dead-end streets and alleys without cul-de-sac designs are prohibited. Permanent dead-end mews with or without cul-de-sac designs are prohibited.

(b) "Stub" Streets and Alleys / Mews: Temporary dead-end "stub" streets and alleys / mews (without temporary cul-de-sacs) will only be permitted on local streets and alleys / mews at the discretion of the City Engineer. Stubs shall not be longer than one residential lot. See Standard Drawings for design requirements of temporary dead-end "stub" streets.

(c) Signs Required: A sign must be provided at the temporary street or alley / mews end noting that it will be extended in the future.





STREET CLASSIFICATION	RADIUS (MIN.)		NO PARKING	PARKING ONE SIDE	PARKING TWO SIDES
	A	B (MAX)	W	W	W
LOCAL SINGLE FAMILY RESIDENTIAL	55'	30'	15'	23'	31'
LOCAL MULTIFAMILY RESIDENTIAL	60'	30'	22'	30'	38'
LOCAL COMMERCIAL & INDUSTIRAL	65'	26'	24'	32'	38'

1) THE SIDEWALK AROUND THE EYEBROW SHALL BE PLACED ACCORDING TO THE STREET CLASSIFICATION. THE SIDEWALK ACROSS THE STREET END OF THE ISLAND IS TO BE PLACED IN THE SAME LOCATION AS ON THE CROSS STREET.
2) MEDIAN MAY BE LANDSCAPED OR HARDSCAPED AS REQUIRED AND SHALL BE MAINTAINED BY THE OWNERS ASSOCIATION.
3) WHEN PARKING IS RESTRICTED TO ONE SIDE, IT SHALL BE PROVIDED ON THE OUT–SIDE OF THE STREET.

HISTORIC FRANKLIN TENNESSEE

N.T.S

Eyebrow Design
FIGURE 2.3 (1)

(4) Half Streets
The City Engineer may allow the construction of half streets on Minor Collector and Local streets when only one side of a street right-of-way is available. A minimum of twenty-two (22) feet of pavement must be provided on any half street. In such cases, the property owner is responsible for right-of-way dedication and construction of the half of the new street section that is adjacent to their property. Typically, these partial street sections will be built to permanent street standards including all curb and gutter, drainage, sidewalks and other elements as called for in the typical section for that street classification. Additional dedication of street easement may be required by the City Engineer in these cases.

(5) Provisions for Future Public Street Intersections
Where provisions are to be made to intersect a future side street with the street being designed, the curb radii and pavement section of the future intersecting street "stub" shall typically be built to the end of the radii curb return. If the expected construction of the future street connection is anticipated to occur more than three (3) years after the primary street is constructed, then the street approach "stub" may be omitted and temporary curb, gutter and sidewalk improvements provided through this section. In such cases, the curb and gutter shall be concrete while the temporary sidewalk or path may be asphalt.

(6) Improvement of Annexed Streets
Streets annexed into the City may be required to meet these engineering standards before they are accepted as City streets. The City Engineer shall evaluate all proposed street annexations to determine their adherence to these standards, and any recommendations for improvements to meet minimum public safety, health and welfare requirements.

2.3.8 Horizontal Alignment
The design of horizontal curves in street design shall be based on an appropriate relationship between design speed and curvature and on their joint relationships with superelevation and side friction. On Arterial and Major Collector streets, curve radii and tangents shall be as large as possible using the minimums only where necessary. However, minimum radius curves shall be used on Local and Collector streets unless otherwise required. Angle point direction changes are not allowed. All changes in direction shall be made using standard curves.

(1) Horizontal Curve Radii
The minimum allowable centerline radii for horizontal curves shall be as designated in **Table 2.3 (2).** Reverse and compound curves shall be used only when a single radius curve will not work. For driver safety, compound curves shall preferably have a ratio no greater than one and one-half (1.5) where the value of the larger radius is divided by the smaller radius. When they are designed, "*TDOT Standard Specifications"* and AASHTO's "*Green Book"* design standards and procedures shall be used.

Based on typical conditions in the City, the absolute minimum and desirable horizontal curves for streets without superelevation are shown in **Table 2.3 (2)**. This table also provides the minimum tangent distance between reverse curves.

The effect of grade shall also be considered by the designer when selecting horizontal curvature. The design of more complex horizontal curve geometry shall be conducted in accordance with "*TDOT Standard Specifications"*, AASHTO's "*Green Book" and* AASHTO's "*Guidelines for Geometric Designs of Very Low-Volume Local Roads (ADT ≤ 400)".*

(2) Minimum Tangent Length

(a) Intersection: Whenever a minor street intersects a street of higher classification, a tangent length (measured from the nearest gutter flow-line of the intersected street to the point of curvature in the intersecting street) shall be provided for a safe sight distance and safe traffic operation. The minimum required tangent lengths indicated in **Table 2.3 (2)** apply to the minor leg(s) only. The angle of departure shall not exceed ten (10) degrees for the length of the tangent.

(b) Reverse Curves: Reverse curves in streets shall be separated by minimum tangents of between two-hundred (200) and one-hundred (100) feet for arterial and major collector streets as shown in **Table 2.3 (2)**.

(c) Broken Back Curves: Two curves in the same direction (broken back curves) shall be separated by a tangent with a length of at least two (2) times the minimum length shown in **Table 2.3 (2).**

(3) Curves with Small Deflection Angles (10° or less)
To reduce the appearance of kinks in the street, minimum lengths of curve shall be designed with minimum arc lengths as shown in **Table 2.3 (4).**

Table 2.3 (4) Minimum Centerline Arc Length	
Street Classification	Minimum Centerline Arc Length (ft)
Local – Residential	100
Local – Commercial & Industrial	200
Minor Collector	250
Major Collector – Residential	250
Major Collector – Commercial & Industrial	300
Minor Arterial	300
Major Arterial	400

(4) Horizontal Curves on Vertical Curves
For driver safety, horizontal curves shall not begin near the top of a crest vertical curve nor near the bottom of a sag vertical curve.

(5) Off-Site Design Centerline, Flow-lines and Cross Sections
To assure that future street improvements will meet these Standards, the centerline, flow-line, and cross sections of all streets, except cul-de-sacs, shall be continued for five-hundred (500) feet beyond the proposed construction. The grade and ground lines of all arterials shall be continued an additional five-hundred (500) feet for a total of one-thousand (1000) feet beyond the end of the proposed construction.

(6) Joining Existing Improvements
Connection with existing streets shall be made to match the existing alignment grade of the existing improvements, in accordance with horizontal alignment criteria.

(7) Cross Slope
Cross slope on a pavement is provided to drain water from the street surface. The design of cross slope shall consider driver comfort and safety.

(a) Minimum Cross Slope: A minimum cross slope on all new streets shall be two (2.0) percent. Minimum cross slope on reconstruction or overlays is one and one-half (1.5) percent. All other values of cross slope shall be independently reviewed and approved by the City Engineer.

(b) Maximum Allowable Cross Slope: Maximum allowable tangent cross slope on all new construction shall be two (2.0) percent. Maximum allowable cross slope on any reconstruction or overlays of existing streets shall be four (4.0) percent.

(c) Cross Slope for Street Modifications: When widening an existing street or adding turn lanes to an existing street, the resulting cross slope of the widened portion shall be within the limits stated above and the new Cross Slope shall be no less than the existing cross slope. However, if the cross slope of the existing street exceeds the Standards then new curb and gutter shall be designed such that the existing pavement, when overlaid, will result in a straight line cross slope grade that meets these

Standards. Alternatively, the existing pavement may be removed and re-profiled to comply with these Standards.

(d) Cross Slope for Cul-de-Sacs: Cul-de-sac cross slopes shall not be less than two (2.0) percent nor more than five (5.0) percent, with two (2.0) percent being desirable.

(8) Superelevation on Horizontal Curves

The purpose of superelevating a street is to maintain the riding comfort on horizontal curves. Superelevation is not typically used on streets in the City with design speeds at or less than 30 MPH. For design speeds higher than 30 MPH or where superelevation is required or preferred, "*TDOT Standard Specifications"* and AASHTO's "*Green Book"* design standards and procedures shall be used. The following criteria shall be followed:

(a) Where Superelevation Is Permitted: Superelevation may be allowed for curves on Arterial and Collector streets. In no case shall superelevation exceed four (4.0) percent cross slopes. As specified in **Table 2.3 (2),** superelevation shall not be used on Local Streets.

(b) Transition Length: When superelevation is used, use the TDOT method of a 50/50 split of the transition length each side of the tangent point

(c) Drainage: Where superelevation is used, the gutter shall always be an inflow type. The water must enter a storm sewer system or other acceptable outlet from the street rather than crossing the street in sheet flow. Where medians are present in a super-elevated section, water may be allowed to sheet flow from the median to the street gutter.

2.3.9 Vertical Alignment

The design of vertical curves in street design shall be simple in application and shall result in a design that is safe and comfortable in operation, pleasing in appearance and adequate for drainage.

(1) Maximum and Minimum Grades for Streets

The maximum and minimum grades for specific street classifications are shown in to **Table 2.3 (2)**. The centerline grade in the bulb of a cul-de-sac shall not exceed five (5.0) percent.

(2) Grade Breaks

No single point grade break shall exceed four-tenths (0.40) percent, except for the flow line in sag curves where the maximum grade break is one (1.0) percent. In curb returns, a grade break may be as great as three (3.0) percent for extreme circumstances.

(3) Minimum Flow-line Grades

Minimum flow-line grades for gutters shall be one-half (0.50) percent, except in the bulb of cul-de-sacs where the minimum shall be one (1.0) percent.

(4) Grades Through Intersections

The profile grade lines on the legs of an intersection shall be adjusted for a distance back from the intersection to provide a smooth junction and proper drainage. Normally, the grade line of the major street shall be carried through the intersection and that of the minor street shall be adjusted to it. Any changes in profile through an intersection shall meet the crest and sag curve criteria noted below, to the extent deemed practical. The City Engineer shall approve all variations from these criteria.

Intersection approach grades shall consider the deceleration and acceleration that occurs due to traffic control and turning movements. It is desirable to provide near-level intersection approach grades to improve operations and safety within the intersection area. Maximum intersection approach grades are shown in **Table 2.3 (5).**

Table 2.3 (5) Maximum Grades		
Classification	Maximum Grade	Maximum Grade Approaching Signalized Intersection
Freeway	Determined by TDOT	n/a
Expressway	Determined by TDOT	2 % for 600 ft.
Major Arterial	6 %	2 % for 500 ft.
Minor Arterial	7 %	2 % for 500 ft.
Major Collector	8 %	3 % for 400 ft.
Minor Collector	8 %	3 % for 300 ft.
Local High Volume	8 %	4 % for 200 ft.
Local Low Volume	10 %	4 % for 100 ft.
Cul-de-Sac	5 %	n/a
Alley / Mews	8 %	n/a

(5) Requirements for Using Vertical Curves
The major control for safe operation on "crest" vertical curves is the provision of ample sight distance for the design speed. Crest vertical curves shall be designed to at least provide the minimum stopping sight distance as established in AASHTO's "*Green Book*".

The design of "sag" vertical curves is controlled by headlight distance, passenger comfort, drainage control and general street appearance. At under-crossings the structure may limit sight distance which could cause the need for higher K factors to achieve adequate stopping sight distance.

(6) Joining Existing Improvements
Connection with existing streets shall be made to match the existing grade of the existing improvements, in accordance with vertical alignment criteria (grade breaks shall not exceed allowable).

(7) Vertical Clearance
Vertical clearance above a street shall be a minimum vertical clearance of sixteen and one-half (16.5) feet. The City Engineer may require greater clearance when considered necessary to meet future street operation requirements.

(8) Off-Site Continuance of Grade and Ground Lines
To assure that future street improvements will meet these Standards the grade and ground lines of all local and collector streets, except cul-de-sacs, shall be continued on the plans for five-hundred (500) feet beyond the proposed construction. The grade and ground lines of all arterials shall be continued one-thousand (1000) feet beyond the end of the proposed construction.

(9) Coordinating Horizontal and Vertical Alignments
Horizontal and vertical design shall not be designed independently. Horizontal alignment and profile are among the more important design elements of a street. Their effective combination increases safety, encourages uniform speed, and improves appearance. Some general guidelines for their relationships are:

(a) Curves and grades shall be in proper balance. The designer shall not combine extreme horizontal and/or vertical conditions or introduce significant curves at the end of long tangent sections or flat grades.

(b) Sharp horizontal curvature shall not be introduced at or near the top of a pronounced crest vertical curve, nor shall it be introduced near the bottom of a steep grade approaching or near the low point of a pronounced sag vertical curve.

(c) Both horizontal and vertical curvature and profile shall be made as flat as practical at intersections where sight distance along both streets is important and vehicles may have to slow or stop.

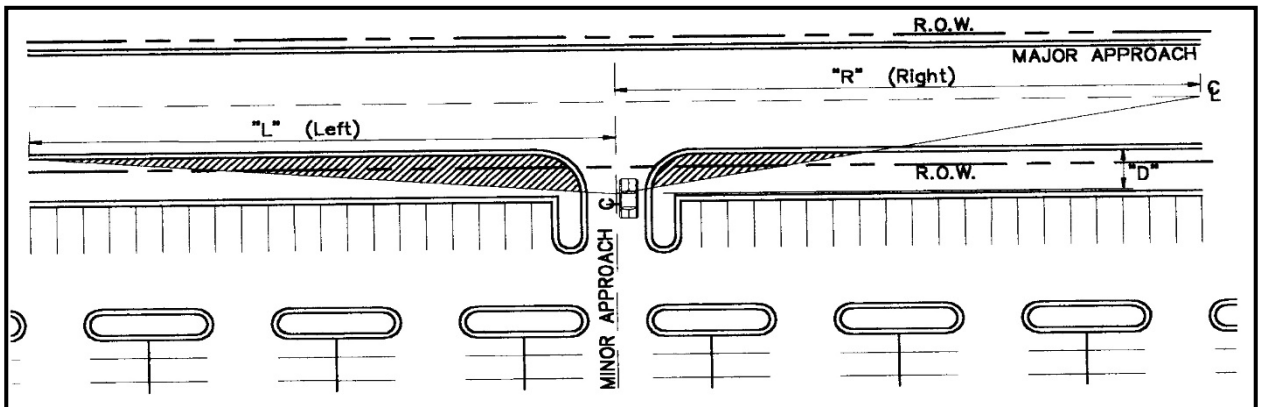
(d) Designers should begin evaluating horizontal alignment and profile in the preliminary design stage. Proposed alignment and profile shall be submitted to the City for review and comment prior to advancing the design process.

2.3.10 Sight Distance

(1) General
Sight distance calculations shall be based on AASHTO's "*Green Book"* requirements.

All streets designed in the City shall provide adequate sight distance for all types of users, considering both horizontal and vertical alignment. Sight distance shall be carefully considered in the preliminary stages of design when both the horizontal and vertical alignment may still be subject to adjustment. Specific sight distance requirements include:

(2) Sight Obstructions
Any object within a sight distance triangle more than twenty-four (24) inches above the flow-line elevation of the adjacent street shall constitute a sight obstruction, and shall be removed or lowered. Such objects include but are not limited to berms, buildings, parked vehicles on private property, cut slopes, hedges, trees, shrubs, mailbox clusters, utility cabinets or tall crops. Since vehicles parked on-street are under the control of the City, parked vehicles shall not be considered an obstruction for design purposes. The city may limit parking to protect visibility as needed. The sight distance shall be measured to the approach lane positions as shown in **Figure 2.3 (2**). In no case shall any permanent object encroach into the line-of-sight of any part of the sight distance triangle. Street trees within the sight distance easement may be excepted from this requirement if pruned up to eight (8) feet, and the trunks at maturity do not collectively hinder sight lines as determined by the City Engineer. The shaded portion of the diagram depicts the sight triangle area where site element heights and locations are strictly limited.



Intersection Sight Distance Triangle
Figure 2.3 (2)

During the street design process, the designer shall identify and correct for any sight obstructions that could limit the driver's sight distance beyond the distances noted above. This process shall investigate both the vertical and horizontal plane for sight obstructions. No landscaping or hardscaping shall be permitted within a corner area that will block the line of sight for pedestrian visibility (not higher than twenty-four (24) inches and possibly less depending on street geometry).

Street intersections shall be designed so that adequate sight distance is provided along all streets. The required sight distance shall be determined by the design speed and grades of the street and the acceleration rate of an average vehicle. In addition, for all streets that intersect with Arterial and Collector streets, the sight distance must be large enough to allow a vehicle to enter the street and accelerate to the average running speed without interfering with the traffic flow on the Arterial or Collector Street.

Intersection sight distance is generally determined based on the different types of traffic control at an intersection. In most cases sight distance triangles will be required as described below. The different situations, or cases, that must be considered are defined in the following discussion.

(3) Sight Distance Easements

All sight distance easements must be shown on the street plan/profile plans. All necessary sight distances must be within the public right-of-way or a sight distance easement dedicated to the City. When the line of sight crosses onto private property, a "Sight Distance Easement" shall be dedicated to provide the required clear sight distance. The easement or right-of-way shall be dedicated to the City; however, maintenance shall be the responsibility of a private entity such as the property owner or the appropriate home owners association (HOA).

2.3.11 Lane Transitions

Lane transitions are necessary when through lanes require lateral transitions without the use of horizontal curves. Also, when constructing a street that will directly connect with an existing street of different width, it is necessary to install a transition taper between the two. The length of taper depends upon the lateral offset distances between the outside traveled edge of the two sections and the design speed of the roadway. Formulas for determining transition taper lengths are shown below:

For Speeds ≤ 40 MPH: $L = \frac{W * S^2}{60}$

For Speeds > 40 MPH: $L = W * S$

L = transition taper length, feet
W = width of pavement offset, feet
S = roadway design speed, MPH

When transition tapers are located on a curve, the separate halves of the roadway shall be designed with different curves to create the taper without any angle points in the curvature.

2.3.12 Auxiliary Lanes

Auxiliary through lanes may be required along sections of any arterial or collector street to address existing or projected capacity or safety issues, at the determination of the City Engineer.

2.3.13 Intersections

Intersections shall be designed to provide for the safety of motorists, pedestrians, and bicyclists. Designs shall be based on criteria from the ITE's "*Traffic Engineering Handbook*" and AASHTO's "*Green Book*".

Typical Intersection of Arterial Streets

(1) Basic Intersection Design

By their nature, intersections are conflict locations. Vehicles, pedestrians, and bicycles all cross paths. Each crossing is a conflict point. Intersections contain many conflict points. The basic design of intersections includes the following objectives:

- Minimize points of conflict;
- Simplify areas of conflict;
- Limit conflict frequency; and
- Limit conflict severity.

These objectives can be achieved using the design elements presented as follows.

(2) Minimum Number of Intersection Turn Lanes

Intersections planned and constructed in the City shall allow for a minimum number of lanes to provide acceptable levels of traffic operations. **Table 2.3 (6)** identifies the minimum number of turn lanes to be provided at typical arterial, collector and local street intersections. The City Engineer may increase or decrease these requirements based on a traffic impact analysis or other relevant factors.

Table 2.3 (6) Typical Minimum Intersection/Interchange Requirements						
Class	**Intersecting With A:**					
	Major Arterial	**Minor Arterial**	**Major Collector**	**Minor Collector**	**High Volume Local**	**Low Volume Local**
Major Arterial	Separate Rights Double Lefts Possible Interchange	Separate Rights Double Lefts Possible Interchange	Separate Rights Double Lefts Possible Interchange	Separate Rights Double Lefts Possible Interchange	Should not connect	Should not connect
Minor Arterial	Separate Rights Double Lefts Possible Interchange	Separate Rights Double Lefts on Arterial	Separate Rights on Arterial Lefts on Collector	Separate Rights on Arterial Lefts on Collector	Should not connect	Should not connect
Major Collector	Separate Rights Double Lefts Possible Interchange	Separate rights Single lefts	Single lefts Possible separate Rights Possible roundabout	Single lefts Possible separate Rights Possible roundabout	Possible Lefts on Collector	Possible Lefts on Collector
Minor Collector	Separate Rights Double Lefts Possible Interchange	Separate rights Single lefts	Single lefts Possible separate Rights Possible roundabout	Single lefts Possible separate Rights Possible roundabout	Possible Lefts on Collector	Possible Lefts on Collector
High Volume Local	Should not connect	Possible Lefts on Arterial	Possible Lefts on Collector Possible roundabout	Possible Lefts on Collector Possible roundabout	Possible roundabout	Possible roundabout
Low Volume Local	Should not connect	Should not connect	Possible Lefts on Collector Possible roundabout	Possible Lefts on Collector Possible roundabout	Possible roundabout	Possible roundabout

NOTE: It is assumed that , at a minimum, single left turn lanes will be provided at all public street intersections along major streets, and will also be provided on any collector approach to an arterial street.

(3) Location of Intersections
Intersections create turning movements and therefore conflict points in the traffic stream. It is therefore essential that they be carefully planned, located and designed to function effectively and safely. For intersection location criteria, refer to **Section 2.3.23, Access Management and Design**.

(4) Spacing of Intersections
Intersections with arterial and collector streets shall be as shown on the Major Thoroughfare Plan. When not shown, intersection spacing shall be determined based on a traffic circulation and operations analysis considering elements such as left and right turn lane requirements, traffic weaving movements, location of private access points, and traffic signal coordination. In no case shall these intersections be less than those shown in **Table 2.3 (2)**. Street jogs and/or intersections on local streets of less than two-hundred (200) feet shall not be allowed, except where both intersecting streets are cul-de-sacs in which case the street jogs with centerline offsets of less than one hundred and twenty-five (125) feet shall not be allowed.

(5) Lane Alignment
All lanes shall be in alignment through each intersection, with a maximum of a two (2) foot shift in a hardship situation only, subject to approval by the City Engineer. Should a shift of greater than two (2) feet be allowed, special markings and signs may be required to support that shift design.

(6) Angle of Intersection
Crossing streets shall intersect at ninety (90) degrees whenever possible. In no case shall they intersect at less than eighty (80) degrees or more than one-hundred (100) degrees.

(7) Horizontal Alignment and Vertical Profile

(a) Horizontal: The horizontal alignment of streets through an intersection shall be designed in conformance with **Tables 2.3 (2)**. Intersections may be placed on horizontal curves, provided that the tangent lengths given in **Tables 2.3 (2)** are provided on the minor street and the required intersection sight distance is met.

(b) Vertical: The street profile grade shall not exceed the percentages shown in **Table 2.3 (5)** for the approaches to the intersection, as measured along the centerline of the street. The profile grade within the intersection streets shall not exceed three (3) percent.

(c) Prevailing Street Grade: The grade of the street with the higher classification shall prevail at intersections. The lesser street shall adapt to the grade of the major street. Grading of adjacent property and driveways shall adapt to the street grades. When streets are of equal classification, the City Engineer shall determine which street grade prevails.

(8) Exclusive Left Turn Lanes
Exclusive left turn lanes shall be provided on all arterial streets and other streets wherever left turn lanes are specified as needed by an access plan, required by these Standards or warranted and approved by the City Engineer. The Designer shall use information in the traffic impact study, when available, to determine whether an exclusive left turn lane is warranted on non-arterial streets.

(a) At Signalized Intersections: A separate left turn lane shall be required unless otherwise determined by the City Engineer.

(b) At Unsignalized Intersections: Left turn lanes may be required at approaches to intersections for which the combination of through, left, and opposing volumes exceeds warrants as stated in a traffic analysis**.** The City Engineer will determine which peak hours to consider in this evaluation. The traffic impact analysis (TIA) shall make recommendations for the location and dimensions of all left turn lanes.

(c) Design Criteria: Left turn lanes shall be designed to provide the following functions:

i. A means for safe deceleration outside the high speed through lane.
ii. A storage length long enough for left turning vehicles so that signal phasing can be optimized and intersection delay minimized.
iii. A means of separating movements at unsignalized intersections to reduce left turn impacts on other flows.

The design elements for a left turn lane are the approach taper, bay taper, lengths of lanes, width of lanes, and departure taper. For a graphical representation of bay taper and approach taper lengths, see **Figure 2.3 (3)**. The required left turn lane widths shall be as specified in **Table 2.3 (1)**. Other dimensions shall be as defined in the traffic impact analysis (TIA).

(9) Exclusive Right Turn Lanes

Exclusive right turn lanes shall be provided at locations where they are specified as needed by an access plan, or where required by the applicable traffic impact study, approved by the City Engineer.

(a) Warrants for Right Turn Lanes: The traffic impact analysis (TIA) shall determine whether a right turn lane is to be provided at intersections or accesses.

(b) Design Criteria: Right turn lanes shall be designed to accomplish the following functions:

i. Provide a means of safe deceleration outside the high speed through lane.
ii. Provide a separate storage area for right turns to assist in the optimization of traffic signal phasing.
iii. Provide a means of separating right turn movements at stop controlled intersections.

The design elements are the approach taper, bay taper, lengths of lanes, width of lanes, and departure taper. For approach taper lengths and other elements, see **Figure 2.3 (4).**

Pedestrian Refuge

(c) Pedestrian Refuge: Where pedestrian refuge is required between a right turn lane and through lanes, it shall be designed in accordance with **Figures 2.3 (5).**

(10) Acceleration/Deceleration Lanes

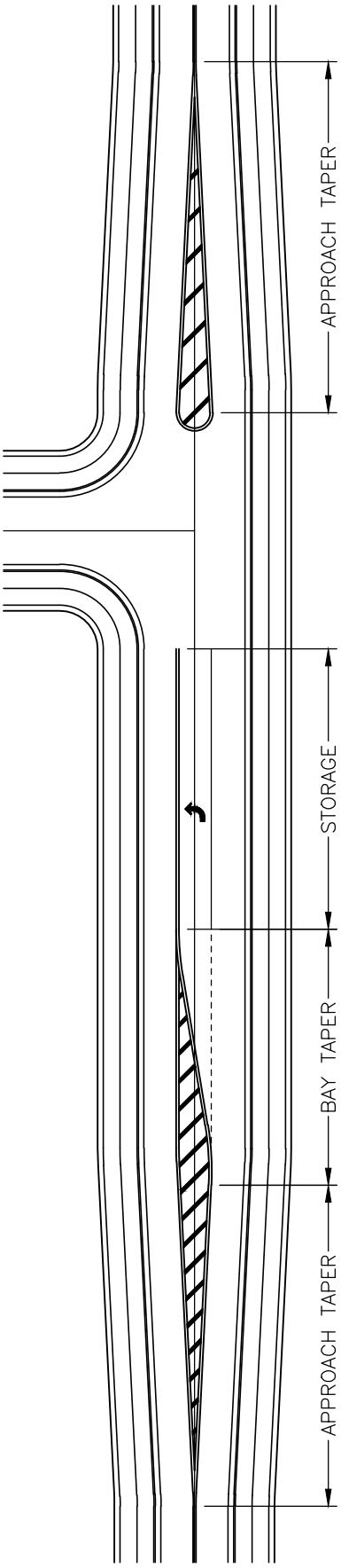
For each high volume driveway and major intersection, acceleration/ deceleration lanes shall be considered. The specific designs for these lanes shall be in accordance with the design for left and right turn lanes given above. *NCHRP Report 279* shall also be consulted during the design process for additional guidance.

(a) Acceleration Lane Transition Tapers: The traffic impact analysis (TIA) shall determine the necessary distances for designing acceleration lane lengths and tapers, subject to approval of the City Engineer.

(b) Deceleration Lane Transition Tapers: The traffic impact analysis (TIA) shall determine the necessary distances for designing deceleration lane lengths and tapers, subject to approval of the City Engineer.

(c) Left Turn Approach and Bay Tapers: When left turn lanes are designed with lateral transitions, the formula on **Figure 2.3 (3)** shall be used to compute the necessary distances, subject to approval of the City Engineer.

(d) Right Turn Approach and Bay Tapers: When right turn lanes are designed with lateral transitions, the approach and bay taper formulas on **Figure 2.3 (4)** shall be used to compute the necessary distances, subject to approval of the City Engineer.



1) APPROACH TAPER
   L=W*S, SPEED ≥ 45 MPH
   $L=W*S^2/60$, SPEED < 45 MPH
   L = LENGTH OF TAPER IN FEET
   W = WIDTH OF OFFSET IN FEET
   S = DESIGN SPEED IN MPH

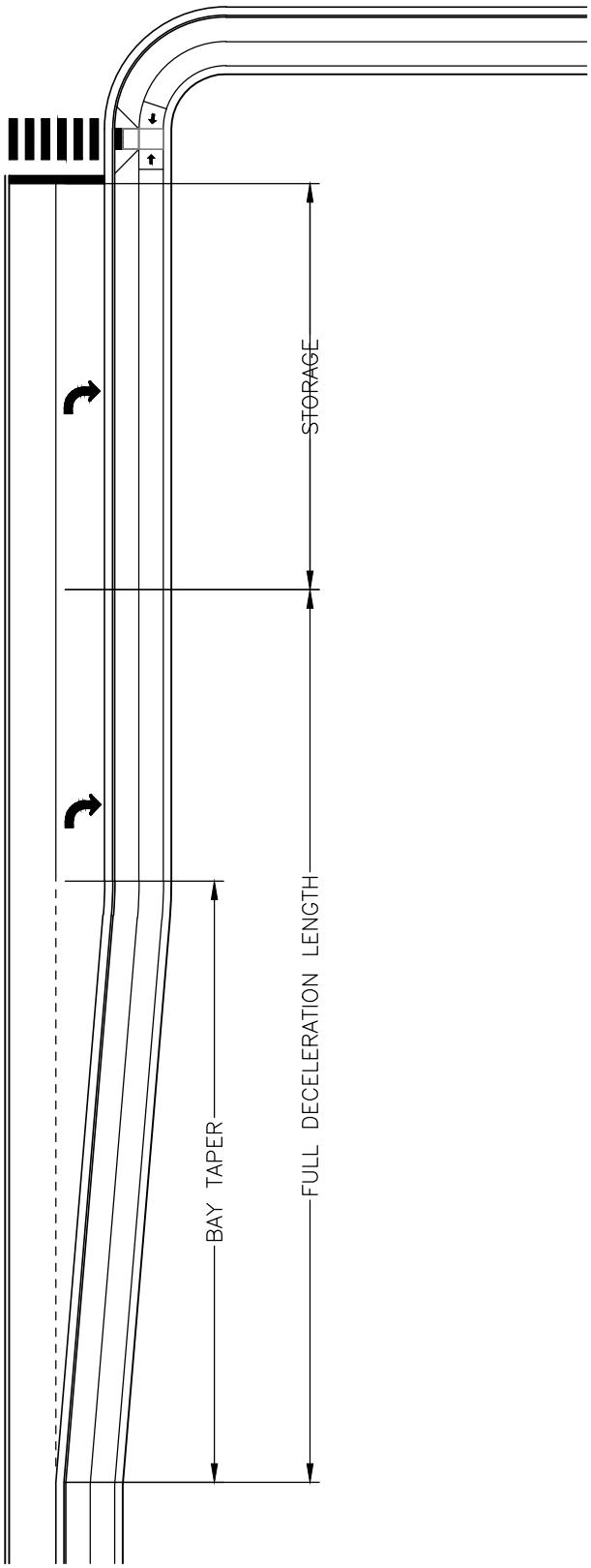
2) BAY TAPER
   L=WS/3

3) STORAGE
   BASED ON TRAFFIC IMPACT STUDY

	TAPER RATIONS					
TAPER	DESIGN SPEED					
TYPE	25	30	35	40	45	50
APPROACH	11:1	15:1	21:1	27:1	45:1	50:1
BAY	9:1	10:1	12:1	14:1	15:1	17:1

N.T.S

LEFT TURN LANE
FIGURE 2.3 (3)



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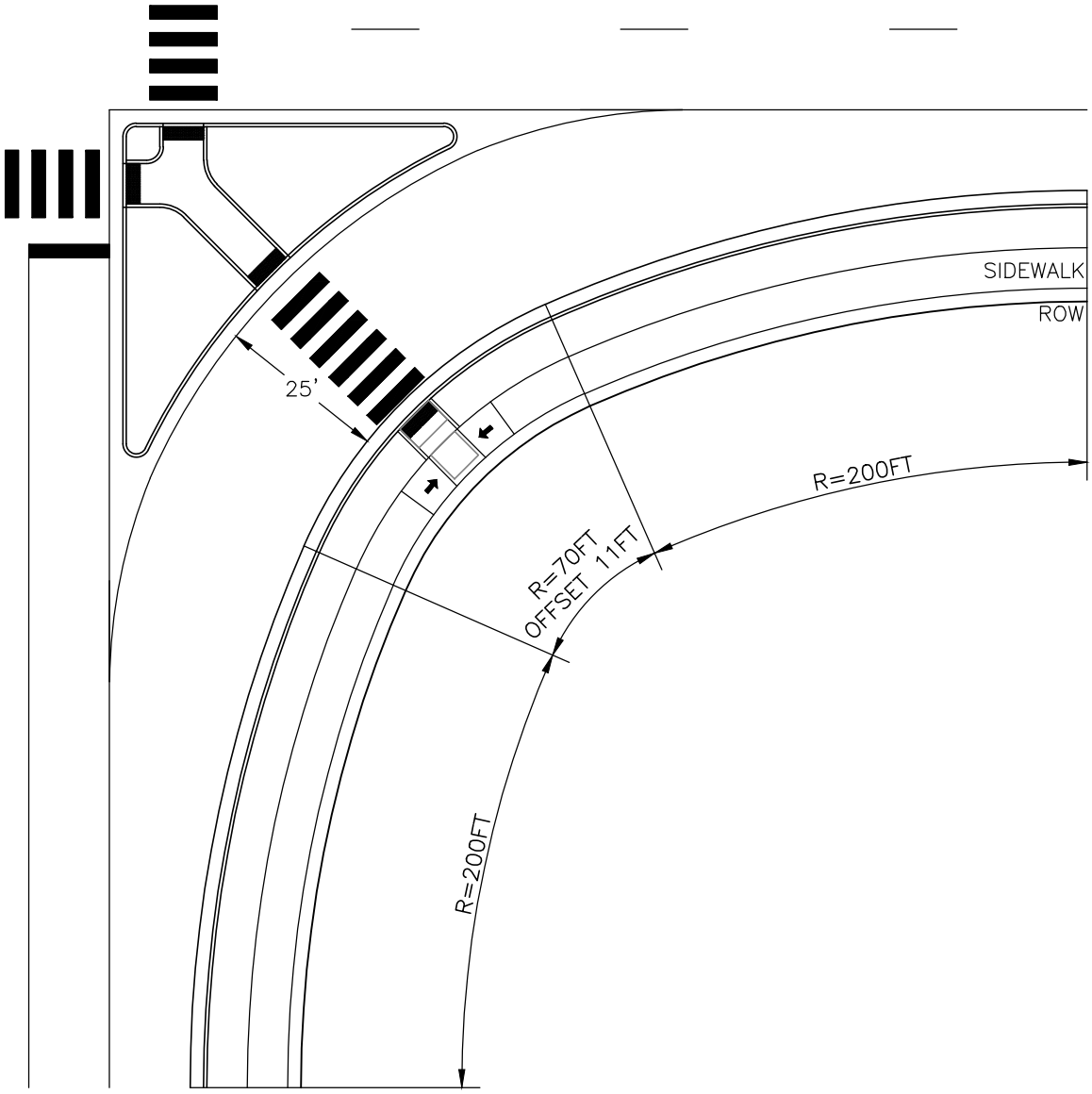
RIGHT TURN LANE
FIGURE 2.3 (4)



1) SEE GREEN BOOK AND TDOT STANDARDS FOR DESIGN OF CORNER ISLANDS.
2) REFER TO MUTCD AND TDOT STANDARDS FOR PAVEMENT MARKINGS.
3) TURNING RADIUS BASED ON DESIGN VEHICLE AND ROADWAY CLASSIFICATION.

N.T.S

PEDESTRIAN REFUGE ISLAND DESIGN WITH CONTINUOUS RIGHT TURN AND THREE-CENTERED CURVE
FIGURE 2.3 (5)

(11) Curb Returns

(a) Radii of Curb Returns: The corner radii at street intersections shall meet the following minimum requirements in **Table 2.3 (7)** unless otherwise approved or required by the City Engineer. For curb returns on a State Highway, TDOT's curb radii requirements shall supersede these requirements. At street intersections in residential areas, the minimum radius of curb return shall be twenty-five (25) feet. In industrial and commercial areas, and when a residential street intersects with a non-residential street, the minimum curb return radius shall be thirty (30) feet. Should the expected right-turning truck volumes exceed ten (10) vehicles per hour in the design hour, then the designer shall use larger radii or 3-centered compound curves to provide for the turning movements of the larger vehicles. Where the angle of the street intersection is less than ninety (90) degrees, the City Engineer may require greater radii. See **Table 2.3 (3)** for general requirements regarding vehicle turning needs at intersections.

Table 2.3 (7) Operating Characteristics of Intersection Corner Radii

Corner Radius	Operational Characteristics
≤ 9	Not appropriate for passenger cars
25-30	Low speed turn for passenger car; crawl-speed for single unit trucks with minor lane encroachment
40	Moderate speed turn for passenger cars. Low speed turn for single unit trucks with minor lane encroachment.
50	Moderate-speed turns for all vehicles up to WB-50

(b) Curb Return Grades: The desirable grade for gutter flow-lines around the curb return shall be a minimum of one (1) percent. The minimum allowable grade for gutter flow-lines around curb returns shall be a minimum of one-half (0.5) percent.

(12) Traffic Islands

(a) Corner Islands Separating Right Turns: Standard corner islands shall be used in four (4) or six (6) lane Arterial/Arterial intersections to channelize traffic where required to provide pedestrian refuge or where required by the City Engineer. The corner islands shall be designed as raised islands in accordance with **Figure 2.3 (5)** and "*Green Book*" Standards**,** for a right turn lane continuing to an exclusive lane or for a right turn lane stop or yield condition, respectively. The striping shall be in accordance with the requirements of the Traffic Control Section.

(b) Median Islands Separating Opposing Traffic:
Median islands are required at all Arterial/Arterial intersections. If raised medians are not required by these Standards, the median islands may be raised or painted. The length of the island shall include the appropriate approach taper, bay taper and length of lane required by these Standards, or supported by another approved resource standard. The design shall be as follows:

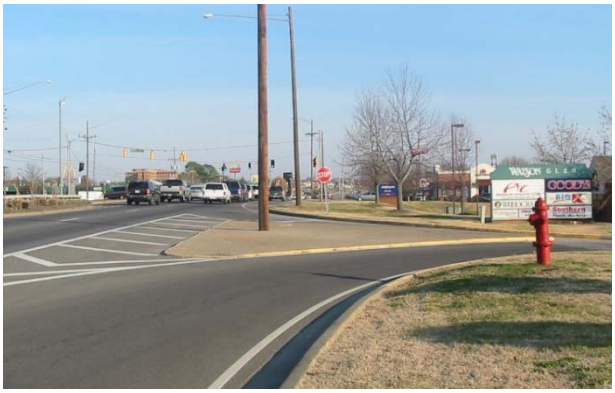
Typical Raised Median

i. No Obstruction. Medians must not obstruct the minimum left turn radius for the design vehicle(s).
ii. Drainage. Landscaped medians shall include drainage facilities to handle sprinkler run-off and nuisance flows. When low maintenance landscaping is used in conjunction with trickle irrigation, drainage requirements may be waived and outfall curb and gutter shall be used.
iii. Median Islands Required. Median islands are standard on all new 6-lane and 4-lane Arterial streets. These islands shall be designed to provide pedestrian refuge.

(c) Median Islands on Minor Arterials, Collectors, or Local Streets: Raised medians may be placed in Minor Arterial, Collector, and all Local streets. If medians are included, they shall be placed in the public right-of-way, and they must meet the following standards for design:

i. No Obstruction. The medians may not obstruct the design vehicle turns.
ii. Visibility. The medians must be placed such that the required visibility in the intersection is not obstructed.
iii. Undiminished Use. Medians must be placed so they do not diminish the intersection use except where designing a right-in/right-out intersection.
iv. Alignment. Lanes on one side of the intersection must align with the correct lanes on the opposite side of the intersection.
v. Median Maintenance. Most medians will be maintained by parties other than the City. The maintenance responsibility must be defined on the Final Plat or Development Agreement. The City will maintain selected medians, primarily along State highways based on agreements with TDOT.
vi. Public Use. The City may use these islands for street signing and may choose to remove the medians if it is deemed necessary by the City Engineer.
vii. Additional Right-of-way. The Developer shall dedicate all additional right-of-way necessary to include these medians.
viii. Compliance with these Standards. The median design must comply with all applicable median criteria in these Standards and the streetscape standards of the City.

(d) Turn Prohibition Islands: An intersection may be designed with islands to prohibit left and right turn movements into or out of the intersection. Typically, these islands should not be used unless there is also a street median present to ensure that improper movements are not made.



Turn Prohibition Island

e) Splitter Islands on Roundabouts: In modern roundabout designs, raised splitter islands shall be designed in accordance with the Federal Highway Administration *"Roundabouts: An Informational Guide"* to direct traffic and provide pedestrian refuge.

(13) Right-of-Way

All intersection rights-of-way and utility easements shall be dedicated to provide adequate right-of-way to include sidewalks, access ramps, and utilities. Additional right-of-way may be required at intersections to provide space for additional left or right turn lanes without reducing the widths of standard required facilities. Where standard intersections are used, additional right-of-way may be required to accommodate the potential installation of a roundabout in the future.

(14) Channelization

Channelization refers to physical or visual guides used to separate vehicles, bicycles and pedestrians into particular lanes.

(a) Intent of Channelization:
Channelization is intended to:

Channelization at intersection

i. Prohibit undesirable or wrong way movements.
ii. Define desirable vehicular paths.
iii. Encourage safe vehicle speeds.
iv. Separate points of conflict wherever possible.
v. Cause traffic streams to cross at right angles and merge at flat angles.
vi. Facilitate high-priority traffic movements.
vii. Facilitate traffic control scheme.
viii. Remove decelerating, stopped, or slow vehicles from high-speed through-traffic streams.
ix. Provide safe crossings for pedestrians/bicycles.
x. Provide safe refuge for pedestrians.

(b) Specific Channelization Requirements: Channelization shall be required at locations where it is necessary for safety or to protect the operation of the major street. Examples include:

i. Providing raised medians in all Arterials where left turns are prohibited.
ii. Prohibiting undesirable turning movements such as right and left turns, in and/or out.
iii. Providing exclusive turning lanes, with appropriate striping.
iv. Providing travel lanes, with widths as specified in the standard street cross sections.
v. Raised islands must be large enough to be visible to vehicle drivers. Therefore, no single island, including pedestrian paths and/or pedestrian refuge, shall be smaller than 100 square feet.

(15) Street Narrowing
Minor Collector or Local streets may be narrowed at intersections to provide more visibility for pedestrians. This shortens the distance necessary for pedestrians to cross the street. The narrowing shall not encroach into bike lanes or travel lanes. Narrowing may not be used on Major Collectors without any parking lanes, on any Arterials, or where the standard width is necessary. When narrowing is proposed, turning paths shall be evaluated to ensure that anticipated service vehicles (fire, sanitation, school buses) can be accommodated with the proposed design.

(16) Roundabouts
Roundabouts are considered a form of traffic control. Roundabouts shall be considered as two types: (1) Modern Roundabouts and (2) Mini Roundabouts.

(a) Modern Roundabouts: Modern Roundabouts shall be specially designed to the specific need on high traffic volume streets and used to improve traffic flow. Roundabouts shall be designed based on the FHWA's, *"Roundabouts: An Informational Guide"*, *"TDOT Standard Specifications"* for typical layout and comply with all *"PROWAG"* requirements.

(b) Design Experience. The design shall be performed or checked by a registered Professional Engineer who has designed a minimum of two roundabouts, located on either collector or arterial streets.

(c) Mini Roundabouts: Mini Roundabouts may be allowed in a neighborhood setting for traffic calming. Mini roundabouts may be used on Local Streets. The design shall be performed in accordance with the FHWA *Roundabout Design Guide*, or other design criteria approved by the City Engineer.

2.3.14 Sidewalks, Curbs & Gutters, Shoulders and Ditches

(1) Sidewalks

Typical Sidewalk with Grass Strip

(a) Typical Cross-Sections: Street cross sections that include sidewalks shall be as specified in this chapter and as shown on the Typical Section Drawings.

(b) Clear Zone: Sidewalks shall be designed to provide a desirable lateral clear zone of six (6) feet, except when located at back of curb. Vertical clearance shall be at seven (7) feet or higher.

(c) Other Sidewalk Requirements: Refer to **Section 2.4, Pedestrian Facilities,** and Zoning Ordinance for other related sidewalk requirements and guidance from the City's Major Thoroughfare Plan.

(d) Location of Sidewalks: Sidewalks are required on both sides of all streets in the City except Mack Hatcher Parkway, Interstate 65, rural roads, alleys and mews. Sidewalk design shall comply with the standards in this section.

(e) Setback: Sidewalks shall typically be set back a minimum of six (6) feet behind the street curb. The intervening space between the back of the curb and the edge of the sidewalk is intended for the placement of street trees and other roadside features.

Along nonresidential and mixed-use lots within urban areas, sidewalks may be located at the back of the curb. In no instance shall the intervening space between the back of the curb and the façade of a building be less than twelve (12) feet.

(f) Minimum Width: Sidewalks and trails running along streets shall meet the minimum widths as specified in **Table 2.3.1**.

(g) Ramps: Ramps meeting requirements of the Americans with Disabilities Act (ADA) shall be installed at the intersection of all sidewalks with public streets. Ramps shall be designed in accordance with the Standard Drawings and shall comply with *Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way*.

(h) Configuration

i. Sidewalks shall be constructed of concrete, textured pavers or a combination of these materials, and shall be raised above the adjacent street level. In special circumstances, brick sidewalks may be allowed by the City Engineer, provided that an agreement is executed requiring maintenance by others.
ii. Pedestrian street crossings at intersections may be raised above the adjacent street level as a traffic-calming measure.
iii. Sidewalks shall connect with existing or planned sidewalks at property boundaries.
iv. Sidewalks shall connect building entries within and between developments.
v. Except where brick or pavers are used, all public sidewalks shall maintain a brushed concrete finish for safety.

(i) Inlets: Drainage inlet accesses located in a sidewalk shall be integrated with sidewalks. The inlet access shall be flush with the sidewalk surface. No manholes, inlets, or other storm sewer facilities are

allowed within curb ramps. Refer to the drainage study requirements for sizing of inlets. Inlets are not allowed in the curb return, but shall be located at or behind the tangent points of the curb returns.

(j) Payment In-Lieu of Sidewalks: See City of Franklin Zoning Ordinance.

(2) Curb and Gutter

Type and Location: **Table 2.3 (1)** notes the type of curb and gutter to be used for the various street classifications and sections. See the Standard Drawings for City details for combined curbs and gutters.

(a) Post Curbs - Post curb sections without an integral gutter pan shall not be used unless approved by the City Engineer. Under no circumstances will they be used when water flows along the curb face.

(b) Ribbon Curbs - Ribbon curb, which is typically 8 inches wide at the top and is cast near the asphalt surface, may be used in locations such as adjacent to medians where surface water runoff is conveyed over the curb to detention areas.

(c) Standard Combined Curb with Gutters - The standard vertical face curb and gutter section consists of a 6-inch wide concrete curb cast integral with a 24-inch wide sloping gutter for a combined width of 30 inches. Local streets shall be allowed to use 18-inch wide sloping gutter as approved by the City Engineer.

(d) Spill Curbs - Where curb and gutter sections are used in superelevated streets and adjacent to medians, the gutter pan shall be sloped away from the median ("spill curb") to allow sheet flow toward the drainage structures.

(e) Mountable Curbs - The standard mountable curb or "rollover" curb is to be cast integral with a 12-inch wide gutter pan for a combined width of 24 inches. Vane grating for mountable curbs requires a width transition of the gutter pan to match the traffic edge of the drain casting.

Vertical combined curb and gutter

Rollover curb with grate transition

(3) Shoulders

All streets constructed in the City shall be constructed with curb and gutter. However, in extenuating circumstances, shoulders may be allowed by the City Engineer on a case by case interim basis. Where authorized, they shall be provided in addition to the elements shown on the typical cross sections contained at the end of this chapter.

(4) Roadside Ditches

(a) Location: Ditches are not normally allowed in the City unless otherwise approved by the City Engineer.

(b) Ditch Profile: The profile grade of the ditch shall be maintained at a minimum slope of one (1.0) percent and a maximum slope of five (5.0) percent. The side slopes of the ditches outside of the right-of-way shall be a minimum of 4:1 and meet any specific criteria of the drainage study. Flatter slopes may be considered when a paved invert is designed for the ditch bottom.

(c) Ditch Slope: The slope and capacity of any roadside ditches shall be maintained in any areas that driveways cross the ditch. Each site is required to provide a concrete pipe, a minimum of fifteen (15) inches in diameter, calculated to meet capacity and strength requirements of the drainage study. The pipe shall be designed to have no less than twenty-four (24) inches of cover over the pipe. All portions of the driveway within the right-of-way shall be paved with concrete or asphalt.

(d) Ditch Maintenance: All driveway improvements within the right-of-way including piping, ditches, curb and gutter, and sidewalk are generally the responsibility of the City.

2.3.15 Medians

(1) General Requirements

General criteria for medians are specified in **Table 2.3 (1)**. Also refer to the Franklin Zoning Ordinance. In the City, medians are required on all Arterial and Major Collector Streets. Raised medians are preferred, but depressed or painted medians may be allowed on a case by case basis. Other medians may be required by the City Engineer for specific circumstances to control traffic. Medians requested by developers may be approved as long as additional rights-of-way are dedicated and all maintenance shall be done by viable private parties. The minimum width of any raised median shall be four (4) feet wide, from face-of-curb to face-of-curb.

Typical Street Median

(2) Turn Lane and Access

The design of medians shall include the evaluation for current and future turn lanes and accesses.

(3) Design of Openings

Median openings shall be designed to accommodate the selected design vehicle for all movements. Raised island and other geometric design features shall be installed at median openings when necessary to prohibit certain turning or cross movements in the intersection.

Typical Median Opening

(4) Spacing of Openings

The effectiveness of medians is diminished by frequent and/or poorly spaced median openings. Openings should therefore be carefully coordinated with public and private street access points. Median openings shall be located only at major public or private access points, or at midblock locations if needed to serve U-turns. Optimum location of openings is best determined based on the findings of a Traffic Impact Analysis. Minimum spacing on major streets should normally be at least six-hundred (600) feet to accommodate back to back left turn lanes and weaving between openings.

(5) Drainage

Landscaped medians shall be provided with drainage facilities to handle sprinkler runoff and nuisance flows. Sprinklers shall be designed to prevent spray onto the pavement surface. A properly designed drain system shall be required.

(6) Nose Design
Vehicle tracking templates shall be used to determine the optimum position and design of the median nose so that vehicles do not track onto the median, and are coordinated with other movements in the intersection. The minimum radius for nose curbs shall be two (2) feet to flow-line.

(7) Paving
When medians are not landscaped, they shall be paved with stamped, colored, or broom finished concrete in accordance with the City's streetscape standards.

(8) Transitions
The ends of medians shall transition into turn lanes with a minimum radius of one-hundred (100) feet. Change in curb directions must be accomplished with the use of radii. Angle points shall not be allowed.

(9) Objects
No permanent structures, including light poles, fire hydrants, trees, walls or other fixed objects in the median shall be placed within clear zone as determined by the *Green Book*, or in any location that would obstruct sight distance except for structures as approved in these Standards. All objects placed within the clear zone shall be an approved TDOT/FHWA breakaway design.

2.3.16 On-Street Parking

(1) General
This chapter defines the parking criteria for on-street parking, including Downtown parking, parking on cul-de-sacs, and other special areas. Parking may be allowed on Local and Minor Collector streets at the discretion of the City Engineer. Parking shall not be allowed on Major Collector and Arterial streets.

(2) Parallel Parking
Parallel parking is permitted on certain streets as approved by the City Engineer.

(3) No Parking Signs
For all streets in which parking is limited or not allowed, "No Parking" street signs may be required as a part of the street design.

(4) Non-Parallel Parking
Diagonal parking shall not be allowed on City public streets and shall not be allowed to utilize the public street for maneuvering. The City Engineer must specifically approve any on-street parking areas that are not designed as parallel parking. All areas approved for diagonal parking shall be designed at an angle of thirty, forty-five, or sixty degrees, as approved by the City Engineer.

(5) Parking in Cul-de-Sacs
See **Section 2.3.7(1).**

(6) On-Street Accessible Parking Requirements
Where on-street parking is provided on the block perimeter and the parking is marked or metered, a minimum number of parking spaces must be accessible and shall comply with the *Public Rights-of-Way Accessibility Guidelines.* Where accessible parking spaces are constructed in conjunction with a new street, a 5'-0" wide access aisle, exclusive of the gutter, is required regardless of the parking space location along the block face. Additional right-of-way shall be dedicated as necessary to accommodate the accessible parking space, access aisle, and sidewalk beyond. (**See Figure 2.3 (6)**)

(7) Inset Parking
On-street parking shall be inset from the curb line unless otherwise allowed by the City Engineer. In these cases, additional right-of-way will likely be required to provide the roadside features shown on the typical cross sections.

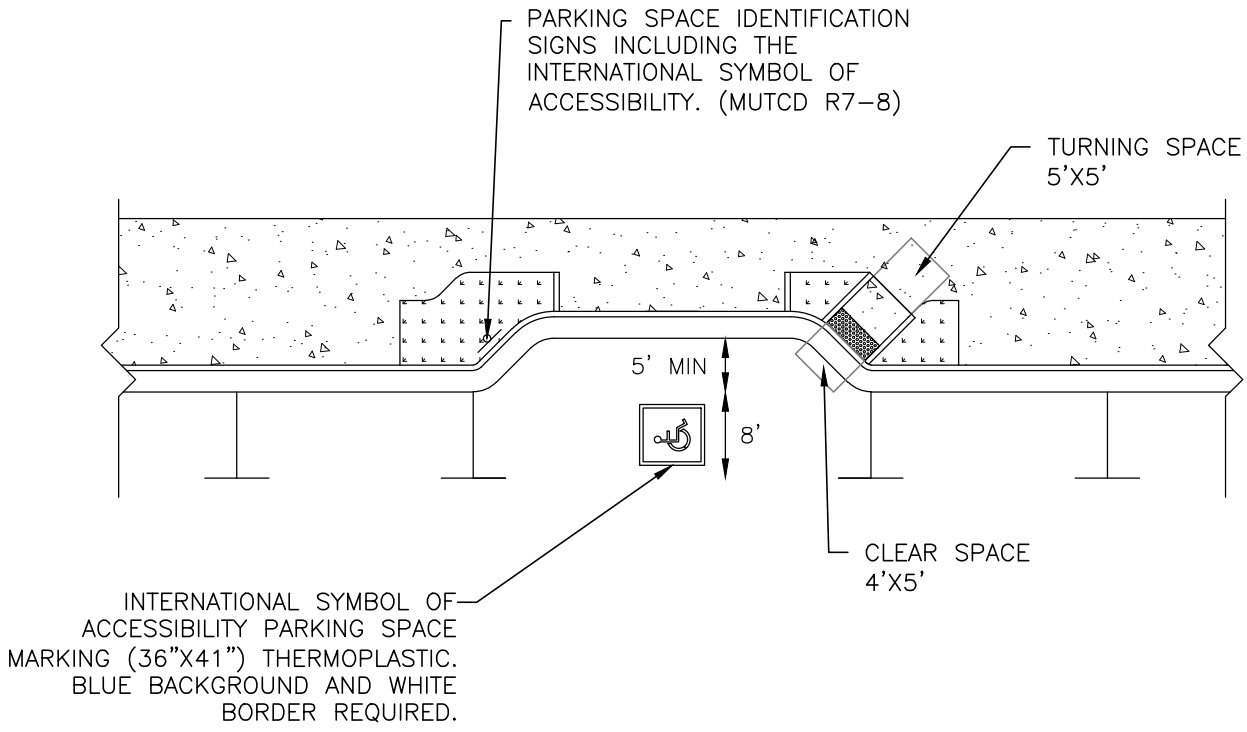
Typical Inset Parking

(8) Driveway Clearance
A vehicular parking space within the street shall be designed with a minimum clearance of six (6) feet from the edge of a driveway.

(9) Intersection Clearance
A vehicular parking space in the street shall be designed with a minimum clearance of thirty (30) feet from the intersection flow-line. The designer shall establish the minimum clearance by reviewing sight distance requirements in the *Green Book*.

(10) Mailboxes
Special consideration shall be given to mailbox locations near on-street parking such that parked vehicles do not interfere with mail delivery.

(11) Sidewalks and Trails Adjacent to On-Street Parking
Sidewalks, trails, and grass strips adjacent to on-street parking shall meet the minimum widths as specified in **Table 2.3.1**. In the rare occurrences where space constraints necessitate the sidewalk or trail to be located immediately adjacent to the on-street parking, the grass strip may be removed subject to the approval of the City Engineer. In these cases, the sidewalk or trail width shall be as specified in **Table 2.3.1**, but not less than 7 feet.



1) VEHICLES MAY PARK AT THE CURB OR AT THE PARKING LANE BOUNDARY AND USE THE SPACE REQUIRED ON EITHER THE DRIVER OR PASSENGER SIDE OF THE VEHICLE TO SERVE AS THE ACCESS AISLE.
2) SEE PROWAG STANDARDS FOR THE NUMBER OF ACCESSIBLE PARKING SPACES THAT MUST BE PROVIDED ON THE BLOCK PERIMETER WHERE ON-STREET PARKING IS PROVIDED.
3) PARKING SPACES MUST BE IDENTIFIED BY SIGNS DISPLAYING THE INTERNATIONAL SYMBOL OF ACCESSIBILITY.
4) ACCESSIBLE PARKING SPACES SHOULD BE LOCATED WHERE THE STREET HAS THE LEAST CROWN AND GRADE AND CLOSE TO KEY DESTINATIONS.
5) SIDEWALK ADJACENT TO ACCESSIBLE PARALLEL PARKING SPACES SHOULD BE FREE OF SIGNS, STREET FURNITURE, AND OTHER OBSTRUCTIONS TO PERMIT DEPLOYMENT OF VAN SIDE-LIFT OR RAMP OR VEHICLE OCCUPANT TO TRANSFER TO A WHEELCHAIR OR SCOOTER.
6) MODIFIED VERSIONS OF THIS DETAIL ARE ALLOWED BUT SHALL COMPLY WITH PROWAG STANDARDS.

HISTORIC FRANKLIN TENNESSEE

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ACCESSIBLE ON-STREET PARALLEL PARKING SPACE
FIGURE 2.3 (6)

2.3.17 Bridges

(1) Lane and Sidewalk Widths
The width of street travel lanes and sidewalks across bridge structures shall be equal to the widths on the street approaching the structure. Sidewalk and lane widths shall not be reduced from approach dimensions when crossing a bridge structure. Grass strip width may be eliminated across the bridge.

(2) Rails
All bridge rail or safety barriers shall concrete or metal beam guardrail constructed in accordance with approved "*TDOT Standard Specifications"* as approved by the City Engineer. Bridge rails shall incorporate aesthetic features such as form liners or stone veneers where approved by the City Engineer.

(3) Approach End Treatments
All approach end treatments for bridge rails shall be required at each end and shall be in accordance with "*TDOT Standard Specifications"* as approved by the City Engineer.

2.3.18 Clearance Requirements

(1) General
Streets shall be designed to minimize the potential for traffic accidents involving fixed objects beside the street travel way. The street designer shall consult the latest edition of the AASHTO "*Roadside Design Guide"* to design the safest possible roadside along City streets.

(2) Horizontal Clearance to Obstructions
The AASHTO "*Roadside Design Guide"* shall be consulted in the design process to identify the suggested clear zone dimensions and/or barrier for the street being designed. Regardless of this guidance, the desirable minimum lateral clearance from the face of curb to the nearest edge of an object is two (2) feet.

(3) Vertical Clearance
The minimum vertical clearance above a street is sixteen feet and six inches.

(4) Guardrails
The type and location of guardrails used in the City shall be approved by the City Engineer on a case-by-case basis and comply with TDOT and FHWA standards. Wood Guard rails are prohibited on public and private roadways within the City of Franklin.

2.3.19 Barriers and Fencing

(1) Roadside Barriers
All safety barriers shall be TDOT/FHWA approved crash-tested barriers. Aesthetic treatments such as stone veneer, concrete with a form liner finish, or painted railings may be used with the approval of the City Engineer.

Bridge Rail Barrier

(2) Median Barriers

All median divider barriers shall be TDOT approved, crash-tested barriers walls. Glare screens may be required for high volume streets as approved by the City Engineer.

(3) Fencing

No fencing shall be installed in the street right-of-way. Fencing installed behind the right-of-way shall not result in sight distance less than the recommended distances in this document.

Access Fencing

(4) Maintain Sight Distance

No fencing or barrier installed in or adjacent to the street right-of-way shall result in sight distance less than the recommended distances in this document.

2.3.20 Provision for Utilities

This section sets forth the criteria and location requirements for all utilities located within the right-of-way and/or public utility easements located adjacent to public rights-of-way, such as: water, sewer, storm sewer, subdrains, power (electric and natural gas), phone, cable television (CATV), traffic signals and mailboxes. The appropriate utility department or agency shall determine all final alignments of utilities in consultation with the City Engineer. For new and widened streets, provisions shall be made to include conduit for future signal interconnects and all required pull boxes.

(1) General Requirements

Standard plan requirements and layout requirements are discussed in earlier sections. Refer to **Figure 2.3 (7)** for general utility placement guidelines.

(2) Minimum Depth

Utilities shall be located at least thirty-six (36) inches below the finish grade elevation, unless specifically approved to be less by the City Engineer. The minimum depth of cover for storm sewer pipes may be reduced to twenty-four (24) inches to the top of pavement. Greater depth of cover may be specified by the City Engineer.

(3) Access Covers

(a) Clearance: All manhole lids, utility access covers, and range box access covers shall be flush with the street finished surface. If located in concrete drives or sidewalks, all access covers shall be set flush with surrounding concrete.

(b) Wheel Path: Manholes or valves installed in the street travel way shall not be designed or constructed in the wheel path of the travel lane or at any location within a bike lane.

(4) Trees and Large Shrubs

(a) Buried Utilities: Trees, berms or large shrubs shall not be placed directly over buried utilities in the public right-of-way or easement. Additional horizontal clearances from the trunk of any tree or shrub to any buried utility may be required by the respective utility department or agency, as required for access, repair and/or maintenance activities.

(b) Overhead Utilities: Trees shall not be planted under overhead power lines when mature growth of the tree would encroach within the influence areas of the power lines.

(5) Use of PVC Sleeves by Franchised and Private Utilities

(a) General: It is the intent of these standards to reduce the amount of open cuts in the street. Therefore, franchised and private utility companies shall install all utilities within a non-corrosive sleeve equivalent to Schedule 80 PVC or other sleeves encased in concrete, slurry or flowable fill material, across all public streets to accommodate future repairs without street cuts.

(b) Exceptions: Steel gas line street crossings will not require sleeves.

(c) Depth: Sleeves shall be installed at a minimum depth of forty-two (42) inches from the top of the pipe to the top of pavement or thirty-six (36) inches from the top of pipe to the top of subgrade, whichever is greater.

(d) Location: Unless otherwise approved by the City Engineer, all utility sleeves shall be located within fifteen (15) feet of the parallel gutter flow-line of the existing street and shall be coordinated with other utilities. Sleeves shall be separated for existing buried utilities in accordance with the utility owner requirements. Ten feet of separation is typically preferred.

(e) Street Cuts: Utility crossings of existing streets shall be performed in accordance with an approved Street Crossing Permit as issued by the City. Installations utilizing jacking or boring under the street is the primary methods. Open cuts must be justified for need.

(f) Potential Signalized Intersections: Refer to **Chapter 8, Signal Design**, for guidance on underground facilities for traffic signals.

(6) Location Criteria

(a) General: The utility locations discussed below are recommended for new development and preferred in the case of existing streets and established developments.

(b) Water Mains: Water mains shall be located on the north and east sides of streets approximately seven (7) feet south or west of the north or east gutter flow-line. Water mains shall be separated by a minimum of ten (10) feet horizontally from sanitary sewer and storm sewer facilities. The vertical depth of the water lines shall meet the requirements of the appropriate utility department or agency.

(c) Fire Hydrants: Fire hydrants shall be located two (2) feet minimum from curb and gutter flow-line or two (2) feet minimum from back edge of a sidewalk or ten (10) feet minimum from edge of pavement if no curb is present. In addition, the water line shall be located such that the valves will not be in the wheel path of the street lane.

(d) Sanitary Sewer: Sanitary sewer shall be on the centerline of the street pavement. If a median is present, the sanitary sewer line shall be located six (6) feet west or south of the median. The sanitary sewer shall be located such that the manhole locations are not within the wheel path of the street lane. The vertical depth of the sanitary sewer lines shall meet the requirements of the sanitary sewer standards of the City.

(e) Storm Sewer: The storm sewer shall be placed so the manhole locations are not within the wheel path of the street lane. The storm sewer lines shall meet the requirements of the storm sewer standards as provided in this document.

(f) Natural Gas: Gas mains shall be located either within the right-of-way or in an adjacent easement on the south and west sides of the street. For double mains (a main on each side of the street), the requirement of north and east/south and west may be waived by the City Engineer.

(g) Power and Street Lighting: Generally, power and street lighting conduits shall be located on both sides of the street either within the right-of-way or in an adjacent easement. Double conduits (a conduit on each side of the street) may be acceptable as approved by the City Engineer.

(7) Other Systems

(a) Cable TV/Telephone: Cable TV and telephone lines generally serve properties from the back. For mains along the street front the utility shall coordinate the location in the right-of-way or easements with the City Engineer. All pedestal boxes, new and relocated, located in the right-of-way between the curb and the sidewalk shall be installed below ground.

(b) Mailboxes: Mailboxes shall be installed a minimum of one and one-half (1.5) feet from the face of the curb, or travel lane. Mailboxes shall not cause any sight obstruction for motorists exiting side streets or driveways. Mailbox supports shall not pose a fixed object hazard for vehicles and pedestrians.

(c) Poles

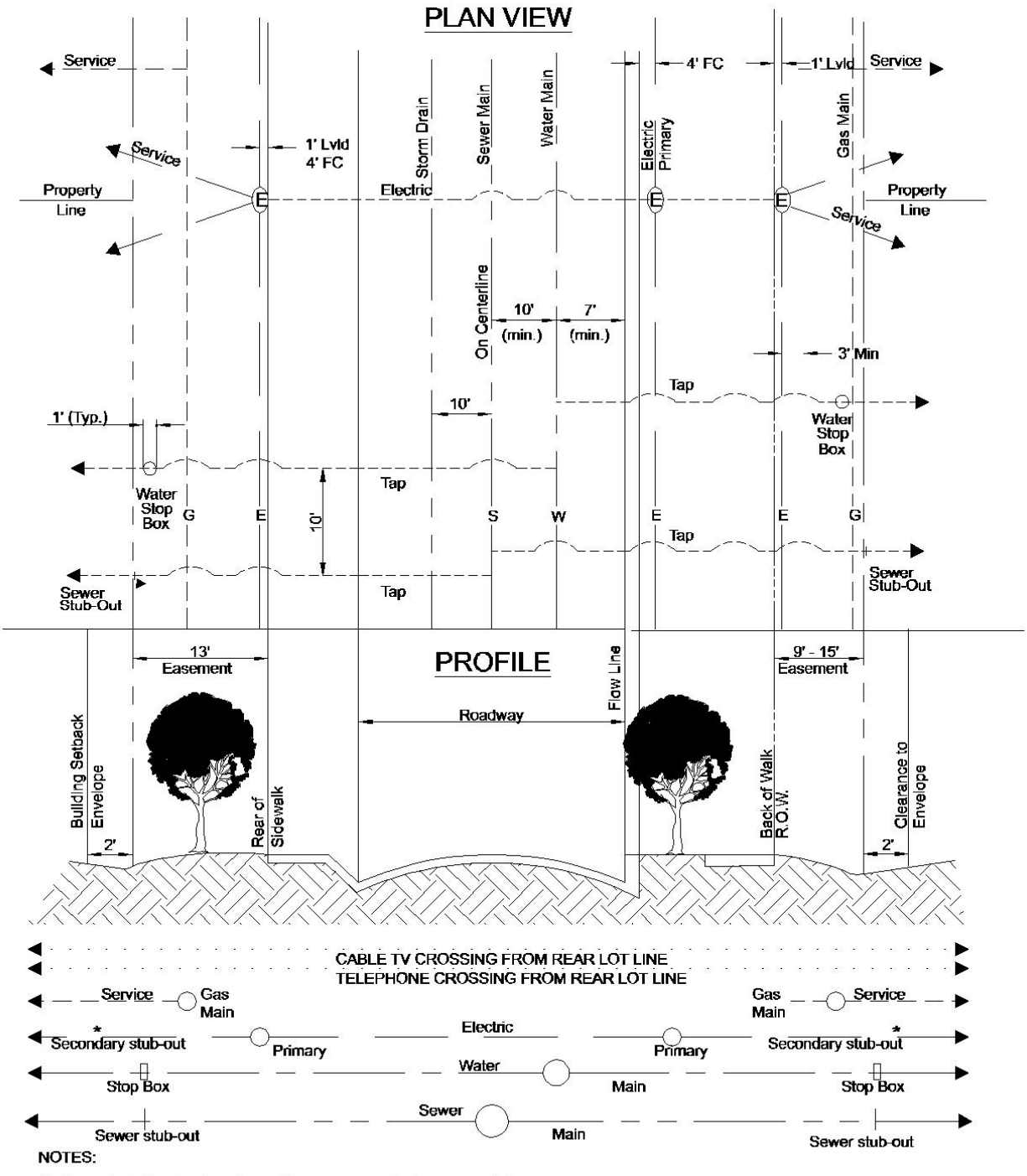
i. Location: Poles, signs, and any other above ground streetscape (except regulatory signs) shall be located within five (5) feet of the right-of-way line or ten (10) feet from the travel lane (flow-line), whichever is most restrictive.
ii. Clearance: Street light poles shall be placed no closer to the street than two (2) feet behind a vertical curb line and no closer than two (2) feet to any sidewalk.
iii. Pole Requirements: The City Engineer may require breakaway poles on public right-of-way where speed limit is 40 MPH or higher.
iv. Engineer Approval: All poles within the public right-of-way must be approved by the City Engineer prior to the permit application for installation.
v. Other Requirements: All signs and heights shall meet the requirements of **Chapter 8, Traffic Signs and Marking**.

(d) Subdrains: Subdrain main lines may be permitted within the public right-of-way. The Developer shall be required to provide additional information and soils investigation. In addition, subdrains shall be designed in accordance with the requirements of this document. If the soils investigation shows that subdrains are required for private property foundations, these lines may be designed to be installed within the public right-of-way only if all requirements of these Standards are met.

i. Private Property. Subdrains built within the right-of-way for private drainage shall be private improvements and shall have provisions for viable maintenance by the local homeowners association or other private entities. The City may require the private party to abandon or relocate such subdrains.
ii. Public Property. A subdrain is public if it is used to drain public improvements, such as the street/pavement section.
iii. Depth. Top of pipe shall be at least thirty-six (36) inches below pavement surface.
iv. Outlet. All subdrains shall outlet to a detention pond, inlet, or other approved location. Each outlet shall have a device to prohibit backflow into outlet pipe.
v. Perforated subdrains for private improvements shall not be allowed within any public right-of-way or easement.
vi. Professional Engineer. Subdrains must be designed by a Professional Engineer and are subject to approval of the City Engineer.

(8) Utility Crossings with Bridge Structures

Conduit sleeves may be required within the bridge structures to provide for electrical, gas, telephone, and cable crossings. The City Engineer may require additional sleeves to be designed with the bridge structure for sewer, water, or other utilities.



NOTES:

1. No scale to the drawing above. All measurements shown are minimums.
2. Storm and sanitary sewers, manholes, water valves or telephone manholes are not allowed in the wheel path.

Utility Location Guidelines
Figure 2.3 (7)

2.3.21 Emergency Access Street Requirements

Any emergency street access not on public right-of-way shall be provided in accordance with the Emergency Access Section in the City Zoning Ordinance, or in accordance with the requirements of the City Fire Marshall.

(1) Grade

The grade of the fire lanes shall be a minimum of one-half (0.5) percent and a maximum of ten (10.0) percent.

(2) Cross Slope

The Cross Slope of the fire lanes shall be a minimum of one (1.0) percent and a maximum of four (4.0) percent.

(3) Lane Width

The lane width shall be a minimum of twenty (20) feet from the edge of the street to edge of the street and shall be in an access Easement. The access easement shall have a minimum width of twenty (20) feet. The lane widths may be required to be increased through horizontal curves to accommodate fire truck passage.

(4) Vertical Clearance

There shall be a minimum of thirteen and one-half (13.5) feet of vertical clearance over the entire fire lane.

(5) Barricade

The fire lane may contain an approved barricade, but it must be of a type approved by the City Fire Marshall.

(6) Signs and Markings

The fire lane shall contain signs and markings as required by the City Fire Marshall.

(7) Street Surface

The surface of the street must be a paved surface complying with Local Street pavement thickness requirements, unless approved otherwise by the City Engineer.

(8) Maintenance

All access streets shall be maintained and kept clear for emergency use at all times.

2.3.22 Bus Stops

(1) General

The minimum design criteria for the location and construction of bus stops is as described below. The City Engineer may vary any of the following requirements as deemed appropriate for the site and its particular situation. The Designer shall propose and the City Engineer will approve the exact location of the bus stop in a proposed development. All bus bay locations shall be coordinated with the City Engineer.

Bus stop locations may be required to be constructed with special pavement designs. Developments shall include a trolley shelter along streets served by trolleys at locations identified by the Transit Agency. A statement confirming the viability and availability of the site as a current and/or future trolley stop, and the appropriateness of the design of the shelter, shall be obtained from the agency. If the stop is deemed not viable, then the City Engineer may waive the trolley shelter requirement.

(2) Bus Lane Width
Bus bays shall be at least ten (10) feet wide.

(3) Approach Leg (Near-side) Minimum Criteria
Bus stops on the approach leg of an intersection shall be at least fifty (50) feet long for a single bus, plus a sixty (60) to eighty (80) foot transition distance kept clear approaching the stop.

(4) Departure Leg (Far-side) Minimum Criteria
Bus stops on the departure leg of an intersection shall provide a fifty (50) foot long loading area plus forty (40) to sixty (60) feet of transition distance.

(5) MidBlock Stops
Midblock stops shall be designed with entrance and exit designed for the posted speed limit in accordance with transition criteria approved by the City Engineer.

(6) Bus Bays
All bus pullouts and bays required by the City shall be designed and constructed in accordance with AASHTO guidelines.

(7) Bus Shelters
For access and design guidelines for bus shelters required by the City, refer to *AASHTO* guidelines and *"PROWAG"* standards.

(8) Bus Pullout Lanes
Bus pullouts shall be constructed with no less than fifty (50) feet between an intersection curb return (point of curvature, P.C.) and the beginning of the lead-in taper.

2.3.23 Access Management & Design

(1) General
Driveway and street access to the public street system shall be evaluated in the preparation of any plans and Traffic Impact Analysis. The City Engineer may modify any of the requirements of the driveway location and design standards based on trip generation, topography, and/or the anticipated impacts on traffic safety and movement on the street. Notwithstanding any other provisions of these standards, an access, which demonstrates a potential threat or danger to the public and/or which could affect the safe and efficient flow of traffic, may be denied by the City Engineer, based on commonly accepted and applied traffic engineering principles.

(2) Driveway Design Criteria
Plans shall provide for compliance with the minimum standards noted below for access from one or more lots to a public street:

(3) Number of Driveways Permitted
Access to streets shall be provided to lots either by means of shared access easements, private-drive easements, including frontage or rear access drives, or direct access.

(a) From Arterial Streets

i. Shared-access or private-drive easements shall be used to serve multiple lots. However, when these are unavailable or deemed unnecessary by the City Engineer, then single lots fronting less than six-hundred (600) feet along an arterial street shall have no more than one driveway onto the arterial street.
ii. Lots fronting between six-hundred (600) feet and twelve-hundred (1,200) feet along an arterial street may have a second driveway, provided that the City Engineer may approve additional driveways based on trip generation or topography.

iii. Lots fronting in excess of twelve-hundred (1,200) feet along an arterial street may have additional driveways, provided that the City Engineer may approve additional driveways based on trip generation or topography, and it is determined that the impact to traffic safety and movement on the street will be minimal.

iv. Access to a corner lot fronting on two arterial streets shall be required to have access from the street with the lower average daily traffic volume. Access to a corner lot fronting on an arterial street, and bordered by a collector or local street, shall be required to have access only from the collector or local street. A lot may be permitted to have an additional driveway from the abutting arterial street, provided that the City Engineer may approve additional driveways based on trip generation or topography, and it is determined that the impacts on traffic safety and movement on the street will be minimal. Approval may be conditioned upon other geometric improvements which will mitigate traffic impacts.

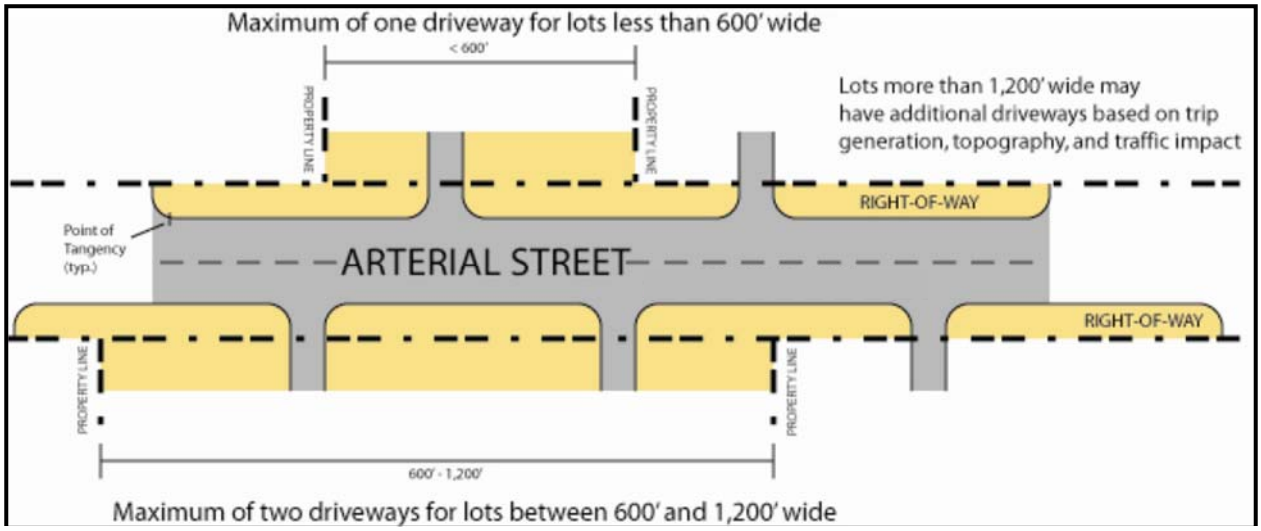


Figure 2.3 (8) – Arterial Street Driveway Spacing Criteria

(b) From Collector Streets

i. Single lots fronting less than three-hundred (300) feet along a collector street shall have no more than one driveway onto the collector street.

ii. For nonresidential uses, lots fronting more than three-hundred (300) feet along a collector street may have more than one driveway, provided that the City Engineer may approve additional driveways based on trip generation or topography, and it is determined that the impacts on traffic safety and movement on the street will be minimal.

iii. Access to a corner lot fronting on two collector streets shall be required to have access from the street with the lower average daily traffic volume. Access to a corner lot fronting on a collector street, and bordered by a local street, shall be required to have access only from the local street. A lot may be permitted to have an additional driveway from the abutting collector street, provided that the City Engineer may approve the driveway based on trip generation or topography, and it is determined that the impact on traffic safety and movement on the street will be minimal.

iv. In general, no access shall be permitted to residential lots from collector streets. However, where no alternative access is available, residential lots with one-hundred and twenty-five (125) feet of frontage or less shall be permitted to have one driveway. Residential lots fronting in excess of one-hundred and twenty-five (125) feet along a collector street may have more than one driveway, provided that the City Engineer may approve an additional driveway only if it will have a minimal impact on traffic safety and movement on the street. Driveways shall be a minimum of fifty (50) feet apart, measured from the nearest point of the radius return of the two driveways.

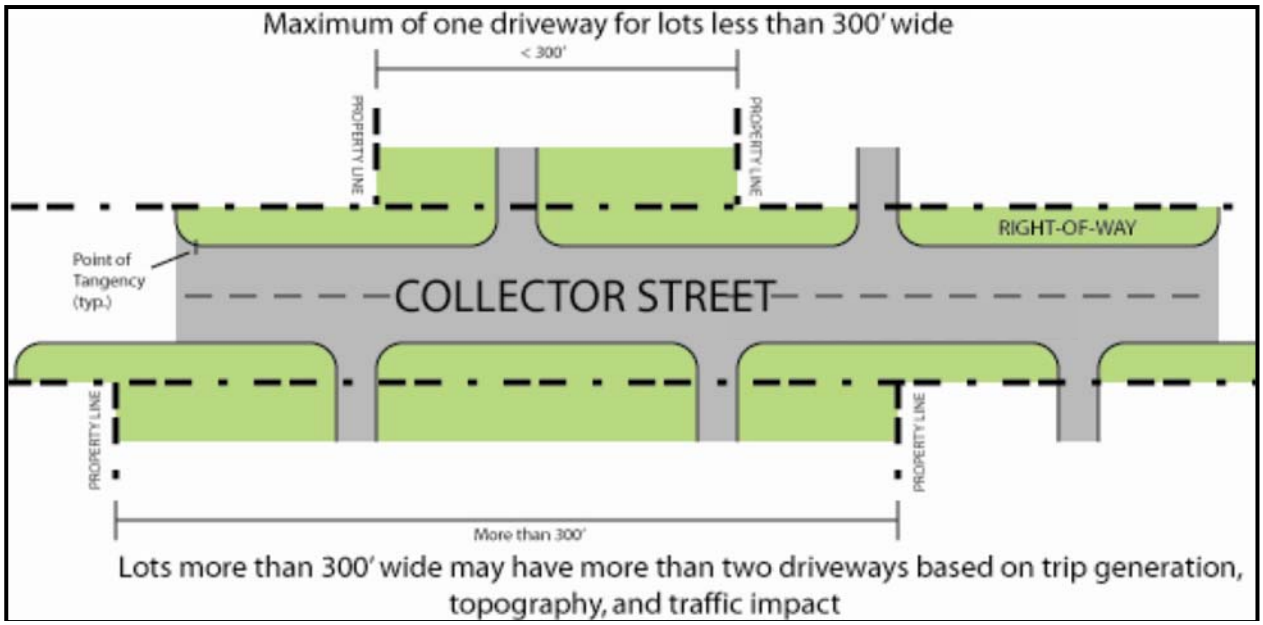


Figure 2.3 (9) – Collector Street Driveway Spacing Criteria

(c) From Local Streets

i. There shall be no more than one driveway for lots fronting less than one hundred (100) feet along a local street.

ii. Lots fronting in excess of one-hundred (100) feet along a local street may have more than one driveway, provided that, if approved by the City Engineer for nonresidential uses or the Codes Department for residential uses, the additional driveway will be justified based on trip generation or topography, and it is determined that the impact on traffic safety and movement will be minimal. Driveways shall be a minimum of fifty (50) feet apart, measured from the nearest point of the radius return of the two driveways.

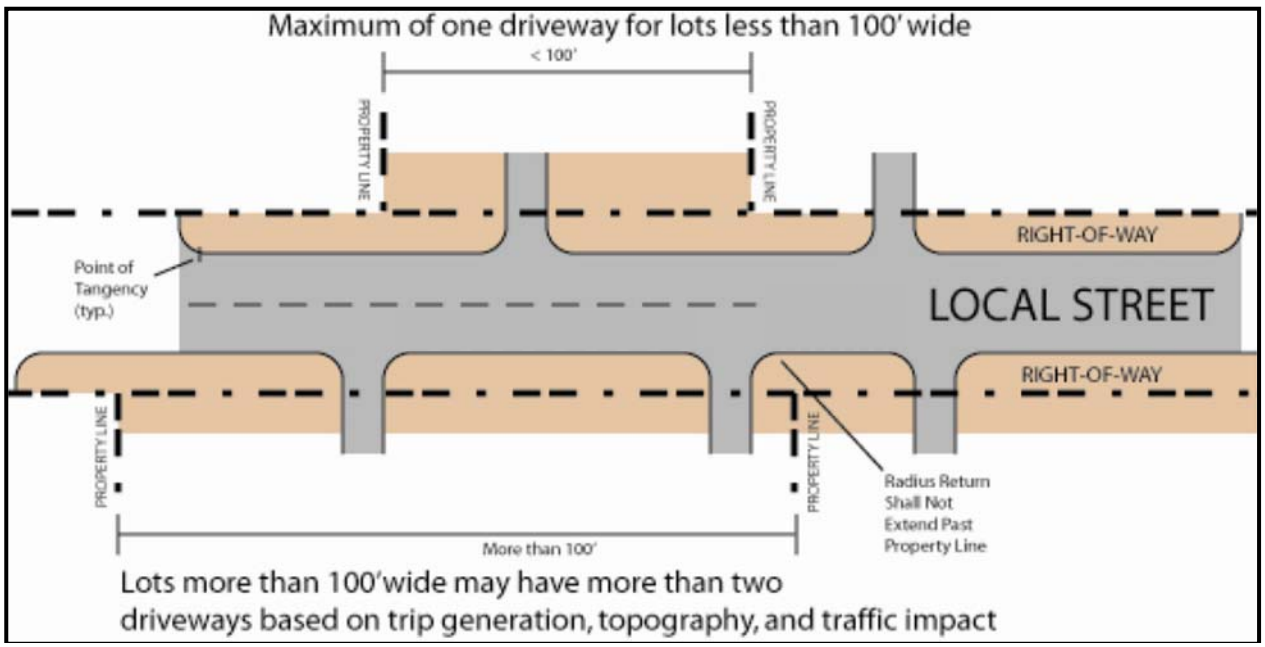


Figure 2.3 (10) – Local Street Driveway Spacing Criteria

(4) Minimum Distance from Intersections

(a) No low volume driveway to an arterial street shall be established within two-hundred and fifty (250) feet of an intersecting street. See **Figure 2.3 (11)** for design criteria.

(b) No low volume driveway to a collector street shall be established within two-hundred and thirty (230) feet of an intersecting street. See **Figure 2.3 (12)** for design criteria.

(c) No low volume driveway to a high volume local street shall be established within one-hundred and twenty-five (125) feet of an intersecting street. On low volume local streets, no low volume driveway shall be established within fifty (50) feet of an intersecting street. See **Figure 2.3 (13)** for design criteria.

(d) All distance measurements shall be made from the nearest point of tangency of the curve of the intersecting street right-of-way to the nearest point of radius return of the driveway.

(e) For residential uses, a corner lot abutting two local streets may have a driveway with less than the above required distance from the intersecting street, if, in the opinion of the City Engineer, the driveway will not adversely affect traffic safety and movement on the streets.

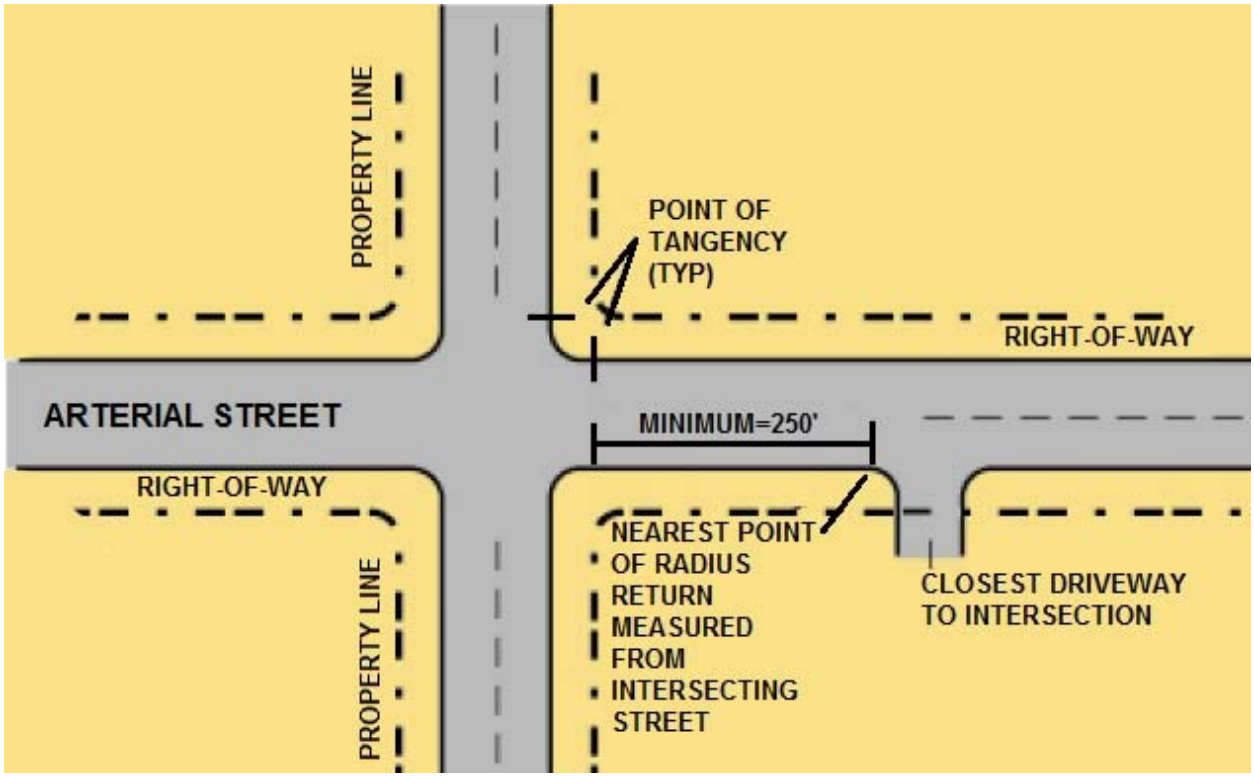


Figure 2.3 (11) – Arterial Street Driveway Intersection Clearance

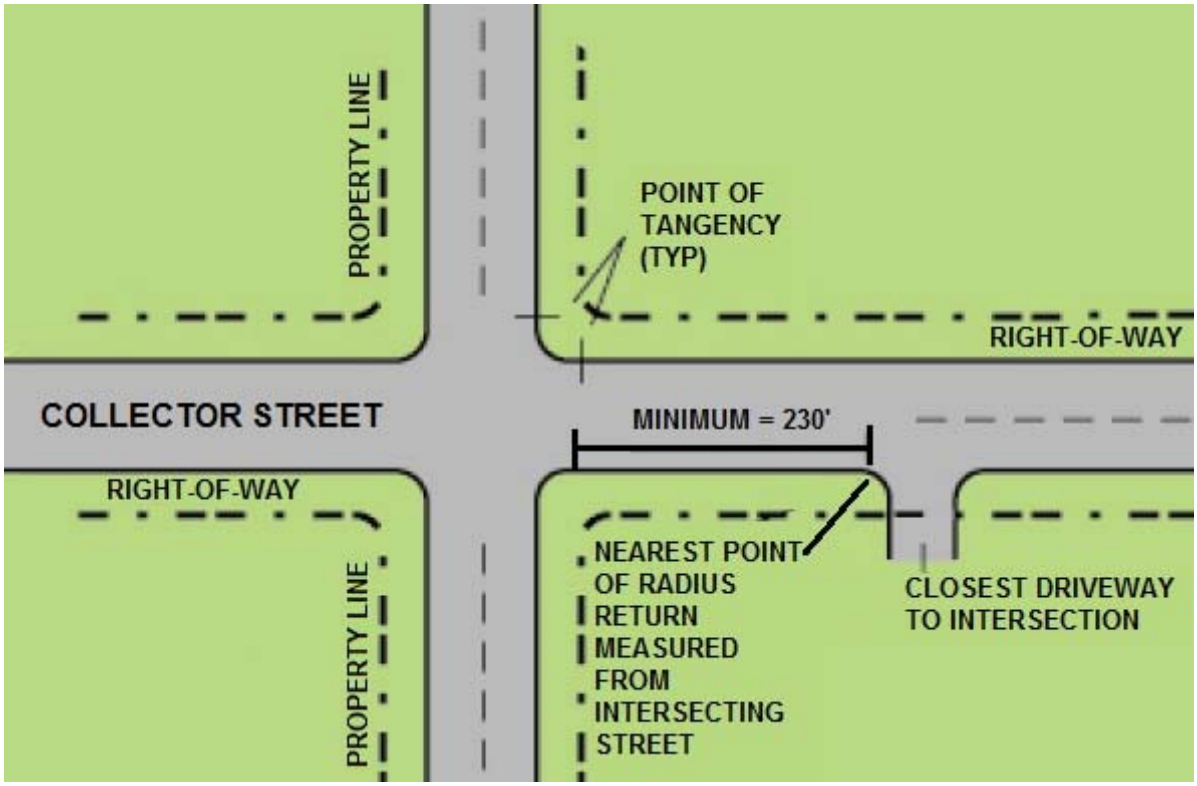


Figure 2.3 (12) – Collector Street Driveway Intersection Clearance

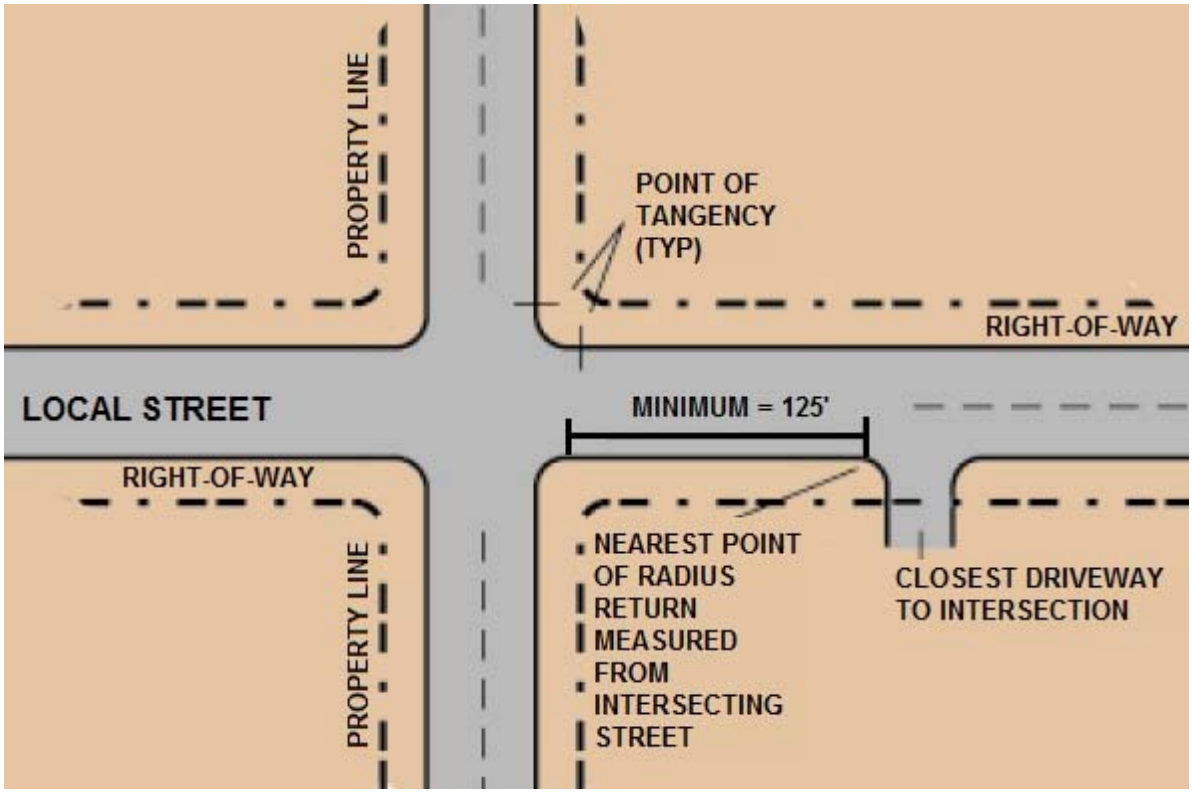


Figure 2.3 (13) Local Street Driveway Intersection Clearance

(5) Minimum Distance Between Driveways on Separate Lots

(a) The minimum distance between driveways serving separate lots shall not be less than those shown Table 2.3(2).

(b) The minimum distance may be reduced, provided that, if approved by the City Engineer for nonresidential uses, or Building and Neighborhood Services Department for residential uses, the following conditions exist, based on commonly accepted and applied traffic engineering principles: the use of shared-access or private street easements is not feasible or possible; exceptional topographic constraints or unusual site conditions exist at the driveway location (such as in-place utility or drainage features) which would make strict application of the standard exceptionally and/or practically difficult or unduly harsh; application of this section would conflict with other sections of this ordinance; and where the reduction would not constitute a threat or danger to the safe and efficient flow of traffic.

(6) Minimum Distance from Property Line

No driveway, other than a shared-access driveway, shall extend beyond a straight line projection of any side or rear lot line; provided, however, that the provisions may be waived subject to approval by the City Engineer for nonresidential uses or the Codes Department for residential uses.

(7) Deceleration Lanes

Approval of a nonresidential use driveway to an arterial or a collector street may be conditioned upon construction of a deceleration lane. The lanes shall be required in conjunction with each driveway to arterial or collector streets where a proposed land use will increase traffic volumes on the existing street to a total in excess of one-thousand (1,000) vehicle trips per day or one-hundred (100) peak-hour vehicle trips per day. The deceleration lane, a minimum of twelve (12) feet wide, measured from the face of the curb for curb sections without a monolithic gutter, the edge of the gutter for a monolithic curb and gutter section, or the edge of the shoulder line for a non-curbed section to the center of the lane line, shall be constructed to City standards with the length measured from the centerline of the driveway according to AASHTO's "*Green Book"*.

(8) Acceleration Lanes

In instances of unusual topography or traffic safety considerations, the City Engineer may require the construction of an acceleration lane for nonresidential uses. The length of taper and total length shall be determined based on AASHTO's "*Green Book"* and other commonly accepted and applied traffic engineering principles.

(9) Left-Turn Storage Lane

(a) Approval of a nonresidential use driveway to an arterial street or to a collector street which does not have an exclusive left-turn storage lane may be conditioned upon the construction of a left turn storage lane with appropriate median and/or pavement markings.

(b) The requirement and design of each storage lane, including the paved approach, bay, and departure tapers, shall be determined from the recommendations of the traffic study and approved by the City Engineer based on commonly accepted and applied traffic engineering principles. See **Figure 2.3 (3)** for design criteria.

(10) Shared-Access Easements

(a) In the re-subdivision of property, the City Engineer may require private driveway easements or other conditions that require multiple lots or parcels to have shared vehicle access locations to arterial or collector streets such as through the use of rear-access or frontage drives where, in accordance with commonly accepted and applied traffic engineering principles, these may be necessary in order to provide for the safe and efficient flow of traffic. Rear-access or frontage drives shall be used only when they can be designed properly to provide safe and efficient access for properties.

(b) Where shared-access easements are required, the subdivision plat shall state that the transfer of lots shall be subject to the provision of such easements, which shall provide for a guaranteed, unrestricted, right of access to all other owners providing such easements and that the owners of lots subject to shared-access easements shall be required to execute an agreement specifying responsibility for construction and perpetual maintenance of the easements in accordance with the approved access plan. The agreement shall specify that the parties thereto shall hold the City harmless from liabilities resulting from unsafe conditions on shared-access easements.

Copies of the agreements from the current owners of lots through which shared-access easements are to run shall be filed with the City Engineer. Construction on shared-access easements shall not be commenced until all agreements are filed. Copies of all subsequent amendments to the agreements shall also be filed with the City Engineer.

(c) In the event that the owners fail to maintain shared-access easements in a safe and stable driving condition, the Building and Neighborhood Services Director, after appropriate notice, may have the unsafe or unstable conditions corrected and bill the owners for all reasonable costs. Should the owners fail to pay the City the amount of such charge within thirty (30) days from receipt of a certified invoice, then the costs shall be certified to the City Attorney, who shall process a lien on the properties upon which the expenditure was made.

(11) Driveway Approach Length and Restrictions

Driveways for nonresidential, multi-family, and other similar uses must extend a minimum of thirty (30) feet into the property from the lot line abutting the street before the edge of the driveway may be intersected by a parking lot space, aisle, or drive. The minimum length of the driveway restriction may be extended, provided that it is determined by the City Engineer that anticipated traffic volumes and commonly accepted and applied traffic engineering principles justify the need for longer, controlled storage lanes. See **Figure 2.3 (14)** for design criteria.

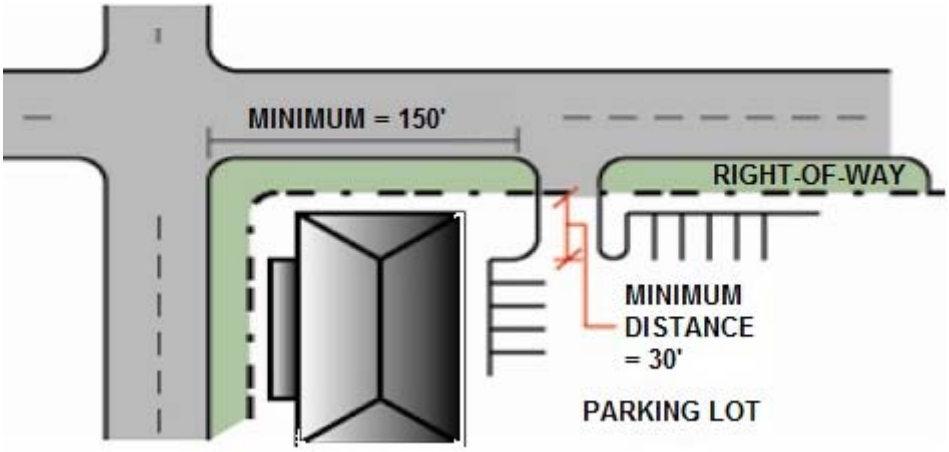


Figure 2.3 (14) – Driveway Approach Design Criteria

(12) Driveway Width Requirements

(a) The width of driveways, measured at the nearest points of the radius returns, shall meet the requirements in the table below.

(b) Driveways to nonresidential uses may exceed the maximum width, provided that it is determined by the City Engineer that the need to provide safer turning movements and/or the number of trips generated for truck traffic to or from the property will justify the need for additional driveway lanes.

Table 2.3 (8) Driveway Width Requirements

Use	Drive Width (feet)	
	Minimum	Maximum
Residential (to individual dwelling units)	10	20
Nonresidential – One Way Traffic	15	20
Nonresidential – Two Way Traffic [note a]	24	36

NOTE: a. Multilane driveways may be wider subject to the approval of the City Engineer.

(13) Median Driveways

Median driveways, in which ingress and egress lanes are separated by a minimum four (4) foot wide raised concrete curb median, may exceed the maximum two-way width, provided that the individual ingress or egress lane will not exceed the limits of one-way access width, and the median will not exceed fourteen (14) feet in width. These dimensions and lanes may be increased for higher-volume driveways if justified by a Traffic Impact Study. Additionally, monuments, walks, vegetation, or signing must not be located in the median in such a way as to interfere with driver vision and safety when entering or exiting the driveway.

(14) Radius Return at Driveway Entrance

(a) The radius return connecting the edge of the acceleration or deceleration lane or through-traffic lane and edge of driveway shall meet the requirements of **Table 2.3 (9).**

(b) The radius of the driveway return to nonresidential uses may exceed the maximum radius length, provided that it is determined by the City Engineer that the need to provide safer

turning movements and/or the number of trips generated to or from the property for truck traffic will justify the need for additional radius length.

Table 2.3 (9) Radius Return at Driveway Entrance		
Use	Radius (feet) [1]	
	Minimum	Maximum
Residential	5	15
Nonresidential:		
- Arterial Street	25	40
- Collector Street	25	30
- Local Street	10	25

NOTES: [1] A driveway flare may be used instead of a curve for residential uses.

(15) Pavement Markings and Signing
Driveways with more than one ingress or egress lane shall have the pavement surfaced marked with center lines, lane lines, channelization lines, stop lines, and symbol arrows plus traffic control signing in accordance with the requirements of the *"MUTCD"*. The pavement markings and signing shall be continually maintained by the property owner in good condition and visible to drivers at all times.

(16) Materials
All driveway areas within the public right-of-way used for vehicular traffic shall be paved with Portland cement concrete (PCC) from the edge of street pavement to the edge of right-of-way or to the back of the sidewalk, whichever is farthest from the curb. PCC may only be required to extend to the back of sidewalk if approved by the City Engineer. In the event a driveway serving a residential use is crossed by a concrete sidewalk, the portion of the driveway from the sidewalk to the flare of the driveway shall utilize the same material and finish as the sidewalk.

(17) Additional Right-of-Way
The applicant shall provide or dedicate additional right-of-way and/or easement if it is determined by the City Engineer that the right-of-way and/or easement is necessary for street improvements, such as acceleration/deceleration lanes, as established on the approved access plan.

(18) Offset from Opposite Streets
Intersections of streets with Major Arterial streets shall only align with streets intersecting on the opposite side of the Arterial street where a traffic signal or Roundabout will be permitted unless a raised median exists within the Arterial street that restricts the access at the intersections to right-in and right-out turns only. All other intersections must be offset by a minimum of one-hundred and twenty-five (125) feet or greater as required by the City Engineer.

(19) Avoiding Conflicts in Center Left Turn Lane
When establishing the placement of offset accesses (either driveways or intersections), ensure that traffic making left-hand turns into the accesses does not conflict or compete for the simultaneous use of a center left turn lane.

(20) Potential for Future Signalization
For any driveway access to a Major Arterial, an Access Management Plan and a signal progression plan may be required by the City Engineer. Generally, private direct access is discouraged onto a Major Arterial street to allow the Arterial to better meet its primary function. Public street access to a Major Arterial, where left turns are to be permitted, must meet the signal spacing criteria and the Access Management Plan. Access points that do not meet these requirements shall normally be limited to right turns only, unless they meet the requirements above.

(21) Public Street Intersection Spacing
Local streets should not typically intersect Arterials, but where they do they shall be spaced at a minimum of six-hundred and sixty (660) feet. Full movement access to Major Arterials shall be limited to one-half mile intervals wherever possible, plus or minus approximately two-hundred (200) feet, in order to achieve good speed, capacity, and optimal signal progression. However, to provide flexibility for both existing and future conditions, an approved engineering analysis of signal progression shall be made to properly locate any proposed access that may require signalization.

(22) Right Turns Only
Left turns may be prohibited, allowing right turns only. If left turns are restricted, raised medians will be required to prevent the left turn movements. Access points to arterials will normally be limited to right turns only (through signing and a raised median), unless:

(a) The access has the potential for signalization, in accordance with the general spacing requirements in this section,

(b) Left turns would not create unreasonable congestion or safety problems and not appreciably lower the level of service, and

(c) Alternatives to the left turns would not cause unacceptable traffic operation and safety problems to the general street system.

(23) Entrance-Only and Exit-Only Approaches
Driveway approaches, where the driveway is to serve as either an entrance-only or exit-only drive, shall be appropriately signed by, and at the expense of, the property owner to guide motorists in proper driveway operation. The property owner shall provide whatever means are necessary to ensure that motorists will use the driveway in the intended manner.

(24) Profile
The profile of a driveway approach and the grading of the adjacent area shall be such that when a vehicle is located on the driveway outside the traveled portion of the street the driver can see a sufficient distance in both directions to enter the street without creating a hazardous traffic situation. The driveway profile grade within twenty (20) feet of the flow line shall not exceed eight (8) percent unless a variance is approved by the City Engineer. Driveways within the sidewalk and parkway area of the right-of-way shall slope toward the street. See **Figures 2.3 (15)** for allowable grades and grade breaks for driveway approaches.

(25) Adjustments for Existing Structures
Any adjustments made to utility poles, street light standards, fire hydrants, catch basins or inlets, traffic signs and signals, or other public improvements or installations required for the curb openings or driveways shall be accomplished without cost to the City.

(26) Access to Streets with No Curb and Gutter
Private drive access to Local, Collector, or Arterial streets that have no curb and/or gutter improvements shall be constructed to meet the following requirements:

(a) **Surface Requirements**: The driveway shall extend from right-of-way line to edge of existing driving surface and shall be constructed based on local street section or concrete driveway per City Standard Drawings.

(b) **Right-of-Way**: New driveway accesses from private property to existing pavement shall be paved within the right-of-way. On Local rural streets HBP or concrete pavement shall be installed from

the right-of-way line to the edge of the traveled street. The width of the driveway within the right-of-way shall be twelve (12) to twenty-two (22) feet.

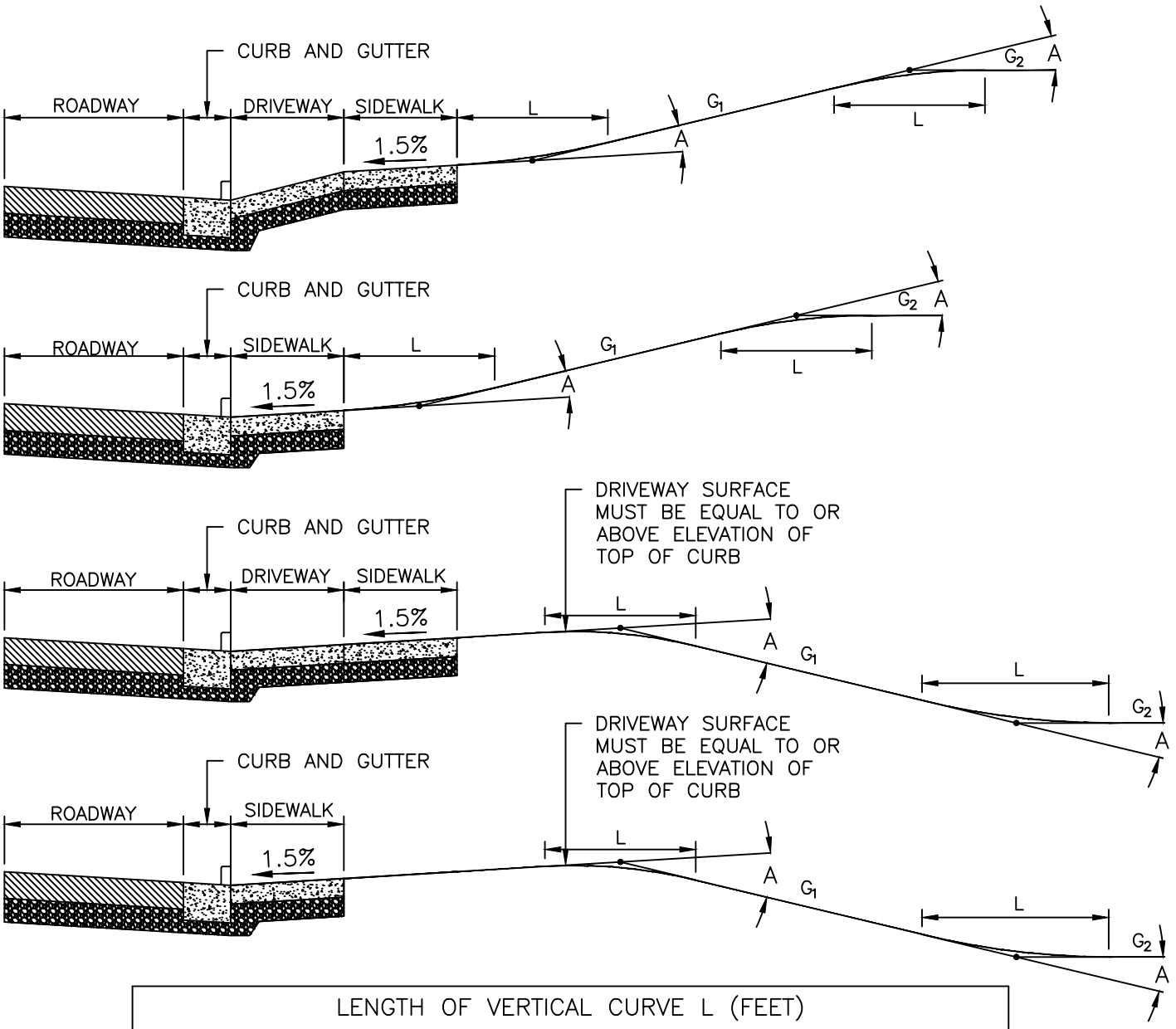
(c) **Culvert**: A culvert shall be installed at the established roadside ditch flow-line elevation beneath the private drive access. The culvert diameter shall be specified by the approved storm drainage report or in absence of the report by the City. A culvert shall be installed in the flow-line of the borrow ditch of a size necessary for the design storm flow (fifteen (15) inch minimum diameter). The pipe shall have flared end sections. The minimum cover over the culvert shall be twenty-four (24) inches. Additional cover may be required for heavy vehicles.

(d) **Sketch Plan**: A drawing of the proposed driveway installation showing all dimensions shall be submitted with the right-of-way or Access permit application.

(27) Entrance Angle
In general, the entrance angle for all driveway approaches and intersections shall be as near ninety degrees (90°) to the centerline of the street as possible. The minimum angle that will be permitted is ninety degrees (90°) plus or minus ten degrees (10°) for a minimum of twenty-five (25) feet measured perpendicular to the street and measuring from the curb or edge of pavement toward the private property served.

(28) Access Approaches
Access approaches shall not be approved for parking or loading areas that require backing maneuvers within the right-of-way except on Local Residential streets. All off-street parking areas on Collector and Arterial streets must include on-site maneuvering areas and aisles to permit user vehicles to enter and exit the site in forward drive.

(29) Minimum Off-Street Parking Set Back Distance
Parking maneuvers within a parking lot shall not restrict entering vehicles from safely and efficiently entering the driveway from the public street. The minimum parking setback distance for non-residential driveways is 30 feet from the right-of-way line as described in **Section 2.3.23(11).** The City Engineer may increase this distance based on a Traffic Impact Study.



LENGTH OF VERTICAL CURVE L (FEET)				
CHANGE IN GRADE, A	CREST MINIMUM LENGTH		SAG MINIMUM LENGTH	
	DESIRABLE	MINIMUM	DESIRABLE	MINIMUM
4–5%	5 Ft	3 Ft	7 Ft	4 Ft
6–7%	6 Ft	4 Ft	8 Ft	5 Ft
8–10%	8 Ft	5 Ft	10 Ft	7 Ft

1) GRADES SHALL BE COMPATIBLE WITH THE SITE REQUIREMENTS FOR SIGHT DISTANCE AND DRAINAGE, TO PREVENT EXCESSIVE DRAINAGE RUNOFF FROM ENTERING THE ROADWAY OR ADJACENT PROPERTY.
2) MAX CHANGES IN DRIVEWAY GRADES WITH A VERTICAL CURVE (BETWEEN THE PAVEMENT CROSS SLOPE AND THE DRIVEWAY APRON SLOPE) IS 10% FOR PRIVATE RESIDENTIAL DRIVEWAYS AND 8 PERCENT FOR ALL OTHER DRIVEWAYS.
3) MAXIMUM DRIVEWAY GRADES WITHIN TWENTY (20) FEET OF THE FLOW LINE SHOULD BE LIMITED TO 8 PERCENT UNLESS APPROVED BY THE CITY ENGINEER. WHERE POSSIBLE, THE DRIVEWAY GRADE SHOULD BE LIMITED TO 6 PERCENT OF LESS WITHIN THE ROADWAY RIGHT–OF–WAY
4) THE LENGTH OF THE VERTICAL CURVE BETWEEN THE PAVEMENT CROSS–SLOPE AND THE DRIVEWAY APRON IS A FUNCTION OF THE ALGEBRAIC DIFFERENCE IN THE GRADES. SEE TABLE ABOVE FOR DESIRABLE AND MINIMUM LENGTHS FOR THESE VERTICAL CURVES.

HISTORIC FRANKLIN TENNESSEE

N.T.S

DRIVEWAY APPROACH PROFILE DESIGN CRITERIA
FIGURE 2.3 (15)

(31) Drainage

(a) Drainage at Curb Cuts: Where curb cuts are allowed, concentrated storm water runoff from property adjoining the right-of-way shall not be discharged across the sidewalk. These flows must be directed elsewhere or directed to a sidewalk chase where storm water may pass under a sidewalk section.

(b) Sheet Flow Drainage: Sheet flow drainage is allowed where it does not interfere with the pedestrian use of the sidewalk

(32) Change in Use

If the use of an existing access to right-of-way changes, or there is a change in the use of the property, the change in access use must be approved through the development review process, access management plan, or traffic impact analysis. Change in access or property use may include, but is not limited to, change in the amount or type of traffic (twenty (20) percent or twenty-five (25) vehicles per hour, whichever is less), structural modifications, remodeling, change in type of business, expansion in existing business, change in zoning, change in property division creating new parcels, etc.

(33) Un-permitted Access

Any access, driveway, or curb-cut which is constructed within public right-of-way without a right-of-way or access permit issued by the City (or State if a State highway) shall be subject to removal. Failure to remove the un-permitted access may result in the removal of said access by the City. The cost for removal shall be charged to the property owner from which the access originates.

(34) Abandoned Access

If a parcel of land with direct access has been in a state of non-use for more than one year, re-commencement of access use shall be considered a change in use. If the use of the access exceeds the design limitations of the access or does not conform with the present code, a new approval may be required through the development plan review process, access management plan, or the City's work in right-of-way permit.

(35) Removal

Any curb opening or driveway that has been abandoned shall be removed and restored by the property owner except where such abandonment has been made at the request of, or for the convenience of, the City.

(36) Access Permit Required/Appeals

(a) No curbs or rights-of-way shall be cut, paved, or otherwise altered for the purposes of obtaining access until a permit approving the access cut has been secured from the City and/or any other governmental agency owning or controlling street right-of-way.

(b) Whenever the City disapproves the location and design of a residential access, or when it is claimed that an equally good or more desirable access plan can be employed, or when it is claimed that the true intent and meaning of these standards have been misconstrued or wrongly interpreted, then the property owner, or his duly authorized agent, may appeal the decision to the City Engineer.

2.4 Pedestrian Facilities

All streets shall accommodate pedestrian travel as called for in this chapter

2.4.1 ADA Requirements

All pedestrian facilities provided within a City street right-of-way or easement shall be designed to accommodate movement by the disabled as required by the *Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way*.

2.4.2 Typical Sections

(1) Sidewalk Location

The minimum cross sections for sidewalks are provided in **Table 2.3 (1)**, and as shown in the Typical Section Drawings. These cross-sections are consistent with the City's Major Thoroughfare Plan and shall be used to construct sidewalks along both sides of a street. As shown, the cross sections are dependent upon the classification of the street on which they are located. For additional information regarding street classifications and street cross-sections, see **Section 2.2**.

(2) Sidewalks on Streets with Ditches

On a street that has ditches instead of curb and gutter; the sidewalk shall be five (5) feet wide and constructed of concrete. It shall also be located behind the ditch. Vertical objects shall be placed at least one (1) foot from the sidewalk edge. A one (1) foot wide graded area that has a maximum slope of 6:1 shall be provided on each side of the sidewalk. The grass strip buffer, which contains the ditch and is located between the innermost graded area and the edge of the street, shall be at least twelve (12) feet wide and shall be landscaped with grass. Drainage requirements may dictate an increased ditch section.

2.4.3 Managing Access for Pedestrian Safety

Unlimited access creates many points where conflicts may occur between pedestrians and vehicles entering or leaving the street. By restricting the number and size of driveways along a street, many of these potential conflicts can be avoided. Multiple driveways that have multiple lanes and continuous access driveways shall be avoided. When possible, multiple driveways shall be combined. If these driveways serve adjacent properties, cross-access drives between the properties shall be provided in order to eliminate the need for multiple driveways. Continuous access driveways shall be re-designed to create a limited number of entry/exit points. This design shall include grass strips between the street and the parking lot to prevent access at unwanted locations.

2.4.4 Intersections

All intersections shall be designed with the assumption that pedestrians will be present. Signalized intersections shall have crosswalks that are clearly marked. They shall also have ramps, landings, pedestrian push buttons, and other pedestrian features that are accessible to everyone. The signing and pavement markings at intersections shall clearly indicate how all street users should operate.

2.4.5 Sidewalk Ramps

A sidewalk ramp shall be constructed for each crosswalk at each street corner, as illustrated in the Standard Drawings. In addition to providing the shortest, direct route between sidewalks, this practice makes it easier for pedestrians crossing the street to see right-turning vehicles. If only a single, diagonal sidewalk ramp is provided at a street corner, then right-turning vehicles approach pedestrians crossing the intersecting street from behind. If two perpendicular sidewalk ramps are provided, then right-turning vehicles will approach the pedestrians from the side.

2.4.6 Corners

An obstruction-free area shall be provided at street corners between the curbs and a continuation of the adjacent property lines. At a minimum, this distance shall be twenty feet. Only pedestrian push button posts and other pedestrian features shall be located in this area.

2.4.7 Crosswalks

(1) Crosswalk Locations

Crosswalks shall be provided at each stop controlled leg of intersections where significant pedestrian activity is encouraged or exists. Crosswalks across non-stop controlled legs of intersections shall not be allowed. Midblock crossings will be reviewed on a case-by-case basis and per 2.4.7 (3) below. All crossings shall conform to Public Right-of-Way Accessibility Guidelines (PROWAG) guidelines.

Standard Crosswalk

(2) Crosswalk Markings

Crosswalks shall be clearly marked with a "ladder" pattern, as shown in the Traffic Control chapter, so that they are highly visible to all street users. Crosswalks that are marked with reflective white thermoplastic tape are more visible than those that are marked with brick or cobblestone, especially at night and during rain. Crosswalks that are marked with brick or cobblestone can be made more visible by outlining them with reflective white thermoplastic tape or white concrete outline. Brick and cobblestone are not recommended for crosswalks because these materials can create bumpy paths that are difficult for people with limited mobility to navigate.

(3) Midblock Crosswalks

Midblock crosswalks shall adhere to the following criteria:

(a) Midblock pedestrian crossing facilities shall abide by the MUTCD and FHWA "*Guide for Improving Safety at Uncontrolled Crossing Locations*", July 2018 Updated, with applicable countermeasures per roadway facility type and as approved by the City Engineer (See Table 1 of the "*Guide for Improving Safety at Uncontrolled Crossing Locations*" for recommended countermeasures).

(b) Midblock pedestrian crossings may be considered when protected intersection crossings are spaced greater than 400 feet or so that crosswalks are located no greater than 200 to 300 feet apart in high pedestrian volume locations. Examples of high volume pedestrian locations include mixed-use pedestrian/bike paths not near a stop controlled intersection, neighborhood pool/park facilities that are located away from a protected intersection crossing, school crossings, parking lots in which pedestrians must cross a roadway to get to an office building, mixed use developments with few stop controlled intersection crossings, etc.

(c) Midblock crosswalks shall be located at least 125 feet from the nearest side street or driveway so that drivers turning onto the major street have a chance to notice pedestrians and properly yield to pedestrians who are crossing the street.

(d) Proper stopping sight distance at design speed shall be required. Landscaping or other objects that hides or shields a pedestrian waiting to cross a midblock crossing shall not be allowed.

(e) Safety street lighting shall be installed on both sides of midblock crossings.

(f) Advance crosswalk warning signs and/or yield lines may be required by the City Engineer.

2.4.8 Detectable Warning Surfaces

The *Accessibility Guidelines for Pedestrian Facilities in the Public right-of-Way* calls for detectable warnings for pedestrian street crossings, including curb ramps and blended transitions, certain median and refuge islands, and rail lines. These surfaces feature a distinctive pattern of raised domes to provide a tactile cue detectable by cane or underfoot at the boundary between pedestrian and vehicular routes. The City's standard material for installing detectable warnings shall be (ADA Solutions, Inc. or approved Equal) cast in place and shall contrast visually with adjacent walking surfaces either light-on dark or dark-on light. Brick red detectable warnings shall be used within City of Franklin right-of-way, and yellow detectable warnings shall be used within State of Tennessee right-of way.

2.4.9 Transit Stops

Transit stops shall typically be located at the far side of an intersection**.** This design encourages pedestrians to cross behind the bus, improving their visibility to oncoming vehicles. A bus stop located on the near side of an intersection blocks the site lines between pedestrians and motorists. The preferred location for a transit stop waiting area is in the buffer strip between the sidewalk and the street. All transit stops shall comply with *Public Rights-of-Way Accessibility Guidelines*.

2.4.10 Grade-Separated Pedestrian Crossings

Grade-separated pedestrian crossings may be warranted across freeway, expressway or arterial streets where the volume of projected vehicular and pedestrian traffic justifies the expense of such a facility. Pedestrian overpasses and underpasses shall be designed based on *Public Rights –of - Way Accessibility Guidelines*. Where the grade separation directs the pedestrians under the street, the subway path shall be substantially illuminated and recessed into the structure.

2.5 Bicycle Facilities

All streets designed in the City shall accommodate bicycle travel as called for in this chapter of these standards and further defined in the City's Major Thoroughfare Plan (latest edition). Specific streets as outlined in the Plan shall receive the design treatments so designated.

Typical bike lane with signing and markings

2.5.1 Types of Facilities

A bicycle lane is a travel lane that is between four (4) and six (6) feet wide and that is designated for exclusive use or preferential use by bicyclists. The City standard shall be as shown in **Table 2.3 (1).** Bicycle lanes are separated from travel lanes with a lane stripe and are identified by pavement markings and signing. These facilities shall be one-way facilities, located on the right side of the street, that carry bicycle traffic in the same direction as the adjacent motor vehicle traffic. Another type of bicycle lane is a shoulder bikeway. A shoulder bikeway is a paved shoulder that is at least five (5) feet wide and that is separated from motor vehicle traffic by a lane stripe. It is also designated by signing. Unlike a bicycle lane, a shoulder bikeway is not designated exclusively for bicyclists. It may serve as a location to temporarily park a damaged vehicle, or it may serve other functions. Typically, shoulder bikeways are applied to rural streets that do not have curb and gutter.

2.5.2 Bicycle Shared Streets

A shared street is a street in which motorists and bicyclists share the same travel lanes. There are three types of shared streets. These are:

- Wide outside lane (WOL)
- Signed shared roadway (SSR)

- Local street

(1) A WOL is a travel lane, located on the right side of the street, that is typically fifteen (15) feet wide and that is shared by motorists and bicyclists. The extra width that is provided by a WOL allows motorists to comfortably pass bicyclists without changing lanes and without getting too close to the bicyclists. WOLs are identified by signing and can include pavement markings.

(2) A SSR is a street that is shared by motorists and bicyclists and is identified by signing. Unlike WOLs, SSRs do not provide additional street width for bicyclists. However, they should provide features that make them suitable for bicyclists. These features include traffic control devices that are sensitive to bicyclists, bicycle-safe storm grates, and smooth pavement surfaces. They should also be routinely swept in order to prevent debris from accumulating on the street. Typically, SSRs are reserved for streets that have a high demand for bicycle traffic but cannot accommodate a bicycle lane or WOL due to physical constraints. SSRs should be considered as temporary bicycle facilities and should be replaced by bicycle lanes or WOLs as soon as this is feasible.

(3) Local streets are typically low-speed, low-volume streets. Therefore, they do not usually require special treatment in order to accommodate bicyclists. However, signing may be used to identify a through-bicycle route that follows a local street.

2.5.3 Multi-use Paths/Greenways

A multi-use path/greenway is a designated facility that is used for bicycling, walking, running, skating, and other forms of non-motorized travel. It is physically separated from motorized vehicular traffic by a barrier or open space, and can be located within a street right-of-way or an independent right-of-way. Paths/greenways are typically twelve (12) feet wide. They are not part of the street network, but may travel parallel to certain street segments. Also, these facilities may follow the course of natural boundaries, such as rivers and streams, or man-made boundaries, such as railroad lines and utility easements. See Typical Section Drawings.

2.5.4 Bicycle Typical Sections

The recommended cross-sections for bicycle lanes, shared streets, and multi-use paths are presented in the Typical Section Drawings. These cross-sections are generally consistent with the recommendations of the City's Major Thoroughfare Plan. In addition to the recommendations contained in this plan, AASHTO's "*Guide for the Development of Bicycle Facilities"* and the "*MUTCD"* shall be consulted in order to determine appropriate pavement markings, signing, etc. for new bicycle facilities.

2.5.5 Intersections

Intersections shall be designed so that a bicyclist's path of travel is direct, logical to both bicyclists and motorists, and is as similar to the path of motor vehicle travel as possible. Also, bike lanes shall extend to the stop line/ crosswalk and shall not extend through the pedestrian crossing.

(1) T-Intersections

Bike lanes at T-intersections shall be constructed according to the design illustrated in the City's Major Thoroughfare Plan. As shown, left and right turn lanes for bicycles shall be provided unless severe physical constraints prevent the construction of two bicycle turn lanes. If physical constrains do exist, then the bicycle turn lanes can be omitted as long as the vehicular left turn lane is fourteen (14) feet wide. With either design, the bike lane across from the intersection shall be striped through the intersection. However, this bike lane shall not be striped through the crosswalks.

(2) Intersections without Exclusive Right Turn Lanes

When a bike lane is present at an intersection that does not have an exclusive right turn lane, the solid bike lane stripe shall be replaced with a dashed line at least fifty (50) feet prior to the stop line/crosswalk.

(3) Intersections with Exclusive Right Turn Lanes

At intersections with exclusive right turn lanes, the paths of motorists and cyclists should cross in advance of the intersection in order to reduce the number of conflicts that occur at the intersection. The pavement

markings shall direct bicyclists to the left of the exclusive right turn lane. The bike lane stripes shall be dashed across the area where motorists should cross into the right turn lane. The solid bike lane markings shall resume when the right turn lane achieves full width and shall continue to the stop line/crosswalk. Under severe physical constraints, the bike lane can be terminated if the outermost through lane is fourteen (14) feet wide.

(4) Intersections with Dual Right Turn Lanes
At an intersection with a right turn lane and a shared through/right turn lane, the bike lane shall terminate at the location where the taper for the right turn lane begins. A dashed line shall be striped between the edge of pavement at the terminus of the bike lane to the lane stripe between the dual right turn lanes. The shared through/right turn lane shall be fourteen (14) feet wide. Also, signing alerting motorists and bicyclists of the approaching lane configuration is recommended.

(5) Complex Intersections
Intersections of multiple streets and intersections that have offset lanes or skewed streets can create confusion for motorists and bicyclists. When possible, these intersections should be realigned so that the intersecting streets are perpendicular to each other, with only two streets intersecting at a given point. If a complex intersection cannot be avoided, then bike lanes at the intersection shall be defined with a dashed line strip through the intersection. However, the bike lanes shall not be striped through the crosswalks.

2.6 Traffic Calming

2.6.1 General
This section presents acceptable methods of neighborhood traffic calming that are determined by the City to be acceptable for use on existing local streets. This chapter also provides for specific design criteria for a number of traffic calming methods.

(1) Intended Use
The necessity or desire for traffic safety and calming stems from the perception that local streets, particularly in residential areas, do not always function as intended. These streets shall be low traffic volume streets used for direct access to residences on the street. They are also intended as a multi-modal system that is shared by vehicular, bicycle, and pedestrian traffic equally, in a manner that minimally impacts residents in these areas.

(2) For New Street Design
The devices presented in this section are generally not intended for use on new streets. New street design is addressed earlier in this section. New local streets are to be designed to minimize cut through traffic, high volumes, and high speed operation and to maximize the efficiency of the street to provide vehicular access and bicycle and pedestrian traffic. Plans prepared for new streets serving residential, nonresidential, and mixed-use development shall comply with the following standards:

(a) Minimal street widths, short block lengths, on-street parking, controlled intersections, roundabouts, and other traffic calming measures shall be used on all local and minor collector streets to the maximum extent practicable.

(b) In cases where residential development has been organized around a grid street network, measures to interrupt or terminate long vistas exceeding twelve-hundred (1,200) feet in length shall be employed to the maximum extent practicable. Such measures shall include, but shall not be limited to:

i. Curvilinear street segments;
ii. Street jogs or off-sets designed to require vehicles to slow their travel speed;

iii. Street chicanes or neck downs;
iv. Terminated vistas;
v. Mid-block traffic circles; and
vi. Stop signs at street intersections, where warranted.

2.6.2 Traffic Calming Design Criteria

Reference the City of Franklin Neighborhood Traffic Calming Program (NTCP) on the City of Franklin Engineering webpage for traffic calming requirements.

2.6.3 Traffic Calming Techniques

(1) Approved Techniques

There are a variety of techniques that can be used to calm traffic on local, residential streets. Techniques that are specifically permitted, as well as techniques that are specifically prohibited, in the City are described below. Techniques that are specifically permitted are summarized in the following table, which also identifies the potential benefits and disadvantages of each.

Table 2.6 (1)
POTENTIAL IMPACTS OF TRAFFIC CALMING TECHNIQUES THAT MAY BE USED IN THE CITY OF FRANKLIN

Measure	Potential Benefits			Potential Disadvantages			Cost
	Speed Reduction	Volume Reduction	Conflict Reduction	Limits Local Access	Increases Emergency Response Time	Extent of Maintenance Required	
Chicane	●	●	●	o	◎	◎	$$-$$$
Curb Extension	◎	o	o	o	o	◎	$-$$
Education	◎	o	◎	o	o	o	$
Enforcement	◎	o	◎	o	o	o	$-$$
Lower Speed Limit	◎	o	o	o	o	o	$
Raised Median	◎	o	◎	◎	o	◎	$-$$
Road Diet	◎	o	◎	o	o	o	$-$$$
Speed Table/Hump	●	◎	●	o	◎	◎	$-$$
Traffic Circle	●	◎	●	o	◎	◎	$$-$$$

● Substantial Benefits/Disadvantages ◎ Minor Benefits/Disadvantages o No Benefits/Disadvantages
$ Low Cost $$ Moderate Cost $$$ High Cost

(a) Chicane: A chicane shifts motorists' path of travel by creating a horizontal diversion in the roadway. A chicane is usually formed by a series of curb extensions that are placed on alternating sides of the roadway. These curb extensions reduce the roadway width and force motorists to steer from one side of the roadway to the other in order to travel through the chicane. See **Figure 2.6 (2)** for a typical drawing of this technique.

(b) Curb Extensions: Curb extensions are formed by extending the curb on one or both sides of the roadway into the vehicular travel lanes to reduce the paved roadway width. The reduction in width creates "slow points" in traffic flow. Curb extensions are also commonly referred to as chokers, neck downs, traffic throats, and pedestrian bulbs. Curb extensions reduce the width of the roadway at intersections and create shorter crossing distances for pedestrians. The reduction in lane width encourages motorists to slow down when driving through the intersection. See **Figure 2.6 (3)** and **Figure 2.6 (4)** for a typical drawing of this technique.

(c) Education: Education is a key component of all traffic calming projects in the City. Before implementing physical traffic calming measures, the City Engineer will work with participating neighborhoods to educate their residents regarding safe, on-street, vehicular travel. The City Engineer will assist the neighborhood associations/groups in developing educational programs for the residents. However, it will be the responsibility of the neighborhood associations/groups to implement the educational programs.

(d) Enforcement: Enforcement efforts will be combined with neighborhood education as a first step in all traffic calming projects in the City. The Police Department will work with the City Engineer to help resolve traffic problems, such as speeding. Enforcement efforts may involve the use of speed trailers and may include tickets for violators.

(e) Lower Speed Limits: Establishing lower speed limits may help to reduce speeding and cut-through traffic in residential neighborhoods. Some local, residential roadways have speed limits that are posted at 30 MPH or more. It may be desirable to lower the speed limits on these roadways to the City's default speed limit, which is 25 MPH for local, residential streets.

(f) Raised Median: A raised median is an elevated island that is constructed on the centerline of a two-way street to reduce the width of the adjacent travel lanes. Raised medians can be paved or landscaped. They create "slow points" in the roadway, can serve as pedestrian refuges for pedestrians crossing the street, and can be used in conjunction with other traffic calming measures. See **Figure 2.6(5)** for a typical drawing of this technique.

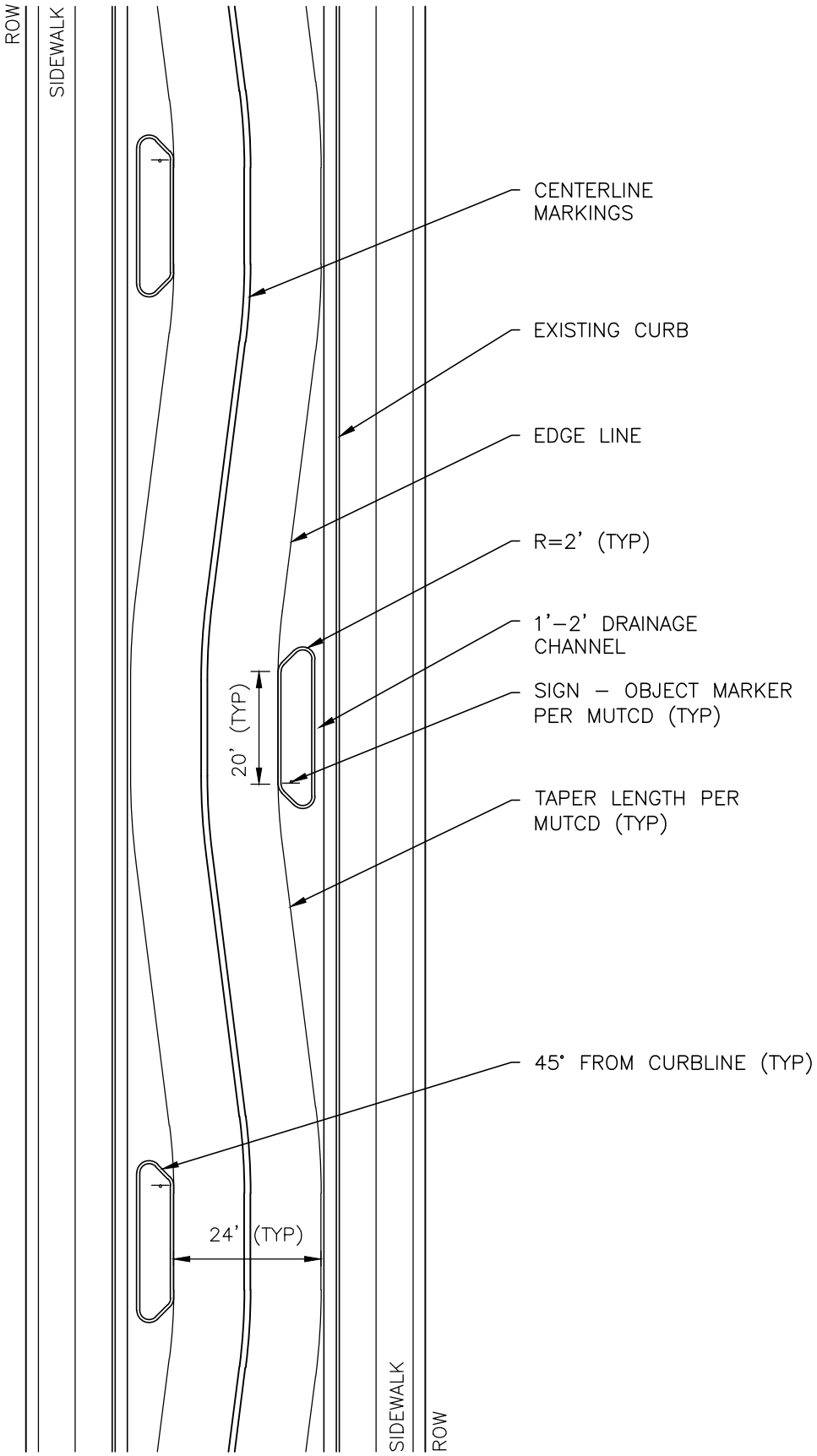
(g) Travel Lane Reduction: Reducing the number of travel lanes, or the width of travel lanes, on a roadway can be an effective technique for calming traffic on that street. This process, called a "road diet", can help to reduce vehicular speeds, reduce the number of conflict points for right-of-way users, and can help make streets more bicycle and pedestrian-friendly. Road diets can be accomplished by adding parking lanes, adding bike lanes, adding a median, or by reclaiming some of the roadway width, which can create room for sidewalks and street trees.

(h) Speed Table/Hump: A speed table/hump is a wide and flat undulation that is placed on a street, typically across the width of the roadway, to reduce vehicular speeds. They have a height of three (3) to four (4) inches and a length of twelve (12) or twenty-two (22) feet. Speed humps shall be distinguished from speed bumps, which are much shorter (six to twelve inches long) and have been associated with maintenance, safety, and liability concerns. The speed table/hump that may be used in the City is twenty-two (22) feet long and three (three) inches high. See **Figure 2.6 (6)** for a typical drawing of this technique.

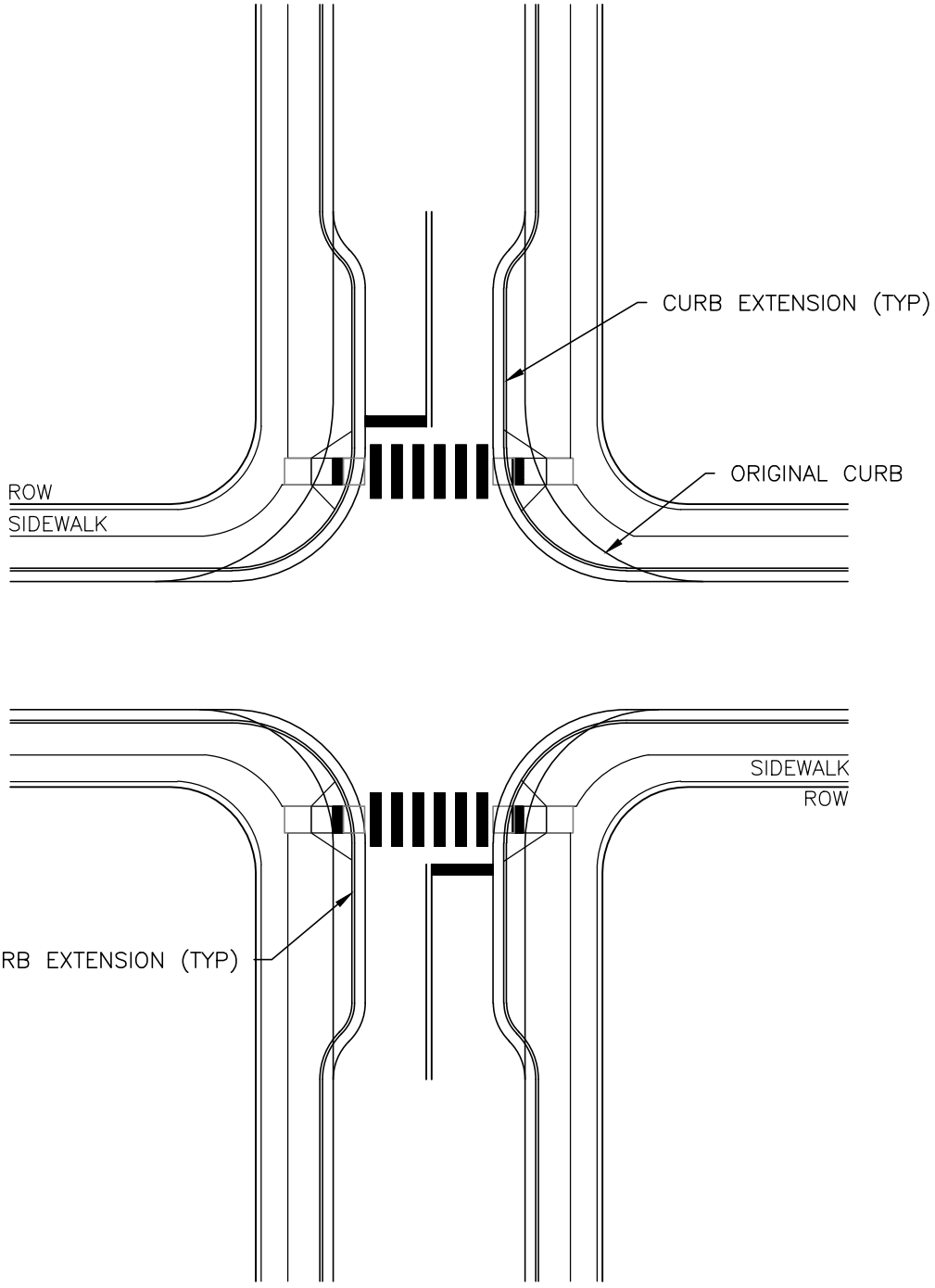
(i) Traffic Circle: A traffic circle is a raised, circular island that is typically placed in the center of a residential street intersection to allow traffic to flow through the intersection without being controlled by a stop sign or a traffic signal. The design of a traffic circle requires motorists to travel through the intersection in a counter-clockwise direction around the island, which reduces the number of conflict points and reduces vehicular speeds. A traffic circle creates a horizontal deflection in the roadway, which causes motorists to slow down as they travel through the intersection. See **Figure 2.6 (7)** for a typical drawing of this technique.

(2) Prohibited Techniques

(a) Rumble Strips: Rumble strips are raised buttons, bars, or groves that are closely placed on a roadway at regular intervals. They cause both noise and vibration in vehicles as motorists drive over them. Typically, rumble strips are used to alert motorists of unusual conditions ahead. As motorists get used to the rumble strips, the strips become less effective over time. Rumble strips can result in increased noise levels for nearby residents. Also, rumble strips require a high amount of maintenance. For these reasons, rumble strips shall not be used as a traffic calming technique in the City.



CHICANE
FIGURE 2.6 (2)



1) INTERSECTION RADII SHOULD ACCOMMODATE DESIGN VEHICLES APPLICABLE TO STREET.
2) MID-BLOCK CURB EXTENSIONS SHOULD BE COMBINED WITH CROSSWALKS WHERE POSSIBLE.
3) LENGTH OF CURB EXTENSIONS MUST RECOGNIZE SITE CONDITIONS, EX. DRIVEWAY LOCATIONS.

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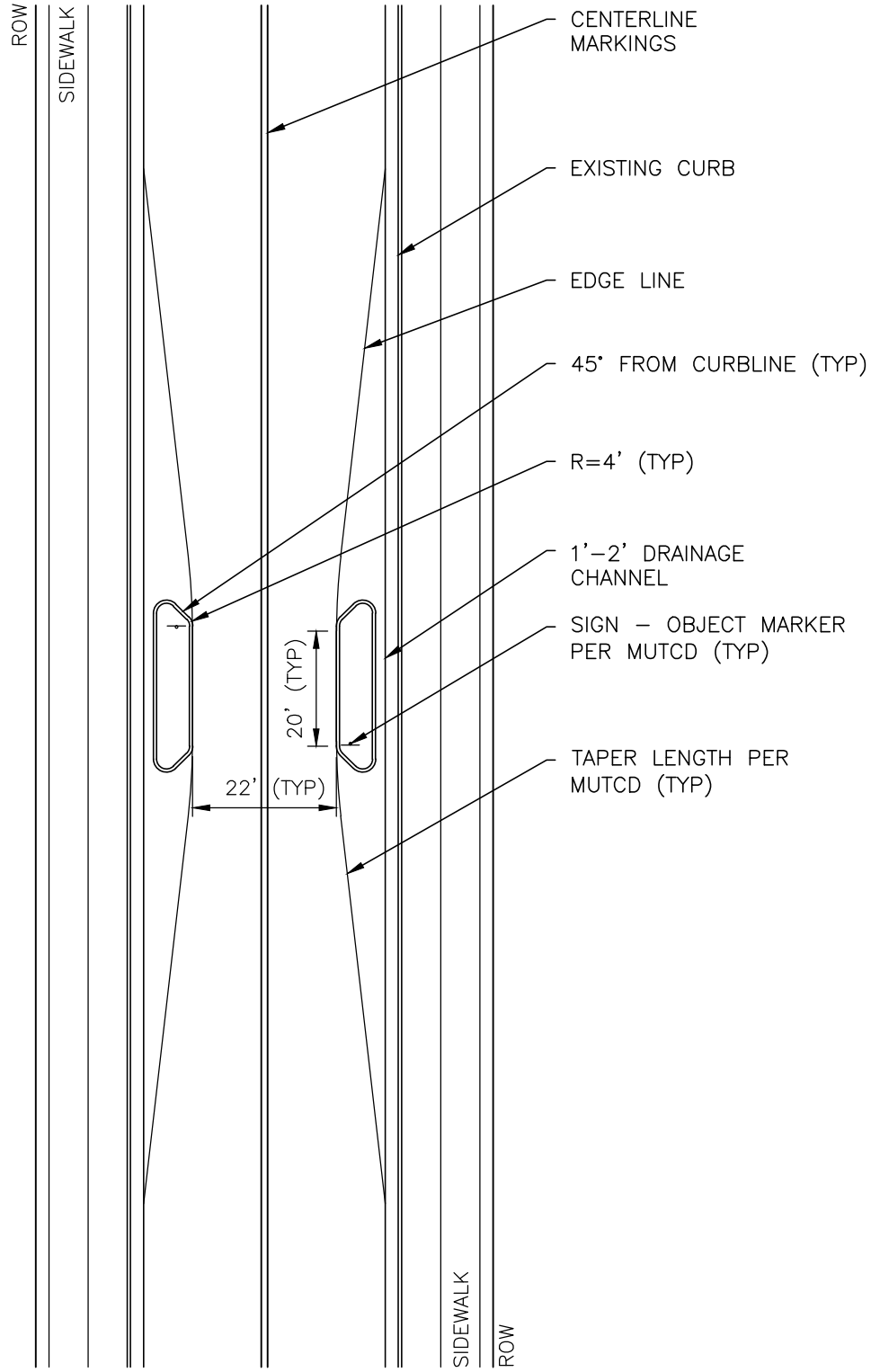
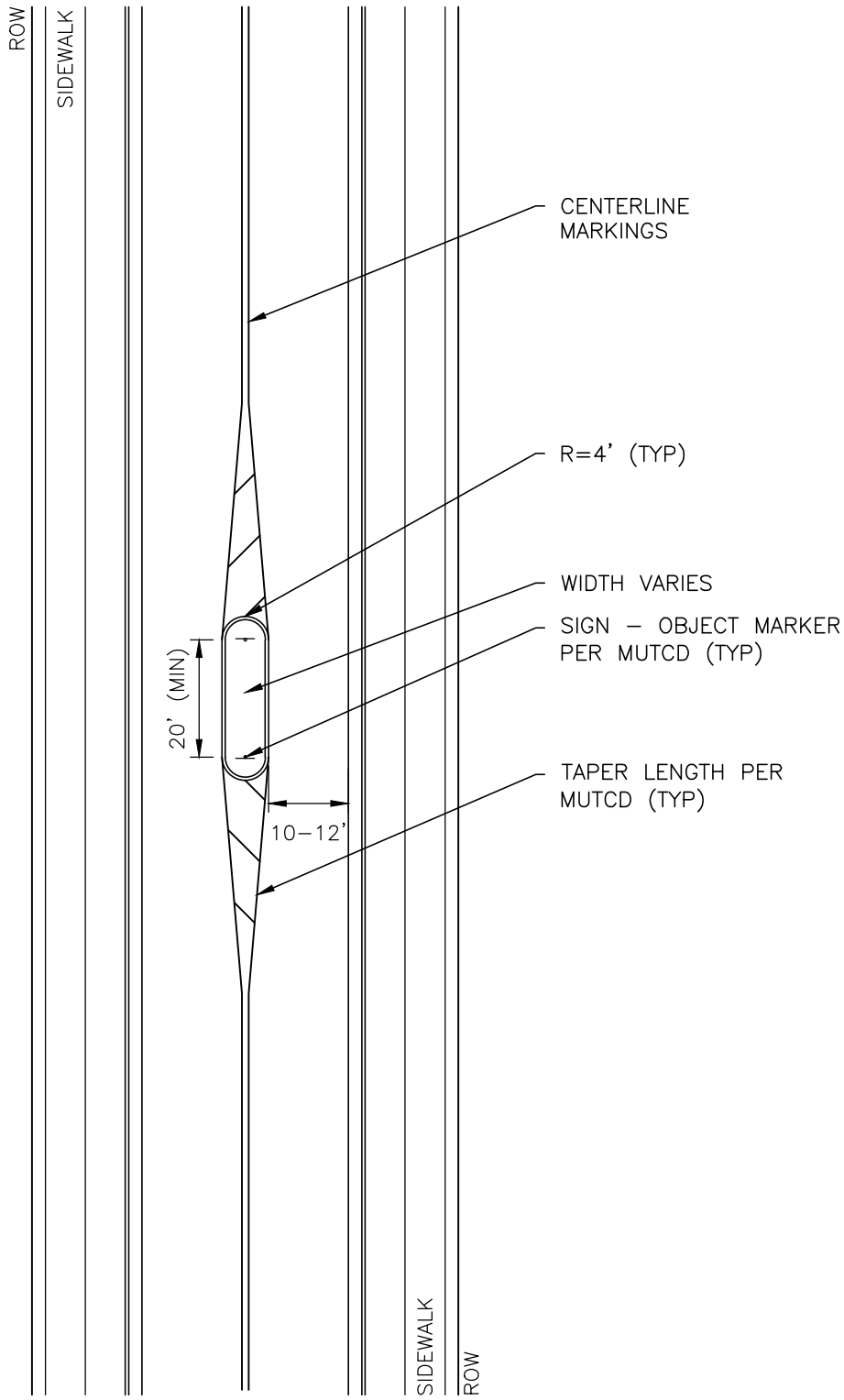
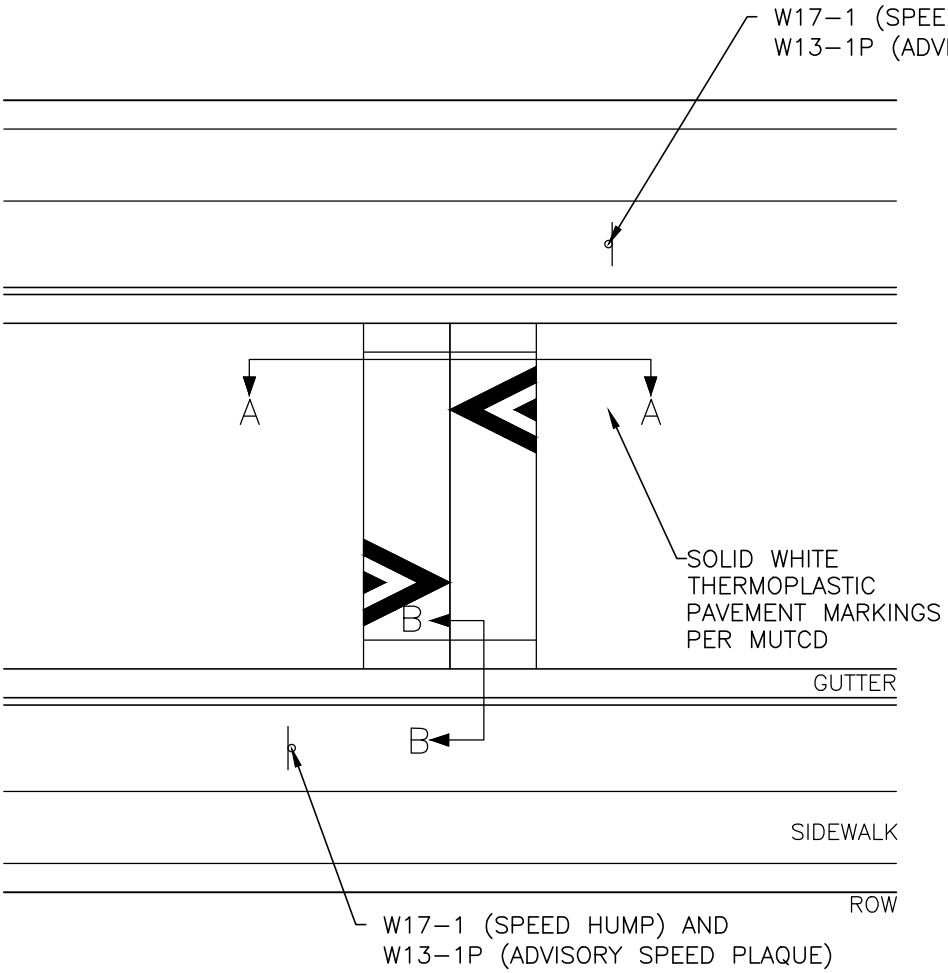
CURB EXTENSION
FIGURE 2.6 (3)

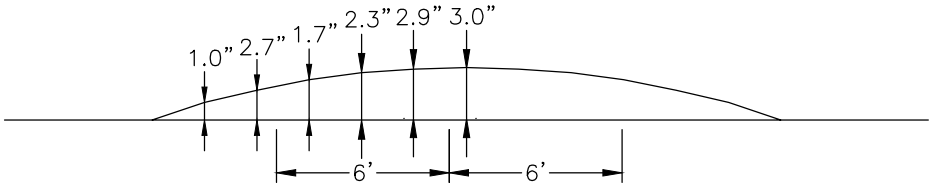


CURB EXTENSION – CHOKERS
FIGURE 2.6 (4)

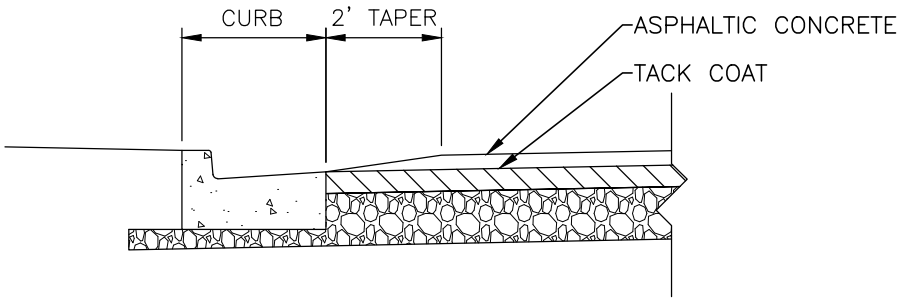


RAISED MEDIAN ISLANDS
FIGURE 2.6 (5)





SECTION A–A



SECTION B–B

1) SIGNS AND MARKINGS SHALL BE IN ACCORDANCE WITH MUTCD & ITE PRACTICES.
2) ADVANCE SIGNING AT EACH LOCATION IS OPTIONAL WHEN PART OF AN AREA WIDE SCHEME.
3) CROSS–SECTION SHOWS APPROXIMATE ELEVATION FOR 3" (MAX) SPEED HUMP
4) SPEED HUMPS SHALL NOT BE PLACED OVER MANHOLES, VALVES, JUNCTION BOXES, ETC.
5) SPEED HUMPS MUST BE PLACED AT LOCATIONS APPROVED BY THE CITY ENIGNEER
6) DESIGN SHALL BE MODIFIED TO ACCOMMODATE FIELD CONDITIONS (EX. DRAINAGE).

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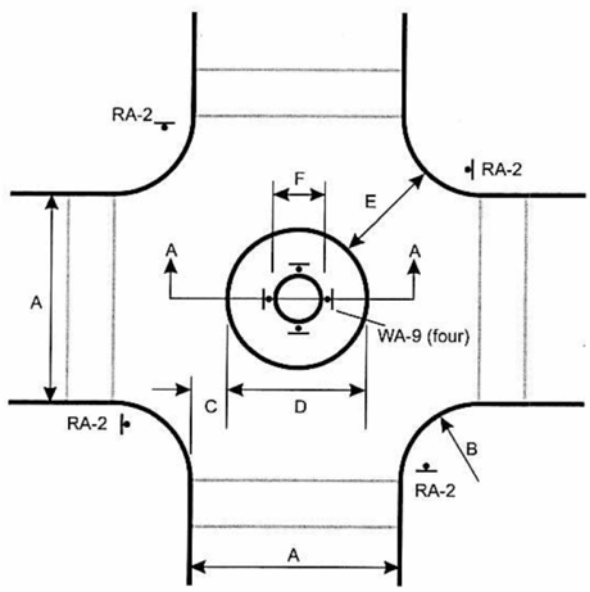
SPEED BUMP
FIGURE 2.6 (6)

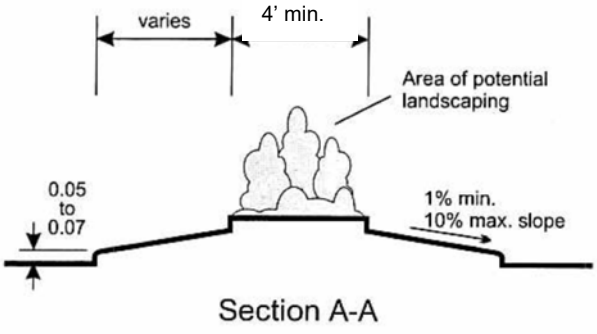
Figure 2.6 (7) Mini Traffic Circle



Dimension Chart for Varying Roadway Widths				
A Roadway Widths	B Curb Return Radius	C Off-set Distance	D Circle Diameter	E Min. Opening Width
20	15.5	5.5	8.5	16.0
	17.5	5.0	9.0	16.5
	22.5	4.5	10.5	18.0
	26.5	4.0	11.5	19.0
24	14.0	5.5	12.0	16.0
	16.0	5.0	12.5	16.5
	21.0	4.5	14.0	18.0
	25.5	4.0	15.0	19.0
28	12.0	5.5	15.0	16.0
	14.0	5.0	15.5	16.5
	19.5	4.5	17.0	18.0
	24.0	4.0	18.5	19.5
32	10.5	5.5	15.5	16.0
	12.5	5.0	19.0	16.5
	17.5	4.5	20.5	18.0
	22.0	4.0	22.0	19.0
	25.0	3.0	23.0	20.0
36	10.0	5.5	22.0	16.5
	11.0	5.0	22.5	16.5
	16.0	4.5	23.5	18.0
	20.0	4.0	25.0	19.0
	22.5	3.0	26.0	19.5
40	11.0	5.0	26.0	17.0
	12.0	4.5	27.0	17.0
	18.5	4.0	28.0	19.0
	22.0	3.0	29.5	20.0
44	10.0	5.0	29.5	17.0
	13.0	4.5	30.0	18.0
	17.0	4.0	31.5	19.0
	21.0	3.0	33.0	20.0

Legend:

A	Roadway Width
B	Curb Return Radius (10' min.)
C	Off-Set Distance (5' max.)
D	Circle Diameter
E	Opening Width (See Table above)
F	Raised Island Diameter (4' min.)



Minimum Opening width to be provided to all crosswalks

A deflection triangle painted on the pavement on each approach to the traffic circle may be appppropriate.

NOT TO SCALE

DRAINAGE DESIGN

Section	Section Title	Article	Article Title	Pg
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3.1 Overview

As it relates to roadways, the objective of surface drainage is to remove storm water from the traveled roadway as rapidly as possible so that traffic may move safely and efficiently. This is accomplished through careful roadway engineering practices such as using proper cross slopes, longitudinal grades, and cross drainage structures. Streets are not to be designed as conveyance systems for surface water. However, all streets must be so designed as to provide for the discharge of surface water from the right-of-way of the streets by grading and drainage as shall be approved by the Street Department Director and the City Engineer. Hydraulic capacities and locations of drainage structures in the public street right-of-way shall be designed to take into consideration upstream and downstream properties and to secure as low a degree of risk of traffic interruption by flooding as is consistent with the importance of the street being designed.

In the case of private development design, the planning and design of the overall drainage system shall be done simultaneously with the road or street layout and gradient planning and design. Where positive lot drainage is proposed, coordination of the road or street grades and the finished lot elevations must be achieved.

3.2 Requirements

3.2.1 Design Criteria

(1) Design Frequency

Design frequency for roadway drainage facilities is based on achieving a balance between construction cost, maintenance needs, amount of traffic, potential flood hazard to adjacent property and expected level of service. The design frequencies presented below are the minimum that will achieve this balance for the various road classifications and types of drainage facilities.

Cross structures and drainage structures shall be designed based on the design frequencies in **Table 3.1** such that they:

i. Shall not significantly increase the flood hazard for adjacent property;
ii. Shall permit maintenance of traffic on roads and streets under design flood conditions.
iii. Shall limit the encroachment onto the traveled lanes which could cause a hazard to traffic.

	Interstate and Limited Access Roadways	Arterials	Collectors	Local Road
Inlet Design Frequency	50-yr	10-yr	10-yr	10-yr
Storm Sewer Design Frequency	50-yr	10-yr	10-yr	10-yr
Culvert Design Frequency	50-yr Check for 100-yr	50-yr Check for 100-yr	50-yr Check for 100-yr	50-yr Check for 100-yr
Roadway Freeboard	50-yr	50-yr	50-yr	50-yr
Ditch Design Frequency	50-yr	10-yr	10-yr	10-yr

Table 3.1

(2) Drainage Inlets

Drainage inlets shall be designed and located to limit the spread of water on the traveled way to no more than one half of the travel lane width. Bike lanes and shoulders may be used full width for spread. Because grates may become blocked by trash accumulation, curb openings or combination inlets with both grate and curb openings are advantageous for City streets. These inlets and grates shall be located outside the travel lanes to minimize shifting of vehicles attempting to avoid them. Inlet grates shall also be designed to accommodate bicycle and pedestrian traffic where appropriate. Drainage inlets located at low points along the streets and at the end of cul-de-sacs are to be as a minimum double inlet catch basins/curb inlets. Grate inlets shall be moved to curb and gutter when adding turn lanes. The grate shall be replaced with a manhole lid for any structure remaining in the turn lane.

(3) Storm Sewers

Where water cannot be adequately discharged by surface drainage, storm sewers shall be required. Public streets are not to be used to collect and convey storm water runoff other than that which falls on a lot fronting that street. In addition, the street and drainage design shall be such that storm water runoff shall not be allowed to flow across street intersections. The minimum slope of storm sewer pipes shall not be less than 0.50%. Flow shall not be directed into a junction at an angle less than 90 degrees from that leaving the junction. Headwalls shall be oriented to be in line with the flow. Flow from the 10-year design storm event shall not surcharge above storm sewer interior crown elevations or create hydraulic jump conditions.

3.2.2 Drainage and Hydrology Calculations

The Engineer of Record shall determine the appropriate analysis method for determining flows and design of the drainage system for both volume and water quality requirements. The rational method shall be an acceptable method for peak flow estimating for drainage basins of less than one hundred (100) acres. The Engineer of Record should be familiar with the limitations of each of the methods so that appropriate methods are applied. The City Engineer may require a particular method on critical portions of the drainage system. The methods shall be limited to and comply with the methods as outlined in the "*TDOT Standard Specifications"*.

Drainage and hydrology calculations shall be submitted with the construction plans. The calculations shall include:

- Drainage area calculations include area in acres, runoff coefficients, a description of runoff calculation methods used, including rainfall intensity, and runoff (Q) used in calculations.
- Culvert cross sections clearly showing invert and outlet elevations, culvert lengths, roadway elevation and lengths.
- Energy Dissipation Design calculations.
- Computer analysis report output. Method shall be acceptable to the City Engineer.
- Force effects (including earth pressure, dead load, and vehicular dynamic loading) on buried drainage structures if requested by the City Engineer.
- Summary of high water elevations if open channel flow is present.

All necessary support data shall be submitted, including a map detailing the drainage basin and sub-basins, storm event, methods for calculating peak runoff, headwater and tail water conditions (assumed and calculated), methods for sizing channels and culverts, flow depths on channel and channel lining calculations. All design drawings, calculations and support data shall be submitted to the City Engineer for approval and must be sealed by a registered Professional Engineer licensed to practice in the State of Tennessee.

3.3 Ditch Sections

Erosion Prevention and Sediment Control is a significant issue during and after construction. The City has a Stormwater Management Ordinance that serves as the City's primary Stormwater guideline. Adherence to these ordinances is required at all times during the construction of ditch sections to ensure that slopes and channels will continue to function adequately.

3.4 Detention / Retention Basins

Detention basins are used to collect and hold stormwater runoff for a period of time to compensate for increases in stormwater runoff caused by reduced ground surface perviousness due to activities such as paving or building construction. Retention basins are similar to detention, but they retain a certain portion of the runoff in the basin. Both types of basins must adhere to the current edition of the City's Stormwater Ordinance.

3.5 Best Management Practices (BMPs)

The City has compiled a Best Management Practices Stormwater Management Manual that is designed to assist contractors, developers, and various businesses and industries to comply with the guidelines set forth by the National Pollution Discharge Elimination System (NPDES) Phase II Rule. The BMP Stormwater Management Manual should serve as the major tool to insure that the guidelines set forth in the City's Stormwater Management Ordinance are followed during the design and construction of transportation projects.

3.6 Inspection and Laboratory Testing

It is the developer's responsibility to perform all materials testing required. The owner's engineer or his representative, familiar with assumptions inherent in the structure design, shall review the construction in sufficient detail to confirm that the construction is as specified. Inspection shall occur as frequently as necessary to assure that the construction conforms to the plans and specifications. Inspection shall be by qualified technical personnel experienced in the inspection of similar structures. Testing of materials shall conform to the requirements of "*TDOT Standard Specifications"* and applicable interims.

CHAPTER 4

EARTHWORK AND DEMOLITION

Section	Section Title	Article	Article Title	Pg
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4.1 Overview

This Section includes all clearing and grubbing, stripping topsoil, excavation, embankment, trench excavation, backfilling, demolition of transportation features/structures and testing required for construction of city streets within the City. Earthwork embankments and excavations shall be constructed in close conformance with the lines, grades and typical cross sections shown on the approved plans. Work associated with demolition and abandonment will consist of the demolition, removal and satisfactory disposal of items that have been selected for demolition on approved construction plans. Demolition will not be approved until satisfactory arrangements have been made to maintain traffic. Demolition of all items, including those not detailed below, shall be coordinated with the City and/or the Director of Building and Neighborhood Services Department. For all earthwork operations, the developer/contractor will be required to provide testing from an independent geotechnical firm pre-approved by the City.

4.2 Reference Specifications

Unless modified by these Standards, all earthwork materials and construction requirements shall conform to "*TDOT Standard Specifications*".

4.3 Clearing and Grubbing

Clearing the right-of-way of all vegetation and debris shall be limited to an area bounded by a line established within the project limits unless otherwise directed by the engineer. Complete removal of shrub and tree roots is required except for sound undisturbed stumps and roots that will be a minimum of 5 feet below proposed subgrade or slopes which may be allowed to remain.

4.3.1 Tree Protection: Living trees with drip lines located beyond the construction lines are to remain undisturbed and protected by the contractor. The Developer will be responsible for establishing the lines of construction clearing in accordance with the above requirements.

4.3.2 Burning Permit: Burning of cleared vegetation and perishable debris is not allowed unless approved by the City Fire Department by issuance from the Fire Marshall of the required burn permit.

4.3.3 Debris Removal: Unless otherwise approved, all debris (i.e. cleared trees, brush, fences, building materials, etc.) shall be removed from the right-of-way, out of view from the street, and shall not be buried or otherwise become part of the street subsurface. Removal of cleared materials from the developer's property shall be legally disposed of.

4.4 Excavation

Excavation within the right-of-way includes stripping topsoil, grading of the street and required ditches, borrow material, channel excavation, rock excavation and undercutting. Excavation shall be performed in close conformance to the lines, grades, side slopes and typical cross sections of the approved construction plans.

4.4.1 Property Protection: Excavation shall be performed in a safe and orderly manner with due consideration given to protection of adjoining property and trees outside the clear lines. Approved erosion control measures shall be installed and regularly maintained to insure protection of adjacent properties. Excavated material when required shall be stockpiled in such a manner as to not obstruct streets, driveways or sidewalks.

4.4.2 Structure Excavation: Excavation for bridges and pipes shall be in accordance with "*TDOT Standard Specifications"*. Excess rock excavation below foundation elevations shall be filled with leveling concrete. Excess rock excavation below the elevation of the bottom of the pipe bedding, cradle or encasement shall be filled with material of the same type and placed and compacted in the same manner as the bedding material.

4.4.3 Channel Excavation: Excavation within waterways will require approved permits prior to commencing operations, and the equipment shall be kept out of the waterway to the greatest extent possible.

4.4.4 Blasting: Rock excavation requiring blasting shall be performed only after obtaining blasting permits from the City of Franklin Fire Marshall. Blasting operations shall be performed only by experienced, licensed blasting contractors. Blast areas shall be protected with mats or earth overburden to prevent flying debris. When blasting near public areas or motorists, blast zones are to be set up with proper signing and flagmen to secure the blast area prior to detonating explosives. The contractor shall be responsible for all damages and shall repair or replace any and all damages at no expense to the City. A pre-blast survey will be required by the Engineering Department.

4.5 Undercutting

When unsuitable material such as tree roots, trash, concrete and asphalt fragments or soft organic or plastic clays are encountered in the subgrade, the area shall be undercut and backfilled with select material.

4.5.1 Limits of Undercutting: Areas and depths of undercutting required for existing streets will be determined by City officials during inspections of subgrade construction and for final acceptance of city streets. The extent of undercut areas shall be determined by proof-rolling the subgrade. Undercutting required after curbs are installed shall be located no closer than 12 inches from the nearest concrete face.

4.5.2 Proof-Rolling: Vehicles for proof-rolling shall be tandem axle dump trucks fully loaded with a minimum material payload of 23 tons.

4.5.3 Backfill: Suitable material shall consist of approved, competent soil from the site that matches the soil classification of the subgrade, or approved classified rock (surge rock). Backfill material shall be placed in lifts not to exceed 12 inches, and each lift shall be compacted with a dozer or other approved heavy equipment.

4.5.4 Stabilization: Geotextile fabrics may be used to strengthen backfill material in undercut areas provided the contractor can demonstrate their effectiveness on test repair areas at the same site or based on the recommendations of a pre-approved geotechnical engineer.

4.6 Embankment

Embankment material shall consist of approved soil or rock obtained from on-site excavations or hauled from a borrow pit area, and shall be placed in fill embankments in reasonably close conformance with the

lines, grades, side slopes and typical cross sections shown on the approved plans. All embankments shall be placed in accordance with "*TDOT Standard Specifications"*.

4.7 Trench Excavation

Trenches cut within the limits of the subgrade shall be excavated to neat lines to minimize disturbance of the surrounding material. The contractor/ developer is solely responsible for the stability of trench excavations and conformance with OSHA regulations.

All excavation for pipe and utility installation shall be performed in accordance with the "*TDOT Standard Specifications"*.

4.7.1 Existing Street Cuts: Utility trenches cut into existing streets shall be performed in such a manner as to maintain the existing integrity and rideability of the street. Trench limits shall be saw-cut a minimum of 2-inch deep into the existing pavement. Excavation width shall be limited to the minimum width required to permit satisfactory jointing of the pipe and thorough backfilling.

4.7.2 Backfill: Utility trenches excavated into existing streets shall be backfilled as indicated on the Standard Drawings. Each layer of backfill material shall be placed with optimum moisture content and thoroughly compacted with mechanical tampers.

4.7.3 Flowable Fill Backfill: For trench excavations subject to moderate and heavy truck traffic, the excavation shall be backfilled with flowable concrete fill. Pipe bedding shall be installed and thoroughly compacted prior to placement of flowable fill material.

4.7.4 Pavement Replacement: Base stone and asphalt paving shall be placed over trench backfill with thicknesses and gradations equal to the existing street pavement section, see Standard Drawings. Each course of base stone and asphalt shall be thoroughly compacted with mechanical tampers. Trench excavations within public streets shall be milled and overlay a minimum of fifty (50) feet on either side of the trench unless otherwise approved by the City Engineer.

4.8 Underdrains

In addition to stormwater drainage structures and appurtenances, subgrade underdrains are required under city streets adjacent to medians with irrigation systems. Underdrains shall consist of free draining crushed stone, 4-inch diameter perforated pipe and filter cloth. All underdrains shall be constructed in accordance with "*TDOT Standard Specifications"*.

4.9 Street Damages

Damage to existing streets and structures, utilities, trees, or private property shall be repaired and restored to its original condition by the Contractor.

4.10 Demolition

4.10.1 Removal of Drainage Structures

Where portions of existing drainage structures lie within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure. Pipe designated to become the property of the City of Franklin shall be carefully removed and every precaution taken to avoid breaking or damaging the pipe.

4.10.2 Removal of Pavement, Sidewalks, Curbs, Etc.

All pavement, base course, sidewalks, curbs, gutters, driveways, etc. shall be removed and disposed of as follows: If the items are more than two feet below sub-grade elevation, they shall be broken into sizes not to exceed two feet in maximum dimension and remain in place, unless it interferes with succeeding items of construction. If the items are less than two feet below the sub-grade elevation, they shall be removed and disposed of.

Failure of the plans to identify the existing of concrete pavement under asphaltic pavement shall not be construed to imply that concrete is not present. It is the contractor's responsibility to determine the presence of concrete pavement when it is not identified by the plans.

CHAPTER 5

PAVEMENT DESIGN

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5.1 Overview

The Contractor (Developer) shall provide all plant, labor, material and equipment to furnish and construct the bituminous concrete pavements in conformity with the lines, grades, thickness and typical cross sections shown on the construction standards and specified herein, or as called for on the approved plans and specifications.

The specifications referenced for each material shall fully apply and no deviations from said specification limits or quality will be permitted unless specifically stated otherwise in this Section. The failure of any component of a product to comply with the referenced specifications shall constitute failure of the whole product.

The Contractor (Developer) shall obtain approval of the subgrade and stone base from the Street Department Director prior to commencing with the paving operations.

For all paving operations, the developer/contractor will be required to provide testing from an independent geotechnical firm pre-approved by the City. See **Chapter 1** for additional testing and inspection requirements

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5.2 Requirements

5.2.1 General Criteria

(1) Existing Streets
For existing streets, the City Engineer may require testing of the existing pavement and base structure to determine if an overlay is feasible, or if reconstruction is necessary. The City Engineer shall notify the Developer if and when this testing is required prior to the Final Pavement Design Report.

(2) TDOT Design Standards
The design criteria and procedures presented follow "*TDOT Standard Specifications"*.

(3) Pavement Type
Streets are to be constructed of asphaltic concrete pavement, base course material, or subbase material (where required), placed on compacted subgrade.

(4) Treated Subgrade
The use of treated subgrade, treated base, and/or full depth asphalt pavement may be acceptable when designed and submitted by the designer, and approved by the City Engineer in accordance with these standards as well as "*TDOT Standard Specifications"*.

(5) Approval
A preliminary pavement design shall be submitted with final construction plans. The City Engineer shall review and approve the Pavement Design Report prior to construction.

5.3 Design Criteria

5.3.1 Design Factors

(1) ADT & Equivalent Daily Load Applications (EDLA)
Loading values can be calculated using TDOT approved ADT numbers or Equivalent Daily Load Applications (EDLA) and Equivalent Single Axle Loads (ESAL) units if available. The City of Franklin Major Thoroughfare Plan traffic data shall be used as a reference.

(2) Minimum Pavement Section
The Standard Drawings provide the default acceptable pavement sections for each street classification based on assumed subgrade support and traffic values. These pavement thicknesses may be used for preliminary planning purposes, cost estimates, or final pavement designs when approved by the City Engineer. All pavement thickness designs must be based on actual subgrade support test results and traffic projections for the specific project. In specifying layer thickness, the designer shall consider how the pavement section will be physically constructed (e.g. Specify how to construct 2' of treated subgrade.)

(3) Flexible Pavement Strength Coefficients
Nonstandard design coefficients may be used, only if approved in advance by the City Engineer. In addition, design values must be verified by pre-design mix test data and supported by daily construction tests.

5.3.2 Special Considerations

On paved surfaces, within public right-of-ways, do not use or operate tractors, bulldozers, off-road trucks or other power-operated equipment, the treads or wheels of which are so shaped as to cut or otherwise damage such surfaces. Damaged roadways shall be repaired to the City's satisfaction by the Contractor (Developer). Placing of mats or using other methods of protection may be allowed subject to the approval of the Street Department Director.

Any roadway surface damaged shall be promptly restored to a condition at least equal to that in which they were found immediately prior to the beginning of operations. Suitable materials and methods shall be used for such restoration. All dirt and mud tracked on existing roadways shall be removed promptly.

Prior to overlaying existing asphalt, the City Engineer may require nondestructive testing to determine the amount of overlay necessary to bring the street to current standards. The method of nondestructive testing and the data obtained must be in a form compatible with the pavement management system for the City Engineer. All "pot-holes," utility trench settlement, cracking, and any similar imperfections shall be repaired to the City Engineer's satisfaction prior to overlaying. The following shall serve as a guideline for the rehabilitation and repairing of existing asphalt streets in the City:

(1) General - The contractor is to provide the necessary labor, materials and equipment to restore and maintain the various street and driveway surfaces of all types, pavement and driveway bases, curbs, curbs and gutters, and sidewalks disturbed, damaged, or demolished during the performance of the work.

(2) Permits - Before starting any work, secure the necessary permits to work within the City or State ROW and easements when surface materials will be disturbed or demolished. Separate street excavation permits are required for street cutting and road subsurface boring/jacking operations. See City of Franklin Municipal Code for permit requirements and fees.

(3) Materials

The quality of materials used in the restoration of existing streets, parking areas and driveways shall produce a finish surface equal to or better than the condition before work began. Compacted crushed stone backfill shall be in conformance with "*TDOT Standard Specifications"*.

Asphalt for a temporary patch shall be Bituminous Plant Mix Surface Course (Cold Mix) as specified in "*TDOT Standard Specifications"*.

(4) Execution

Where trenches have been opened in any roadway or street that is a part of the State of Tennessee highway system, restore surfaces in accordance with the requirements of "*TDOT Standard Specifications"*. All other restorations shall be done in accordance with the City Standards;

Before trenching in paved areas the Contractor shall saw-cut the pavement in a straight line along the sides of the proposed trench to allow for pavement removal and trench excavation without damage to adjacent pavement. During construction, suitable precautions shall be taken to protect the pavement edges and surfaces and to minimize damage.

Upon completion of the utility installation, including backfill, fill the trench with crusher run and temporary pavement patch until such time that the permanent pavement patch will be constructed. The temporary patch shall be placed the same day or within 24 hours. The temporary pavement patch shall consist of at least twelve (12) inches of compacted stone base brought to within two (2) inches of the surface of the existing permanent pavement. A two (2) inch layer of cold mix asphaltic concrete shall then be applied to protect the base, prevent "pot holes" or "chuck holes", and provide a reasonably smooth pavement surface until the permanent patch is made. The temporary pavement patch shall be placed within twenty-four (24) hours of the completion of the utility installation. Permanent Hot Mix patching shall only be applied after the Cold Mix patch has been completely removed.

Concrete curbs, gutters and sidewalks shall be restored as required to match existing construction. Replace damaged sections with complete new sections or squares; patching of damaged sections will not be permitted.

When a manhole or valve box frame and cover, or other utility casting, requires adjustment to an elevation one inch or more above the existing pavement grade and is exposed to traffic before final paving is completed, a temporary ramp shall be constructed by feathering a cold mix for 360 degrees around the casting. A taper slope of not less than two feet per one inch shall be used. During the final paving operation, the temporary ramp shall be removed from around the casting to allow for the permanent paving installation.

5.3.3 Special Requirements

Unless otherwise determined by the City Engineer, full-depth milling and resurfacing of the roadway shall be required for all cuts within the roadway limits. The limits of milling and resurfacing shall extend 50' past the trench edge in each direction. The final limits of associated with milling and resurfacing shall be determined by the City Engineer.

5.4 Asphaltic Concrete Pavement Design

Pavement is required to be a 20-year design. All pavement design shall comply with "*TDOT Standard Specifications"* and meet or exceed the minimum requirements as shown in the Standard Drawings.

5.5 Rigid Pavement Design

For concrete rigid pavement, see **Chapter 6, Concrete,** for concrete riding surfaces.

5.6 Design Report

The pavement design report shall be prepared by an independent geotechnical laboratory under the supervision of and signed and stamped by a Professional Engineer registered in the State of Tennessee. The report shall make a recommendation for a typical pavement structural section based on known site soil conditions and the valid traffic impact study. The following list of items shall be included in the report:

(1) Vicinity map to locate the investigated area.

(2) Scaled drawings showing the location of final borings.

(3) Final Plat with street names.

(4) Scaled drawings showing the estimated extent of subgrade soil types and EDLA for each street classification.

(5) Pavement design alternatives for each street classification.

(6) Tabular listing of sample designation, sample depth, Group Number, liquid limit, plasticity index, percent passing the No. 200 sieve, AASHTO Classification, Group Index and soil description.

(7) R-value test results of each soil type used in the design.

(8) Borrow source identification.

(9) Pavement design computer printouts or nomographs properly drawn to show Soil Support - EDLA - SN

(10) Design calculations for all phases of soil report.

(11) Design coefficient used for asphalt, base course, etc.

(12) A discussion of potential subgrade soil problems including, but not limited to:

(a) Heave or settlement prone soils.

(b) Frost susceptible soils.

(c) Ground water.

(d) Drainage considerations (surface and subsurface).

(e) Soluble sulfates in subgrade.

(f) Other factors or properties that could affect the design or performance of the pavement system.

(13) Recommendations to alleviate or mitigate the impact of problems discussed in the previous paragraph.

5.7 Installation

Installation shall be in accordance with "*TDOT Standard Specifications"*.

5.8 Testing, Inspection and Acceptance

All pavement installations and repairs will require the contractor to submit material testing certifications to the City Engineer. Materials shall meet the requirements found "*TDOT Standard Specifications"*.

The City Engineer reserves to right to request any additional tests deemed necessary for acceptance.

CHAPTER 6

CONCRETE

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6.1 Overview

This Section includes cast-in-place and pre-cast concrete, including reinforcement where required, concrete materials, mix design, placement procedures, and finishes. All concrete pavements, sidewalks, ramps, driveway aprons, curb and gutter sections, paved ditches, pipe and pipe end treatments, box culverts and bridges, drainage structures, foundations and wall panels and all other miscellaneous concrete elements indicated on the approved drawings shall be constructed in accordance with these Standards unless approved otherwise by the City. All concrete shall be ready mixed concrete and not field mixed unless otherwise approved.

The Contractor (Developer) shall provide all materials, labor, and equipment necessary for the completion of all concrete work in accordance with the lines, grades, thickness and typical cross sections shown on the construction standards specified herein, or as indicated on the approved plans.

6.2 Reference Specifications

Unless modified by these Standards, all concrete materials and construction requirements shall conform to "*TDOT Standard Specifications".*

Where project plans and specifications refer to particular items, materials, equipment and construction requirements, the appropriate section of "*TDOT Standard Specifications"* shall apply. "*TDOT Standard Specifications"* sections regarding compensation shall not apply unless directed by the City Engineer. The absence of a description or specification for any item of work shall automatically refer to the appropriate section of "*TDOT Standard Specifications"*.

"*TDOT Standard Specifications"* shall apply for all structural concrete to be used in load carrying structures including box and slab culverts, foundations including drilled caissons, traffic signal and overhead sign foundations, retaining walls and girder bridge members. Section 604 also specifies the requirements of concrete used in structures as well as other miscellaneous or incidental items. Miscellaneous concrete items such as sidewalks, curbing and gutters, rigid street pavement, medians, driveways, paved ditches and roadside sign foundations, shall meet the requirements of "*TDOT Standard Specifications"*.

All precast concrete including precast drainage structures, headwalls, box culverts, pipe, temporary barriers, noise and retaining walls, and bridge members shall meet the requirements of TDOT's Standard Operating Procedure regarding the *"Manufacture and Acceptance of Precast Concrete Drainage Structures, Noise wall panels, and Earth Retaining wall products"*. This document requires that all producers of precast concrete products be certified in accordance with national quality standards developed by the National Precast Concrete Association (NPCA), the American Concrete Pipe Association (ACPA) and/or the Prestressed Concrete Institute (PCI). Certified producers must submit a copy of their certifications and documentation that have successfully completed the annual inspections. The City Engineer may waive the requirements of precast concrete producer certification on a case-by-case basis.

6.3 Submittals

Where required in the project plans, technical performance and/ or quality certification of concrete materials proposed for the work shall be submitted to the City Engineer for approval. Such submittals may include the following:

6.3.1 Concrete Mix Designs

Concrete mix designs are required for load carrying structures such as bridges, box culverts, junction boxes within the roadway and retaining walls. Mix designs shall be prepared and certified by approved materials testing company, or alternately, an existing TDOT approved design may be submitted provided the design is approved within the calendar year. Mix designs shall certify all admixtures and cement replacement such as fly ash proposed for the project concrete.

6.3.2 Reinforcing Steel

Certifications for reinforcing steel used in load carrying structures shall be submitted to the City Engineer. Letter of certification shall bear the signature of the supplier's representative and shall certify that the reinforcing meets the requirements of "*TDOT Standard Specifications"*.

6.3.3 Miscellaneous Items

Items included in the concrete work such as handrails, anchors, joint materials, curing materials and other items may require submittals and or representative samples at the discretion of the City Engineer.

6.4 Curbing and Sidewalks

6.4.1 Residential Sidewalks

All residential street sidewalks within the City shall be constructed within the street right-of-way and shall meet all City requirements and standard drawings. The sidewalk forms and base material shall be inspected prior to concrete construction.

It is the contractor's responsibility to ensure safety and maintain access for pedestrians when sidewalks are under construction and to protect the in place work from damage or vandalism.

Traffic control devices including cones, barrels and signs may be required on high volume streets to warn vehicular traffic in advance and adjacent to the area of construction.

(1) All concrete sidewalks shall be a minimum uniform thickness of 4" using Class A Concrete, minimum 28-day compressive strength of 3,000 psi. Sidewalks shall be constructed on 4 inches (minimum) of compacted, granular aggregate base stone (TDOT Class A, Grade D Base Stone). The base stone shall be mechanically compacted to a firm, even surface in reasonably close conformity with the grade and cross section required.

(2) Subgrade soil which in the opinion of the City Engineer is soft or subject to large volume changes, shall be excavated and replaced with suitable material as approved by the City Engineer.

(3) Where driveway and alley approaches cross the sidewalk, the minimum concrete thickness of the approach slab shall be 6". See Standard Drawings for details. Granular base material for driveways shall be compacted base stone material conforming to Class A, Grading D of "*TDOT Standard Specifications"*. A 2" lowered curb height above the gutter line shall also be maintained at the front edge of the driveway approach.

(4) Reinforcement of residential sidewalks is required and shall consist of synthetic fiber reinforcement.

(5) Sidewalk cross slope shall be 1.5% (2.0% Max) sloping toward the curb. Longitudinal sidewalk grades within a street or highway right-of-way shall not exceed the general grade established for the adjacent street or highway. Pedestrian street crossings shall be 5 percent maximum.

(6) For detached sidewalks, the difference in elevation between the top of sidewalk and the top of curb at any adjacent location shall not exceed the grade difference produced by a maximum 4:1 slope.

(7) Sidewalk surface is to receive a light broom finish, to achieve a sandy texture with texture lines perpendicular to traffic. Exposed aggregate sidewalk finishes are not acceptable within the street right-of-way.

(8) All exposed concrete edges shall be rounded to a 1/2" radius.

(9) Final longitudinal surface variations shall not exceed 1/4" under a 12-foot straight edge and transverse variation shall not exceed 1/8" in 5 feet. Low spots which allow water to pond will not be acceptable.

(10) Transverse control joints shall be spaced 5 feet maximum and shall be placed at right angles to traffic. Joints shall also be placed to intersect all inside or re-entrant corners. Joints shall be formed with a grooving trowel to a depth of 1 inch. The top edges of the grooves shall be rounded to 1/4" radius.

(11) Longitudinal control joints are required for sidewalk widths greater than 6 feet and less than 10 feet. Two longitudinal joints are required for sidewalks greater than 10 feet. Longitudinal joints shall be centered in the width of the sidewalk.

(12) Expansion joints shall be constructed with 1/2" thick pre-molded rubberized expansion joint filler (manufactured by J.D. Russell Company, or equal). Bituminous fiberboard shall not be used. Expansion joint material shall extend the full width of the sidewalk and the depth shall extend to within 1 inch of the top surface. Space expansion joints at 30 feet maximum spacing and at each driveway and at any cold joint. Expansion joints are also required at the back edge of driveway approaches between the approach and the private drive and at each side interface with the sidewalk.

(13) 1" thick pre-molded expansion joints are required when sidewalks are adjacent to curved sections of the street curb and when curb is placed adjacent to buildings and/ or retaining walls. Use 1/2" isolation joints around other fixed objects like utility poles and hydrants. Use 1/2" expansion joints between the curb and sidewalks where constructed adjacent to each other.

(14) Sidewalks and bikeways shall not be opened to pedestrian or bicycle traffic for at least 24 hours after placement. The contractor shall provide and maintain measures to restrict use during the curing period.

(15) Concrete driveway aprons shall not be opened to vehicular traffic for at least 7 days after placement or until test cylinder breaks indicate an attained compressive strength of 2500 psi.

(16) Backfill sidewalks flush with the surface of the walk and the surrounding ground line with soil. For detached sidewalks, backfill the area between the curb and the sidewalk on a straight line from the top of walk to the top of curb, but not to exceed a 4:1 slope.

6.4.2 Commercial Sidewalks

In addition to and including the above requirements for residential street sidewalks, commercial sidewalks within the City shall be constructed to the following requirements:

(1) Driveway and alley approaches crossing the commercial sidewalks shall have a minimum concrete thickness of 8 inches. See Standard Drawings for details. Granular base material for driveways shall be compacted base stone material conforming to Class A, Grading D of "*TDOT Standard Specifications"*. A 2-inch lowered curb height above the gutter line shall also be maintained at the front edge of the driveway approach.

(2) Isolation joints are required around penetrations in the sidewalk such as fire hydrants, utility poles, manholes, and adjacent to any fixed structure such as a building or retaining wall. Use 1" thick joints against buildings and retaining walls and 1/2" thick pre-molded non-bituminous expansion joint material shall be used in all other locations.

(3) All valve boxes, manhole covers and other castings in the sidewalk area shall be adjusted to the grade of the sidewalk.

(4) Commercial sidewalk widths shall be specifically reserved for pedestrian travel. Furniture, planters, newspaper stands and other protruding obstacles shall be kept clear of a minimum required width of 4 feet. Obstacles in the pedestrian path shall be eliminated or a widened pathway around the obstacle will be required.

6.4.3 Bikeways

Where desired, concrete bike paths within the City shall be constructed using the same requirements of commercial sidewalks except that control joints shall be saw cut 1" deep through the concrete slab in lieu of tooled joints to improve rideability. Expansion joint material shall be recessed 1/2" minimum below the riding surface.

6.4.4 Accessible Ramps

All sidewalks within the City shall include compliant accessible ramps at all intersections, crosswalks and commercial driveways. Accessible ramps shall be constructed in accordance with the City Standard Drawings.

(1) Concrete for ramps to be Class A and shall be finished by light broom finish texturing.

(2) Install a 1/2-inch pre-molded, rubber expansion joint between the ramp section and the sidewalk and between the ramp section and the curb.

(3) Truncated dome detectable warning areas shall be installed using Armorcast Detectable Warning Panel or approved equivalent.

(4) Minimum concrete thickness for an accessible ramp shall be 8 inches.

6.4.5 Curb and Gutter Sections

All concrete curb and gutter sections shall be constructed in accordance with details shown in the Standard Drawings and the project plans. Curb openings will be located as shown on the approved plans and will be evaluated based on acceptable access control requirements by the City.

(1) Class A Concrete shall be used for all curb and gutter sections and the concrete mix shall be air-entrained.

(2) Curb and gutter sections shall be constructed on compacted stone aggregate base for residential and commercial streets. Extruded curbs are to be constructed on asphalt binder course surfaces for residential streets.

(3) Curb and gutter sections shall be reinforced with synthetic fiber reinforcing.

(4) Control joints for curb and gutter sections shall be spaced at a maximum of 10 feet.

(5) Expansion joints are required at all tangent points in curved sections, between curbs and sidewalks and between curbs and other rigid objects such as buildings, catch basins and driveway aprons.

(6) Where curbs are attached to the sidewalk, expansion joint spacing shall match the spacing of expansion joints in the sidewalk.

(7) Maximum expansion joint spacing for detached curbs shall be 100 feet.

(8) Curbs and gutters shall be constructed to follow the geometry of the roadway unless noted otherwise on the plans. Curved sections of curb shall conform to the roadway curve geometry with smooth continuous curves with no chorded portions.

(9) Flow lines of gutters shall be true to line and grade with no areas of ponding water. Final longitudinal surface variations shall not exceed ¼ inch under a 12-foot straight edge.

(10) Concrete finish for curb and gutter sections shall be a light broom finish with finish lines parallel to the flow of water.

(11) Curb and gutter sections aprons shall not be opened to vehicular traffic for at least 7 days after placement or until test cylinder breaks indicate an attained compressive strength of 2500 psi.

6.5 Stamped Concrete and Brick Pavers

6.5.1 Stamped Concrete

For areas designated by the City, concrete finishing may incorporate imprinting or stamping and coloring of the exposed finish for improved aesthetics. Stamped concrete finishes are to be performed only by qualified contractors with a minimum of five-years experience in commercial concrete stamping finishes. For projects with proposed concrete stamping, the proposed pattern, finish and color shall be submitted with related product data to the City Engineer for approval. Prior to construction, a mock-up sample of a minimum 4 square feet size shall be constructed to demonstrate a typical finished product for review and approval by the City.

Concrete stamped areas may include color of the final surface by applying a colored antiquing release agent just after initial set of the concrete. Concrete may also contain a color additive provided the colorant additive is mixed at the batch plant and the color is completely dispersed in the concrete. After concrete curing, the colored concrete surface shall be sealed with a clear sealer containing at least 30% solids in a minimum of two coats. Alternate method of coloring the concrete surface may be submitted to the City Engineer for approval.

6.5.2 Concrete Unit Pavers

While stamped concrete is the preferred method for aesthetic enhancement of concrete surfaces, concrete pavers may be used to create borders or bands within sidewalk areas. Pavers will not be allowed in areas subject to vehicular traffic unless otherwise approved by the City Engineer.

All paver units shall be concrete pavers installed over concrete mats with bituminous adhesives. Clay brick paver units shall not be used. Pavers subject to vehicular traffic shall be required to have a minimum of 10" thick poured concrete base with weep holes filled with bedding material and a ¾" thick bituminous setting bed (E-Mix). All other pavers shall have a minimum of 4" thick poured concrete base with a ¾" thick bituminous setting bed (E-Mix). See Standard Drawings for examples of standard drawings.

6.6 Rigid Concrete Pavement

For specific locations on city streets with large volumes of truck traffic and damage to asphalt pavement due to braking forces, rigid concrete pavement may be utilized. Typical locations for its use include intersection approaches, particularly at the bottom of steep grades. Thin concrete overlay with thickness of 4 inches or less, commonly referred to as "white topping" and are constructed over existing hot mix asphalt shall not be used on City streets.

Minimum design requirements for new concrete pavements include a fiber reinforced, 8-inch concrete pavement thickness on 10 inches of compacted mineral aggregate base stone. Use of Class CP (3000 psi strength) concrete is a minimum requirement with the additional requirement of High Early Strength cement for a reduced construction time. Concrete pavement construction shall be in accordance with "*TDOT Standard Specifications"*.

6.7 Concrete Reinforcement

Where indicated on the approved drawings, concrete for load carrying structures such as box and slab culverts, bridges and retaining walls shall be reinforced with steel bar reinforcement, welded wire fabric and pre-stressing strands. Sidewalks, curbs, combined curb and gutters and concrete pavement areas shall be reinforced with synthetic fiber reinforcement.

All steel reinforcing materials required for load carrying structures shall meet the requirements of "*TDOT Standard Specifications"* unless noted. Sizes, spacing, gauges, locations and arrangements shall be as shown on the approved plans. Where project plans do not depict reinforcing placement plans or schedules, the contractor shall develop and submit reinforcing steel shop drawings to the City Engineer for approval. All hooked bars shall conform to CRSI standard hook details.

In the case of bridge decks, top slabs of box and slab culverts used as riding surfaces, concrete barrier rails and bridge sidewalks, all reinforcing steel shall be epoxy coated per "*TDOT Standard Specifications"*. In addition, the dowel bars projecting from the footing into the back face (backfill side) of the wall stem in retaining walls shall also be epoxy coated.

6.7.1 Reinforcing Materials

Use the reinforcing materials below where indicated on the approved plans:

(1) Steel Reinforcing shall be deformed steel bars conforming to ASTM A 615, Grade 60.

(2) Steel reinforcement for bridge decks and top slab of box bridges and slab culverts when used as the riding surface shall be epoxy coated. All concrete bridge railing shall also require epoxy coated reinforcement.

(3) Smooth steel dowel bars shall conform to ASTM A 615

(4) Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

(5) Prestressing steel shall be in accordance with ASTM A416

(6) Synthetic Fibers (fiber reinforced concrete): Fibrillated or monofilament polypropylene fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

6.8 Concrete Placement

All formwork shall be constructed in accordance with "*TDOT Standard Specifications"* using pre-manufactured metal forms or dressed form lumber and plywood. Formwork shall be adequately braced, mortar tight and true to line and grade. Provisions shall be made during placement of concrete to minimize aggregate separation and ensure proper consolidation throughout the pour. To highlight a few key requirements of "*TDOT Standard Specifications"* in particular, the contractor shall ensure the following placement operations are observed:

(1) Elapsed time from truck loading to delivery and placement shall be limited to 90 minutes when the air temperature is 90 degrees or less. When the air temperature exceeds 90 degrees, this time is reduced to 60 minutes.

(2) Concrete that does not meet the specified limits regarding slump, air content, temperature and delivery time shall not be used unless approved by the City Engineer.

(3) Concrete shall be mechanically vibrated with suitable vibrators operating within the concrete unless otherwise directed by the City Engineer.

(4) Concrete may not be placed from a chute discharge height greater than five (5) feet.

(5) No concrete other than foundation seals shall be placed underwater.

(6) Do not add water to concrete during delivery, at project site, or during placement unless the concrete delivery ticket indicates that mix water was withheld at the plant. In such cases only the amount withheld per cubic yard may be added at the jobsite.

(7) Concrete shall be placed in cold weather only when the air temperature is 40 degrees and rising.

(8) Protect newly placed concrete from air temperatures below 40 degrees with insulation blankets to maintain the concrete temperature at not less than 45 degrees for a period of 120 hours after placement.

6.9 Inspection and Laboratory Testing

It is the contractor's responsibility to ensure quality concrete meeting "*TDOT Standard Specifications"* is delivered and placed on the project. All quality testing of the concrete shall be performed by an independent testing company pre-approved by the City in accordance with Section 1 of these Standards. All quality testing performed by the testing agency is subject to monitoring and review by the City Engineer to ensure established procedures are followed. Reports of testing shall be certified and submitted to the City within ten days of actual testing to document the quality control before final acceptance of the project. The contractor will be responsible for the costs associated with all testing and also re-testing due to failed acceptance tests.

Required tests for concrete construction to be performed by the testing agency include:

(1) Slump
(2) Yield
(3) Entrained air content
(4) Mix temperature
(5) Representative test cylinders

6.9.1 Testing Frequency

One composite sample (4 test cylinders) for each day's pour of each concrete mix exceeding 5 cu. yd. but less than 25 cu. yd. plus one set for each additional 50 cu. yd. or fraction thereof.

Concrete placement operations shall be inspected by an on-site superintendent to ensure placement of the concrete meets requirements of "*TDOT Standard Specifications"*. On-site inspection is required to be documented by the contractor and recorded in a field book subject to review by the City Engineer.

CHAPTER 7

STRUCTURES

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7.1 Overview

This Section includes all fabricated, installed and erected structures and appurtenances related to street construction including pipes, culverts, headwalls, box culverts and bridges, retaining walls and sign supports.

7.2 Reference Specifications

Unless modified by these Standards, all structure materials and construction requirements shall conform to "*TDOT Standard Specifications"*.

7.3 Pipe Culverts and Storm Sewers

Pipe used for cross drains under the street or side drains under driveways shall be rigid concrete pipe. Pipe manufactured from ADS plastic pipe may only be used outside of the street right-of-way. Plastic pipe may enter the back side of a street drainage structure provided it extends away from the street right-of-way or under a driveway and not under the street. All pipe culverts, side drains and storm sewers shall be furnished and installed in accordance with "*TDOT Standard Specifications"*.

Reinforced concrete pipe is standard for city streets

7.3.1 Concrete Pipe

Concrete Pipe shall be reinforced Class III rigid pipe and shall be round, oval or flat based as shown on the approved plans. All precast concrete pipe shall be manufactured in accordance with the "*TDOT Procedures for Manufacture and Acceptance of Precast Concrete Drainage Structures, Noise Wall Panels and Earth Retaining Wall Products"*.

7.3.2 Corrugated Metal Pipe

Corrugated metal pipe shall not be allowed within the City of Franklin. Extensions of existing Corrugated Metal Pipe shall not be allowed. Existing Corrugated Metal Pipe shall be removed in its entirety and replaced with Concrete Pipe unless otherwise approved by the City Engineer.

7.3.3 High-Density Polyethylene (HDPE) Pipe

This pipe may be used for site drainage, but shall not be used under streets or driveways. HDPE pipe may exit from the back side of a street drainage structure and extend off of the City ROW. Max pipe diameter shall be 36 inches.

7.3.4 Poly Vinyl Chloride (PVC) Pipe

PVC pipe shall not be allowed within the City of Franklin.

7.3.5 Pipe Bedding

Pipe bedding for pipe shall comply with "*TDOT Standard Specifications"*.

7.3.6 Pipe Sizes

Normal pipe sizes readily available from suppliers may be used to satisfy drainage requirements. Minimum pipe size for side drains and storm sewers shall be 15-inch diameter.

7.3.7 Pipe Backfill

Pipe backfill shall comply with "*TDOT Standard Specifications"*.

7.3.8 Pipe Cover

The minimum depth of cover for storm sewer pipes is twenty-four (24) inches to the top of pavement.

7.4 Pipe Culvert Endwalls and Inlets

Pipe culvert endwall treatments may be precast or cast-in-place concrete and are required for all pipe locations within the street right-of-way.

(1) End treatments for a culvert shall consist of either an endwall or safety end section conformed to the slope of the roadway embankment. The choice of end treatment for a culvert shall be determined by the type of facility being served, the culvert size and whether the ends of the culvert are within the clear zone as defied by AASHTO Standards. "*TDOT Standard Specifications"* shall be followed when selecting the appropriate endwall. The City Engineer shall have final determination on the type and final placement of all endwalls.

(2) To improve the aesthetics of pipe headwalls, textured concrete finishes simulating stacked stone may be used. Additionally, veneers of stone or brick may be applied to exposed surfaces to enhance the appearance from the street.

Protected Endwall with Stone Veneer

TDOT Safety Endwall

7.5 Storm Drainage Structures

Storm drainage structures consist of junction boxes, drop inlets, catch basins and manholes which may be constructed as precast concrete sections or cast-in-place concrete. Inlet and outlet pipes shall extend through the walls of structures a sufficient distance to make connections, but shall be cut flush with the inside surfaces of the box structure.

Vane grate for curb and gutter section

7.5.1 Catch Basin Castings

Catch basin castings that are damaged during construction will be rejected. Castings shall be set true to line and grade. Standard catch basin grates shall be per "*TDOT Standard Specifications"* or as specified in **the** Standard Drawings, or as approved by the City Engineer.

7.5.2 Concrete Catch Basins and Junction Boxes

Standard catch basins and junction boxes are precast concrete or cast-in-place where directed by the Engineer. Catch basins and junction boxes shall be designed and detailed on the plans or shall be "*TDOT Standard Specifications*". Knockout structures shall not be used.

7.5.3 Additional Pipe Openings

All boxes, existing or new installation, requiring additional pipe openings shall be neatly cored by means of mechanically sawing through wall of structure. Any damages caused to the structure or use of other means to create openings may require replacement, as determined by an authorized representative of the City of Franklin.

7.5.4 Trench Drains

Trench drains shall not be used within public right-of-way unless otherwise allowed by the City Engineer.

7.6 Box Culverts and Bridges

Box culverts and bridges shall be designed in accordance with AASHTO's "*LRFD Bridge Design Specifications*" and "*TDOT Standard Specifications*". Design drawings shall be sealed by a Professional Engineer licensed to practice in the State of Tennessee.

Bridges spanning the floodway shall provide a minimum clearance of 1-foot between the 100-year base flood elevation (BFE) and the lowest point of the bridge superstructure. Bridges shall also be able to pass the 500-year flood without structural failure.

7.7 Pedestrian Bridges

Pedestrian bridges shall be designed in accordance with the *AASHTO "LRFD Guide Specification for Design of Pedestrian Bridges"* (latest edition). Design drawings shall be sealed by a professional engineer licensed to practice in the State of Tennessee. Where pedestrian bridges allow passage of maintenance vehicles and small trucks, the vehicular loading shall be accounted for in the design of the bridge. For bridges prohibiting maintenance vehicular traffic, provisions shall be made to restrict access by means of suitable barriers, bollards or other permanent barricades.

7.8 Retaining Walls

Retaining walls shall be designed in accordance with the AASHTO "*LRFD Bridge Design Specifications*" (latest edition). Design drawings for retaining walls over 48 inches in height measured from the bottom of the footing to the top of the wall shall be sealed by a professional engineer licensed to practice in the State of Tennessee.

Retaining walls shall be designed for a live load surcharge corresponding to the maximum design loading, but in no case less than 250 psf applied over the full extents of right-of-way. Retaining wall designs shall provide a minimum sliding and overturning factor of safety of 1.50 and a minimum global stability factor of safety of 1.30. Unless otherwise permitted by the City Engineer, retaining walls shall be located outside of right-of-way with no elements necessary for wall stability located within right-of-way or public utility easement extents. Walls outside of, but supporting, right-of-way or public utility easements shall not utilize timber or rockery retaining

walls. Walls within right-of-way or public utility easements shall consist of cast-in-place concrete walls meeting TDOT standards, unless otherwise permitted by the City Engineer.

Pedestrian and/or vehicular guards shall be provided when a pedestrian and/or vehicular path, respectively, extends to within five (5) feet of the top of a retaining wall or where otherwise deemed necessary by the City Engineer.

7.9 Overhead Sign and Ground Mounted Sign Supports

Sign support structures and foundations shall be designed, fabricated and erected in accordance with "*TDOT Standard Specifications"*. Design drawings for overhead sign supports shall be sealed by a professional engineer licensed to practice in the State of Tennessee.

SIGNAL DESIGN

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8.1 Introduction

The purpose of this chapter is to outline the City's review process for traffic signal plans and highlight basic design requirements for traffic signal installations and/or modernizations. This chapter outlines plan and design requirements for the various stages of review and also discusses some basic design elements the City requires on traffic signal projects.

Traffic signal technology changes at a rapid pace; the City reserves the right to change its traffic signal standards and specifications at any time without advance notice.

8.2 Administration

8.2.1 Signal Warrants

For the installation of traffic signals to be considered, the location must satisfy the warrants outlined in the most recent edition of the *"MUTCD"*. In high growth areas where significant changes in traffic conditions are expected due to the development of the area, hourly volumes for 5 years after full build-out shall be estimated and compared with the *"MUTCD"* signal warrants. The growth rate utilized to estimate the future traffic volumes is subject to the review and approval of the City Engineer prior to its use. The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic signal. The City Engineer shall make the final recommendation regarding the location of any new traffic signal. For state routes within the city, TDOT and City will review to make final decisions regarding signal warrants.

8.2.2. Engineering Study

An engineering study will be required for all proposed traffic signal installations. The engineering study shall evaluate the effects of the proposed traffic signal on progression. The engineering study shall include the estimation of future volumes and an analysis of the progression of traffic through the signal system, as defined by the City Engineer. The evaluation shall include any planned future traffic signal installations. The analysis shall be submitted to the City Engineer for review and shall include capacity analysis (using Synchro, HCM Cinema or other software as approved by the City Engineer), as well as time-space diagrams of the signal system. The study periods shall be the AM, midday and PM peak hours, although other time periods may be required. Signal timing optimization for a corridor may be required depending on traffic impact analysis.

8.2.3. Signal Spacing

Signalized intersections shall be located to maintain progression of traffic along arterial streets. This normally entails relatively uniform spacing and sufficient distances between signals to allow vehicles to travel at reasonable speeds. Optimal spacing of traffic signals is always the desire of the City. The optimal spacing is a function of the cycle length and the progression speed of traffic along the major street, but a general guideline is that signals should be placed at least a quarter of a mile apart. New signal locations shall be subject to spacing requirements on a case by case basis as determined by the City Engineer. Proposed signal locations not adhering to this spacing will be reviewed. The spacing requirements may be waived if the City Engineer determines that the proposed traffic signal will not significantly hinder the progression traffic along the major street. If the proposed location is rejected, the City Engineer may require either the relocation of the proposed signal location, to better accommodate progression, or the evaluation of other alternatives, for management of the traffic generated by the side street / private access.

8.2.4. Private Benefit Signals

Private benefit signals provide signalized access to private streets or developments. These signals are generally required when the property owners must improve access from their site onto the major street or facilitate movement between developments on opposite sides of the street.

(1) Required Installations: If the Traffic Impact Study for a new development indicates that a traffic signal will be warranted within 10 years of full build-out, the City Engineer may require the inclusion of a traffic signal as a part of the development plan. The financial responsibility for these signals shall be in accordance with the arrangements made during preparation of the development plan. The time frame for installation is dependent on the traffic projections and subject to the discretion of the City Engineer. The site development plans will not be approved until provisions for the installation of the traffic signal or other alternative measures to enhance the safe movement of traffic through the intersection are included in the plans.

8.2.5 Designer Prequalifications

The design of traffic signals shall be performed by the City or a qualified Engineer approved by the City. The design staff for any firm supplying traffic signal plans to the City must be familiar with the traffic signal design procedures used by the City. At the request of the City, the design engineer may be required to provide copies of their most recent traffic signal design and / or modification projects to the City Engineer prior to their being assessed as qualified.

8.2.6 Intersection Design Study (IDS)

An IDS must be prepared for any intersection that is proposed for the installation or modernization of traffic signals. Engineering work associated with the IDS will include topographical surveys, preparation of a base map, roadway geometric design, traffic signal layout and traffic signal phasing. The IDS shall include the traffic signal warrant study, detailed preliminary intersection and signalization design to meet present and future traffic needs, a list of needed rights-of-way, and a total project cost estimate suitable for budgeting purposes. An IDS that has been reviewed and approved by the City Engineer is required prior to the submittal of traffic signal plans for review. If an IDS does not exist for the intersection, one shall be prepared as part of the project presentation stage of design (described in the following section). If an IDS exists and, at the discretion of the City Engineer, the traffic conditions at the intersection have significantly changed since the preparation of the IDS, an update of the IDS may be required.

8.3 Design Standards

8.3.1 Referenced Standards

The design of traffic signals is under the jurisdiction of the City and shall conform to the requirements and specifications outlined in this chapter. Traffic signal design on State highways in the city shall meet the requirements of the City as approved by TDOT. All traffic signal design shall conform to the requirements of the *"MUTCD"*, *"TDOT Standard Specifications"* and *"Special Provision Regarding Section 730f – Traffic Signals City of Franklin 730 General Requirements"*

8.3.2 Design Requirements:

(1) Internally illuminated Street Name Signs - Temple Edge-Lit Internally-Illuminated LED Street Signs shall be installed on all mast arms. Signs shall have a Green Background and rigid mount back brace.

(2) Radar Detection System - Wavetronix detectors (Stop Bar and Advanced) complete with wiring and detector circuits for counting traffic shall be used on all approach lanes

except for exclusive right turn lanes that will operate with the associated through and/or left turn phases. In addition to stop bar and advance detectors in the thru lanes of moderate and/or high speed approaches (35 mph or greater), system detection shall be installed in the opposite direction thru lanes at the same location (subject to lane restrictions) as the advance loops.

(3) Signal Head Assembly

i. Shall be fabricated from cast aluminum. The signal housing shall be painted federal yellow (Signal housing in the Historic Downtown area shall be painted gloss black). Door faces shall be painted gloss black. Visors shall be constructed of sheet aluminum and the exterior painted gloss black. Visors shall be of the cutaway tunnel type. LED reflectors with polycarbonate lens shall be required.
ii. Backplates shall be furnished and attached to the signal head. All backplates shall be louvered on each of the four sides of the panel, and fabricated from black ABS UV stabilized plastic sheet.
iii. Bracket mounted signal heads shall be supported by mounting brackets consisting of assemblies of 1 ½" standard pipe size. All members shall be either plumb or level, symmetrically arranged, and securely assembled. Construction shall be such that all conductors are concealed within the poles and mounting assembly.
iv. Signal indications on mast arms shall be aligned per "*TDOT Standard Specifications".*

(4) Electrical Service Connection - Underground service connection shall be installed per the Standard Drawings. The service pedestal shall be Milbank Model No. CP3B "SL" Series CP3B11110A22SL1.

(5) Vehicle Detector (Infrared and GPS Activated Priority Control) – All traffic signal installations shall include dual GPS/infrared Opticom emergency vehicle priority control system complete with detectors, wiring and card in the cabinet (3M system).

(6) Cabinet / Controller – The following shall be required for all traffic signals:

i. The Cabinet shall be an Eagle ELS1014 size "P-UPS" base mounted cabinet with integrated UPS compartment. The UPS system shall be a Clary SPD2000 PD-N for rack mounting.
ii. The Traffic Controller shall be an Eagle EPAC 3108-M52 with
iii. A Fiber Connection Inc. "Gator Patch" Model # GP20L006FRB-xx-1 fiber optic distribution panel and drop cable shall be installed in the cabinet. (xx is cable length to splice pull box in meters).
iv. NEMA Signal Monitor shall be Eberle Design Inc. SSM-12LEip Series.
v. Surge Protector shall be EDCO ACP-340 (120 VAC – 1 Phase)
vi. Loadswitch shall be Eagle Load Bays NEMA TS-1 TF4000 Series, with 16 load bay positions and 8 flash relay positions.

(7) Pedestal Pole – shall be powder coated black with a square pedestal base and installed per "*TDOT Standard Specifications"*. Specialty poles and standards shall be required by the City Engineer in the Historic Downtown area.

(8) Cantilever Signal Support

i. Signal Support shall be Cantilever type and powder coated black. The installation of strain poles shall generally not be approved by the City and will be reviewed on a case by case basis by the City Engineer. Specialty poles and standards shall be required by the City Engineer in the Historic Downtown area.
ii. Combination mast arms and other equipment necessary to provide intersection lighting will be required for all new traffic signal installations and modernizations. Aluminum and painted mast arm/signal poles, luminaire arms, and extensions shall be used.
iii. Any street light luminaire extensions (aluminum and painted) shall be approved by the City Engineer. A minimum 30-foot luminaire mounting height and a minimum 15-foot luminaire arm (aluminum and painted) shall be used to mount the streetlight fixture. The attachment height for mast arm to pole shall be per approved shop drawings.

(9) Countdown Pedestrian Signal, Push Button Post, Button and Sign

i. All items shall be in compliance with "*MUTCD"* and ITE specifications.
ii. Pedestrian signals and pushbuttons shall be provided at all signals unless otherwise directed by the City Engineer. All pedestrian signals shall have both audible and vibrotactile walking indications.
iii. Yellow 16-inch LED countdown pedestrian signal with visor and a clamshell / banding mounting system are required, with ADA pedestrian buttons for all standard pedestrian movements with marked crosswalks (Pedestrian signal housing in the Historic Downtown area shall be painted gloss black). Housing material shall be one-piece die-cast aluminum alloy.
iv. Pedestrian buttons shall be the bulldog type with audio alert, LED light, and sign housing/back plate. The accessible push button system with voice messages (APS) shall be used only where approved by the City Engineer.

(10) Battery Back-up and Power Conditioner – An uninterruptible power supply (U.P.S) shall be provided at all signals and shall be manufactured by Clary SP Series, Model PD, SP20000PD-N integrated PIM and Programmable Digital Display. Installation shall include SNMP Adapter SP-09G and outpost Batteries OP96SC-41

(11) Two 3-inch conduits (Schedule 40 PVC minimum) will be used for wiring between the signal bases and the cabinet.

(12) Pull box covers installed in the roadway shall meet or exceed TDOT specifications.

(13) Loop Lead-Ins shall be per "*TDOT Standard Specifications"* with the exception of provide a minimum 2-inch diameter conduit for better accessibility.

(14) Designer shall be required to include provisions for new streets and widening projects to include conduit for future signal interconnects and pull boxes as required.

(15) All shop drawings for signals are to be approved by the City Engineer prior to installation.

8.3.3 Traffic Signal System Requirements

(1) The installation of a fiber optic interconnect is required between signalized intersections that are within 1/2 mile of one another or if analysis indicates that the signals would benefit from signal coordination. Communications interface must be installed as a part of the project if one does not exist already. All traffic signal systems will use IP based communications protocols and equipment shall have IP addressable ports.

(2) The City Engineer may require the installation of detection for the purpose of collecting traffic counts.

8.3.4 Electrical Requirements

(1) The traffic signal design shall conform to the National Electric Code.

(2) Traffic signal equipment shall conform to NEMA standards.

(3) Fiber optic interconnect shall include a copper tracer, pull string/jet line, marker tape and curb markers in all ITS conduit.

(4) Power back up shall be provided at locations required by the City Engineer, with the ability to provide stop-and-go control for up to one hour.

(5) The traffic signal plan shall include a continuous grounding plan for the intersection.

(6) Double hand holes are required at all traffic signal cabinet locations.

(7) Power disconnects shall be provided.

(8) New power installations shall be continuously metered by MTEMC.

(9) Service pedestals shall contain circuits and test switches for safety lighting and illuminated street name signs.

8.3.5 Construction

Traffic signal installations / modernizations shall be constructed in accordance with applicable sections of the *"TDOT Standard Specifications"*.

8.3.6 Materials and Construction Notes

The specifications for traffic signal equipment and related appurtenances required by the City are maintained by the Engineering Department. A copy of these specifications is included and subject to change by the City Engineer.

8.3.7 Pedestrian Signals and Timings

The *"MUTCD"* identifies the situations in which pedestrian signal shall be used and the situations in which pedestrian signals shall not be used. Because one should assume that pedestrians will be present at all intersections in the City to some level, all signalized intersections shall be designed to accommodate pedestrians. Other locations that have high pedestrian volumes with marked crosswalks may also warrant the installation of a dedicated pedestrian actuated traffic signal, subject to review and approval by the City Engineer.

Bicyclists are required to follow the rules of the road, including those related to traffic signals. Therefore, signal timing and detection shall accommodate the needs of bicyclists. Traffic signal clearance intervals are recommended to be timed to provide bicyclists with sufficient time to react, accelerate, and proceed through an intersection on the clearance interval. Normally, a bicyclist can travel through an intersection under the same signal phasing arrangement as motor vehicles. However, special consideration of bicyclists' needs may be necessary at multi-lane crossings and at acute angle intersections, which take longer to cross. The clearance interval shall take into consideration a bicyclist's speed of 6-8 MPH, and a perception/reaction/braking time of one (1.0) second. Traffic detectors for traffic-actuated signals are recommended to be set to detect bicycles.

There are various types of detector loops that can be used for bicycle lanes. Quadruple and diagonal quadruple loop detectors generally provide for bicycle detection, unlike standard loops, which are difficult to adjust to detect bicycles. Detectors shall be located in the bicyclist's expected path of travel. When bicycle lanes are not present, pavement markings shall be used to indicate where bicyclists should position themselves in order to activate the signal detector.

The *"MUTCD"* and "PROWAG" standards shall be consulted regarding pedestrian signal timings. However these documents contain some differences. Each of these documents shall be reviewed, and the most stringent requirements shall be applied when designing pedestrian signal timings.

8.4 Signal Phasing and Timing

8.4.1 Purpose

The City has adopted a set of traffic signal timing and phasing guidelines which are to be implemented at signalized intersections under their jurisdiction. The purpose of these guidelines is to establish standard practices and operational procedures for traffic signal timing parameters to be used by City staff and consulting engineers performing signal timing services for City. This policy is in no way in conflict with *"MUTCD"*. Should a conflict arise, the *"MUTCD"* shall prevail.

The guidelines in this document are to be implemented at new traffic signal installations, traffic signal upgrades, and along signalized corridors as they are re-timed. The adoption of these guidelines does not imply that each and every traffic signal under the jurisdiction of the Engineering Department will automatically comply with these new guidelines. Rather, traffic signal settings will be updated along signalized corridors throughout the City as they are retimed.

These guidelines have been established to provide guidance on various signal timing parameters. However, signal timing shall be evaluated for all situations independently based upon standard traffic engineering principles and local intersection characteristics. Necessary adjustments shall be made to meet the traffic conditions at each individual signalized intersection. These guidelines should serve to provide consistent, safe, and efficient control of traffic signals within the City.

8.4.2 Vehicle Clearance Intervals

The *"MUTCD"* requires that vehicle clearance intervals consist of a required yellow change interval and an optional red clearance interval. The *"MUTCD"* defines both the yellow change and red clearance intervals as:

Yellow Change Interval – the first interval following the green interval during which the yellow signal indication is displayed.

Red Clearance Interval – an optional interval that follows a yellow change interval and precedes the next conflicting green interval.

The timing of Yellow Change and Red Clearance intervals are to be established per the ITE Recommended Practice.

8.4.3 Pedestrian Control Features

There are a number of pedestrian-related items that are covered in this portion of the guidelines. They include recommended pedestrian walking speeds, minimum pedestrian walk intervals for pedestrian signal phasing, guidelines for pedestrian clearance intervals. The City adheres to *"MUTCD"* recommended standards for pedestrian timing.

8.4.4 Pedestrian Push Button Usage

Pedestrian push button actuation is recommended for pedestrian phases that cross the 'main street' approaches so that 'side street' vehicle phases do not have to accommodate pedestrian timings unless they are actuated via a pedestrian push button. The need for push button actuation to cross side street approaches shall be determined via engineering judgment by the City. For the purposes of determining main street approaches in reference to pedestrian timings, the main street approaches will be considered the signalized approaches that are coordinated and are therefore non-actuated. If a traffic signal is pre-timed or fully-actuated, the differentiation between main street and side street does not apply for this situation.

8.4.5 Walk Rest Modifier Option

During main street vehicle signal phases that are non-actuated, there are often situations where the vehicle split is significantly larger than the required pedestrian walk and clearance intervals. Rather than increasing the pedestrian clearance interval to accommodate the additional time available, City staff will allow the signal controller to extend the length of the pedestrian walk interval. There are however, situations where this option, known as the walk rest modifier, should not be allowed. Such applications where the walk rest modifier should not be utilized include the following: (a) cases where right-turn volumes are heavy across the pedestrian crossing area, (b) cases where permissive left-turn volumes are heavy across the pedestrian crossing area, and (c) any other cases where City staff has determined that the walk rest modifier option should not be implemented.

8.4.6 Minimum Vehicle Green Times

Minimum vehicle green times shall be short enough so that green time is not wasted, yet not so short such that motorists unexpectedly see the yellow change interval while entering the intersection and become confused. The minimum times documented in this section of the policy are the minimum allowed which does not suggest that all signalized intersections will utilize these minimum values. Greater minimum green times are allowed; however values lower than these mentioned below are not recommended. In addition, the percentage of trucks shall also be reviewed on an intersection-by-intersection basis since a high percentage of trucks may necessitate increasing the minimum green time controller setting. Maximum green time setting are not discussed in this policy since they vary significantly by location and are based on signal operation, vehicle demand, and other operational characteristics.

Minimum Green Times for Left-turn Phases - A minimum green time setting of five (5) seconds is allowed for left-turn phases.

Minimum Green Times for Side Street Through Phases - A minimum green time setting of seven (7) seconds is allowed for side street phases.

Minimum Green Times for Main Street Through Phases - A minimum green time setting of ten (10) seconds is allowed for main street through phases.

8.4.7 Main Street and Side Street Definitions

It is often obvious, when comparing approach geometry, traffic volumes, road classification and/or route continuity, which roadway is considered the 'main street' and which is considered the 'side street'. However, there are instances where there is no clear cut distinction between the two. Some intersections include two main streets. For the purposes of selecting minimum green time settings, the City Engineer will apply the above factors in determining whether or not a main street approach exists.

8.4.8 Left-Turn Signal Phasing Guidelines

Left-turn phasing guidelines as discussed in the ITE *Traffic Engineering Handbook* are to be used for assistance in assessing the need for left-turn phasing at signalized intersections under City jurisdiction. There are two Transportation Research Record documents suggested by ITE for traffic engineers to consider where determining the need for some form of protection for left turn phases. They are:

From J. E. Upchurch. Guidelines for Selecting Type of Left-turn Phasing. In *Transportation Research Record* 1069, Transportation Research Board, National Research Council, Washington, D.C., Figure 5, p. 37.

From Asante, S. A., S. A. Ardekani, and J. C. Williams. Selection Criteria for Left-Turn Phasing and Indication Sequence. In *Transportation Research Record* 1421, Transportation Research Board, National Research Council, Washington, D.C., 1993, Figure 4, p. 17.

These guidelines shall be used as a tool for determining the need for left-turn phasing at signalized intersections along with engineering judgment by the traffic engineer.

In addition to the guidelines referenced above, there are two additional guidelines that are to be adopted as City policy:
(1) Exclusive/permissive left-turn signal phasing is allowed when three (3) opposing through lanes exist as long as there is no accident experience problem and/or sight distance issue that would hamper the safety of permissive left-turn movements.
(2) Exclusive left-turn signal phasing shall be installed where multiple left-turn lanes exist.

8.4.9 Protected/Permissive Left-Turn Phase Operation

Phasing for eight-phase signal controllers shall prohibit a phase change from main street green to a main street left-turn phase if the left-turn phase operates protected/permissive. In the absence of a side street actuation, the signal controller shall remain in main street green to allow left-turn movements to occur on the permissive green.

Where left-turn delay and/or safety problems exist, the City may investigate and apply the flashing Yellow Arrow (FYA) protected/permitted signal display, in accordance with the guidelines described in the "*MUTCD*" All such installations shall provide the regulatory signs as required in the "MUTCD". City Engineer approval shall be required for the FYA.

8.4.10 Split-Phase Timing Operation Guidelines

The term split-phase signal operation describes a signal phasing sequence where one approach is given exclusive right-of-way into the intersection followed by the opposing approach being provided exclusive right-of-way into the intersection. This operation eliminates left-turn conflicts; however, it is often described by traffic engineers as an inefficient signal phasing option since the entire intersection is given a red indication to service only one of the four signalized approaches. The City Engineer may require intersection upgrades to remove split-phase operations to improve or maintain level of service. For traffic signals under the jurisdiction of the City, the following situations may necessitate the need for split-phase timing operation:

(1) Where offset approaches exist that may cause motorist conflicts/confusion if permissive phasing were implemented.

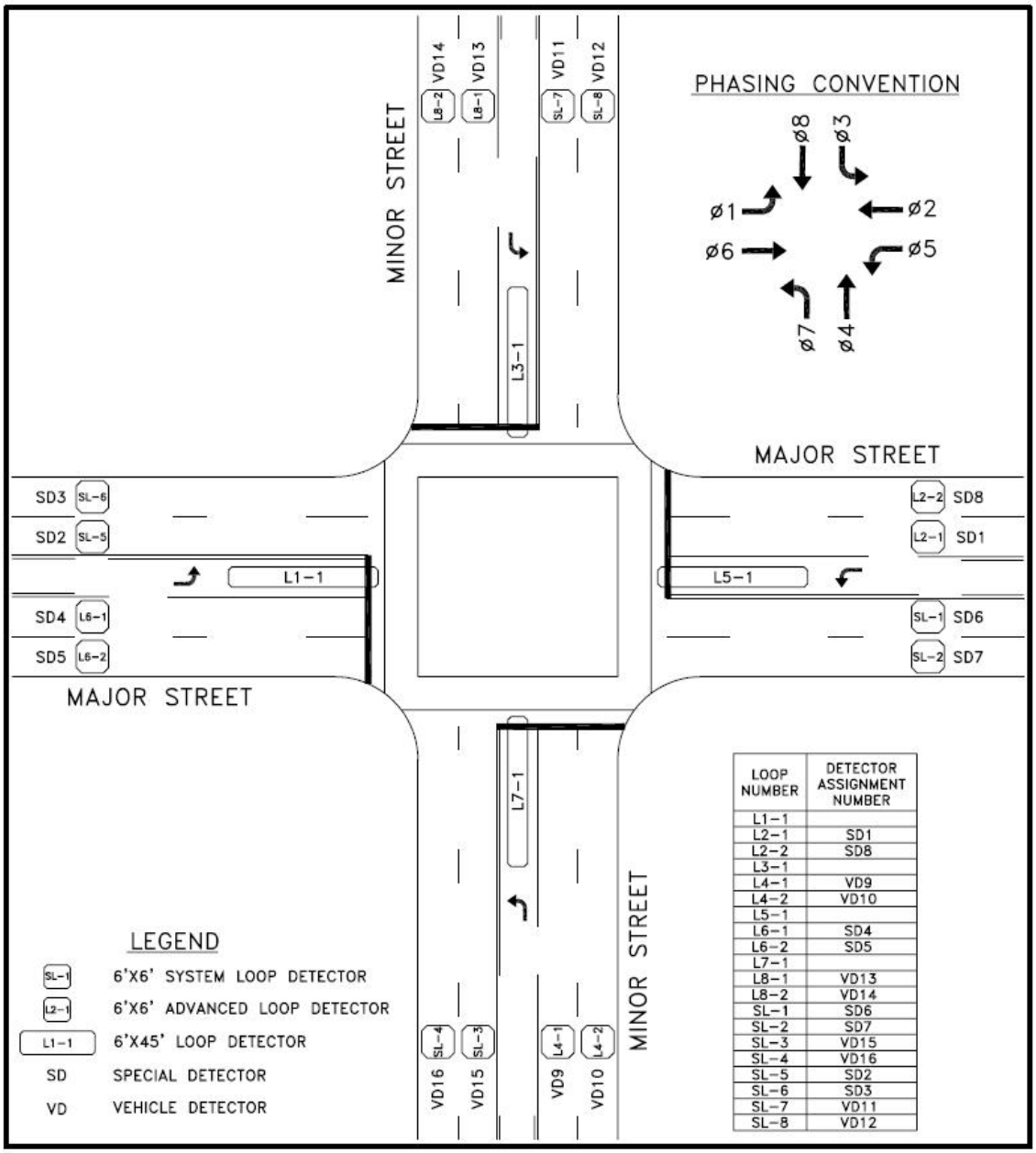
(2) Where intersection width prevents opposing left turn movements from operating concurrently. The City Engineer may require intersection upgrades to correct the opposing left turn movements. Prior to implementing split-phase operation due to this geometric limitation, the installation of lead-lag phasing shall also be considered.

(3) When an accident problem exists between left-turn and through movement conflicts that has not been successfully remedied via other operational improvements.

(4) Where a sizeable volume imbalance exists on the side street approaches.

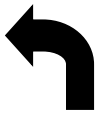
(5) Where a second left-turn lane is needed but must be shared with a through movement lane. The City Engineer may require intersection upgrades to correct this issue and maintain adequate level of service.

(6) Where the need to serve the left-turn volume is relatively close to the time needed to serve the through movement volume. For each case, a capacity analysis shall be performed comparing split-phase timing operation versus other signal phasing options prior to implementation.



Typical Detector Numbering and Phasing Convention

PHASING MAP FOR NORTH/SOUTH MAIN STREET

Phase 1 – NBLT	Phase 2 – SB Thru	Phase 3 – EBLT	Phase 4 – WB Thru
			
Phase 5 – SBLT	**Phase 6 – NB Thru**	**Phase 7 – WBLT**	**Phase 8 – EB Thru**

PHASING MAP FOR EAST/WEST MAIN STREET

Phase 1 – EBLT	Phase 2 – WB Thru	Phase 3 – SBLT	Phase 4 – NB Thru
Phase 5 – WBLT	**Phase 6 – EB Thru**	**Phase 7 – NBLT**	**Phase 8 – SB Thru**

8.4.11 Leading/Lagging Left Turn Operation

Leading/Lagging Left Turn operation shall be considered as an option for signal operation. It must consistently operate in the same mode throughout the day. Leading and lagging assignments may not be changed by time-of-day.

STREET LIGHTS

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9.1 Introduction

Adequate lighting shall be provided to ensure safe movement of persons and vehicles in the public right-of-way, and to assist for security purposes. The primary purpose of streetlights is to illuminate the public traveled ways to a level and uniformity that provides for the safe passage of public traffic, both vehicle and pedestrian.

9.2 Definitions

AFG: Above finished grade.

COF: City of Franklin

LEED: Leadership in Energy and Environmental Design

LED: Light Emitting Diode

LLF: Light Loss Factor: A percentage of the initial light output of a fixture that will be present at the maintained average life of the fixture.

MTEMC: Middle Tennessee Electric Membership Corporation: Cooperatively owned electric power distributor for the 4-county area of Williamson, Wilson, Rutherford, and Cannon counties of Tennessee.

NFPA: National Fire Protection Association

Street Light: A raised source of light on the edge of a street or walkway, which is turned on or lit at a certain time every night.

Street Lighting System: A series of street lights within the same development or project.

IES: Illuminating Engineering Society of America.

9.3 Ownership / Responsibilities

In General, ownership shall be based on the roadway classifications as indicated below:
Local and Private Streets – Street lighting placed on local and private streets shall be owned and operated by MTEMC and shall be required to meet the minimum requirements as outlined herein.
Collector and Arterial Streets – Street lighting placed on Collector and Arterial Streets shall be owned and operated as determined by the City Engineer.

9.3.1 Responsibilities Delineated

(1) Developer/Property Owners' Association/Contractor Responsibilities:

(a) Submit lighting plans for approval by the City of Franklin.

(b) Obtain a City of Franklin electrical permit for City or Privately owned and operated street lights.

(c) Obtain MTEMC approval for street lighting systems that are to be owned and operated by MTEMC.

(d) Responsible for utility initiation charges and energy usage charges until City accepts ownership.

i. Ownership for private development project occurs at the time the City of Franklin releases all performance sureties. The Franklin Municipal Planning Commission (FMPC) must approve the lighting of the City owned part of the projects prior to turn-over to maintenance and billing.

ii. Ownership for City capital projects occurs at the time the entire project is substantially complete and accepted by the City.

(2) City of Franklin (COF) Responsibilities:

(a) COF shall review and approve all street lighting through appropriate submittals in accordance with Site Plans, PUD Development Plans, Preliminary Plats, Final Plats, Infrastructure Plans, Lighting Plans, and Lighting Calculations.

(b) COF shall inspect, review and approve final record drawings associated with the record lighting plans.

i. MTEMC owned and operated street lights:

- COF shall inspect street light locations as shown on the City approved construction documents.
- COF shall coordinate with MTEMC to specify the billing rate class for the new street light services.

ii. COF owned and operated street lights

- COF shall inspect conduit pole bases.
- COF shall perform scheduled ditch/conduit inspections before ditches are closed.
- COF shall perform scheduled foundation inspections before concrete is poured.
- COF shall preform electrical inspections on the customer side of the meter.
- COF shall perform final inspections before lights are connected to the MTEMC system.

9.4 Design Guidelines

Street lighting systems will be implemented in such a way as to improve the development in which the system is serving. The specifics of each street light will be reviewed by the City, as outlined herein, to ensure that any proposed street light will enhance its surroundings and improve public safety while also optimizing energy efficiency and cost savings. The City of Franklin has adopted the following basic lighting standards.

9.4.1 General Design Standards

All street lighting of public and private streets in the City shall be designed in accordance with these standards. Adjacent bikeways and pedestrian ways are to be included when associated with the public right-of-way.

(1) Underground Electric Service
Street lighting shall be installed with underground electric service on all newly developed dedicated public streets in the City. Curb returns shall be installed after the installation of the electrical system, including underground vaults. The Developer is responsible for coordinating with MTEMC for all aspects of electrical service.

(2) Fixture Type
All luminaires shall have a LED light source. The city seeks to minimize light pollution and avoid distributing light into windows of residents. All fixtures shall include cutoff shields or other mechanisms so that light levels outside of the right-of-way does not exceed levels stipulated by LEED for the lighting zone of the project. No luminaries shall have any blinking, flashing or fluttering lights or other illuminating device which has a changing light intensity, brightness or color, nor is any beacon light permitted, except those required for fire alarm and/or emergency systems.

(3) Fixture Location

(a) The final installation location and quantity of all street lights shall be determined by detailed calculations, coordination with the site during design and approved by the City Engineer.

(b) Poles may be located within landscaped areas or islands; however, to avoid conflicts with required trees, the location of poles shall yield to existing mature trees. Proposed trees shall be relocated to avoid conflicts with light standards.

(c) Unless otherwise approved by the City Engineer or their designee all street lighting equipment conduits and foundations shall be located in the street right-of-way.

(d) When locating proposed lighting, the designer shall avoid possible conflicts with above-ground and below-ground utilities.

(4) General Layout Criteria

(a) A minimum of two lights shall be placed at every intersection with the exception of alleys. Intersections with alleys will only require one light. (See **Figure 9.1 and 9.2**)

(b) Signalized intersections may be lighted using combined streetlights and/or lighting located on the signal mast arms. A minimum of four lights shall be placed at every signalized intersection.

(c) Roundabout lighting shall be in accordance with recommendations of IES DG-19-08 "Design Guide for Roundabout Lighting." Lighting shall make roundabout visible from a distance, and make key conflict areas more visible. If continuous roadway lighting is not present, transition lighting is to be provided.

(d) Railroad crossing lighting will conform to the latest version of the Railroad-Highway Grade Crossing Handbook (FHWA) and the Lighting Handbook (FHWA). If considered a conflict, luminaire supports shall be placed in areas of accessibility. Where placed in the clear-zone of a high speed road, they shall have a break-away base.

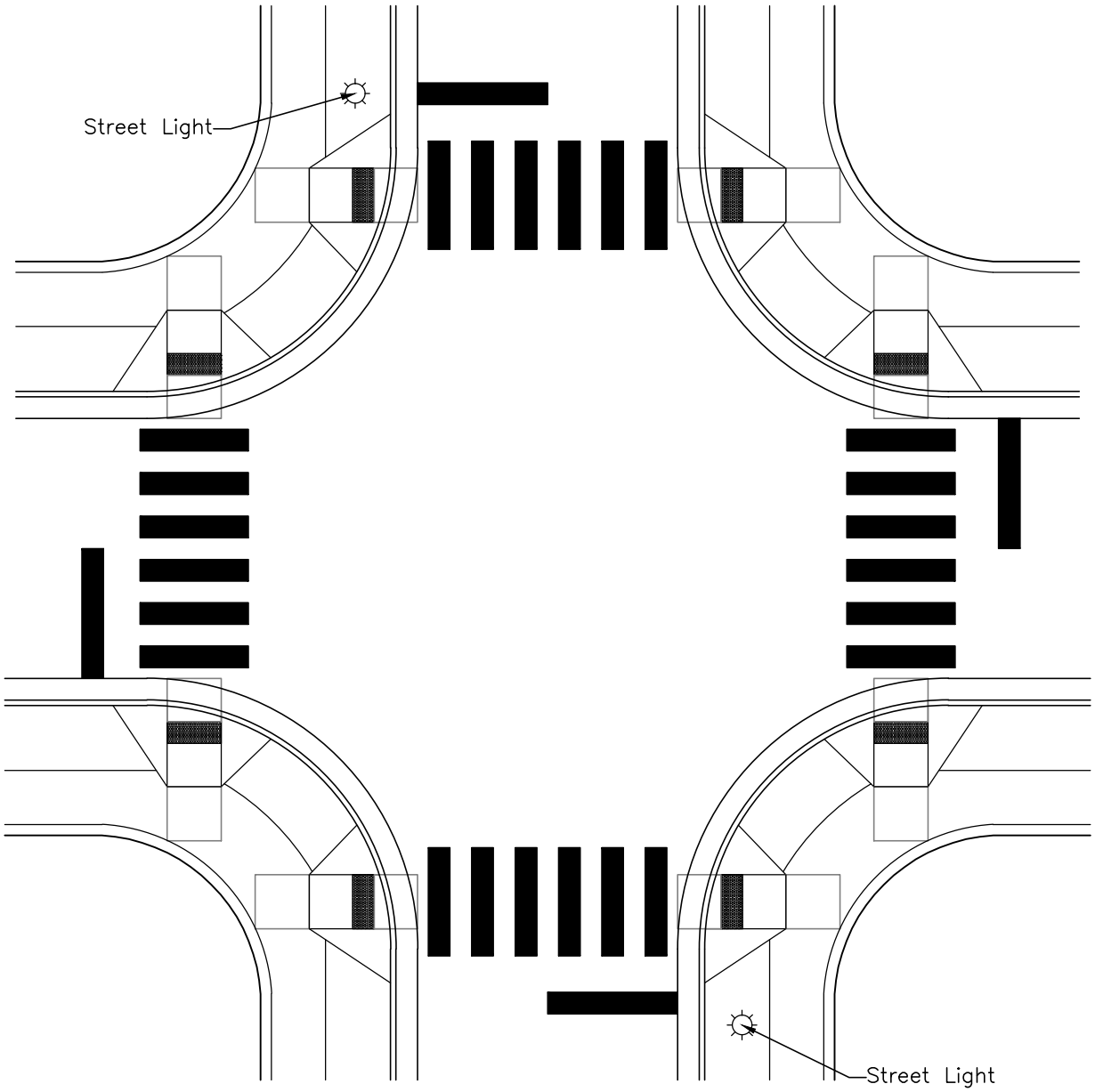
(e) All bridge underpasses, where vehicles, pedestrians, bicyclists, or equestrians may be present, shall require lighting.

(f) Where sidewalks are attached to the curb, street lights shall be installed behind the sidewalk (in right-of-way or easement) with at least 1-foot clearance on Local streets (2 feet clearance on Major Collectors and Arterials). Poles within the clear zone shall be breakaway designs.

(g) For sidewalks detached from the curb, street lights shall preferably be located between the curb and sidewalk and installed a minimum of 2 feet from the back of curb, and 2 feet clear from all walks (1 foot on Local Streets). Poles within the clear zone shall be breakaway designs.

(h) Non-Curbed Streets - On streets without curb and gutter, street lights shall be place no closer than ten (10) feet to the edge of the traveled way. Poles within the clear zone shall be breakaway designs.

(i) Street Lighting in Medians - Street trees shall not be placed within 30 feet of a street light. Understory trees shall be no closer than 15 feet to any street light. Poles within the clear zone shall be breakaway designs.



N.T.S

FIGURE 9.4 (1)
NON–SIGNALIZED INTERSECTION PRESCRIPTIVE LIGHTING

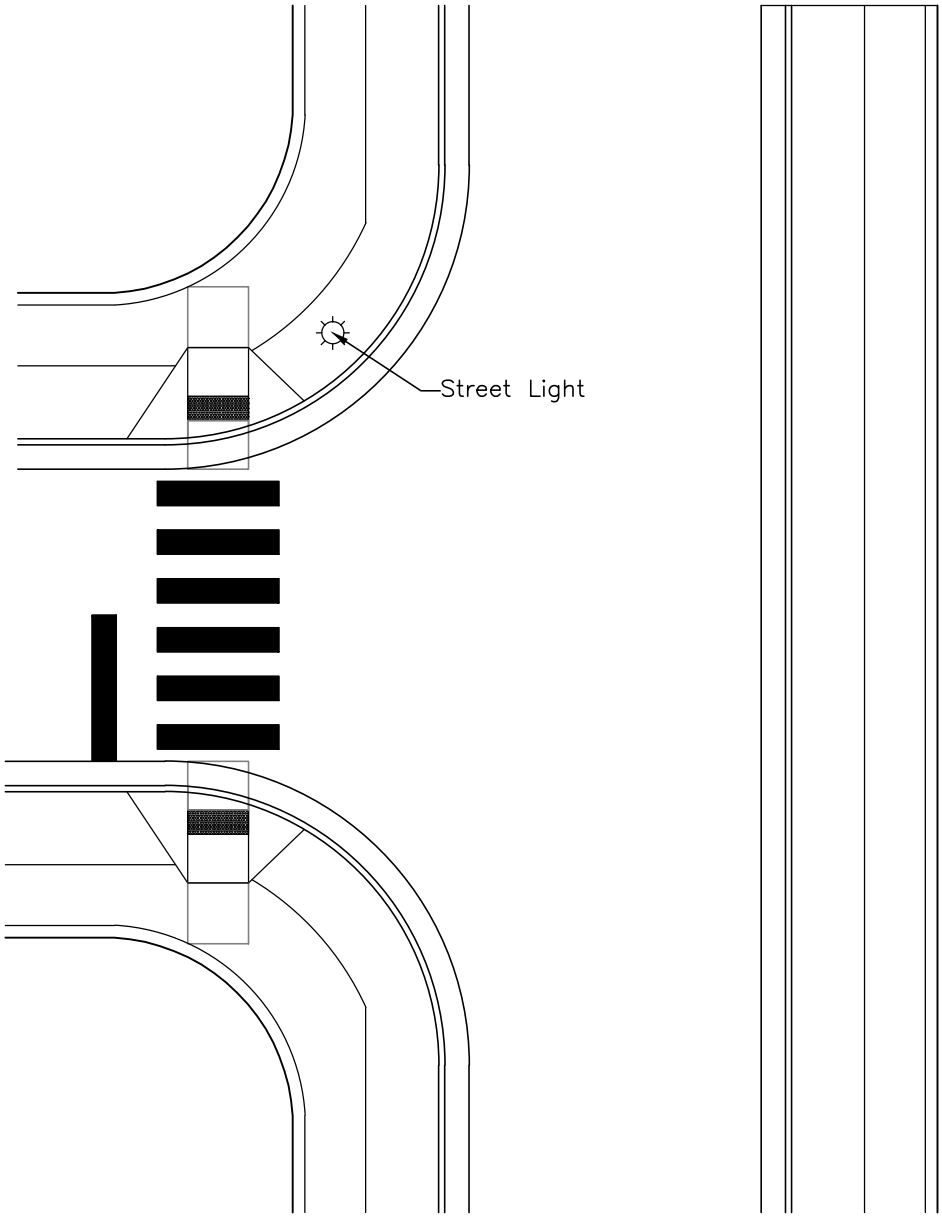


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FIGURE 9.4 (2)
TEMPORARY CUL–DE–SAC

9.4.2 Local, Private, and Minor Collector Streets

In addition to the General Design Standards, all street lighting on local, private, and Minor Collector streets shall be LED and installed per MTEMC standard drawings. MTEMC shall be responsible for operation and maintenance of all street lighting on local and private streets.

Energy cost associated with lighting on public streets shall be the responsibility of the City of Franklin, TN.

Energy cost associated with lighting on private streets shall be the reasonability of an association of the development.

(1) Prescriptive Lighting Standards

All local, private, and Minor Collector streets shall have prescriptive lighting based on the following standards:

(a) Max Spacing of light poles shall not exceed 300' with a clear line of sight within the ROW from one pole to the next (excluding landscaping). (See **Figure 9.3**)

(b) Street lighting shall be placed in every cul-de-sac and dead end streets (Temporary or permanent). (See **Figure 9.2** and **Figure 9.3**)

(c) Street lights shall be placed thirty (30) inches from curb face to center, in line with trees in the furnished zone between the sidewalk and the curb.

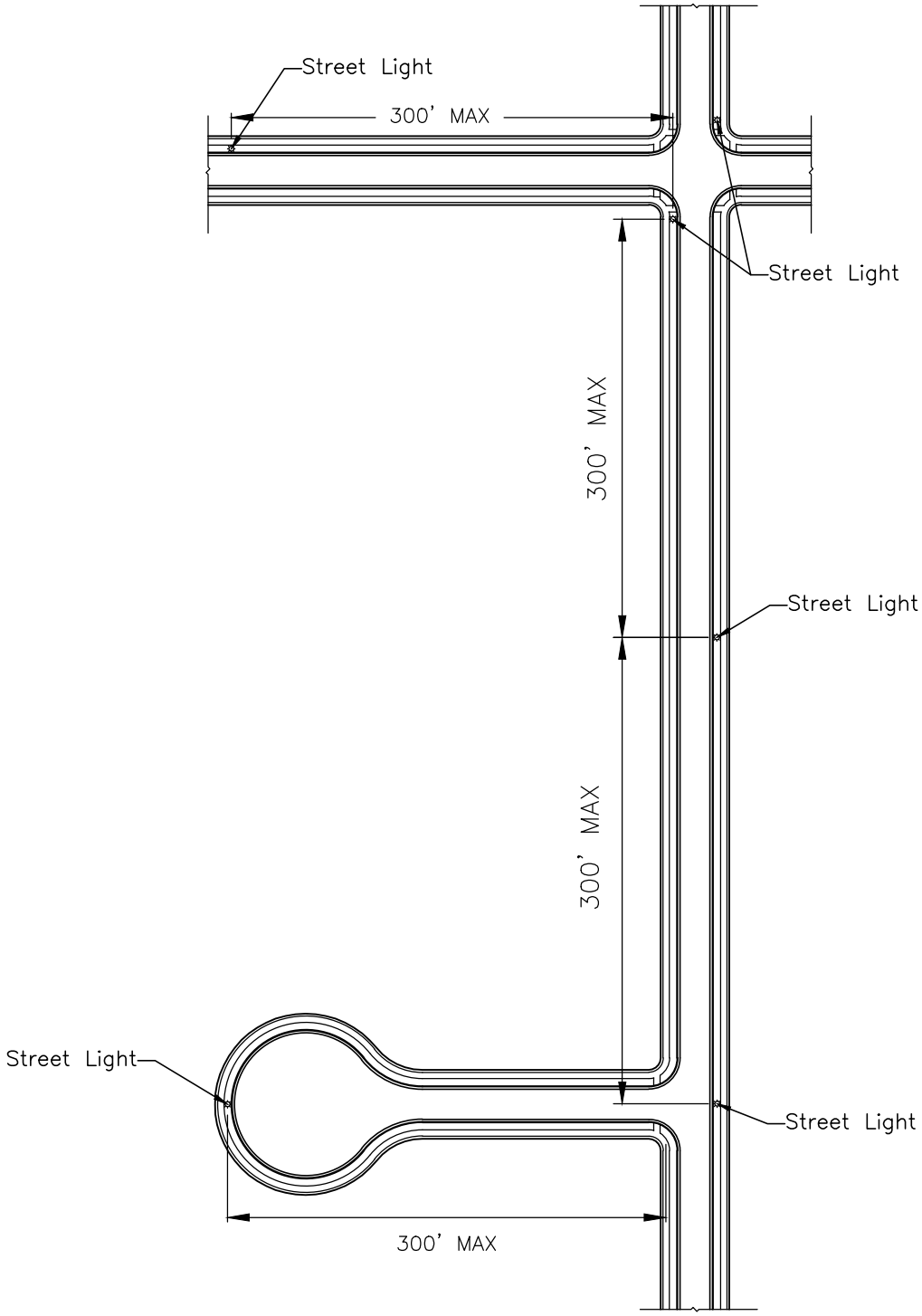
(d) Poles shall be placed a minimum of ten (10) feet from driveway aprons;

(e) Street light poles and foundations shall not be located over any other utilities. When locating proposed lighting, the designer should avoid possible conflicts with above-ground and below-ground utilities.

(f) Street light poles shall be located along lot lines whenever possible.

(g) Streetlight mounting height shall be limited to 16 feet AFG.

Upon the request of any owner of property to which this subsection applies, the City Engineer may approve an alternative prescriptive lighting plans. In making this determination, the City Engineer may consider specific design constraints such as large lot subdivisions.



N.T.S

FIGURE 9.4 (3)
LOCAL AND PRIVATE STREET PRESCRIPTIVE LIGHTING

9.4.3 Major Collector and Arterial Streets

In addition to the General Design Standards, street lighting on Major Collector and Major and and Minor Arterial streets shall meet the standards set forth in the *Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting (ANSI/IES RP-8), latest edition issued by the American National Standards Institute, ANSI, and the Illuminating Engineering Society, IES, and related documents therein.* The RP-8 is considered a live document, and any supplemental revisions are to be adhered to unless otherwise directed by the City Engineer.

Roundabouts shall conform to the standards set forth in Design Guide Roundabout Lighting (ANSI/IESNA DG-19-08) or latest version thereof.

Trespass light shall be limited to values defined by LEED and shall be based on the lighting zone of the project. Lighting zones shall be as adopted by the IES to describe the ambient lighting conditions/sensitivity of the area.

The street classification and lighting zones used on a project shall be approved by the City Engineer.

(1) Light Temperature

Street lighting shall be of a color temperature approved by MTEMC.

(2) Minimum Wiring Design

Street lighting within the City of Franklin shall be designed as follows:

(a) All wiring methods and equipment construction shall conform to the latest edition of the National Electrical Code adopted by the City of Franklin. Basic wiring shall conform to the Streetlight Installation Detail (see standard drawings).

(b) All splices to be approved solderless waterproof connectors of proper size.

(c) All empty conduits shall have a ¼" nylon pull rope provided insides.

(d) All conduits shall be sealed with an approved duct seal. Conduits stubbed for future extensions shall be capped.

(e) All pull box covers shall be secured with brass hold down bolts and inscribed "**COF STREET LIGHTING**".

(f) All street lights equipped with a photocell control shall have the photocell oriented to the north.

(g) All wire shall be THHN A.W.G. with the minimum size to be No. 8 in runs between poles. Wire runs from junction box to fixture shall be minimum No. 10.

(3) Pull Box and Conduit Design

(a) All conduit to be used shall be a minimum of 2" diameter, except from each street light to the adjacent pull box which may be 1" diameter PVC or metal, and shall have the following cover from top of conduit.

i. Within sidewalk of parkway areas: 3'-0" min. Schedule 40 PVC.
ii. Within roadway areas: 3'-0" min. Schedule 80 PVC.

(b) All metal conduit and other metal parts shall be continuously bonded and grounded.

(c) All bends and/or offset shall be made with factory sections and there shall be no more than three factory bends per conduit run.

(d) Unless otherwise approved by the City of Franklin Street Department, Standard TDOT or COF pull boxes shall be used for all street lighting. See TDOT and COF standard drawings.

(e) Junction boxes shall be located at the base of every pole and not more than 200'-0" apart on long runs.

(f) Pull boxes shall be located a minimum of 18" from the face of the curb to the center of the pull box.

(g) When pull boxes are subject to vehicular traffic, they shall be set on concrete footings and cast iron traffic covers (minimum H-20 rating) shall be installed. A concrete ring shall be provided around the pull box per manufacturer's instructions for application in paved area.

(h) Provide a minimum 18" vertical and horizontal clearance from all other utilities. When clearance cannot be provided concrete encasement shall be required.

(i) Conduit shall be run parallel and perpendicular to the roadway.

(4) Metering Requirements

(a) All City owned and maintained street lights shall be metered. A metering plan will be submitted as part of the lighting plan, and will show, at minimum, all meter locations, wiring extents, and installed meter type(s).

(b) In order to reduce long-term maintenance costs, the City requires the following:

i. The City seeks to connect as many street lights as possible to each power meter to minimize the total number of meters.
ii. The City will not accept ownership and maintenance of street lights that are on the same meter as other non-street lighting electrical uses.

(c) The only service pedestal accepted for use in the City of Franklin is the type "SL" Millbank Service Pedestal.

(5) Other Requirements

(a) The developer/project engineer shall make arrangements for service points with the City of Franklin. Service Points shall be designed to minimize the number of power meters and this shall be verified by City of Franklin through review of the lighting plan.

(b) New developments within an existing developed area shall provide the entire lighting system, including luminaires.

(c) All street light systems shall be designed for 240-volt service unless approved by the City Engineer due to circumstances/availability.

(d) Pole Identification Numbers for metal poles shall be a minimum of 2.5" x 4.5" and located at base of pole with COF approved identification, reflective white on black with adhesive backs.

(e) The City seeks to minimize light pollution and avoid distributing light into the windows of residents. All fixtures shall include cutoff shields or other mechanisms so that light levels outside of the right-of-way does not exceed levels stipulated by LEED for the lighting zone of the project.

(f) Any existing lighting system to be transferred to ownership of the City of Franklin shall be compatible with LED retrofit fixtures. LED fixtures and bulbs shall be specified by the Street Department Director or their designee.

(g) Any street light installed shall be selected from the City of Franklin approved list.

(h) All Wiring shall be underground without prior approval from the City Engineer.

9.4.4 Submission Requirements (MTEMC Owned Street Lights)
The following documentation shall be submitted for City of Franklin review and approval prior to approval of site plan or infrastructure plan.

(1) Lighting Plan

(a) Location, type, and height of all lighting

(b) Clearly identified/labeled property lines, streets and sidewalks.

9.4.5 Submission Requirements (City Owned Street Lights)
The following documentation shall be submitted for City of Franklin review and approval prior to approval of site plan or infrastructure plan.

(1) Lighting Plan

(a) Location, type, and height of all lighting

(b) Location, type, and wiring specifications of all power meters

(c) Details on color, materials, lumen output, light output color (temperature), and wattage for all lighting fixtures

(d) Grid spacing of calculation points on roadways shall be two transverse points per lane at each longitudinal point along one luminaire cycle. Maximum 16.4 feet between longitudinal points.

(e) Maximum illumination at property lines (for non-residential and multi-family projects only). This is on and off roadways.

(f) Clearly identified/labeled property lines

The following charts shall be provided on the drawings of all lighting designs (example data for tables shown):

Street and Site Lighting Data

Street and Site Lighting Data	
Development Standard:	
Land Use:	

Zoning District:	
Height of Proposed/Existing Building:	
Pole Height:	
Pole/Fixture Color:	
Color of Light (in Kelvin):	
Luminaire Wattage:	
Luminaire Volt-Amps:	
Luminaire Lumens:	
Luminaire Light Loss Factor (LLF):	
The Lighting Plan has been designed to meet the City of Franklin Standards, and the approval of the Planning Commission/City of Franklin. Changes shall not be made to the approved Lighting Plan unless approved by either the relevant department Director or the Planning Commission. *Additional lines or tables may be added if multiple lighting styles are to be used in a development or as needed.	

Load Center Load Requirements

LIGHTING LOAD CENTER "3" LOAD REQUIREMENTS					
CIRCUIT NUMBER	LINE WATTS	AMP LOAD	VOLT DROP (%)	CIRCUIT BRKR. SIZE	LIGHTING CONTACTOR SIZE
3-1	3900	16.25	1.86	30A / 2P	30A / 2P
3-2	2703	18.75	1.94	30A / 2P	30A / 2P
3-3	2400	12.5	1.7	30A / 2P	30A / 2P
3-4	2400	12.5	1.77	30A / 2P	30A / 2P
				SPACE	SPACE
				SPACE	SPACE
TOTAL:	11403W	60.0A		MAIN: 100A	

Lighting Design Input Data

LUMINAIRE FIXTURE	MOUNTING HEIGHT	IES DISTRIBUTION CLASSIFICATION	AIM/TILT ANGLE	LIGHT LOSS FACTOR	LUMENS USED (PER FIXTURE)	POLE HEIGHT	COLOR TEMPERATURE	PHOTOMETRIC CURVE NUMBERS
Holophane Teardrop, LED	30'	III	N/A	0.91	10898	30'	4000 K	ESL_150_4K_AS_X_4
Holophane Teardrop, LED, Double Head	30'	III	N/A	0.91	10898	30'	4000 K	ESL_150_4K_AS_X_4

Calculation Summary

Calculation Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Intersection (Main & 1st)	Illuminance	Fc	2.82	N/A	N/A	2.01	N/A
Intersection (Main & 2nd)	Illuminance	Fc	2.9	N/A	N/A	1.38	N/A
Intersection (Main & 3rd)	Illuminance	Fc	3.01	N/A	N/A	1.25	N/A
Main St – East_2_Luminance	Luminance	Cd/Sq.m	1.51	1.9	1.1	1.37	1.73
Main St – East_2_Veil_Lum	Veiling Luminance	Cd/Sq.m	0.21	0.3	0.1	2.1	3
Main St – East_Luminance	Luminance	Cd/Sq.m	1.54	2.1	1.2	1.28	1.75

Main St – East_Veil_Lum	Veiling Luminance	Cd/Sq.m	0.19	0.4	0.1	1.9	4
Main St – West_2_Luminance	Luminance	Cd/Sq.m	1.46	1.9	1.2	1.22	1.58
Main St – West_2_Veil_Lum	Veiling Luminance	Cd/Sq.m	0.16	0.3	0.1	1.6	3
Main St – West_Luminance	Luminance	Cd/Sq.m	1.62	2.4	1.3	1.25	1.85
Main St – West_Veil_Lum	Veiling Luminance	Cd/Sq.m	0.21	0.3	0.1	2.1	3

(2) Lighting Calculations

Calculations shall be submitted as part of a development plan, site plan or infrastructure construction plan submission. The lighting calculations shall include:

(a) Horizontal illuminance (foot-candles) on pavement/sidewalk

(b) Vertical illuminance (foot-candles) along sidewalks and at pedestrian conflicts

(c) Veiling glare (Lvmax/Lmin)

(d) Lighting layout with fixture isoline contours of illuminance on street level:

i. 3 FC – Light Purple
ii. 2 FC – Red
iii. 1 FC – Light Blue
iv. 0.5 FC – Green
v. 0.25 FC – Dark Blue
vi. 0.1 FC – Black

(e) Voltage drop for each branch circuit

(f) Lighting Design Input Data

i. Fixture type
ii. Fixture mounting height
iii. Lumens/fixture used
iv. Distribution type
v. Aim/tilt
vi. Color temperature
vii. Light Loss Factor (LLF)

(g) Include drawings that show the calculation grids (with results) with fixture lighting iso-contours (templates) and drawings that have lighting rendered with iso-contour lines.

(h) Calculations shall be performed in the latest version of AGI-32. Calculations shall be submitted on drawings that match construction drawings (and include overall). Include a copy of the lighting calculation software input/calculation file of approval submittals and as installed calculations.

9.4.6 Light Levels

Lighting shall be designed to the recommendations of the Illuminating Engineering Society of North America for levels, uniformity, and veiling luminance. The illuminance/luminance shall take into account the roadway surface classifications (R-class). For most cases, the R2 and R3 classes will be acceptable.

The following tables are from IES RP-8-14 and IES DG-19-08. Any changes to IES documents supersedes these values.

Table 9.4.1 – Lighting Design Criteria for Streets

STREET CLASSIFICATION	PEDESTRIAN AREA CLASSIFICATION	AVG. LUMINANCE L_{avg} (cd/m²)	AVG. UNIFORMITY RATIO L_{avg}/L_{min}	MAX. UNIFORMITY RATIO L_{max}/L_{min}	MAX. VEILING LUMINANCE RATIO LV_{max}/L_{avg}
MAJOR / ARTERIAL	HIGH	1.2	3.0	5.0	0.3
	MEDIUM	0.9	3.0	5.0	0.3
	LOW	0.6	3.5	6.0	0.3
COLLECTOR	HIGH	0.8	3.0	5.0	0.4
	MEDIUM	0.6	3.5	6.0	0.4
	LOW	0.4	4.0	8.0	0.4

L_{avg} – minimum maintained average pavement luminance
L_{min} – minimum pavement luminance
LV_{max} – maximum veiling luminance

Table 9.4.2 – Illumination for Intersections

Illumination for Intersections				
Functional Classification	Average Maintained Illumination at Pavement by Pedestrian Area Classification in Lux/fc			E_{avg}/E_{min}
	High	Medium	Low	
Major/Major	34.0/3.4	26.0/2.6	18.0/1.8	3.0
Major/Collector	29.0/2.9	22.0/2.2	15.0/1.5	3.0
Major/Local	26.0/2.6	20.0/2.0	13.0/1.3	3.0
Collector/Collector	24.0/2.4	18.0/1.8	12.0/1.2	4.0
Collector/Local	21.0/2.1	16.0/1.6	10.0/1.0	4.0

Note: The High, Medium, and Low Pedestrian Areas are described in Section 5.1.1 of IES RP-8-14.

Table 9.4.3 – Recommended Illuminance for Roundabouts

Illumination for Roundabouts				
Functional Classification	Maintained Average Horizontal Illuminance in Lux/FC on the Pavement based on Pedestrian Area Classification			E_{avg}/E_{min}
	High	Medium	Low	
Major/Major	34.0/3.4	26.0/2.6	18.0/1.8	3:1
Major/Collector	29.0/2.9	22.0/2.2	15.0/1.5	3:1
Major/Local	26.0/2.6	20.0/2.0	13.0/1.3	3:1
Collector/Collector	24.0/2.4	18.0/1.8	12.0/1.2	4:1
Collector/Local	21.0/2.1	16.0/1.6	10.0/1.0	4:1
Local/Local	18.0/1.8	14.0/1.4	8.0/0.8	6:1

Table 9.4.4 – Recommended Values for High Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways

	E_{avg} (lux/fc)	EV_{min} (lux/fc)	E_{avg}/E_{min}*
Mixed Vehicle and Pedestrian	20.0/2.0	10.0/1.0	4.0
Pedestrian Only	10.0/1.0	5.0/0.5	4.0

E_{avg} – minimum maintained average horizontal illuminance at pavement
E_{min} – minimum horizontal illuminance at pavement
EV_{min} – minimum vertical illuminance at 1.5m above pavement
*Horizontal only

Table 9.4.5 – Recommended Values for Medium Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways			
	E_{avg} (lux/fc)	EV_{min} (lux/fc)	E_{avg}/E_{min}*
Pedestrian Areas	5.0/0.5	2.0/0.2	4.0

E_{avg} – minimum maintained average horizontal illuminance at pavement
E_{min} – minimum horizontal illuminance at pavement
EV_{min} – minimum vertical illuminance at 1.5m above pavement
*Horizontal only

Table 9.4.6 – Recommended Values for Low Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways			
	E_{avg} (lux/fc)	EV_{min} (lux/fc)	E_{avg}/E_{min}*
Rural/Semi-Rural Areas	2.0/0.2	0.6/0.06	10.0
Low Density Residential (2 or fewer dwelling units per acre)	3.0/0.3	0.8/0.08	6.0
Medium Density Residential (2.1 to 6.0 dwelling units per acre)	4.0/0.4	1.0/0.1	4.0

E_{avg} – minimum maintained average horizontal illuminance at pavement
E_{min} – minimum horizontal illuminance at pavement
EV_{min} – minimum vertical illuminance at 1.5m above pavement
*Horizontal only

Table 9.4.7 – Recommended Values for the Pedestrian Portion of Pedestrian/Vehicle Underpasses

Maintained Illuminance Values for Walkways			
	E_{avg} (lux/fc)	EV_{min} (lux/fc)	E_{avg}/E_{min}*
Day	100.0/10.0	50.0/5.0	3.0
Night	40.0/4.0	20.0/2.0	3.0

E_{avg} – minimum maintained average horizontal illuminance at pavement
E_{min} – minimum horizontal illuminance at pavement
EV_{min} – minimum vertical illuminance at 1.5m above pavement
*Horizontal only
References 1, 2, 3, and 4 in Annex D of IED RP-8-14 give more background information on the design criteria.

9.5 Record Drawings

Project applicant or designee shall provide record drawings that depict construction to the City prior to the request for City to acceptance.

(1) MTEMC Owned Street Lights – All Fixture locations.

(2) COF Owned Street Lights – Street Light record drawings shall provide the following: Service connection points, service panel parameters, conduit locations (including distance from face of curb and depth), and all fixture locations.

9.6 City of Franklin Approved Street Light Options

(1) Local and Private Streets – See MTEMC LED Street lights for all local and private roads

(2) Downtown Historic Franklin – See Approved COF Streetscape Lighting fixtures. Lighting fixtures to be approved by the Department Review Team.

(3) Arterial and Collector Streets – See Approved COF lighting fixtures.

TRAFFIC SIGNS AND MARKINGS

Section	Section Title	Article	Article Title	Pg
10.1	Signing	10.1.1	Type and Location of Signs	10-2
		10.1.2	Design, Installation, and Maintenance	10-2
		10.1.3	Sight Visibility Standards for Traffic Control Signs	10-2
		10.1.4	New Street Signing	10-2
		10.1.5	Other Standards	10-2
		10.1.6	Sign Posts, Supports, and Mountings	10-2
		10.1.7	Sign Reflectivity	10-3
		10.1.8	Sign Blanks	10-3
10.2	Pavement Marking and Striping	10.2.1	Type and Location of Striping and Markings	10-3
		10.2.2	Design, Installation, and Maintenance	10-3
		10.2.3	Crosswalks	10-4

10.1 Signing

10.1.1 Type and Location of Signs

The City Engineer shall make the final determination regarding the type and location of signing controls within the right-of-way. These controls shall include traffic control signs (regulatory and warning), street name signs, delineators, and permanent barricades.

10.1.2 Design, Installation, and Maintenance

Permanent traffic control devices on public rights-of-way and private streets shall be fabricated and installed in accordance with this chapter, the latest revision of the *"MUTCD"* and *"TDOT Standard Specifications"*.

Bicycle facilities shall be designated with signing. AASHTO's *"Guide for the Development of Bicycle Facilities"* and the *"MUTCD"* shall be consulted in order to determine appropriate signing for new bicycle facilities. Signs should be used in moderation in order to avoid distracting street users. When signs are used, they shall be highly visible and easily understood by all street users. Signs that are directed at bicyclists are smaller versions of standard street signs. This is because bicyclists typically travel at slower speeds than motorists and are typically closer to the signs than motorists are. Standard street signs that are directed at motorists also apply to bicyclists.

10.1.3 Sight Visibility Standards for Traffic Control Signs

These standards are to provide for tree placement and configuration of City streets such that adequate sight distance is provided for traffic control signs. Typical sign types would be mid-block warnings, speed limit signs and stop signs. The recommended standards recognize that different criteria are needed for different travel speeds.

(1) On streets designated at speed limit 20 MPH or 25 MPH, the first tree in front of the sign is to be placed a minimum of forty-five (45) feet before the sign.

(2) On streets designated at speed limit 30 MPH, the first tree in front of the sign is to be placed a minimum of sixty (60) feet before the sign.

(3) For trees exceeding ten (10) feet of canopy vertical clearance from the ground, the first tree in front of the sign is to be placed a minimum of twenty-five (25) feet before the sign.

(4) Where signs are placed at the front end of curb extensions or bulb-outs, the above tree placements do not apply.

10.1.4 New Street Signing

Permanent signing, unless otherwise approved by the City Engineer, shall be completely in place before any new street is opened to the public.

10.1.5 Other Standards

These Standards are to be used in conjunction with other applicable City Regulations. The City Engineer may allow the installation of decorative posts and sign frames. In these cases, the developer, homeowners' association or other responsible entity shall be responsible for the maintenance of these special installations. Decorative traffic supports, whether city-provided or developer-provided shall be black or dark green in color.

10.1.6 Sign Posts, Supports, and Mountings

Sign posts, supports and mountings shall comply with *"TDOT Standard Specifications"*. In general, a 2-inch 12 gage square galvanized steel post section with perforated knockout tubes shall be the Cities

standard for ground mounted signs. All other signs shall be per "*TDOT Standard Specifications"* and reviewed on an individual basis. Posts must be of appropriate length to comply with the "*MUTCD"* and "*TDOT Standard Specifications"*.

10.1.7 Sign Reflectivity
All traffic control signs must be fabricated with reflective materials. All reflective materials must qualify as High Intensity Grade for all signs except those signs for schools, pedestrians and overhead street name blades. For these signs, Diamond Grade sheeting shall be used. All signs or traffic control devices must have a minimum 7-year materials warranty.

10.1.8 Sign Blanks
Aluminum blanks of 0.080 gauges are standard, except for signs larger than 30 x 30 inches, which shall be 0.125-gauge aluminum.

10.2 Pavement Marking and Striping

10.2.1 Type and Location of Striping and Markings
The City Engineer shall make the final determination in regards to the type and location of pavement striping and marking within the right-of-way during the review of the project signing and striping plans. All pavement marking on public and private roadways shall be specified and installed in accordance with these Standards; all designs shall be in accordance with these Standards, the "*MUTCD"* and "*TDOT Standard Specifications".*

Bicycle facilities shall be designated with pavement markings. AASHTO's "*Guide for the Development of Bicycle Facilities"* and the "*MUTCD"* shall be consulted in order to determine appropriate pavement markings for new bicycle facilities. A bike lane shall be separated from motor vehicle travel lanes by a solid white line that is six (6) inches wide. The width of this line can be increased to eight (8) inches for added distinction. If on-street parking is present, a four (4) inch wide solid white line shall be used to separate the bike lane from the parking lane.

10.2.2 Design, Installation, and Maintenance
Permanent striping and marking, unless otherwise approved by the City Engineer, shall be completely in place before any new street is opened to the public. For streets opened to traffic prior to final surfacing and striping, the use of reflectorized paint installed to permanent standards at the end of each day's work shall be allowed. In addition, pavement markings shall be updated as needed to comply with "*TDOT Standard Specifications"* and "*MUTCD"* standards.

New striping on new streets, overlays, and chip seals, etc. will require Extruded or Ribbon-Dispensed Thermoplastic Pavement Markings. Spray Thermoplastic Markings will be evaluated on a case by case basis by the City Engineer. As an alternate, the Contractor may apply preformed thermoplastic markings material for stop bars, cross walks, legends, or directional arrows. Snowplowable raised pavement markers shall be provided on state routes within the City. All pavement markings shall be installed per "*TDOT Standard Specifications"*.

Permanent striping and marking on the roadway centerline shall be installed on each segment of roadway construction on the same day the final lift of asphalt concrete pavement is placed on that roadway segment. New traffic striping of lane lines, crosswalks, and stop bars (skip white and solid white) shall be installed on each segment of roadway construction within one Calendar Day of the final lift of asphalt concrete pavement placed on that roadway segment.

10.2.3 Crosswalks

Crosswalks shall be used at all signalized intersections, approved crossings, school routes, adjacent to schools, and as otherwise directed. Mid-block crosswalks shall be approved on a case-by-case basis subject to and engineering study as approved by the City Engineer. Standard Crosswalk Configuration shall consist of a 10-foot minimum width and 24-inch wide "Continental" style bars and shall be used for all crosswalks unless otherwise approved by the City Engineer. Where concrete pavement is present, the specific manufacturer's primer must be applied as per manufacturer's specifications.

GLOSSARY

AASHTO: American Association of State Highway and Transportation Officials.

ACCESSIBLE PEDESTRIAN SIGNAL (APS): A device that communicates information about pedestrian timing in non-visual format such as audible tones, verbal messages, and/or vibrating surfaces. (MUTCD)

ACCESS EASEMENT: A publicly owned area of land granted by adjacent landowners or reserved as part of a development plan and being part of the City right-of-way for the purpose of accessing public improvements for maintenance.

ACTUATED OPERATION: A type of traffic control signal operation in which some or all signal phases are operated on the basis of actuation. (MUTCD)

ACTUATION INDICATOR: Either a light, a tone, a voice message, or both audible and visual indicators that indicate to pedestrians that the button press has been accepted.

ACTUATION: Initiation of a change in or extension of a traffic signal phase through the operation of any type of detector. (MUTCD)

ALERT TONE AT ONSET OF WALK INTERVAL: A very brief burst of high frequency sound, rapidly decaying to a 500 Hz WALK tone, to alert pedestrians to the exact onset of the walk interval.

APPROACH: The portion of an intersection leg which is used by traffic approaching the intersection

APS: See Accessible pedestrian signal.

ARMY CORPS OF ENGINEERS: Provides engineering services as a government agency as it relates to civil engineering projects.

AUDIBLE BEACON: Use of a sound source to provide directional orientation and alignment information.

AUTOMATIC VOLUME ADJUSTMENT: An APS volume control that is automatically responsive to ambient (background) sound; automatic gain control.

AUXILIARY LANE: The portion of a street adjoining the traveled way for parking, speed change, turning, weaving, truck climbing and other purposes supplementary to through traffic movement.

AVERAGE DAILY TRAFFIC (ADT): The total bi-directional volume of traffic passing through a given point during a given time period (in whole days), divided by the number of days in that time period.

BICYCLE PLAN: Plan initiated by the City to promote multi-modal transportation and to provide safe and accessible facilities for bicycles and pedestrians. Standards address design features of bicycle facilities.

BOMA: Board of Mayor and Alderman

BRAILLE STREET NAME: Provision of the name of the associated street in Braille above the APS pushbutton.

BUTTON ACTUATED TIMER (BAT): See Extended button press.

CAPACITY: The maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform segment of a lane or roadway during a given time period under prevailing traffic, roadway and control conditions.

CITY STANDARDS & SPECIFICATIONS: Those standards prescribed for the construction of streets, sidewalks, driveway access points, curb and gutter set out in this manual and the City Code.

CITY: The City of Franklin, TN

CITY ENGINEER: A licensed professional engineer employed by the City or his duly authorized representative serving to direct and oversee engineering design, coordination and implementation of private and City capital improvements as well as public safety and welfare. All places within these Standards that reference the City Engineer shall refer to the City of Franklin, Tennessee City Engineer or their designated representative.

CLEARANCE INTERVAL INDICATOR: Tones sounding during the pedestrian clearance interval that are differentiated from the walk interval indicator (tones).

BUILDING AND NEIGHBORHOOD SERVICES DIRECTOR: City official responsible for directing the enforcement and interpretations of the provisions of national and local building codes.

COMMERCIAL DRIVEWAY ACCESS: Any driveway access point that does not meet the definition of residential driveway access.

CONNECTIVE STREET: A street within a development, other than a cul-de-sac street or loop street, which will allow vehicular and pedestrian circulation to adjoining developments; thereby providing for community-wide circulation.

CONTROLLER UNIT: That part of a controller assembly that is devoted to the selection and timing of the display of signal indications. (MUTCD)

CORNER CLEARANCE: At an intersecting street, the distance measured from the edge of pavement curb line or the intersection of right-of-way lines to the beginning of outside driveway radius.

CROSSWALK.: (a) that part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or

in the absence of curbs, from the edges of the traversable roadway, and in the absence of a sidewalk on one side of the roadway, the part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the centerline; (b) any portion of a roadway at an intersection or elsewhere distinctly indicated for pedestrian crossing by lines or other markings on the surface. (MUTCD)

CYCLE LENGTH: The time required for one complete sequence of signal indications. (MUTCD)

DEAD-END STREET: A local access system street opened at one end only with special provisions for a vehicle to turn around.

DESIGN SPEED: Usually up to five miles per hour above the expected operating speed of the facility under design.

DETECTABLE WARNING: A standardized surface feature built in or applied to walking surfaces or other elements to warn visually impaired people of hazards on a circulation path.

DETECTOR: A sensing device used for determining the presence or passage of vehicles or pedestrians. (MUTCD)

DEVELOPER: A site planner or subdivider.

DEVELOPMENT OR DEVELOPMENT PLAN: Any site plan or subdivision.

DRIVEWAY ACCESS POINT: A point of ingress and egress, or both, which is considered a private driveway. It can be either a residential access point or a commercial driveway access point.

DRIVEWAY WIDTH: The narrowest width of driveway measured parallel with the edge of street.

EXTENDED BUTTON PRESS: On APS, holding the ped button down between 1-3 sec. may activate special features, including audible beaconing and extended pedestrian clearance interval.

FHWA: Federal Highway Administration

FIXED TIME OPERATION: See Pretimed operation.

FLASHING (FLASHING MODE): A mode of operation in which a traffic signal indication is turned on and off repetitively. (MUTCD)

FLOW LINE: The transition point between the gutter and the face of the curb. For a valley curb it is the center of the pan. Where no curb exists, the flow line will be considered the edge of the traveled way.

FULL-ACTUATED OPERATION: A type of traffic control signal operation in which all signal phases function on the basis of actuation. (MUTCD)

GRADING PERMIT: Permit issued by the City of Franklin Engineering Department that allows the contractor to begin grading work.

HBP: Hot bituminous pavement

INTERSECTION: (a) the area embraced within the prolongation or connection of the lateral curb lines, or if none, the lateral boundary lines of the roadways of two highways that join one another at, or approximately at, right angles, or the area within which vehicles traveling on different highways that join at any other angle may come into conflict; (b) the junction of an alley or driveway with a roadway or highway shall not constitute an intersection. (MUTCD)

INTERVAL SEQUENCE: The order of appearance of signal indications during successive intervals of a signal cycle. (MUTCD)

INTERVAL: The part of a signal cycle during which signal indications do not change. (MUTCD)

ITE: Institute of Traffic Engineers

LEVEL OF SERVICE: A measurement of the quality of service on transportation infrastructure. This is generally links to transportation trip time as it relates to speed.

LOCATOR SIGNAL: See Pushbutton locator tone.

LONG BUTTON PRESS: SEE EXTENDED BUTTON PRESS.

LONG CANE: A cane individually prescribed to provide safety and orientation information to persons who are blind or visually impaired; typically much longer than a support cane and not intended for support; typically has a white, reflective surface.

LOOP STREET: A street which is designed to discourage through traffic from other areas and both ends of the loop street connect with the same intersecting street.

MAJOR STREET: The street normally carrying the higher volume of vehicular traffic. (MUTCD)

MAJOR THOROUGHFARE PLAN: Plan in initiated by the City of Franklin Planning Department to address some design features as they relate to thoroughfares.

MEDIAN: That portion of a divided roadway separating the traveled ways for traffic in opposite directions.

MEWS: A special type of alley that serves as the only vehicular and emergency access for lots abutting the mews.

MINOR STREET: the street normally carrying the lower volume of vehicular traffic. (MUTCD)

NCHRP: National Cooperative Highway Research Program

PASSIVE PEDESTRIAN DETECTION: A feature that uses sensors (piezo-electric, infrared, microwave, or video camera serving remote sensor software) to trigger, cancel, or lengthen pedestrian timing, or to trigger the pushbutton locator tone when the pedestrian enters the detection zone.

PAVEMENT MARKINGS: All lines, words or symbols, except signs officially placed within the roadway or parking area to regulate, warn or guide traffic.

PCC: Portland cement concrete

PEAK-HOUR VOLUME: Hourly traffic volume used for roadway design and capacity analysis, usually occurring during one or more peak travel hours during a 24 hour period.

PEDESTRIAN CHANGE INTERVAL: An interval during which the flashing UPRAISED HAND (symbolizing DONT WALK) signal indication is displayed. When a verbal message is provided at an accessible pedestrian signal, the verbal message is "wait." (MUTCD)

PEDESTRIAN PHASE (OR PED PHASE): The cycle of pedestrian timing consisting of three parts: (1) The walk interval (WALK sign); (2) the pedestrian clearance interval (flashing DON'T WALK); and the pedestrian change interval (steady DON'T WALK).

PEDESTRIAN SIGNAL HEAD: A signal head, which contains the symbols WALKING PERSON (symbolizing WALK) and UPRAISED HAND (symbolizing DON'T WALK), that is installed to direct pedestrian traffic at a traffic control signal. (MUTCD).

PEDESTRIAN: People who travel on foot or who use assistive devices, such as wheelchairs, for mobility.

PERMISSIVE MODE.: A mode of traffic control signal operation in which, when a CIRCULAR GREEN signal indication is displayed, left or right turns may be made after yielding to pedestrians and/or oncoming traffic. (MUTCD)

PLANNING COMMISSION: Appointed board of local citizens responsible for decision making related to growth and development within the City.

PREEMPTION CONTROL: The transfer of normal operation of a traffic control signal to a special control mode of operation. (MUTCD)

PRETIMED OPERATION: Type of traffic control signal operation in which none of the signal phases function on the basis of actuation. (MUTCD)

PRIORITY CONTROL: A means by which the assignment of right-of-way is obtained or modified. (MUTCD)

PROTECTED MODE: A mode of traffic control signal operation in which left or right turns may be made when a left or right GREEN ARROW signal indication is displayed. (MUTCD)

PROWAAC: Public Rights of Way Access Advisory Committee of the U.S. Access Board, that includes advocates, engineers, architects, and public works officials.

PUDE: Public utility and drainage easement

PUSHBUTTON LOCATOR TONE: A repeating sound that informs approaching pedestrians that they are required to push a button to actuate pedestrian timing and that enables pedestrians who have visual disabilities to locate the pushbutton. (MUTCD)

PUSHBUTTON MESSAGE: A speech message that provides additional information when the APS pedestrian pushbutton is pushed.

PUSHBUTTON: A button to activate pedestrian timing. (MUTCD)

REMOTE ACTIVATION: A handheld pushbutton device allowing a pedestrian to send a message over a short distance to call the ped phase.

RESIDENTIAL DRIVEWAY ACCESS: A driveway access point serving a single family dwelling, mobile home, detached townhouse, two attached townhouses, duplex, multi-unit supportive housing residence, supportive housing residence which is required to provide no more than two (2) off-street parking spaces, or a driveway serving a nonresidential use if the daily volume of two-way driveway traffic is expected to be less than fifty (50) vehicles.

RIGHT-OF-WAY CENTER LINE: (1) The right-of-way centerline of a two-way street shall be a point equidistant between the inside edges of the innermost through travel lane in each direction of travel. (2) The right-of-way centerline of a one-way street shall be a point equidistant between the outside edges of the outermost through travel lanes in the direction of travel. (3) Where the alignment of an existing street is to be altered or changed, the right-of-way centerline shall be determined in accordance with the new realignment plan, provided the City and/or TDOT have approved the plan. (4) In special cases where non-symmetrical street widening has occurred or other unique situations not covered by the above exist, the right-of-way centerline shall be defined by the Transportation Director.

RIGHT-OF-WAY, (ROW) : An interest in land to the City which provides for the perpetual right and privilege of the City and it's agents, franchise holders, successors, and assigns to construct, install, improve, repair, maintain, and use a public street, including related and customary uses of street rights-of-way such as sidewalk, bike path, landscaping, traffic control devices and signage, sanitary sewer, stormwater drainage devices, water supply, cable television, electric power, gas, and telephone transmission and related purposes in, upon, over, below, and across the right-of-way. The City is authorized to remove, and keep removed from the rights-of-way all trees, vegetation, and other obstructions as is determined to be necessary by the City to maintain, repair, and protect facilities located in the right-of-way

ROADWAY: See definition of street.

SEMIACTUATED OPERATION: A type of traffic control signal operation in which at least one, but not all, signal phases function on the basis of actuation. (MUTCD)

SIDEWALK: Any public or private pedestrian or bicycle walkway or path.

SIGNAL HEAD. An assembly of one or more signal faces together with the associated signal housings. (MUTCD)

SIGNAL INDICATION: The illumination of a signal lens or equivalent device. (MUTCD)

SIGNAL PHASE: The right-of-way, yellow change, and red clearance intervals in a cycle that are assigned to an independent traffic movement or combination of movements. (MUTCD)

SIGNAL SECTION: The assembly of a signal housing, signal lens, and light source with necessary components to be used for providing one signal indication. (MUTCD)

SIGNAL TIMING: The amount of time allocated for the display of a signal indication. (MUTCD)

SIGNAL WARRANT: A threshold condition that, if found to be satisfied as part of an engineering study, shall result in analysis of other traffic conditions or factors to determine whether a traffic control signal or other Improvement is justified. (MUTCD)

SLOPE EASEMENT: An easement, which is reasonably necessary and incidental to the construction within the adjoining right-of-way of public street or sidewalk, or both, by the City, state, or their contractors. The purposes to which the easement area may be used include cutting, sloping, filling, installation of stormwater drain pipes or other drainage facilities, grading or otherwise changing the natural contour of the easement area in order to support and to accommodate the development of the adjacent street right-of-way, in accord with generally accepted engineering practices. Following the construction of the adjacent street or sidewalk, or both, the area subject to this easement will be graded, stabilized, and restored using conventional engineering and landscaping methods. Thereafter, the landowners with the underlying fee interest may make and enjoy all lawful uses of the property subject to this easement, provided there be no damage to the lateral and subjacent support of the public street, sidewalk, or h or to any stormwater drainage facility.

STATE ROUTE: An arterial highway designated and signed with a route number, which is primarily funded for construction and administered by TDOT. Improvements and maintenance of state routes is under the jurisdiction of TDOT.

STEADY (STEADY MODE): The continuous illumination of a signal indication for the duration of an interval, signal phase, or consecutive signal phases. (MUTCD)

STORMWATER ORDINANCE: Document initiated by the City of Franklin to establish guidelines for dealing with stormwater.

STORMWATER PERMIT: If approaches to handling stormwater are not standard or specified in the stormwater ordinance, a stormwater permit may need to be applied for by the contractor.

STREET BLOCK FACE: The physical characteristics of property and structures adjoining any one side of a street in-between intersections.

STREET SCAPE: Aesthetic additions (trees, decorative lighting) that are placed outside of the traveled way to enhance appearance.

STREET: A public or private roadway, but is not considered a driveway access point.

STREET DEPARTMENT DIRECTOR: City official responsible for directing and overseeing construction, maintenance, traffic control and stormwater implementation for improvements of City streets.

SUBDIVISION REGULATIONS: Documents initiated by the City of Franklin to establish guidelines for subdivision plans.

TACTILE ARROW (ALIGNED IN DIRECTION OF TRAVEL): A raised (tactile) arrow in an APS pushbutton that helps users know which crosswalk is actuated by the pushbutton.

TACTILE MAP: A raised schematic map (located on an APS pushbutton housing) that shows what will be encountered as the pedestrian negotiates the crosswalk controlled by that push button.

TACTILE: An object that can be perceived using the sense of touch.

TDEC: Tennessee Department of Environment and Conservation

TDOT: The Tennessee Department of Transportation

THROUGH STREET: A street, other than a dead-end street or loop street, that connects two perimeter property lines of a development.

TIA: Traffic impact analysis

TN DIVISION OF WATER POLLUTION CONTROL: A regulatory board that monitors pollution.

TRAFFIC CONTROL SIGNAL (TRAFFIC SIGNAL): Any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed. (MUTCD)

TRAFFIC SIGN: A device mounted on a fixed or movable support, conveying a message or symbol to regulate, warn or guide traffic.

TRANSPORTATION ADVISORY COMMITTEE: Committee that reviews transportation related items and makes recommendations to BOMA.

TREE REMOVAL PERMIT: Permit issued by the City of Franklin Codes Department that allows the contractor to clear designated trees.

VIBROTACTILE PEDESTRIAN DEVICE: A device that communicates, by touch, information about pedestrian timing using a vibrating surface. (MUTCD)

VOLUME: The number of vehicles passing a given point during a specified period of time.

WALK INTERVAL: An interval during which the WALKING PERSON (symbolizing WALK) signal indication is displayed. When a verbal message is provided at an accessible pedestrian signal, the verbal message is "walk sign." (MUTCD)

ZONING ORDINANCE: Document that regulates land use for the City of Franklin.

2021 UPDATES TO THE STREET TECHNICAL STANDARDS

City of Franklin
Engineering

Updates

- Updates for the 2020 Zoning Ordinance
- Information Residing as Stand-Alone Documents on Website Removed from Street Standards
  - Traffic Impact Analysis Guidelines
  - Neighborhood Traffic Calming Program
- Video documentation of Storm As-Builts Required
- 'Intermediate' Local Street Designation Removed
- Updates to most Standard Drawings
  - Accessible On-Street Parking
  - Streetlight Standards
  - Intelligent Transportation Systems (ITS) Standards
- Updates to Alley Sections (Crowned Alley)
- Minor Revisions and Clarifications to All Chapters

QUESTIONS?

- City of Franklin Engineering Development Webpage
- https://www.franklintn.gov/government/departments-a-j/engineering/development

PROPOSED 2021 STREET STANDARDS:

- **2021 Street Standards Update Memo**
- **2021 Street Specifications**
- **2021 Standard Drawings**
- **2021 Typical Street Sections**

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01872

DATE: March 25, 2021

TO: Board of Mayor and Aldermen

FROM: Eric Stuckey, City Administrator
Eric Stuckey, City Administrator
Lisa Clayton, Director of Parks

SUBJECT:

Discussion Regarding Street Naming After Tom Miller, Former Mayor Of Franklin.

PURPOSE:

The purpose of this memorandum is to provide information to the Franklin Board of Mayor and Aldermen (BOMA) concerning the proposed street naming after former Mayor of Franklin, Tom Miller.

BACKGROUND/STAFF COMMENTS:

A request has been made by a group of citizens to name the currently unnamed entrance road to the Park at Harlinsdale Farm after former Mayor Tom Miller, who passed away on December 10, 2020. Tom Miller served as Franklin Mayor from 2003 to 2007 as an Alderman from 1997 to 2003. During Mr. Miler's time as Mayor, the City of Franklin made the decision to acquire Harlinsdale Farm and developed the vision of Halrinsdale as a signature park, historic perservation intiative and valued open space for the community for genreations to come. Specifically related to the street naming request, the Board may wish to consider naming policies that are under consideration or that currently exist that could be applicable:

The naming or renaming of city assets can be a complex and emotionally evocative action since naming is a powerful and permanent identity for a public place. The names of parks, buildings, roadways and major features tell the important stories of Franklin's history. In addition, the naming and renaming of city assets often requires significant resources in terms of changing names on signs, maps, and literature, which can also be confusing to the public. Approval of naming requests is a prestigious and cautious process that involves the Board of Mayor and Aldermen, individual City Departments, Planning Commission, and the Williamson County Emergency Operations Center. Consequently, the process for naming or renaming these assets needs to be carefully and thoughtfully undertaken and only done when appropriate. City staff is in the process of creating a naming rights policy in regards to the naming of city parks, buildings, roadways and major features, which will be presented to the Board of Mayor and Aldermen in May of 2021. The proposed policy includes a category in which city assets can be named after outstanding individuals who made a sustained and lasting contribution to the City of Franklin, the State of Tennessee or the United States of America. The proposed policy also encourages, but does not require, that the naming of a city

asset for an outstanding individual be done after the individual has been deceased for at least one year.

The City of Franklin does also have existing practices specifically related to street naming and addresses. There are not specific constratints related to street naming except that the City validate the naming with the Williamson County Emergency Communications Department to ensure that the street name is not a duplicative or confusing naming that would negatively impact the dispatching of emergency services to a location. The preliminary indication is that this street naming does not create a problem in this regard. The other consideration related to street naming/renaming is the impact it may have on existing residents reslulting in a changed address. There is no such concern in this matter since there is no existing street name and the Park at Harlinsdale Farm will be able to maintain its current Franklin road street address.

FINANCIAL IMPACT:

There is no significant financial impact from this request. Signage can be provided through the City's existing Street Department budget.

RECOMMENDATION:

Feedback and guidance from the Board of Mayor and Aldermen is requested regarding this street naming request.

City of Franklin

109 3rd Ave S.
Franklin, TN 37064
(615) 791-3217

File #: 21-01858

DATE: March 26, 2021

TO: Board of Mayor and Aldermen

FROM: Steve Grubb, Director of Streets
William Banks, Staff Engineer

SUBJECT:

Presentation On The Street Department's Main Street Sidewalk Repair Project.
CIC 03/25/21, forwarded to BOMA 4-0 for further discussion without recommendation

PURPOSE:

The purpose of this memorandum is to provide a presentation to the Franklin Board of Mayor and Aldermen (BOMA) concerning the upcoming Main Street Sidewalk Repair Project.

BACKGROUND/STAFF COMMENTS:

The original Main Street streetscape project was completed in the early 1990's. The existing brick pavers along Main Street, from 5th Ave. N to 1st Ave. N/S are now faded and uneven, creating numerous ADA issues. In addition, the sidewalk tree grates are aging and need to be replaced. The Street Department spends a significant amount of funding annually to maintain and fix the brick pavers located in the sidewalks and crosswalks.

On August 13, 2019, the Board of Mayor and Aldermen approved Resolution 2019-68, adopting the project list for the FY 2019-2028 CIP (Capital Investment Program). The Main Street Sidewalk Repair Project was included in this list with an estimated cost of $2,200,000.00. The project is proposing to replace all the brick pavers, brick crosswalks, and sidewalk tree grates from 5-Points to 1st Ave, to bring Main Street up to current ADA standards and refresh the aesthetics of downtown. The intent is to also save as much of the concrete infrastructure as possible, including the sidewalks, curbs, and borders, to help reduce costs. This project will decrease long term brick paver maintenance and decrease the number of ADA deficiency issues that occur on an annual basis.

To help develop an updated project scope, the Street Department and Engineering Department recognized the need to work with our ongoing streetscape consultant, CT Consultants, and have them prepare new project schematics and concept artist renderings. Details of this design work included the following:

1. Prepare a plan to illustrate the proposed sidewalk improvements and alternatives for existing sidewalk tree wells, focusing on Main Street from 4th Ave. to 3rd Ave. as the sample project area:
   a. Treatments for tree wells in their current locations, such as new tree grates, planted cutouts, permeable pavers, or other potential solutions.
   b. Incorporation of additional curb extensions with relocated tree wells and the associated

impacts to parking and circulation.
   c. Review tree well and curb extension alternatives with City and determine desired treatment.
2. Recommend type of brick, color, and pattern to be used in sidewalks and crosswalks at each location to replace the faded existing pre-cast concrete pavers.
3. Recommend alternatives for parking along the perimeter of the square to provide a surface that can be re-striped with paint as needed.

Development of the schematics and concept artist renderings were also influenced through collaboration between multiple departments, such as Planning, Parks, Street, and Engineering. Together, the following items were discussed and may need to be developed further and finalized as the project moves forward:
1. Additional design for the proposed sidewalk improvements to ensure ADA compliance.
2. Finalize the viability of the alternative curb extensions/bioretention areas for tree wells, allowing for a wider sidewalk. Main Street underground basements need to be investigated and surveyed to make sure any tree well relocations or bioretention areas don't compromise these. Underground utility conflicts also need to be reviewed.
3. The proposed street tree varieties have been developed and were coordinated with multiple Landscape Architects and the Parks Dept. Urban Forestry Superintendent.
4. The schematics show 4 options to revitalize the parking areas within The Square. Additional staff discussion will be needed before the appropriate solution is selected.
5. The existing memorial/dedication pavers – Staff have had multiple discussions over the last year on how to navigate the possible reuse, relocation, or remanufacture of these, as they are is poor condition. Staff plans to seek input from the Heritage Foundation and other downtown associations, including the business owners along Main Street. Staff would like to bring options back to the Board, based off the public input, to request guidance on an ultimate plan for the memorial pavers.
6. Phasing – The project spans all of Main Street, from 5 Points to 1st Ave. Staff originally planned to begin the first phase of the sidewalk repair project within the block of 2nd Ave and 1st Ave. Another option is to focus the first phase of the project around the two blocks from 5th Ave through The Square (3rd Ave), because of the heavy pedestrian usage and scheduled events.
7. Coordination with the City Hall Facility Project and what is designed for the sidewalk and crosswalks near City Hall.

Attached for your review is Exhibit A, the final schematics and concept artist renderings.

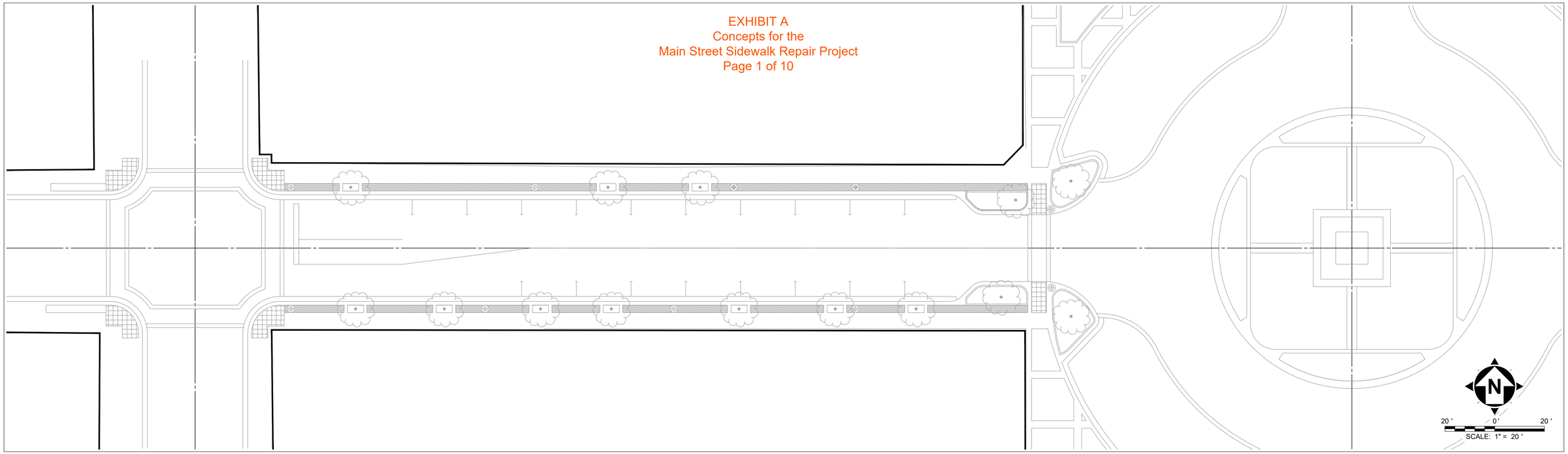
FINANCIAL IMPACT:

As part of the initial project funding from the FY 2019-2028 CIP, $250,000.00 has already been allocated to the Main Street Sidewalk Repair Project. Staff have already utilized $12,700 for the schematics and artist renderings. Staff may in the near future propose utilizing some of the remaining allocated funds to bring a designer on board and help with the following:
1. Verify existing drainage and utility conflicts.
2. Use the city's ADA transition plan to focus on correcting critical ADA non-compliance areas.
3. Produce a sidewalk and tree well relocation design that will allow project phasing scopes and cost estimates to be developed.
4. Help produce the necessary plans for bidding out a future construction project
Once the Board and public input is gathered, staff can begin working with a designer to prepare a proposal for the above items (if the project scope deems this necessary).

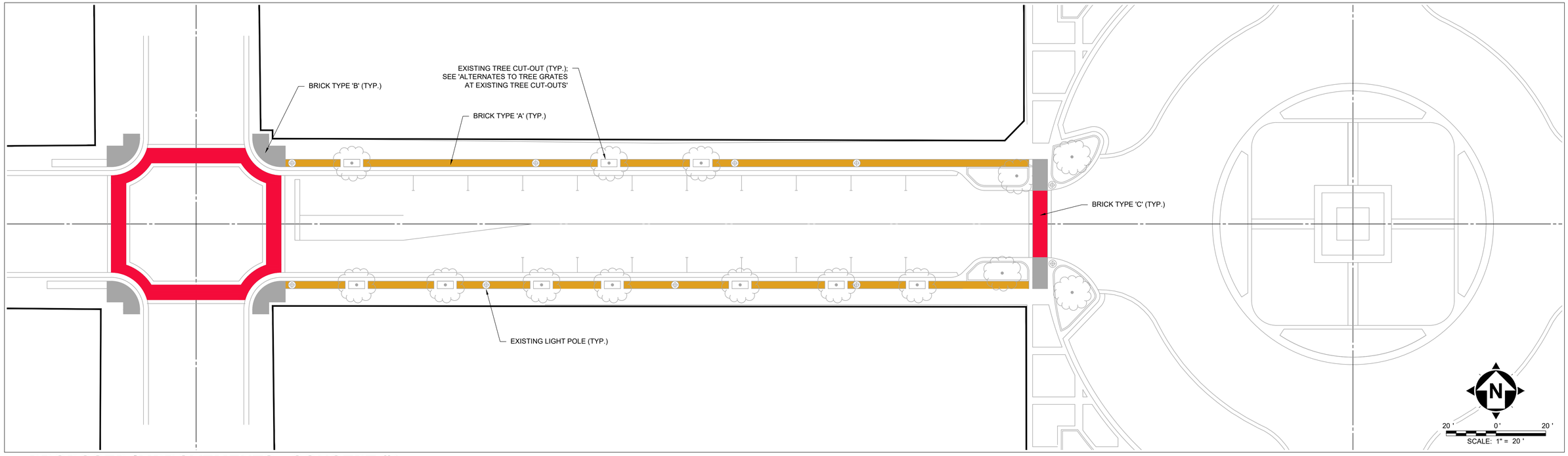
RECOMMENDATION:

Staff is seeking guidance and recommendations on the initial concept renderings before any downtown public engagement begins.

EXHIBIT A
Concepts for the
Main Street Sidewalk Repair Project
Page 1 of 10



EXISTING CONDITIONS



PROPOSED IMPROVEMENTS - CONCEPT #1

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MAIN STREET:
FOURTH AVE. TO PUBLIC SQUARE

SCALE:	AS SHOWN
DATE:	8/25/20
DESIGNED BY:	PJR
DRAWN BY:	BEK
CHECKED BY:	PJR

FRANKLIN TENNESSEE MAIN STREET
SIDEWALK IMPROVEMENT PROJECT
ALTERNATE TREATMENTS FOR TREE
PLANTINGS AND BRICK REPLACEMENTS

PROJECT NO:	
200234	
DRAWING NAME	
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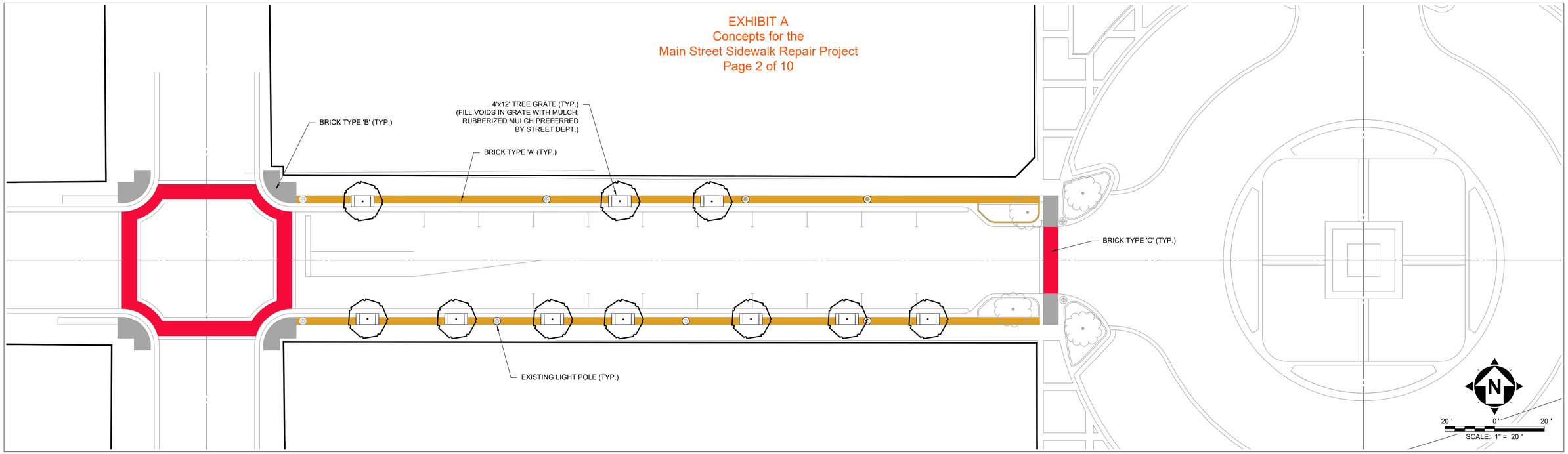
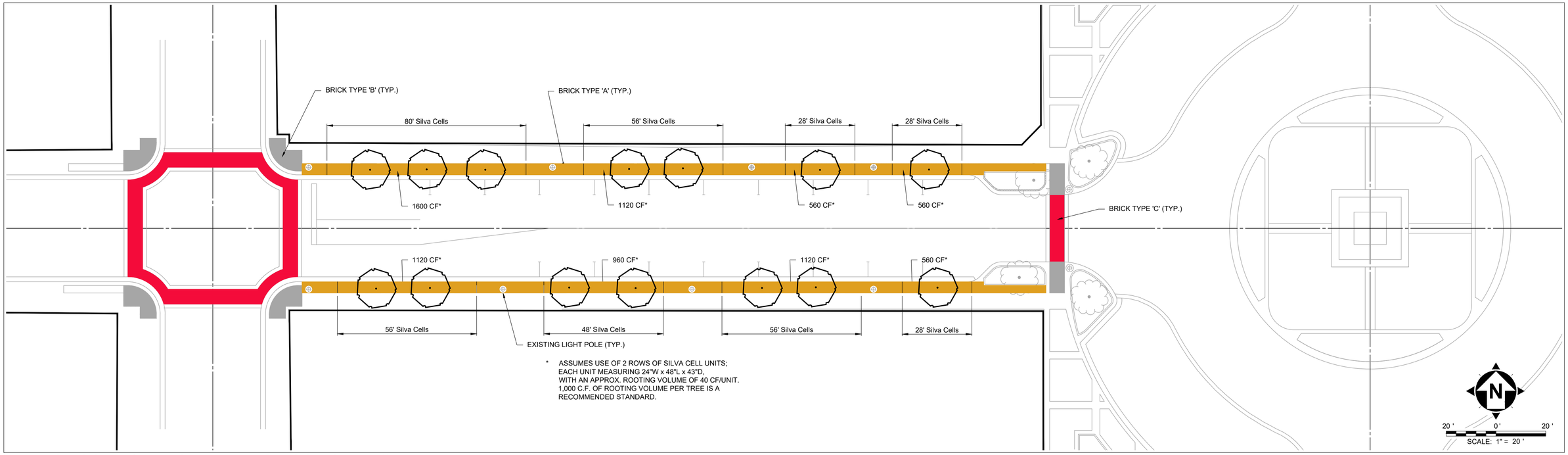


PROPOSED IMPROVEMENTS - CONCEPT #2



* ASSUMES USE OF 2 ROWS OF SILVA CELL UNITS;
EACH UNIT MEASURING 24"W x 48"L x 43"D,
WITH AN APPROX. ROOTING VOLUME OF 40 CF/UNIT.
1,000 C.F. OF ROOTING VOLUME PER TREE IS A
RECOMMENDED STANDARD.

PROPOSED IMPROVEMENTS - CONCEPT #3

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planners

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MAIN STREET:
FOURTH AVE. TO PUBLIC SQUARE

SCALE:	AS SHOWN
DATE:	8/25/20
DESIGNED BY:	PJR
DRAWN BY:	BEK
CHECKED BY:	PJR

FRANKLIN TENNESSEE MAIN STREET SIDEWALK IMPROVEMENT PROJECT ALTERNATE TREATMENTS FOR TREE PLANTINGS AND BRICK REPLACEMENTS

PROJECT NO:	
200234	
DRAWING NAME	
SHEET	OF
2	10

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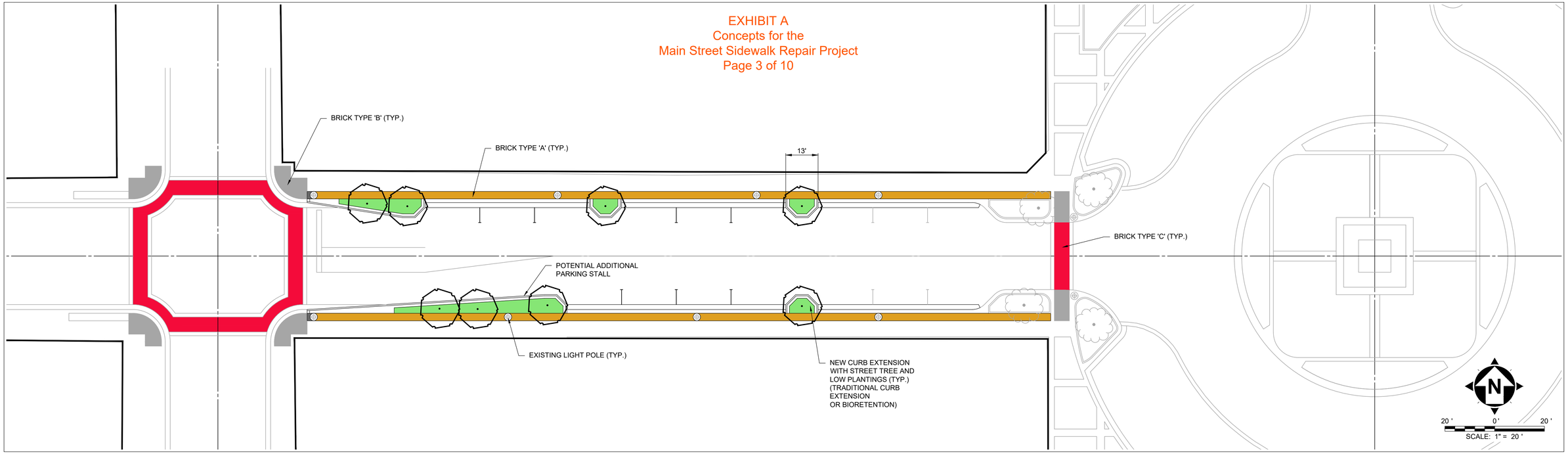
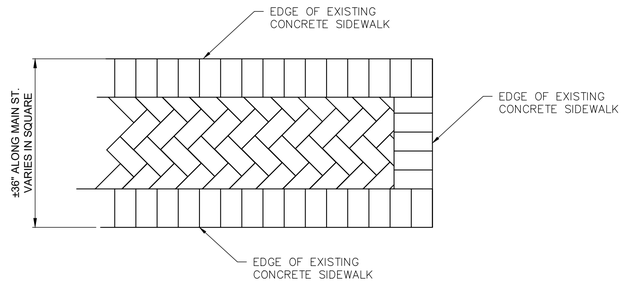
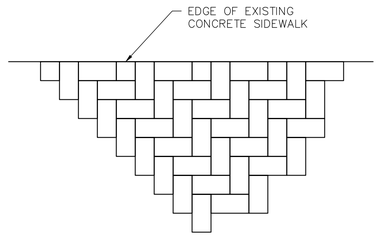


PROPOSED IMPROVEMENTS - CONCEPT #4



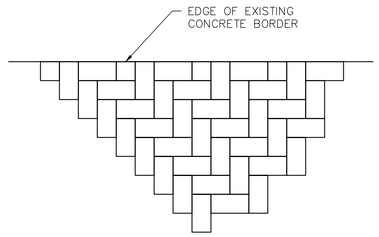
BRICK TYPE 'A' PAVERS SHALL BE STANDARD 4"x8"x2-1.4" ANTIQUE BEVELED EDGE IN PATTERN INDICATED (SOLDIER COURSE BORDERS WITH DIAGONAL HERRINGBONE FIELD). COLOR: "OLDE TAVERN", AS MANUFACTURED BY PINE HALL BRICK, WINSTON-SALEM, NC (1-800-952-7425).

BRICK TYPE 'A'



BRICK TYPE 'B' PAVERS SHALL BE STANDARD 4"x8"x2-1/4" BEVELED EDGE IN PATTERN INDICATED (HERRINGBONE). COLOR: "ENGLISH EDGE IRONSPOT", AS MANUFACTURED BY PINE HALL BRICK, WINSTON-SALEM, NC (1-800-952-7425).

BRICK TYPE 'B'



BRICK TYPE 'C' PAVERS SHALL BE HEAVY VEHICULAR 4"x8"x2-3/4" BEVELED EDGE IN PATTERN INDICATED (HERRINGBONE). COLOR: "ENGLISH EDGE IRONSPOT", AS MANUFACTURED BY PINE HALL BRICK, WINSTON-SALEM, NC (1-800-952-7425).

BRICK TYPE 'C'

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MAIN STREET:
FOURTH AVE. TO PUBLIC SQUARE

SCALE:	AS SHOWN
DATE:	8/25/20
DESIGNED BY:	PJR
DRAWN BY:	BEK
CHECKED BY:	PJR

FRANKLIN TENNESSEE MAIN STREET SIDEWALK IMPROVEMENT PROJECT ALTERNATE TREATMENTS FOR TREE PLANTINGS AND BRICK REPLACEMENTS

PROJECT NO:	
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SHEET	OF
3	10

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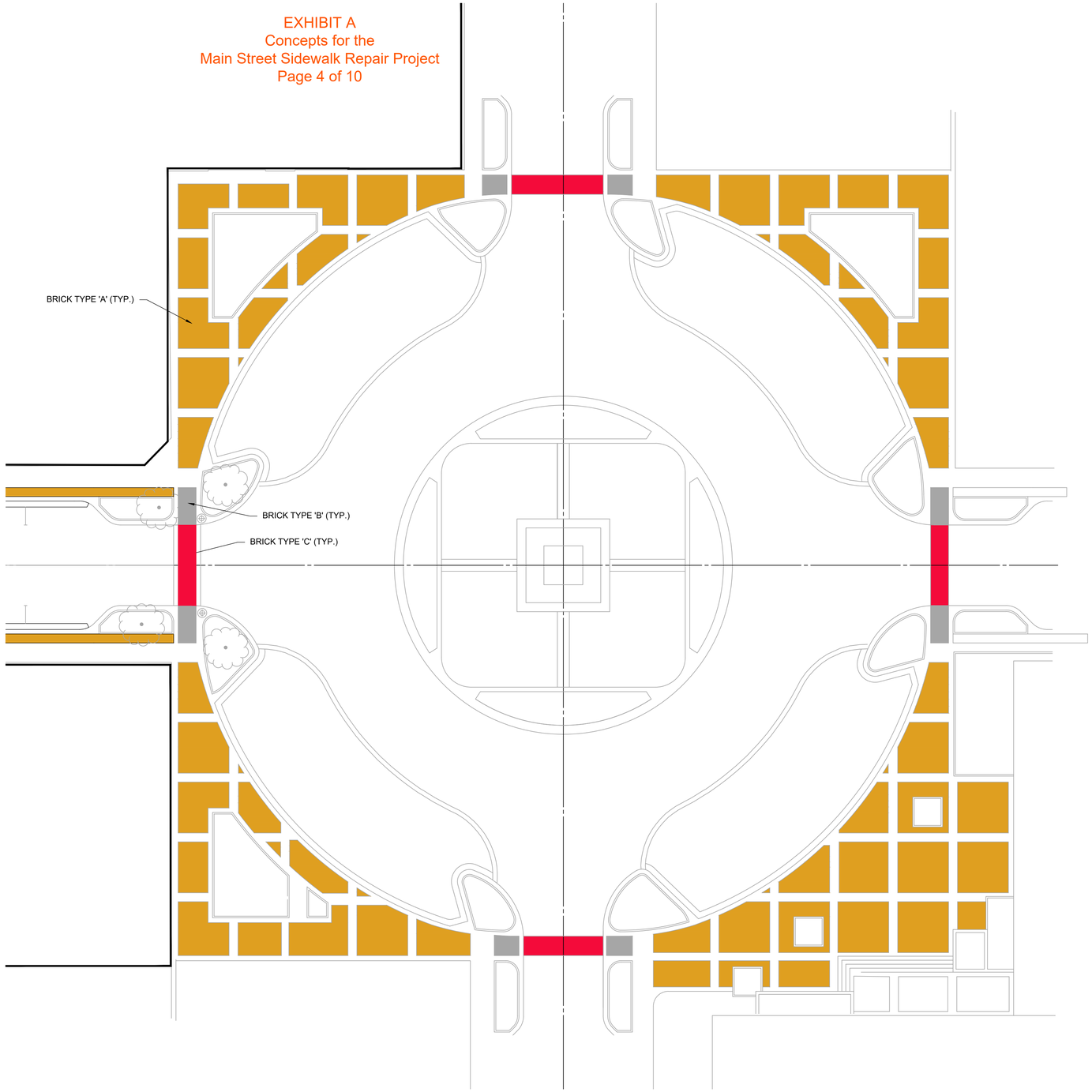
EXHIBIT A
Concepts for the
Main Street Sidewalk Repair Project
Page 4 of 10



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PUBLIC SQUARE

SCALE:	AS SHOWN
DATE:	8/25/20
DESIGNED BY:	PJR
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FRANKLIN TENNESSEE MAIN STREET SIDEWALK IMPROVEMENT PROJECT BRICK REPLACEMENTS

PROJECT NO:	
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SHEET	OF
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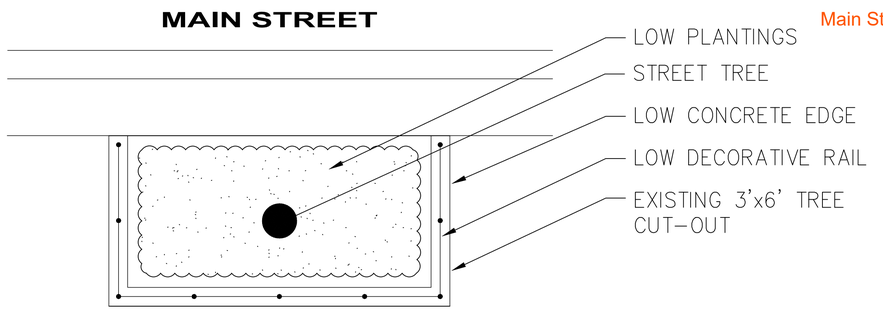
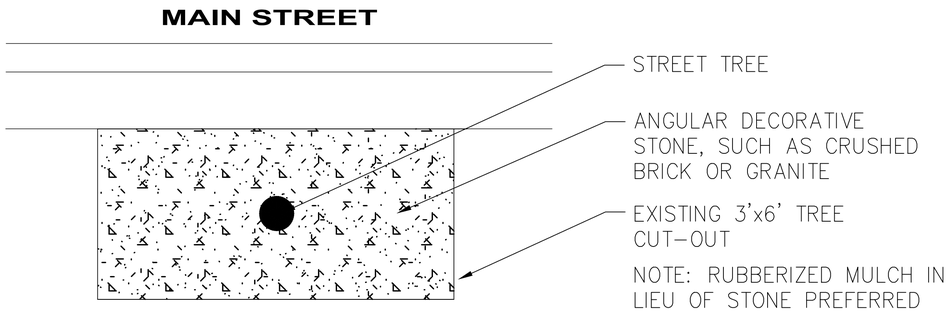
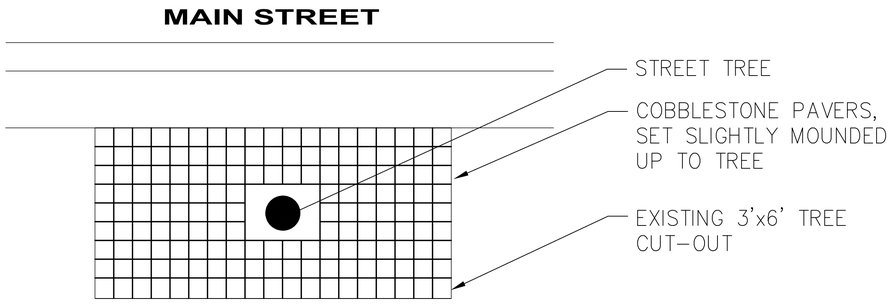
TREE CUT-OUT WITH LOW DECORATIVE RAIL

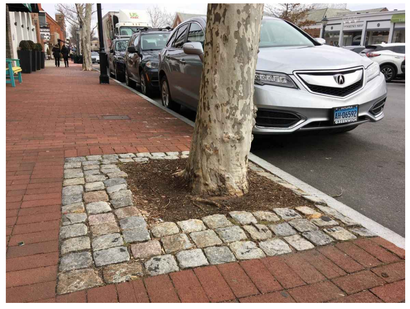


TREE CUT-OUT WITH DECORATIVE STONE



TREE CUT-OUT WITH COBBLESTONE PAVERS





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MAIN STREET:
FOURTH AVE. TO PUBLIC SQUARE

SCALE:	AS SHOWN
DATE:	5/15/2020
DESIGNED BY:	PJR
DRAWN BY:	SVE
CHECKED BY:	PJR

FRANKLIN TENNESSEE MAIN STREET SIDEWALK IMPROVEMENT PROJECT ALTERNATIVES TO TREE GRATES AT EXISTING TREE CUT-OUTS

PROJECT NO:	
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DRAWING NAME	
SHEET	OF
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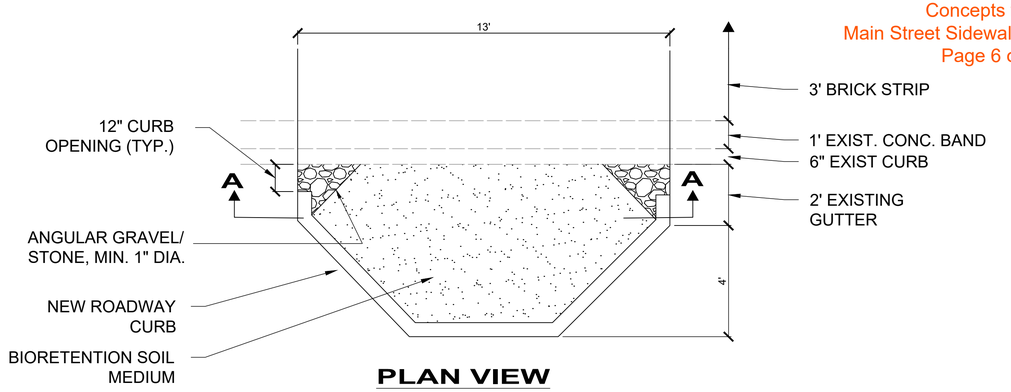
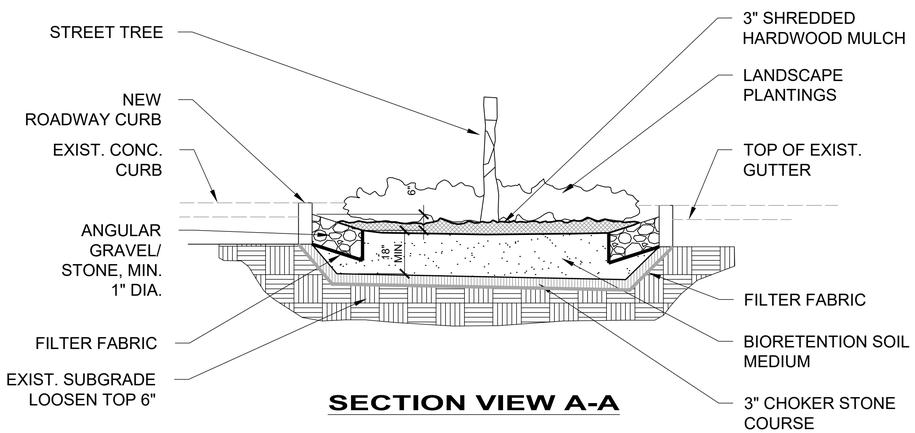


PLAN VIEW



SECTION VIEW A-A

BIORETENTION SOIL MEDIUM

BIO-SOIL SHALL BE CERTIFIED BY A QUALIFIED LABORATORY (1 TEST PER 100 CY) MEETING THE FOLLOWING ATTRIBUTES:

- TEXTURE CLASS: LOAMY SAND
- SAND CONTENT: > 80%
- CLAY CONTENT: < 10%
- pH RANGE: 5.2-8.0
- SOLUBLE SALTS: 500 PPM MAX
- DECOMPOSED ORGANIC MATTER: 3%-5% BY WEIGHT, OR 8% - 20% BY VOLUME
- PHOSPHORUS: 15-60 PPM (10-30 PPM FOR SITES WITH PHOSPHORUS TMDL OR HIGH PHOSPHORUS LOADS)
- SAND ADDED SHALL BE CLEAN AND MEET AASHTO M-6 OR ASTM C-33 WITH A GRAIN SIZE OF 0.02"-0.04"

BIORETENTION PLANTER DETAIL

NOT TO SCALE

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MAIN STREET:
FOURTH AVE. TO PUBLIC SQUARE

SCALE:	AS SHOWN
DATE:	8/25/20
DESIGNED BY:	PJR
DRAWN BY:	BEK
CHECKED BY:	PJR

FRANKLIN TENNESSEE MAIN STREET SIDEWALK IMPROVEMENT PROJECT ALTERNATE TREATMENTS FOR TREE PLANTINGS AND BRICK REPLACEMENTS

PROJECT NO:	
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DRAWING NAME	
SHEET	OF
6	10

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MAIN STREET:
FOURTH AVE. TO PUBLIC SQUARE

SCALE:	AS SHOWN
DATE:	8/25/20
DESIGNED BY:	PJR
DRAWN BY:	BEK
CHECKED BY:	PJR

FRANKLIN TENNESSEE MAIN STREET SIDEWALK IMPROVEMENT PROJECT
VIEW OF EXISTING CONDITIONS:
MAIN ST. AT FOURTH ST. FACING EAST

PROJECT NO:	
200234	
DRAWING NAME	
SHEET	OF
7	10

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NO	REVISION	DATE
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MAIN STREET:
FOURTH AVE. TO PUBLIC SQUARE

SCALE:	AS SHOWN
DATE:	8/25/20
DESIGNED BY:	PJR
DRAWN BY:	BEK
CHECKED BY:	PJR

FRANKLIN TENNESSEE MAIN STREET SIDEWALK IMPROVEMENT PROJECT
VIEW OF IMPROVEMENTS
MAIN ST. AT FOURTH ST. FACING EAST

PROJECT NO:	
200234	
DRAWING NAME	
SHEET	OF
8	10

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NO	REVISION	DATE
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MAIN STREET:
FOURTH AVE. TO PUBLIC SQUARE

SCALE:	AS SHOWN
DATE:	8/25/20
DESIGNED BY:	PJR
DRAWN BY:	BEK
CHECKED BY:	PJR

FRANKLIN TENNESSEE MAIN STREET SIDEWALK IMPROVEMENT PROJECT
VIEW OF IMPROVEMENTS
BIORETENTION PLANTER IN CURB EXTENSION

PROJECT NO:	
200234	
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9	10

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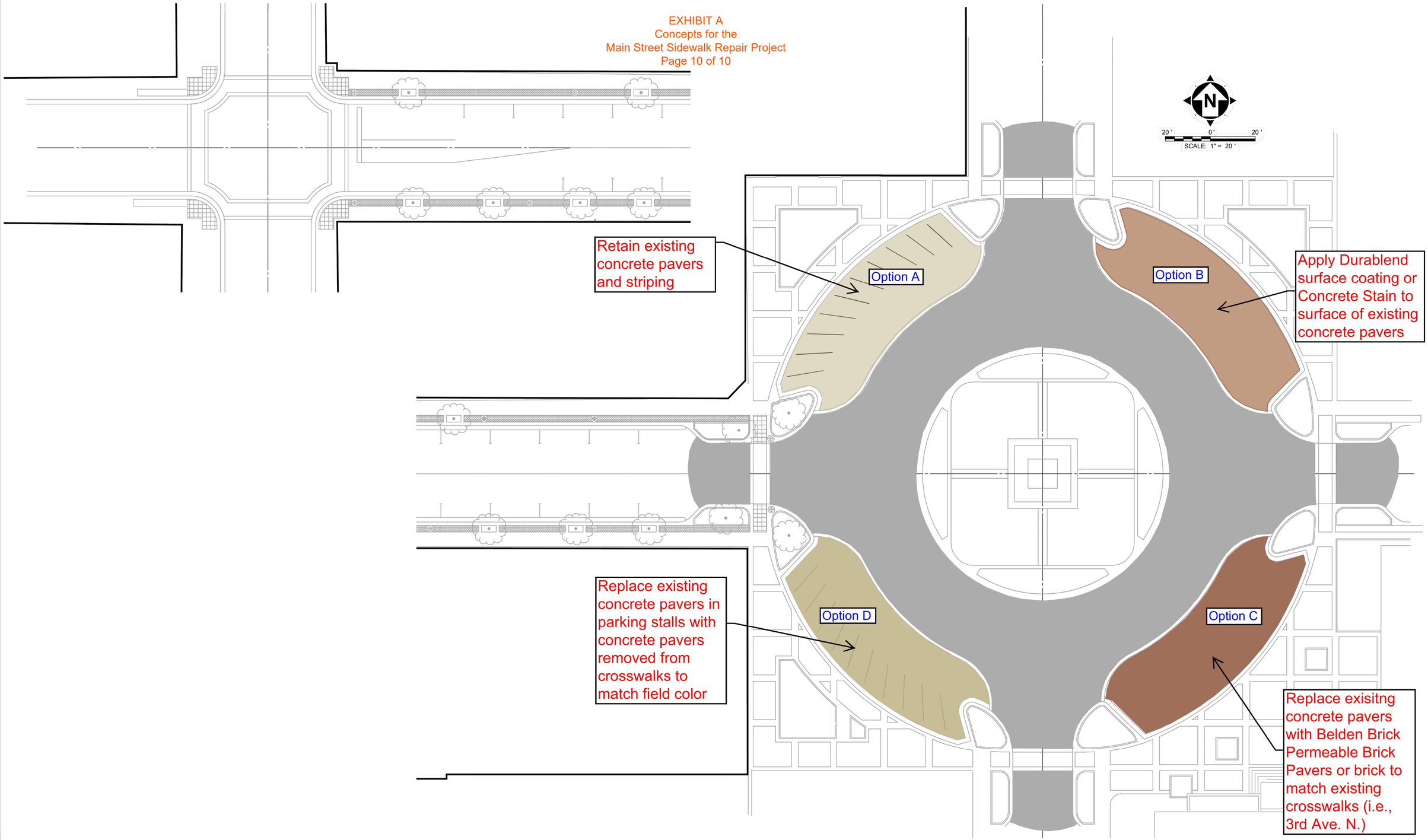

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NO	REVISION	DATE
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MAIN STREET:
FOURTH AVE. TO PUBLIC SQUARE

SCALE:	AS SHOWN
DATE:	8/25/20
DESIGNED BY:	PJR
DRAWN BY:	BEK
CHECKED BY:	PJR

FRANKLIN TENNESSEE MAIN STREET SIDEWALK IMPROVEMENT PROJECT PARKING STRIPING ALTERNATIVES AT PERIMETER OF SQUARE

PROJECT NO:	
200234	
DRAWING NAME	
SHEET	OF
10	10

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EQUINOX
IN MEMORY OF
JAMES EDWARD WALLER
1891 - 1990
JIMMY & LEEANN HOODY
MARRIED ON
9/10/11
MEGAN & CHELSEA
YOU ARE MY SUNSHINES
WITH LOVE, MOM
TALA GREER
OCTOBER 18, 1976
ALEX MUR

ROCKYTOP 1979
ROB AND BETT PILING
WHIPPOORWILL HILL-90

5
PARKING PERMIT
HOLDERS ONLY

CLAUDE AND HILDA
CAMPBELL
50 YEARS
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