MEETING OF THE PLANNING COMMISSION
Town Board Room
807 Mountain Avenue
Town of Berthoud, Colorado
Thursday, November 13, 2025, 6:00 p.m.

This is an IN-PERSON meeting at the location and time noted above.

This meeting will be streamed live on YouTube. The live stream is accessible by visiting www.berthoud.org/stream

1. Call Meeting To Order
2. Pledge Of Allegiance
3. Roll Call
4. Approval Of Meeting Minutes

   Documents:

   2025 10 23 MINUTES PC.PDF

5. Public Hearing

   Public Hearing to consider a request for a Preliminary Plat, known as Fickel Farm 5th Filing, located south of Mountain Avenue at Pyramid Peak Street. Continued from September 11, 2025.

   Documents:

   00 PRELIMINARY PLAT PC INFORMATION FORM.PDF
   01 PRELIMINARY PLAT PC STAFF REPORT.PDF
   01.1 COMBINED STAFF REPORT ATTACHMENTS.PDF
   02 RESOLUTION XX 2025.PDF

6. Public Hearing

   Public Hearing to review the Three-Mile Plan for the Town of Berthoud

   Documents:

01 INFO FORM THREE MILE PLAN.PDF
02 ORDINANCE XXXX (25) THREE MILE PLAN.PDF
03 APPENDIX A THREE MILE PLAN.PDF

7. Public Hearing

   Public Hearing for the adoption of an update to the Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specifications by reference in Section 30-6-102 of the Berthoud Municipal Code and as an insert in the 2021 Comprehensive Plan

   Documents:

   00 INFO FORM.PDF
   01 ORDINANCE 13XX CHAPTER 30.PDF
   02 EXHIBIT A SECTION 30 6 102 AMENDMENT.PDF
   03 EXHIBIT B ENGINEERING AND INFRASTRUCTURE DESIGN STANDARDS AND CNST SPECS 2025.PDF
   04 ORDINANCE 13XX COMP PLAN.PDF
   05 EXHIBIT A SLIP SHEET FOR COMPREHENSIVE PLAN.PDF
   06 PUBLIC NOTICE - BERTHOUD - CHAPTER 11.PDF

8. Report By Staff

9. Adjourn

Individuals needing special accommodation may request assistance by contacting the Town Clerk at 807 Mountain Avenue, Berthoud, Colorado 80513, 970-532-2643 at least 24 hours in advance.

Town of Berthoud Planning Commission
Town Hall
Board Room
807 Mountain Avenue, Berthoud, CO 80513
October 23, 2025 at 6:00 p.m.

1. Meeting called to order – Chairperson Anderson at 6:01 p.m.

2. Pledge of Allegiance

3. Roll Call

   The following Planning Commission members were present:
   Karen Anderson, Chair
   Abigail Smith, Vice Chair
   Marc Hofmans, Commissioner
   Nick Semedalas, Commissioner
   Bryce Filho, Commissioner
   David Pond, Commissioner

   The following Planning Commission members were absent:
   Stacy Sigman, Commissioner

   The following staff members were present:
   Anne Johnson, Community Development Director
   Tawn Hillenbrand, Planning Manager
   Bella Manzo, Planner

4. Approval of Minutes from October 9, 2025, were moved for approval by Commissioner Semedalas and a second to the motion was made by Commissioner Hofmans.

5. Work Session: Tree strips and landscape design in rights-of-way
   a. A work session discussing upcoming changes to tree strips, previously known as tree lawns, and landscaping within public rights-of-way began at 6:03 p.m. and ended at 6:29 p.m.

6. Report by Staff:
   a. The Revere Rezone and Neighborhood Master Plan was approved by the Town Board of Trustees at their October 14 meeting.
   b. Proposed changes to Chapter 30 of the Berthoud Municipal Code, Mountain Avenue Overlay, and Design Standards will be presented to the Town Board of Trustees. The first reading of proposed changes will take place on October 28, and the second reading will take place on November 10.
   c. The November 13 meeting of the Planning Commission will consist of proposed changes to the Town of Berthoud Engineering Specifications and Standards, approval of the Three

Mile Plan, and a potential land use case.

d. The December 11 meeting of the Planning Commission will begin at 6:30 p.m. with a meal for Commissioners to precede. The meeting will consist at this time of one land use matter.

7. Adjourn

The meeting was adjourned by Motion of Commissioner Pond seconded by Commissioner Semedalas 6:40 p.m.

_____ _____

Chairperson Secretary

PLANNING COMMISSION INFORMATION

COMMUNITY DEVELOPMENT DEPARTMENT

Meeting Date:	**November 13, 2025**
Agenda Title/Subject:	**Public Hearing to consider a request for a Preliminary Plat, known as Fickel Farm 5th Filing, located south of Mountain Avenue at Pyramid Peak Street. Continued from September 11, 2025.**
Type of Item:	**Public Hearing**
Purpose:	**Request for approval of a Preliminary Plat to create a residential development consisting of 105 townhome lots and 50 paired home (duplex) lots.**
Presented by:	**Tawn Hillenbrand, Planning Manager**

ATTACHMENTS:

- Staff Report with application materials
- Resolution ## (Series 2025)

BACKGROUND:

The Fickel Farm 5th Filing Preliminary Plat request was continued from the September 11, 2025 Planning Commission meeting due to application materials not being ready for presentation at a public hearing.

Fickel Farm 5th Filing received Neighborhood Master Plan and Rezone approval in November 2024. The currently undeveloped property, consisting of two parcels, is approximately 14.52 acres and is currently zoned Urban Residential. The proposed Preliminary Plat is in substantial compliance with the Neighborhood Master Plan approved in November 2024. The road network, lot configuration, and proposed open space areas are aligned with the previously approved plan. Minor modifications have been made to one stormwater detention area, and the overall density has been reduced from the approved Neighborhood Master Plan. The modification to the stormwater detention area and the reduction in density are not considered substantial changes, and therefore, are consistent with the approved Neighborhood Master Plan.

Preliminary Plat is the next phase of the overall land use approval process for a subdivision following Neighborhood Master Plan and Rezone approval.

UPDATE/NEXT STEPS:

Tonight, the Planning Commission will hear one request of the applicant. The purpose of the Preliminary Plat is to provide the Town with an overall plat and the associated engineering for the proposed development.

Following the Planning Commission public meeting, the Town Board of Trustees will hear

the request at their regularly scheduled hearing on December 9, 2025. The applicant will be required to record the Preliminary Plat if approved by the Town Board of Trustees, and any Conditions of Approval will need to be addressed prior to submitting an application for the final process. The final planning process step would be a public hearing before the Planning Commission for a Final Plat. The Final Plat phase includes review of the Construction Documents (100% completeness), referral agency review, analysis of the utilities and infrastructure planned for the project, off-site and on-site improvements, for example. Both the Preliminary and Final platting must adhere to the Neighborhood Master Plan.

Referral agencies such as the school district, fire protection district, utility and infrastructure providers, for example, have reviewed the Preliminary Plat applications. Referral agency comments at this phase are incorporated into the Staff Report and are used by the applicant when they are preparing their next land use application materials for review. Sanitary sewer and water main engineering designs, the need for water dedication, and school bus stop locations, if needed, for example are reviewed at the Preliminary Plat and Final Plat stages. The developer has provided Construction Documents with this phase and will be required to with the next or final phase of development, and these will be reviewed by the Town Engineer and supportive agencies.

FISCAL IMPACT AND FUND SOURCE:
There is no negative impact to the Town in consideration of this request for Preliminary Plat. Public notice is funded through fees paid by the applicant. Development review is funded through fees paid by the applicant.

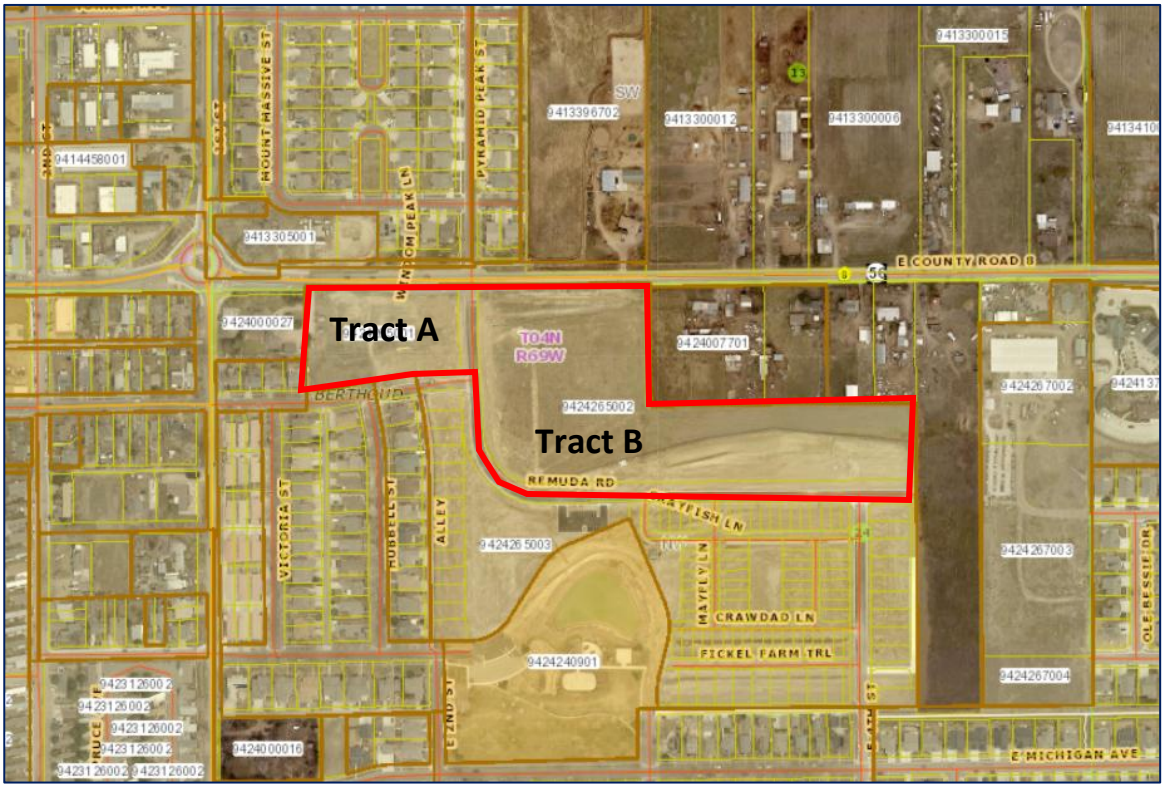
COMMUNITY TOUCHSTONES:
Consideration of this request does not negatively impact community touchstones and in fact is supportive of the 2021 Comprehensive Plan. The proposed Preliminary Plat is consistent with the previously approved Neighborhood Master Plan which aligns with the vision of the Comprehensive Plan.

RECOMMENDED ACTION(S):
Staff recommends approval of the request. See suggested motions in the Staff Report.

807 Mountain Avenue | PO Box 1229 | Berthoud, CO 80513 | O: 970.532.2643 | F: 970.532.0640 | **Berthoud.org**

STAFF REPORT: FICKEL FARM 5TH FILING PRELIMINARY PLAT

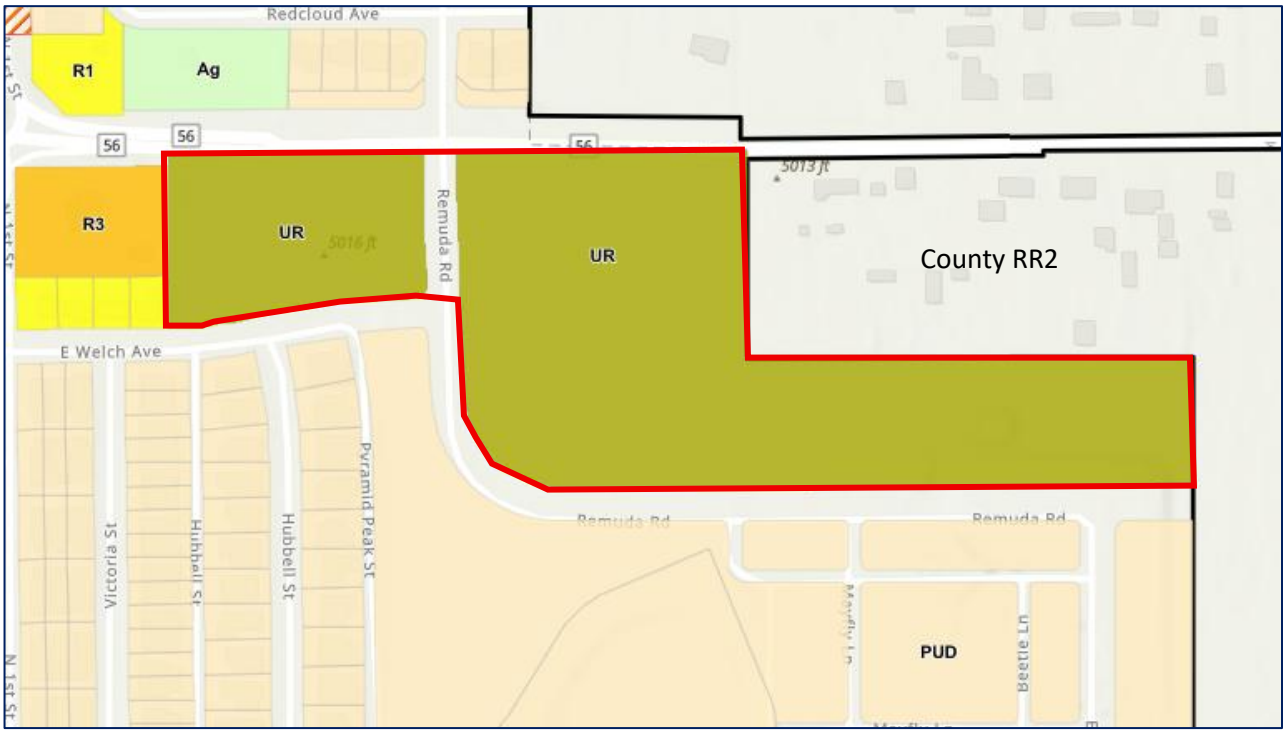
DATE: November 13, 2025

GENERAL INFORMATION		
Applicant:	Kurt Jones – TruMark Homes Kristin Turner – TB Group	Size: 14.52 acres
Site Location:	Tract A: parcel #9424265001 and Tract B: parcel #9424265002. The two subject parcels are located south of Mountain Avenue at the intersection of Pyramid Peak Street.  *Subject property is outlined in red.*	
Applicant's Request:	The Applicant is requesting Preliminary Plat approval to create a residential development consisting of 105 townhome lots and 50 paired home (duplex) lots.	
Current Zoning:	UR – Urban Residential	

ZONING DISTRICT INFORMATION		
	UR (Townhome)	UR (Paired Home)
Max Density	Defined by approved NMP	Defined by approved NMP
Min. Lot Area	1,600sf	2,000 sq. ft
Front Setback	8’-12’	8’-12’
Side Setback	5’ / 10’ corner side (0’ attached)	5’ / 10’ corner side (0’ attached)
Rear Setback	5’ rear loaded garage	5’ rear loaded garage
Max Building Height:	30’	30’

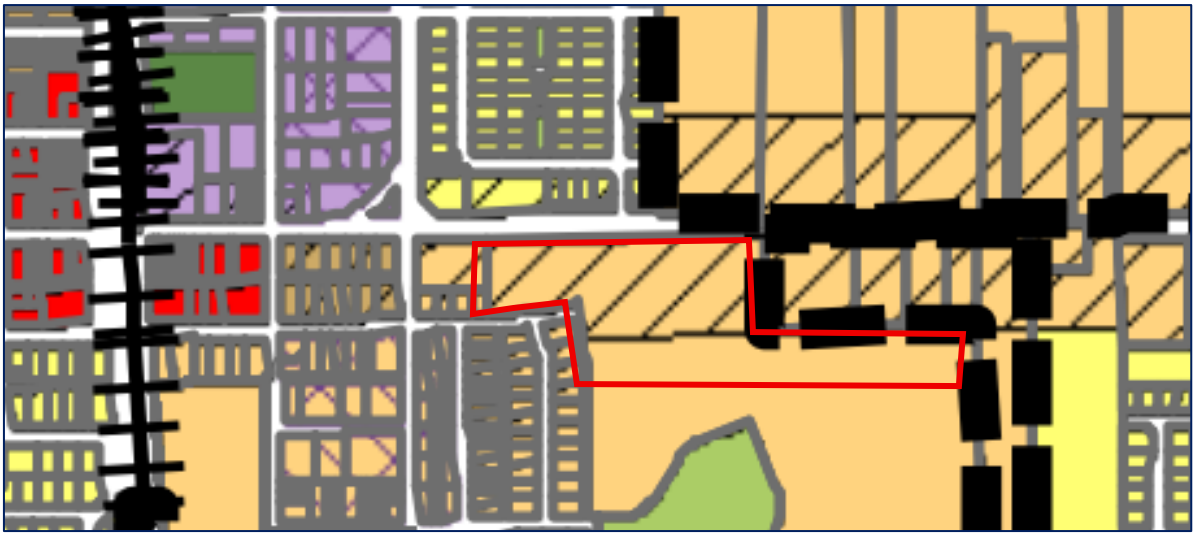
SURROUNDING ZONING, LAND USE AND REQUIRED BUFFERS			
	Adjacent Zoning	**Adjacent Land Uses**	**Setbacks for Adjacent Zoning**
North	AG, PUD, County RR2	Single Family, Single Family/Ag	N/A
South	PUD	Single Family, Paired Homes (Duplex)	N/A
East	County RR2	Single Family/Ag	N/A
West	R3, R1, PUD	Single Family	N/A

Town Zoning Map:



BERTHOUD COMPREHENSIVE PLAN AND MASTER PLANS

Berthoud Comprehensive Plan - Future Land Use Map:



Urban Residential Character District (area in orange) and Mountain Avenue Corridor (area in hatch)

Berthoud Trails Master Plan:



Proposed Regional Trail (purple line) and Planned Neighborhood (orange line)

Berthoud Open Space Plan:



Proposal

The applicant proposes Preliminary Plat approval to create 105 paired home (duplex) lots and 50 townhome lots. The proposed Preliminary Plat is in substantial compliance with the approved Neighborhood Master Plan approved in November 2024. The Preliminary Plat, if approved, would allow the applicant to apply for a Final Plat that would formally subdivide the lots.

Background

The currently undeveloped property is approximately 14.52 acres and is currently zoned Urban Residential. Fickel Farm 5th Filing received Neighborhood Master Plan and Rezone approval in November 2024. The approved Neighborhood Master Plan includes 115 townhome lots and 50 paired home (duplex) lots.

The proposed Preliminary Plat is consistent with the approved Neighborhood Master Plan with two minor modifications:

1. The first minor modification is the size of the stormwater detention area located at the curve of Pyramid Peak Street and Remuda Road. This detention area was expanded as result of the Preliminary Drainage Study to accommodate stormwater flows.
2. The second minor modification is a reduction in the overall density of the development. The approved Neighborhood Master Plan proposed 115 townhome lots and 50 paired home lots, while this Preliminary Plat request proposes 105 townhome lots and 50 paired home lots. The overall density has been reduced from 165 total lots to 155 total lots.

These modifications do not change the overall layout of the development, road network, or lot configuration. And while the density has changed, a reduction in density is not considered a substantial change. Therefore, the Preliminary Plat is considered to be consistent with the approved Neighborhood Master Plan.

Preliminary Plat Review Criteria

In addition to all provisions of this Code, the Town shall use the following criteria to evaluate the applicant's request:

30-6-107(B) Review Criteria	Finding	Rationale
1. The preliminary plat represents a functional system of land use and is consistent with the rationale and criteria set forth in this Code.	Yes	The preliminary plat is a functional system of land use. The road network, lot configuration, density, and proposed open space areas are aligned with the previously approved Neighborhood Master Plan. Those residential lots being created with this plat meet the standards of the UR – Urban Residential zone district.
2. The application is consistent with the approved concept plan and incorporates the Town's recommendations and any conditions of approval.	Yes	The plan is consistent with the approved Neighborhood Master Plan (2024). The approved Neighborhood Master Plan is not subject to any conditions.
3. The land use mix within the project conforms to Berthoud's Zoning District Map and Preferred Land Use Map and furthers the goals and policies of the Comprehensive Plan and PORT Plan.	Yes	The creation of townhome and paired home lots conforms to Berthoud's Development Code for the UR – Urban Residential district. The Future Land Use Map envisions this area as Urban Residential. The approved Neighborhood Master Plan is consistent with the Future Land Use Map, and the Preliminary Plat is consistent with the approved Neighborhood Master Plan. The project provides adequate public sidewalks, trails, and pedestrian connections to allow walkability within the project area and well beyond. Once developed, the project will be well connected to the neighboring residential areas.

30-6-107(B) Review Criteria	Finding	Rationale
4. The utility and transportation design is adequate, given existing and planned capacities of those systems.	Yes	As part of the Preliminary Plat application, the applicant provided a Preliminary Traffic Impact Study (TIS), Preliminary Utility Report, and Preliminary Construction Documents. Additionally, the required dry utility easement locations are included on the Plat. The plans were reviewed by Town Staff as well as outside referral agencies. Staff and referral agencies find that the applicant has provided adequate plans for utilities and transportation designs for Preliminary Plat. Final versions of these reports/plans, at 100% completeness, will be required at Final Plat submittal.
5. Negative impacts on adjacent land uses including, but not limited to: solar access, heat, dust, glare, traffic and noise have been identified and satisfactorily mitigated.	Yes	The applicant provided the following required preliminary plans and reports which were reviewed by Town Staff and referral agencies specializing in specific areas of study: - Preliminary Drainage Plan - Preliminary Utility Report - Soils Report (Geotechnical Report) - Preliminary Landscape Plan - Preliminary Traffic Impact Study (TIS) Staff and referral agencies found that the reports and plans identify and satisfactorily mitigate impacts to adjacent land uses.
6. There is a need or desirability within the community for the applicant's development and the development will help achieve a balance of land use and/or housing types within Berthoud.	Yes	The Future Land Use Map envisions this area as Urban Residential. Additionally, the portion of the property located adjacent to Mountain Avenue is in the Mountain Avenue Overlay District, specifically Berthoud East Character District. The Comprehensive Plan states that the dominant land use in the Urban Residential Character District will be a mix of residential housing types with non-residential uses to support the neighborhoods. Housing types should include single-family detached homes, single-family attached homes (paired homes), townhomes, and multi-family options. Urban Residential areas should generally maintain moderate to high density. The proposed Fickel Farm 5th Filing Preliminary Plat proposes alley loaded Townhomes along Mountain Avenue transitioning to Paired Homes (duplexes) further into the development along Pyramid Peak Street, adjacent to the recently constructed paired homes in Fickel Farm 4th Filing. The proposed product type (townhomes and paired homes) and proposed increase in density address changes in the housing market including a desire for smaller homes at different price points. The proposed project meets the housing diversity standards intended for the Urban Residential Character District while also potentially providing more attainable housing options. The proposed density would be consistent with the intent of the Urban Residential Character District.

		The Mountain Avenue Overlay District envisions this area as Berthoud East Character District with the primary use being residential with mix-use commercial as the secondary use. The plan states that mixed-use commercial should be located near County Line Road 1, away from existing residential neighborhoods; appropriate transitions from existing residential neighborhoods are critical. The Fickel Farm 5th Filing NMP does not include a commercial component, which supports the concept plan for the Berthoud East Character District.
30-6-107(B) Review Criteria	**Finding**	**Rationale**
7. How the applicant has addressed comments received from the public, during the Public Comment portion of the process.	Yes	As of the drafting of this report, Staff have received zero public comment regarding this proposed request.

PUBLIC NOTICE AND COMMENT

Notice of the Planning Commission Public Hearing and Town Board of Trustees hearing has been mailed to property owners within 500 feet of the subject property on October 27, 2025, a legal ad published on October 29, 2025, and the property was posted as required by the Development Code on August 26, 2025. The posted notices was confirmed still in place on October 16, 2025. In addition, notice of application was sent out to all property owners within 500 feet upon initial submittal in February 2025 with an invitation to comment on the request within three weeks of receipt.

Over the course of the last year, Staff has received three (3) public comment emails regarding the proposed request. Comments are provided as an attachment to this report.

The Fickel Farm 5th Filing Preliminary Plat application completed four (4) rounds of referral agency review in the following sequence:

Submittal Number	Review documents submitted by Applicant on:	Staff and Referral Agency comments provided to Applicant on:
1st	February 4, 2025	March 18, 2025
2nd	June 4, 2025	July 15, 2025
3rd	August 6, 2025	August 25, 2025
4th (final)	September 16, 2025	October 15, 2025

FINDINGS AND RECOMMENDATIONS

Staff find that the proposed Fickel Farm 5th Preliminary Plat meets the review criteria as provided in Section 30-6-107(B) of the Berthoud Development Code. Therefore, Staff recommends Planning Commission make a motion to recommend approval of the Fickel Farm 5th Filing Preliminary Plat to the Town Board of Trustees.

Attachments

1. Application form
2. Preliminary Plat
3. Preliminary Landscape Plan
4. Approved Neighborhood Master Plan (for reference only)
5. Preliminary Traffic Analysis
6. Public Comment

Attachment 1

Town of Berthoud
807 Mountain Ave.
P.O. Box 1229
Berthoud, CO 80513
970.532.2643

DEVELOPMENT REVIEW APPLICATION

All required information must be provided before submittal will be accepted and deemed complete.
To be complete, the application must include all items identified on the submittal checklist.
Please complete both sides of application form.

Parcel Number(s): 9424265001 & 9424265002		
Site Address: SE side of Intersection of Mountain Avenue & Pyramid Peak Street		
Project Name: Fickel Farms 5th Filing		
Brief description of project: A residential subdivision which will consist of a combination townhomes and duplex products.		
APPLICATION TYPE *(Check as appropriate)*:		
☐ Annexation	☑ Preliminary Subdivision Plat	☐ Final Site Plan
☐ Rezoning	☐ Final Subdivision Plat	☐ PUD Amendment
☐ Concept Plan	☐ Plat Amendment	☐ PUD Preliminary Development Plan
☐ Minor Subdivision	☐ Oil and Gas	☐ PUD Final Development Plan
☐ Special Use Review	☐ ROW Vacation	☐ Other _____

APPLICANT		
Name: TruMark Homes (Kurt Jones)		
E-mail: kjones@trumarkco.com Phone: 720-346-2800	Mailing Address: 8350 E. Crescent Pkwy, Ste. #450 City/State/Zip: Greenwood Village, CO 80111	
CONTACT PERSON ***(will receive correspondence from Town Staff/Referral Agencies)***		
Name: Kristin Turner		
E-mail: kristin@tbgroup.us Phone: 970-532-5891	Mailing Address: 444 Mountain Ave. City/State/Zip: Berthoud, CO 80513	
OWNER(S) ***(If different than applicant)***		
Name: Edwards Development (Will Edwards)		
E-mail: will@edwardsdevelopment.com Phone: (949) 413-4711	Mailing Address: 506 Shoshoni St, Cheyenne, WY 82009 City/State/Zip: 506 Shoshoni St, Cheyenne, WY 82009	
CONSULTANT ***(Engineer, Surveyor, or Planner)***		
Name: Kristin Turner		
E-mail: kristin@tbgroup.us Phone: 970-532-5891	Mailing Address: 444 Mountain Ave. City/State/Zip: Berthoud, CO 80513	

Docusign Envelope ID: 94898BD6-F009-4F91-BF9A-556494CF4503

LAND USE INFORMATION

Existing Use: Vacant

Proposed Use: Residential

Existing Zoning: UR

Proposed Zoning: (if applicable):

Number of acres: 14.52 AC

Proposed Access: Mountain Ave, Welch Av

Adjacent zoning / land use:

East Side: Larimer County RR2	North Side: Larimer County RR2/HWY 56
West Side: Residential R1	South Side: Residential PUD

UTILITY SERVICE INFORMATION

Water: Town of Berthoud

Sewer: Town of Berthoud

PROJECT INFORMATION

Number of proposed units:
165
Number of phases:
TBD
Number of Units per phase:
TBD
Number of lots proposed:
165
Lot size minimum:
25x70
Lot size maximum:
28x71
Lot size average:
26.5 x70.5
Gross density (units/acre):
11.3
Net density (units/acre):
14.3
Area and percent open space:
2.70 OS

Non-Residential Building Area (Sq. Ft.) Proposed:
N/A
Non-Residential Construction Floor Area Ratio Proposed: N/A

Total Number of Parking Spaces: N/A

Acreage of Site:

a. Gross: 14.52
b. Right-of-Way: 3.01
c. Net (a-b) 11.51

Type of Housing Proposed (*please check*):

☐ Future Single Family	☑ Townhouse
☑ Duplex	☐ Condominium
☐ Multi-family	
(# of units:)	

Signatures are required for ALL Property Owners and the Applicant

I hereby certify that I am the lawful owner of the parcel(s) of land that this application concerns and consent to the action. I hereby permit Town of Berthoud staff to enter upon the property for the purposes of inspection relating to the application. Building Permits will not be accepted while this application is in process.

Property Owner(s): Signed by: Will Edwards D9F34FECDF8E4DD... Date: 1/8/2025

Property Owner(s): Date:

In submitting the application materials and signing this application agreement, I acknowledge and agree that the application is subject to the applicable processing and public hearing requirements set forth in the Development Code.

Applicant: Signed by: Kurt Jones FDE59AE10FFF412... Date: 1/9/2025

FOR OFFICE USE ONLY	Received By:	Date:

FICKEL FARM FIFTH FILING

Being a Replat of Tracts 1 & 2, Fickel Farm PUD Fourth Filing
Situate in the NW Quarter of Section 24, Township 4 North, Range 69 West of the 6th P.M.,
Town of Berthoud, County of Larimer, State of Colorado

LEGAL DESCRIPTION AND DEDICATION:

KNOW ALL MEN BY THESE PRESENTS: That the undersigned, being the owners of a parcel of land situate in the Northwest Quarter of Section Twenty-four (24), Township Four North (T.4N.), Range Sixty-nine West (R.69W.) of the Sixth Principal Meridian (6th P.M.) being more particularly described as follows:

Tracts 1 and 2, Fickel Farm PUD Fourth Filing, (as recorded March 8, 2022, as Reception Number 20220015532 of the records of the Larimer County Clerk and Recorder), Town of Berthoud, County of Larimer, State of Colorado.

Said parcel contains 608,176 Square Feet or 13.962 Acres more or less by this survey.

Have laid out, platted, and subdivided the above described land, under the name and style of FICKEL FARM FIFTH FILING, and by these presents do dedicate to the Town of Berthoud in fee simple the street and public rights-of-way as shown on the plat, and grants to the Town of Berthoud such easements as are created hereby and depicted or, by note, referenced hereon, along with the right to install, maintain, and operate mains, transmission lines, service lines, and appurtenances, either directly or through the various public utilities, as may be necessary to provide such utility, cable television, and sanitary services within this subdivision or property contiguous thereto, through, over, under, and across streets, utility and other easements, and other public places as shown on the plat.

Owner: Trumark Properties, LLC, a California limited liability company

_____

BY: Brian Mulqueen AS: President

NOTARIAL CERTIFICATE

STATE OF COLORADO)
ss
COUNTY OF LARIMER)
The foregoing instrument was acknowledged before me by _____ as _____ this ____ day of _____, 20__.

Witness my Hand and Official Seal.

_____

Notary Public

My commission expires: _____.

APPROVAL CERTIFICATES

Approved by the Board of Trustees of the Town of Berthoud, Colorado, this ____ day of _____, 20___.

_____

Mayor

The foregoing plat is approved for filing and accepted by the Town of Berthoud, Colorado, this ____ day of _____, 20___.

_____

Attest: Town Clerk

APPROVAL CERTIFICATES

Approved by the Planning Commission of the Town of Berthoud, Colorado, this ____ day of _____, 20___.

_____

Chairperson

The foregoing plat is approved for filing and accepted by the Town of Berthoud, Colorado, this ____ day of _____, 20___.

_____

Attest: Planner

NOTICE

According to Colorado law you must commence any legal action based upon any defect in this survey within three years after you first discover such defect. In no event may any action based upon any defect in this survey be commenced more than ten years from the date of the certification shown hereon. (13-80-105 C.R.S. 2012)

SURVEYOR'S CERTIFICATE

I, Matthew A. Kramer, a Licensed Land Surveyor in the State of Colorado, do hereby certify that the survey of FICKEL FARM FIFTH FILING was made under my supervision and the accompanying plat accurately and properly shows said subdivision and is in compliance with the Subdivision Regulations of the Town of Berthoud.

PRELIMINARY

_____

Matthew A. Kramer - On Behalf of Majestic Surveying, LLC
Colorado Licensed Professional Land Surveyor #38844

TOWN OF BERTHOUD NOTES:

VESTING OF PROPERTY RIGHTS
Approval of this site-specific development plan constitutes the creation of vested property rights pursuant to Article 68 of Title 24, C.R.S., as amended. The approval of vested property rights shall be subject to all rights of referendum and judicial review. This approved site specific development plan voids any and all pre-existing vested property rights on the same real property.

PROJECT APPROVAL
The plans contained on this plat as well as the staff report dated _____ and Resolution _____ are the limits of the approval. Any changes to the approved plans may necessitate an amendment or new permit.

DEVELOPMENT IMPROVEMENTS
All Development Improvements shall be constructed in accordance with the Plat and Plans as well as the requirements of the Berthoud Municipal Code, if applicable. The development shall adhere to the Development Agreement entered into between the Developer and the Town of Berthoud.

EROSION CONTROL
Prior to commencement of construction of any Development Improvements including alterations to existing grading contours, removal of vegetation and/or excavating, the Town-approved erosion control plan will be implemented. The Town-approved erosion control plan measures shall be installed and maintained throughout the construction of Development Improvements and shall not be removed or abandoned until authorized by the Town. At all times during construction on the Property, or off-site projects associated with development of the Property, Developer shall maintain all streets, drainage, and drainage facilities in an orderly and workmanlike fashion.

CONSTRUCTION RULES AND REGULATIONS
Construction activities shall adhere to the Construction Rules and Regulations found in Chapter 30 of the Berthoud Municipal Code at all times.

DARK SKY
The Town of Berthoud has adopted a Dark Sky Ordinance. All development shall adhere to the Town of Berthoud Dark Sky Ordinance No. 1230, adopted January 9, 2018, and as may be amended, at all times.

RIGHT TO FARM STATEMENT
The Town of Berthoud has adopted a "Right to Farm" policy. All new and existing residents are expected to read and understand the policy. For a copy of the policy, please contact the Town of Berthoud.

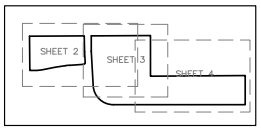
MOUNTAIN AVENUE OVERLAY DISTRICT
The Town of Berthoud has adopted the *Mountain Avenue Overlay District*. This development falls within the Mountain Overlay distinct and is required to adhere to the Overlay plan, adopted October 2019, and as may be amended.

TITLE COMMITMENT NOTE

For all information regarding easements, rights-of-way and title of records, Majestic Surveying, LLC relied upon Title Commitment Number 459-H5082949-414, Amendment No. 4, dated January 6, 2025, as prepared by Heritage Title Company to delineate the aforesaid information. This survey does not constitute a title search by Majestic Surveying, LLC to determine ownership or easements of record.

SITE SPECIFIC DEVELOPMENT PLAN

This plan constitutes a site specific development plan as defined in Article 68 of Title 24, C.R.S., as amended, and Chapter 30 of the Berthoud Development Code available at the Berthoud Town Hall, 807 Mountain Avenue, Berthoud, Colorado 80513.



KEY MAP
SCALE: 1" = 500'

CURVE TABLE					
CURVE	LENGTH	RADIUS	DELTA	CHORD	CH BEARING
C1	5.00'	79.00'	3°37'42"	5.00'	S02°11'26"E
C2	23.56'	15.00'	90°00'00"	21.21'	S41°54'39"W
C3	35.54'	332.50'	6°07'29"	35.53'	S83°53'21"W
C4	67.56'	731.63'	5°17'28"	67.54'	S79°36'48"W
C5	128.88'	570.00'	12°57'16"	128.60'	S83°26'42"W
C6	259.62'	171.00'	86°59'16"	235.39'	N46°34'59"W
C7	4.78'	101.00'	2°42'46"	4.78'	N01°43'58"W

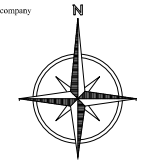
LINE TABLE		
LINE	BEARING	LENGTH
L1	N89°38'07"E	58.00'

FICKEL FARM FIFTH FILING Land Use Table					
Name	Description/Land Use	Area		Intended Fee Ownership	Maintenance Upon Completion & Acceptance
154 Lots	Single and Multifamily Residential	272,805 sq. ft.	6.263 acres	Owner	Owner
Tract A	Private Drive Access, Drainage & Utility Easement	17,599 sq. ft.	0.396 acres	HOA/Metro District	HOA/Metro District
Tract B	Private Drive Access, Drainage & Utility Easement	18,309 sq. ft.	0.420 acres	HOA/Metro District	HOA/Metro District
Tract C	Private Drive Access, Drainage & Utility Easement	46,342 sq. ft.	1.064 acres	HOA/Metro District	HOA/Metro District
Tract D	Private Drive Access, Drainage & Utility Easement	3,112 sq. ft.	0.071 acres	HOA/Metro District	HOA/Metro District
Outlot A	Access, Drainage, Utility Easement	40,039 sq. ft.	0.919 acres	HOA/Metro District	HOA/Metro District
Outlot B	Access, Drainage, Utility Easement	18,370 sq. ft.	0.422 acres	HOA/Metro District	HOA/Metro District
Outlot C	Access, Drainage, Utility Easement	24,615 sq. ft.	0.565 acres	HOA/Metro District	HOA/Metro District
Outlot D	Access, Drainage, Utility Easement	11,690 sq. ft.	0.267 acres	HOA/Metro District	HOA/Metro District
Outlot E	Access, Drainage, Utility Easement	13,629 sq. ft.	0.313 acres	HOA/Metro District	HOA/Metro District
Outlot F	Access, Drainage, Utility Easement	31,410 sq. ft.	0.721 acres	HOA/Metro District	HOA/Metro District
Outlot G	Access, Drainage, Utility Easement	1,184 sq. ft.	0.027 acres	HOA/Metro District	HOA/Metro District
Outlot H	Access, Drainage, Utility Easement	405 sq. ft.	0.009 acres	HOA/Metro District	HOA/Metro District
Outlot I	Access, Drainage, Utility Easement	3,278 sq. ft.	0.075 acres	HOA/Metro District	HOA/Metro District
Outlot J	Access, Drainage, Utility Easement	11,714 sq. ft.	0.269 acres	HOA/Metro District	HOA/Metro District
Outlot K	Access, Drainage, Utility Easement	8,423 sq. ft.	0.193 acres	HOA/Metro District	HOA/Metro District
Outlot L	Access, Drainage, Utility Easement	42,356 sq. ft.	0.972 acres	HOA/Metro District	HOA/Metro District
ROW	Right-Of-Way	43,281 sq. ft.	0.994 acres	Town of Berthoud	Town of Berthoud
TOTAL		608,176 sq. ft.	13.962 acres		

Owner: Trumark Properties, LLC, a California limited liability company
C/O Brian Mulqueen
8350 E. Crescent Pkwy #450
Greenwood Village, CO 80111
720-826-6500

Engineer: Justin Beckner
4025 Automation Way, Ste. B2
Fort Collins, CO
970-698-6046

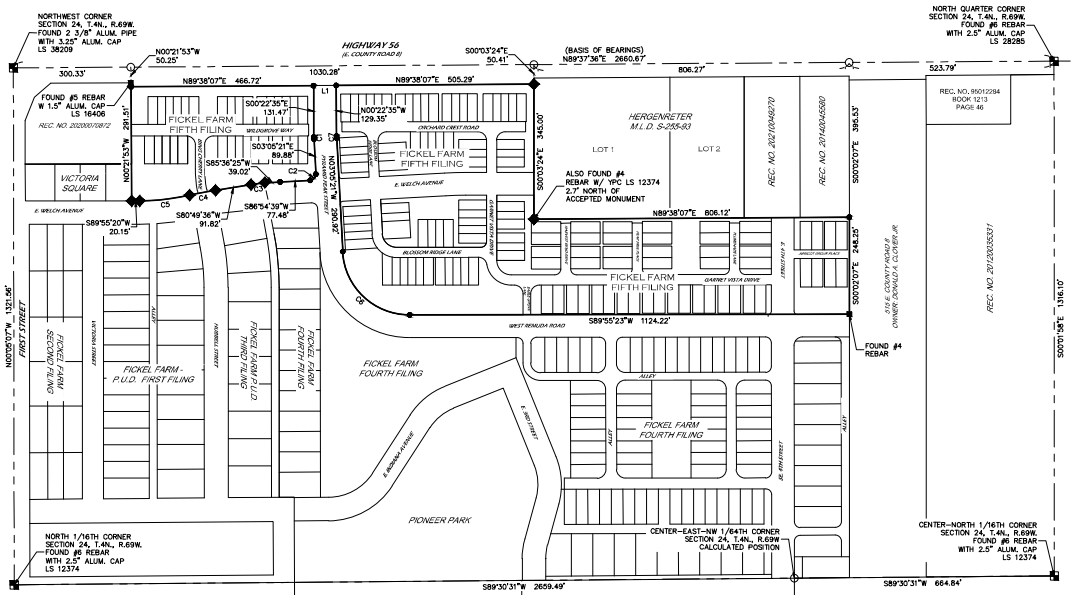
Surveyor: Majestic Surveying, LLC
C/O Matt Kramer, PLS
1111 Diamond Valley Drive, Suite 104
Windsor, CO 80550
970-833-5698



SCALE: 1" = 150'



VICINITY MAP
SCALE: 1" = 1000'



LEGEND

- BOUNDARY LINE
- EASEMENT LINE
- RIGHT OF WAY LINE
- SECTION LINE
- CENTERLINE
- ALIQUOT CORNER AS DESCRIBED
- FOUND MONUMENT AS DESCRIBED
- CALCULATED POSITION
- FOUND #4 REBAR WITH GREEN PLASTIC CAP LS 20676
- SET 24" OF #4 REBAR WITH PINK PLASTIC CAP LS 38844

SURVEYOR'S NOTES

1. No record of Right-of-Way for Colorado State Highway 56 was found for this tract of land. This portion is not included within the vesting deed (Reception No. 20200070872), and was not dedicated with any of the Fickel Farm Annexations. The Blue Spruce Addition has Right of way in this area that does not extend to the west line of Fickel Farm 3rd Annexation, creating an area of obscurity. It is assumed that this Tract of land is being used as Right-of-Way for Highway 56.

2. The area of Right-of-Way dedicated to the Town of Berthoud with this plat is 125,018 sq. ft., or 2.870 acres.

3. The Subject Property is in flood zone X, "areas determined to be outside the 0.2% annual chance of flooding" per FEMA flood maps 08069C1387G and 08069C1391G, revised February 6th, 2013.

BASIS OF BEARINGS AND LINEAL UNIT DEFINITION

Assuming the north line of the NW Quarter of Section 24, Township 4 North, Range 69 West of the 6th P.M., monumented as shown on this drawing, as bearing North 89°37'36" East, being a Grid Bearing of the Colorado State Plane, North Zone, North American Datum 1983/2011, a distance of 2,660.67 feet and with all other bearings contained herein relative thereto.

The lineal dimensions as contained herein are based upon the "U.S. Survey Foot".

MAJESTIC SURVEYING
MAJESTIC SURVEYING, LLC 1111 DIAMOND VALLEY DRIVE #104, WINDSOR, CO 80550

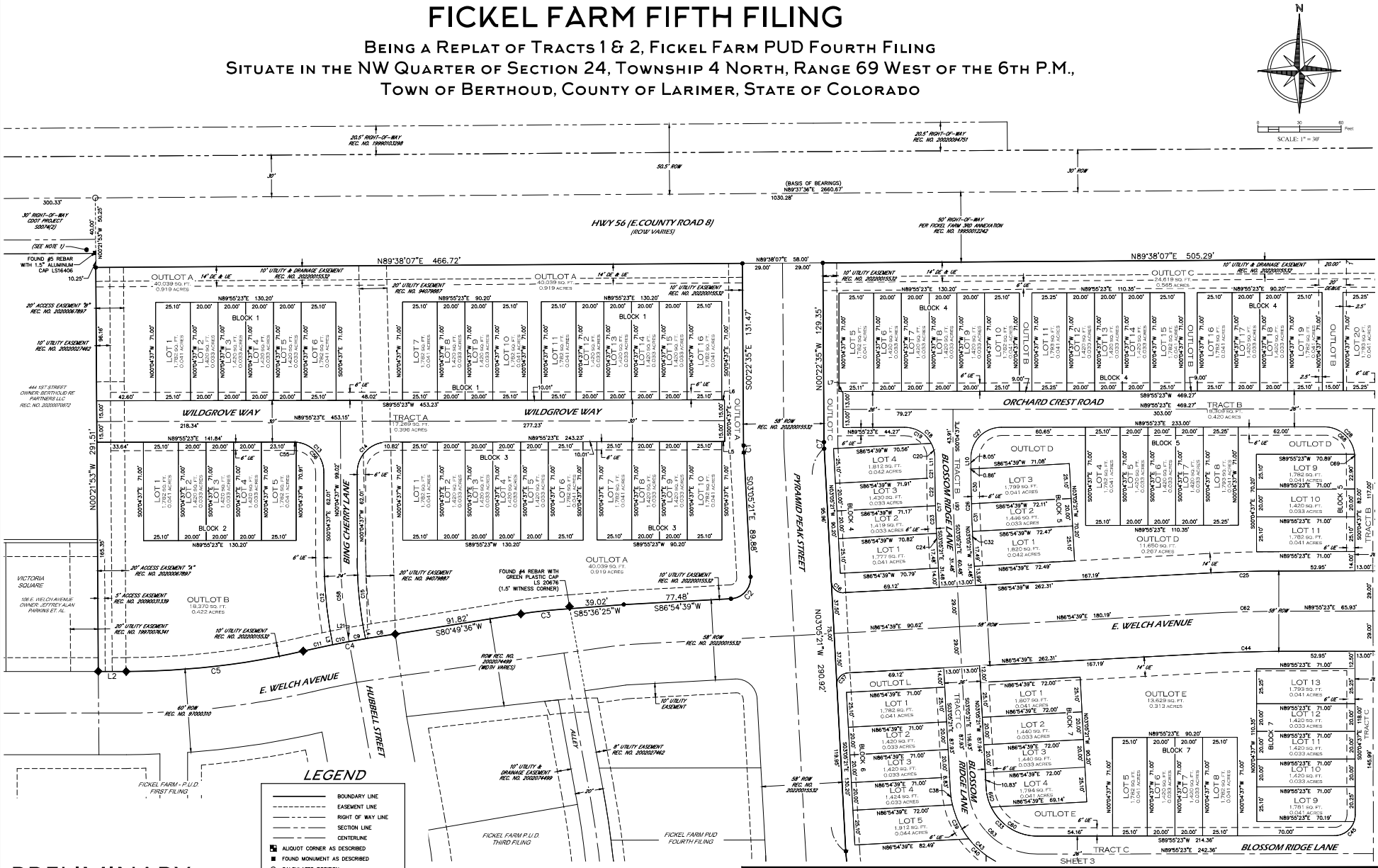
PROJECT NO: 2024487	NAME: FICKEL FARM 5TH	REVISIONS:	DATE:
DATE: 9-12-2025	CLIENT: CIVILWORX	REDLINES	7-30-25
DRAWN BY: MAK	FILE NAME: 2024487SUB		
CHECKED BY: GQ	SCALE: 1" = 150'		

1
SHEET 1 OF 4

Attachment 2

FICKEL FARM FIFTH FILING

Being a Replat of Tracts 1 & 2, Fickel Farm PUD Fourth Filing
Situate in the NW Quarter of Section 24, Township 4 North, Range 69 West of the 6th P.M.,
Town of Berthoud, County of Larimer, State of Colorado



LEGEND

- BOUNDARY LINE
- EASEMENT LINE
- RIGHT OF WAY LINE
- SECTION LINE
- CENTERLINE
- ALIQUOT CORNER AS DESCRIBED
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PRELIMINARY

Matthew A. Kramer - On Behalf of Majestic Surveying, LLC
Colorado Licensed Professional Land Surveyor #38844

NOTICE

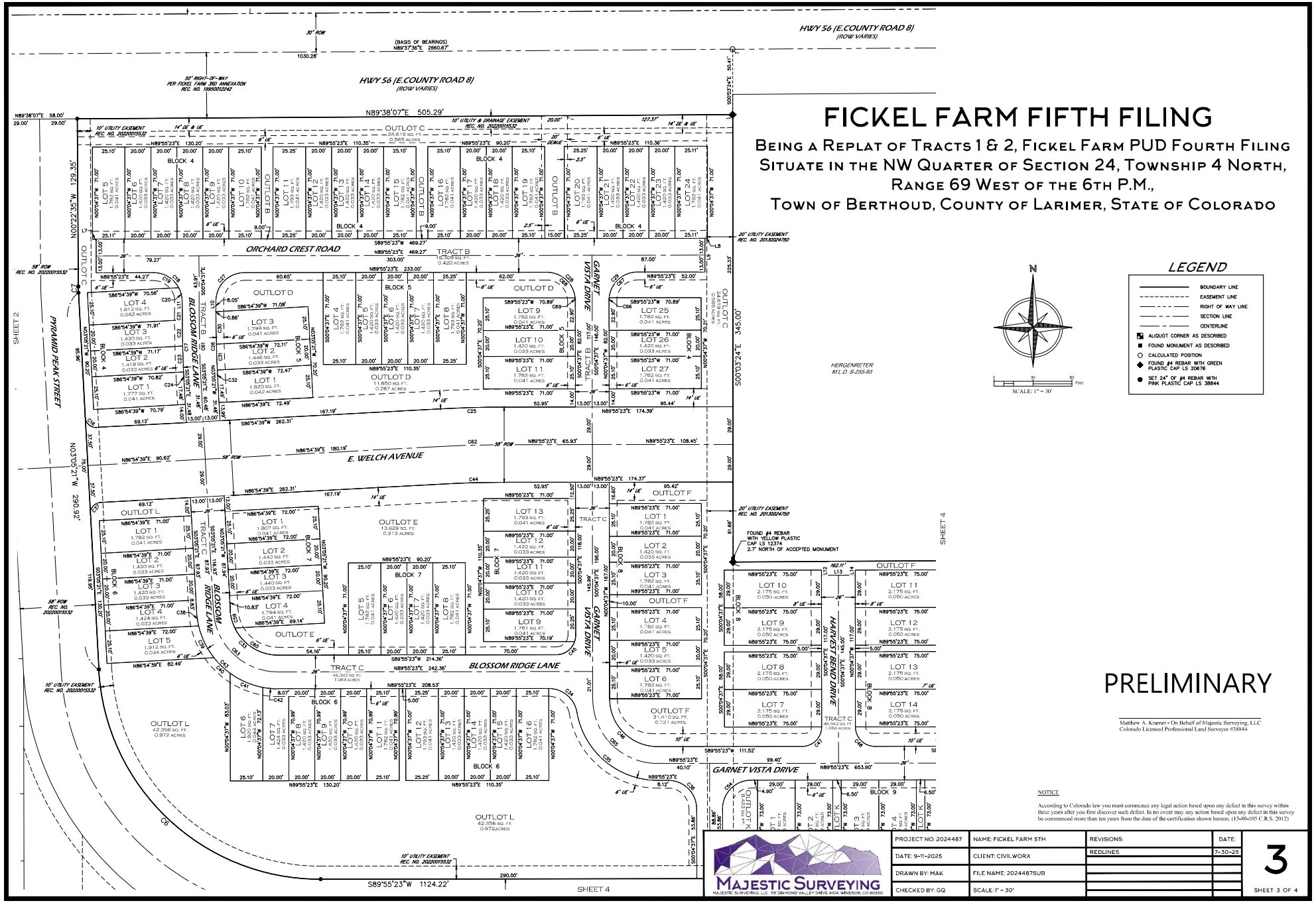
According to Colorado law you must commence any legal action based upon any defect in this survey within three years after you first discover such defect. In no event may any action based upon any defect in this survey be commenced more than ten years from the date of the certification shown hereon. (13-80-105 C.R.S. 2012)

MAJESTIC SURVEYING
MAJESTIC SURVEYING, LLC 111 DIAMOND VALLEY DRIVE #104, WINDSOR, CO 80550

PROJECT NO: 2024487	NAME: FICKEL FARM 5TH	REVISIONS:	DATE:
DATE: 9-11-2025	CLIENT: CIVILWORX	REDLINES	7-30-25
DRAWN BY: MAK	FILE NAME: 2024487SUB		
CHECKED BY: GQ	SCALE: 1" = 30'		

2

SHEET 2 OF 4



Matthew A. Kramer - On Behalf of Majestic Surveying, LLC
Colorado Licensed Professional Land Surveyor #38844

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FICKEL FARM FIFTH FILING

Being a Replat of Tracts 1 & 2, Fickel Farm PUD Fourth Filing

Situate in the NW Quarter of Section 24, Township 4 North, Range 69 West of the 6th P.M., Town of Berthoud, County of Larimer, State of Colorado

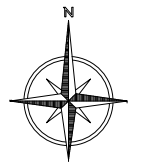
LINE TABLE		
LINE	BEARING	LENGTH
L1	N89°38'07"E	58.00'
L2	S89°55'20"W	20.15'
L3	S10°23'14"E	6.53'
L4	N10°23'14"W	6.53'
L5	S89°55'23"W	2.00'
L6	N89°55'23"E	2.00'
L7	N89°55'23"E	2.85'
L8	N89°55'23"E	2.00'
L9	S00°04'37"E	26.00'
L10	N00°04'37"W	8.91'
L11	S00°04'37"E	8.91'
L12	N00°04'37"W	4.00'
L13	S89°55'23"W	26.00'
L14	S00°04'37"E	4.00'
L15	N00°04'37"W	4.00'
L16	S89°55'23"W	26.00'
L17	S00°04'37"E	4.00'
L18	N00°04'37"W	4.00'
L19	S89°56'27"W	26.00'
L20	S00°04'37"E	4.00'
L21	N10°23'13"W	6.46'

CURVE TABLE					
CURVE	LENGTH	RADIUS	DELTA	CHORD	CH BEARING
C1	5.00'	79.00'	3°37'42"	5.00'	S02°11'26"E
C2	23.56'	15.00'	90°00'00"	21.21'	S41°54'39"W
C3	35.54'	332.50'	6°07'29"	35.53'	S83°53'21"W
C4	67.56'	731.63'	5°17'28"	67.54'	S79°36'48"W
C5	128.88'	570.00'	12°57'16"	128.60'	S83°26'42"W
C6	259.62'	171.00'	86°59'16"	235.39'	N46°34'59"W
C7	4.78'	101.00'	2°42'46"	4.78'	N01°43'58"W
C8	21.79'	731.63'	1°42'22"	21.78'	N81°24'21"E
C9	12.00'	731.63'	0°56'23"	12.00'	N80°04'59"E
C10	12.00'	731.63'	0°56'23"	12.00'	N79°08'35"E
C11	21.78'	731.63'	1°42'20"	21.78'	N77°49'14"E
C12	56.14'	312.00'	10°18'37"	56.07'	S05°13'56"E
C13	34.56'	22.00'	90°00'00"	31.11'	S45°04'37"E
C14	34.56'	22.00'	90°00'00"	31.11'	N44°55'23"E
C15	51.82'	288.00'	10°18'37"	51.75'	N05°13'56"W
C16	13.35'	8.50'	90°00'00"	12.02'	N48°06'21"W
C17	53.26'	101.00'	3°00'44"	53.25'	S01°34'59"E
C18	34.56'	22.00'	90°00'00"	31.11'	S45°04'37"E
C19	23.64'	22.00'	61°34'18"	22.52'	N59°17'28"W
C20	10.92'	22.00'	28°25'42"	10.80'	N14°17'28"W
C21	5.62'	101.00'	0°19'04"	5.62'	N00°14'09"W

CURVE TABLE					
CURVE	LENGTH	RADIUS	DELTA	CHORD	CH BEARING
C22	20.01'	1013.00'	1°07'55"	20.01'	N00°57'39"W
C23	20.00'	1013.00'	1°07'53"	20.00'	N02°05'33"W
C24	7.62'	1013.00'	0°25'51"	7.62'	N02°52'25"W
C25	54.10'	1029.00'	3°00'44"	54.09'	S88°25'01"W
C26	51.89'	987.00'	3°00'44"	51.88'	N01°34'59"W
C27	34.56'	22.00'	90°00'00"	31.11'	N44°55'23"E
C28	34.56'	22.00'	90°00'00"	31.11'	S45°04'37"E
C29	34.56'	22.00'	90°00'00"	31.11'	N44°55'23"E
C30	24.27'	987.00'	1°24'31"	24.27'	S00°46'53"E
C31	20.00'	987.00'	1°09'40"	20.00'	S02°03'59"E
C32	7.62'	987.00'	0°26'32"	7.62'	S02°52'05"E
C33	56.17'	37.00'	86°58'27"	50.93'	N46°34'59"W
C34	30.92'	22.00'	80°31'11"	28.44'	S49°49'01"E
C35	88.52'	62.98'	80°31'48"	81.41'	S49°48'24"E
C36	34.56'	22.00'	90°00'00"	31.11'	S45°04'37"E
C37	13.35'	8.50'	89°59'59"	12.02'	N41°54'40"E
C38	11.23'	63.00'	10°12'57"	11.22'	N08°11'35"W
C39	27.42'	63.00'	24°56'22"	27.21'	N25°46'14"W
C40	17.40'	63.00'	15°49'38"	17.35'	N46°09'14"W
C41	27.59'	63.00'	25°05'15"	27.37'	N66°36'41"W
C42	12.01'	63.00'	10°55'04"	11.99'	N84°36'51"W

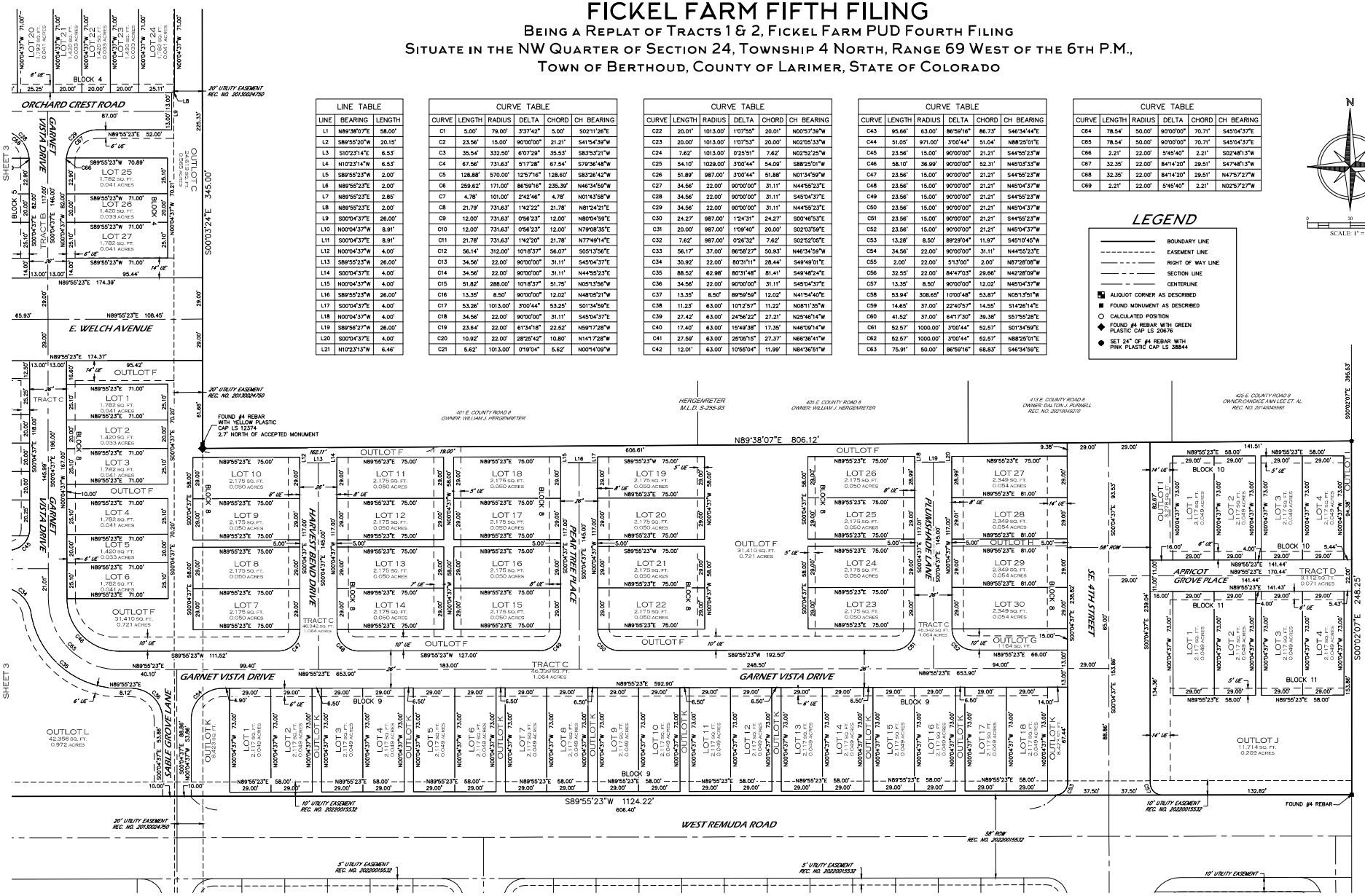
CURVE TABLE					
CURVE	LENGTH	RADIUS	DELTA	CHORD	CH BEARING
C43	95.66'	63.00'	86°59'16"	86.73'	S46°34'44"E
C44	51.05'	971.00'	3°00'44"	51.04'	N88°25'01"E
C45	23.56'	15.00'	90°00'00"	21.21'	S44°55'23"W
C46	58.10'	36.99'	90°00'00"	52.31'	N45°03'33"W
C47	23.56'	15.00'	90°00'00"	21.21'	S44°55'23"W
C48	23.56'	15.00'	90°00'00"	21.21'	N45°04'37"W
C49	23.56'	15.00'	90°00'00"	21.21'	S44°55'23"W
C50	23.56'	15.00'	90°00'00"	21.21'	N45°04'37"W
C51	23.56'	15.00'	90°00'00"	21.21'	S44°55'23"W
C52	23.56'	15.00'	90°00'00"	21.21'	N45°04'37"W
C53	13.28'	8.50'	89°29'04"	11.97'	S45°10'45"W
C54	34.56'	22.00'	90°00'00"	31.11'	N44°55'23"E
C55	2.00'	22.00'	5°13'00"	2.00'	N87°28'08"W
C56	32.55'	22.00'	84°47'03"	29.66'	N42°28'09"W
C57	13.35'	8.50'	90°00'00"	12.02'	N45°04'37"W
C58	53.94'	308.65'	10°00'48"	53.87'	N05°13'51"W
C59	14.65'	37.00'	22°40'57"	14.55'	S14°26'14"E
C60	41.52'	37.00'	64°17'30"	39.38'	S57°55'28"E
C61	52.57'	1000.00'	3°00'44"	52.57'	S01°34'59"E
C62	52.57'	1000.00'	3°00'44"	52.57'	N88°25'01"E
C63	75.91'	50.00'	86°59'16"	68.83'	S46°34'59"E

CURVE TABLE					
CURVE	LENGTH	RADIUS	DELTA	CHORD	CH BEARING
C64	78.54'	50.00'	90°00'00"	70.71'	S45°04'37"E
C65	78.54'	50.00'	90°00'00"	70.71'	S45°04'37"E
C66	2.21'	22.00'	5°45'40"	2.21'	S02°48'13"W
C67	32.35'	22.00'	84°14'20"	29.51'	S47°48'13"W
C68	32.35'	22.00'	84°14'20"	29.51'	N47°57'27"W
C69	2.21'	22.00'	5°45'40"	2.21'	N02°57'27"W



LEGEND

- BOUNDARY LINE
- EASEMENT LINE
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PRELIMINARY

Matthew A. Kramer - On Behalf of Majestic Surveying, LLC
Colorado Licensed Professional Land Surveyor #38844

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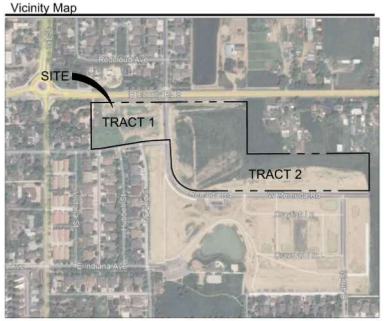
PROJECT NO: 2024487	NAME: FICKEL FARM 5TH	REVISIONS:	DATE:
DATE: 9-11-2025	CLIENT: CIVILWORX	REDLINES	7-30-25
DRAWN BY: MAK	FILE NAME: 2024487SUB		
CHECKED BY: GQ	SCALE: 1" = 30'		

4

SHEET 4 OF 4

Attachment 3

Vicinity Map



Subdivision Identity & Residential Standards

UNITS PROVIDED:	154
SUBDIVISION IDENTITY ELEMENTS POINTS REQUIRED:	7
PREVIOUSLY APPROVED ELEMENTS:	
1. COMMUNITY GARDENS	1
2. USABLE OPEN SPACE	2
3. PLAYGROUND	1
4. ENHANCED ENTRYWAY	1
5. ALLEY LOADED STREETS, MAINTAINED BY TOWN	1
TOTAL	6
PROPOSED IDENTITY ELEMENT:	
1. POCKET PARK	1
TOTAL	7

General Notes:

1. ALL SIGNS SHALL BE REQUIRED TO APPLY FOR SIGN PERMIT.
2. PROPOSED GRADES SHALL MATCH OR IMPROVE EXISTING GRADES TO PROVIDE POSITIVE DRAINAGE AWAY FROM BUILDING WHILE PROVIDING A SMOOTH TRANSITION BETWEEN ALL ADJACENT UNDISTURBED GRADES AND PROPOSED GRADES.
3. JOB SITE TO BE KEPT CLEAN AT ALL TIMES AND CONSTRUCTION AREAS ARE TO BE MAINTAINED FOR SAFETY.
4. ALL SOILS DISTURBED ADJACENT TO WORK AREA, INCLUDING AREAS OUTSIDE OF CONSTRUCTION LIMITS, DUE TO NEW CONSTRUCTION ARE TO BE REGRADED AND SURFACE CONDITIONS REPAIRED EQUIVALENT TO THAT CONDITION PRIOR TO START OF WORK PER THE NATIVE SEED MIX NOTES THIS SHEET.
5. PROTECT EXISTING SURFACES AND SOILS, BOTH INSIDE AND OUTSIDE OF CONSTRUCTION LIMITS, DURING CONSTRUCTION. IF GRADES, CONCRETE OR ASPHALT ARE DAMAGED DUE TO CONSTRUCTION OPERATIONS OR WEATHER THE CONTRACTOR IS RESPONSIBLE FOR REPAIR TO THAT EQUIVALENT TO EXISTING CONDITIONS AT NO EXPENSE TO THE OWNER / TOWN.
6. CONTRACTOR IS RESPONSIBLE FOR SETUP OF BARRICADES, WARNING SIGNAGE, OR OTHER PROTECTIVE DEVICES IF ANY EXCAVATIONS ARE LEFT EXPOSED AFTER ON-SITE WORK HOURS.
7. THE CONTRACTOR SHALL NOT PURPOSEFULLY PROCEED WITH ANY CONSTRUCTION PER PLANS PROVIDED WHEN OBSTRUCTIONS AND/OR GRADE DIFFERENCES EXIST THAT WERE NOT CONSIDERED OR CHANGED AFTER PLANS WERE SUBMITTED. CONTRACTOR SHALL NOTIFY OWNER OR OWNER'S REPRESENTATIVE AND THE TOWN IF SITUATION ARISES AND REVISIONS ARE NECESSARY.

THE CONTRACTOR SHALL PREVENT SEDIMENT, DEBRIS AND OTHER POLLUTANTS FROM ENTERING ANY STORM WATER SEWER SYSTEM OR, ADJACENT WATER WAYS, ETC., DURING THE DEMOLITION OR CONSTRUCTION OPERATIONS THAT ARE PART OF THIS PROJECT. THE CONTRACTOR SHALL BE HELD RESPONSIBLE AND EXPENSE FOR THE CORRECTION OF ANY ADVERSE IMPACTS TO THE STORM WATER SEWER SYSTEM OR, ADJACENT WATER WAYS, WETLANDS ETC., RESULTING FROM THE WORK DONE AS PART OF THIS PROJECT/CONTRACT.

THE CONTRACTOR SHALL BE RESPONSIBLE PRIOR TO BIDDING AND CONSTRUCTION, OF BECOMING AWARE OF ALL EXISTING AND PROPOSED UTILITIES, PIPES, STRUCTURES, ETC. CALL UNCC THREE DAYS BEFORE SCHEDULED WORK AT 811 OR 1-800-922-1987.

TOWN OF BERTHOUD, COLORADO
PRELIMINARY APPROVAL

Town Planner — Date

Landscape Notes

1. LANDSCAPE AREAS SHALL BE MAINTAINED, INCLUDING MOWING, WATERING AND FERTILIZING BY CONTRACTOR, UP TO FINAL ACCEPTANCE. AT SUCH TIME OWNER WILL BE RESPONSIBLE FOR ALL MAINTENANCE. LANDSCAPE AND IRRIGATION WILL BE WARRANTED FOR ONE (1) FULL YEAR AFTER FINAL ACCEPTANCE. ALL NATIVE GRASS AREAS MAY NOT EXCEED 8" IN HEIGHT.
2. ANY DISCREPANCIES WITH THE DRAWINGS AND SITE CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE OWNERS REPRESENTATIVE PRIOR TO PROCEEDING WITH CONSTRUCTION.
3. CONTRACTOR TO VERIFY ALL FIELD CONDITIONS, EASEMENTS, PROPERTY LINES, ETC. PRIOR TO STARTING WORK. SHOULD ANY DISCREPANCIES, OMISSIONS, OR ERRORS OCCUR, NOTIFY THE OWNER'S REPRESENTATIVE IMMEDIATELY.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES 48 HRS. PRIOR TO ANY EXCAVATION OR PLANTING.
5. LANDSCAPE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY COORDINATION WITH SUBCONTRACTORS AS REQUIRED TO ACCOMPLISH PLANTING OPERATIONS.
6. STREET AND ORNAMENTAL TREES SHALL BE PLANTED NO CLOSER THAN FORTY (40) FEET AND FIFTEEN (15) FEET RESPECTIVELY FROM STREET LIGHTS. NO TREES SHALL BE PLANTED WITHIN TEN (10) FEET FROM WATER AND SEWER LINES, FOUR (4) FEET FROM GAS, TELEPHONE AND ELECTRIC UTILITIES, FIVE (5) FEET FROM STORM SEWER LINES, AND FIVE (5) FEET FROM ANY DRIVEWAY.
7. MINIMUM CLEARANCE OF THREE (3) FEET ON EACH SIDE OF FIRE DEPARTMENT CONNECTION (FDC). NO VEGETATION OTHER THAN TURF OR GROUND COVERS PLANTED IN FRONT OF FDC.
8. ANY OBJECT WITHIN THE SIGHT DISTANCE EASEMENT MORE THAN 30 INCHES ABOVE THE FLOWLINE 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, BUSHES, UTILITY CABINETS, OR TALL CROPS. MAILBOX CLUSTERS MUST BE INSTALLED A MINIMUM OF 2 FEET FROM BACK OF WALK AND NOT CAUSE ANY SIGHT OBSTRUCTION. IN NO CASE SHALL ANY PERMANENT OBJECT ENCROACH INTO THE LINE-OF-SIGHT OF ANY PART OF THE SIGHT-DISTANCE TRIANGLE. STREET TREES REQUIRED ARE EXCEPTED FROM THIS REQUIREMENT. TREES ARE PERMITTED IF PRUNED UP TO 8 FEET. IN ADDITION TO THE SIGHT DISTANCE TRIANGLE REQUIREMENTS, A CLEAR SPACE ZONE IS REQUIRED WITHIN ALL CURB RETURNS (MEASURED FROM POINT OF CURB TO POINT OF CURB RETURN) WHERE NO TREES, SHRUBS, AESTHETIC STRUCTURES/FEATURES, MONUMENT SIGNS, OR OBJECTS THAT HAVE THE POTENTIAL TO HINDER DRIVER VISIBILITY, AND/OR PEDESTRIAN AND BICYCLE SAFETY, ARE ALLOWED. SEE LARIMER COUNTY URBAN AREA STREET STANDARDS SECTION 7.4.1.C. FOR ADDITIONAL INFORMATION.
9. IF TREES OR SHRUBS ARE LOCATED ON TOP OF FIELD VERIFIED UTILITIES, CONTRACTOR SHALL NOTIFY OWNER BEFORE ANY DIGGING HAS COMMENCED. VERIFY WITH OWNER IF AND WHICH SHRUBS/TREES SHALL BE TAKEN OUT OF PROJECT/CONTRACT. ANY REMOVAL OR SUBSTITUTION OF PLANT MATERIAL SHALL BE APPROVED BY THE TOWN, PRIOR TO PROCEEDING.
10. TO THE MAXIMUM EXTENT FEASIBLE, TOPSOIL THAT IS REMOVED DURING CONSTRUCTION ACTIVITY SHALL BE CONSERVED FOR LATER USE ON AREAS REQUIRING REVEGETATION AND LANDSCAPING.
11. EXCAVATED MATERIAL TO BE USED AS FILL WILL HAVE ALL ROCKS, DEBRIS, WASTE MATERIAL, FROZEN MATERIAL, VEGETATION LARGER THAN 3" IN ANY DIMENSION REMOVED BEFORE PLACEMENT AND COMPACTION OF SOIL.
12. PRIOR TO FINE GRADING, DURA-TURF TALL FESCUE SOD OR DURA-TURF TALL FESCUE SEEDED AREAS AND PLANTING BEDS, SHALL BE THOROUGHLY LOOSENED AND TILLED TO A 6" DEPTH. REMOVE ALL UNSUITABLE TOPSOIL, INCLUDING ALL ROCKS LARGER THAN 3 INCHES IN ANY DIRECTION, ALL CONCRETE, TRASH, DEBRIS, WEEDS, ROOTS AND OTHER WASTE MATERIALS. AFTER THAT TIME CLASS I OR II, EXCLUDING MANURE, SHALL THEN BE THOROUGHLY TILLED AND INCORPORATED TO A MINIMUM 6" DEPTH IN THESE AREAS AT THE MINIMUM OF RATE OF 3 CU. YDS. / 1,000 SQ.FT.
13. UNIFORMLY COMPACT AND FINE GRADE THESE SOD / GRASS AREAS AND PLANTING BEDS TO A SMOOTH SURFACE, FREE FROM IRREGULAR SURFACE CHANGES. CUT OUT SOFT SPOTS, FILL IN LOW SPOTS AND TRIM HIGH SPOTS TO COMPLY WITH REQUIRED GRADE TOLERANCES.
14. ONCE COMPACTED AND FINE GRADED ALL ROCKS, DEBRIS, WASTE MATERIAL AND VEGETATION MATERIAL LARGER THAN 1/2" WILL BE RAKED FROM THE SURFACE AND REMOVED FROM SITE.
15. SOD TO BE 100% COLORADO GROWN, GRAFF'S RTF TALL FESCUE BLEND (OR APPROVED EQUAL) SPECIFICALLY GROWN FOR LOW WATER LAWN APPLICATIONS WITH MINIMUM THREE (3) IMPROVED VARIETIES, HAVING A HEALTHY VIGOROUS ROOT SYSTEM. ONCE TURF IS LAID IT SHALL BE PROPERLY ROLLED, COMPACTED AND PUSHED TOGETHER TO ELIMINATE ANY GAPS BETWEEN ROLL EDGES. APPLY FERTILIZER IN THESE AREAS PER SOD FARM'S RECOMMENDATIONS.
16. ALL PLANT MATERIALS ARE SIZED AND OUTLINED IN PLANT LIST. ALL PLANTS TO BE PLANTED IN AMENDED SOIL AND STAKED AS SHOWN IN DETAILS. ALL PLANT MATERIAL SHALL MEET OR EXCEED THE CODE OF STANDARDS CURRENTLY RECOMMENDED BY THE COLORADO NURSERY ACT FOR NUMBER ONE GRADE.
17. IF PLANTS ARE IN NEED OF REPLACEMENT DUE TO DECLINING HEALTH, DISEASE, OR DEATH, THE PLANTS MUST BE REPLACED WITH THE ORIGINAL SPECIES UNLESS APPROVED BY THE TOWN.
18. CHANGES IN PLANT SPECIES OF PLANT LOCATIONS FROM WHAT IS LISTED ON THE LANDSCAPE PLAN WILL REQUIRE THE APPROVAL OF THE TOWN PRIOR TO INSTALLATION OF REPLACEMENT. OVERALL QUANTITY AND QUALITY TO BE CONSISTENT WITH THE APPROVED PLANS. IN THE EVENT OF CONFLICT WITH THE QUANTITIES INCLUDED IN THE PLANT LIST, SPECIES AND QUANTITIES SHALL BE PROVIDED.
19. ALL TREES AND SHRUBS TO BE BALLED AND BURLAPPED, OR CONTAINERIZED.
20. ALL EXISTING TREES TO REMAIN UNLESS OTHERWISE NOTED.
21. ALL PLANT MATERIAL SHALL HAVE ALL WIRE, TWINE, BASKETS, BURLAP, AND ALL OTHER NON-BIODEGRADABLE CONTAINMENT MATERIAL REMOVED FROM THE TRUNK AND/OR ROOT BALL OF THE PLANT, PRIOR TO PLANTING.
22. ALL SHRUB BEDS SHALL HAVE MINIMUM 4" DEPTH SHREDDED CEDAR MULCH - NATURAL COLOR AND/OR WASHED SMOOTH COBBLE. A CONTINUOUS LAYER OF TYPAR LANDSCAPE FABRIC OR APPROVED EQUAL SHALL BE INSTALLED IN ALL COBBLE AREA WITH 6" OVERLAP AT SEAMS WITH 4" STAPLES 4' O.C. IN ALL DIRECTIONS.
23. EDGING BETWEEN GRASS TYPES AND SHRUB BEDS / ROCK COBBLE SHALL BE HEAVY DUTY STEEL EDGER MIN. $\frac{3}{8}$" x 4" WITH ROUNDED TOP AND PLASTIC CAP AND SHALL BE SET LEVEL WITH THE TOP OF THE ADJACENT SOD. NO EDGING SHALL BE USED BETWEEN CEDAR MULCH AND COBBLE TRANSITIONS.
24. LANDSCAPING WITHIN THE FRONT YARD SETBACK OF RESIDENTIAL PROPERTIES MUST BE INSTALLED WITHIN ONE (1) YEAR OF CERTIFICATION OF OCCUPANCY.
25. MAINTENANCE OF ALL COMMON AREAS AND PUBLIC R.O.W. LANDSCAPING IS THE RESPONSIBILITY OF THE METRO DISTRICT.
26. ALL TURF GRASSES PLANTED IN PUBLIC R.O.W. MUST BE SOD
27. THE PROPOSED POCKET PARK SHALL BE BUILT AND MAINTAINED BY THE HOMEOWNERS ASSOCIATION OR METRO DISTRICT.
28. STREET TREES WILL BE PLANTED AT LEAST 5' FROM ANY SERVICE LINE AND DRIVEWAY.
29. LANDSCAPE IN TREE LAWNS IS THE RESPONSIBILITY OF THE BUILDER/HOME OWNER IN FRONT OF INDIVIDUAL LOTS.
30. IN ANY CIRCUMSTANCE WHERE PLANT LIST QUANTITIES OR SPECIES DO NOT MATCH THE PLAN LAYOUT, THE LANDSCAPE INSTALLATION SHALL MATCH THE PLAN LAYOUT.
31. WEED CONTROL WILL BE PRACTICED ON ALL AREAS DISTURBED BY CONSTRUCTION AND THOSE AREAS SHALL BE RESEEDED TO PREVENT EROSION. NATIVE, NONINVASIVE GRASSES SHALL BE USED FOR REVEGETATION WHERE PRACTICAL. WEED CONTROL IS THE RESPONSIBILITY OF THE LANDOWNER ON ALL RESEEDED AREAS AND PRESERVATION AREAS. WEED CONTROL SHALL BE A CONTINUAL RESPONSIBILITY OF THE OWNER DURING ALL PHASES OF LAND CLEARING AND CONSTRUCTION, AND OPERATION. EVERY EFFORT SHALL BE MADE TO PREVENT THE SPREAD OF NOXIOUS WEEDS.
32. IF ANY FENCES, COLUMNS, WALLS OR OTHER STRUCTURES ARE LOCATED ON TOP OF FIELD VERIFIED UTILITIES AND/OR WITHIN A UTILITY EASEMENT, CONTRACTOR SHALL NOTIFY OWNER BEFORE ANY CONSTRUCTION OF THOSE ITEMS HAS COMMENCED.
33. RIGHT-OF-WAY TREE SPACING IS CONCEPTUAL AND MAY REQUIRE FIELD ADJUSTMENT AT THE TIME OF CONSTRUCTION. THE INTENT IS TO LOCATE ONE TREE APPROXIMATELY 40' ON CENTER, UNLESS FIRE HYDRANTS, STREETLIGHTS, DRIVEWAY LOCATIONS, UTILITIES OR OTHER ITEMS WHICH REQUIRE SEPARATION FROM TREES, PROHIBIT THE INTENDED SPACING.

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SHEETS 3-4	LANDSCAPE PLANS
SHEET 5	LANDSCAPE PLAN & POCKET PARK ENLARGEMENT
SHEETS 6-7	LANDSCAPE NOTES & DETAILS
IR1.0	IRRIGATION LEGEND AND NOTES
IR1.1 - IR1.5	IRRIGATION PLAN
IR2.1 - IR2.2	IRRIGATION DETAILS
IR2.3	IRRIGATION SPECIFICATIONS

Native Grass Seed Mix

NON IRRIGATED NATIVE GRASS - (TEMPORARY IRRIGATION FOR ESTABLISHMENT)

NATIVE LOW GROW GRASS SEED MIX OR APPROVED EQUAL: SEED SHALL BE A MIXTURE THAT MATCHES THE FOLLOWING:

LOW GROW SEED MIX

COMMON NAME	%
EPHRAIM CRESTED WHEATGRASS	30%
SHEEP FESCUE	25%
PERENNIAL RYE	20%
CHEWINGS FESCUE	15%
CANADA BLUEGRASS	10%

1. SEED SHALL BE AS MANUFACTURED BY ARKANSAS VALLEY SEED SOLUTIONS OR APPROVED EQUAL, 4625 COLORADO BOULEVARD, DENVER, CO 80216, (877) 957-3337, OR APPROVED EQUAL.
2. DRILLED IN TWO PERPENDICULAR DIRECTIONS WITH AN APPLICATION RATE OF 15 - 20 LBS (PLS) PER ACRE.
3. ADEQUATE TEMPORARY IRRIGATION, OR BY OTHER ACCEPTABLE MEANS, WILL BE PROVIDED BY CONTRACTOR FOR THE WATERING , ESTABLISHMENT AND MAINTENANCE OF THESE SEEDED AREAS, AND THAT NATIVE GRASSES SHALL BE MAINTAINED IN A CONDITION OF ACCEPTABLE HEIGHT, FREE OF WEEDS, TRASH AND DEBRIS, AND SHALL NOT REPRESENT A FIRE HAZARD NOR BECOME A NUISANCE SITE FOR WATER OR WIND EROSION.

MULCH IN ALL NATIVE SEED AREAS:

1. IMMEDIATELY FOLLOWING THE RAKING / SEEDING OPERATION, ADD STRAW MULCH TO THE SEEDED AREAS.
2. APPLY STRAW MULCH AT A MINIMUM OF 1.5 TONS PER ACRE OF AIR DRY MATERIAL. SPREAD STRAW MULCH UNIFORMLY OVER THE AREA WITH MECHANICAL MULCH SPREADER / CRIMPER. DO NOT MULCH WHEN WIND VELOCITY EXCEEDS 10 MPH.
3. WHEREVER THE USE OF CRIMPING EQUIPMENT IS PRACTICAL, PLACE MULCH IN THE MANNER NOTED ABOVE AND ANCHOR IT INTO THE SOIL. USE A DISC SUCH AS A MULCH TILLER, WITH A FLAT SERRATED DISC AT LEAS ¼ INCH IN THICKNESS, HAVING DULL EDGES, AND SPACE NO MORE THAN 9 INCHES APART, WITH DISCS OF SUFFICIENT DIAMETER TO PREVENT THE FRAME OF THE EQUIPMENT FROM DRAGGING THE MULCH. ANCHOR MULCH A MINIMUM DEPTH OF 2 INCHES AND ACROSS THE SLOPE WHERE PRACTICAL WITH NO MORE THAN TWO PASSES OF THE ANCHORING EQUIPMENT.
4. IMMEDIATELY UPON COMPLETION OF THE MULCHING AND BINDING OPERATION, THE SEEDED AREAS SHALL BE IRRIGATED, KEEPING THE TOP 2 INCHES OF SOIL EVENLY MOIST UNTIL SEED HAS UNIFORMLY GERMINATED AND GROWN TO A HEIGHT OF 2-INCHES.
5. WATERING APPLICATION SHALL BE DONE IN A MANNER WHICH WILL PROVIDE UNIFORM COVERAGE BUT WHICH WILL NOT CAUSE EROSION, MOVEMENT, OR DAMAGE TO THE FINISHED SURFACE.
6. APPLY TEMPORARY SEEDING OR TACKIFIER ON ALL DISTURBED AREAS WITHIN LOTS.

Irrigation Notes

1. ENTIRE IRRIGATION SYSTEM AND ASSOCIATED IRRIGATION TAP(S) TO BE SIZED, DESIGNED AND BUILT BY CONTRACTOR. IRRIGATION CONTRACTOR SHALL VERIFY P.S.I. AND GPM AVAILABLE. SYSTEM SHALL BE DESIGNED TO MEET THE AVAILABLE P.S.I. AND GPM. IF NECESSARY CONTACT THE WATER DISTRICT PRIOR TO BEGINNING DESIGN TO OBTAIN AVAILABLE PRESSURES.
2. ALL INDICATED TURF GRASS AREAS ARE TO BE IRRIGATED BY A PERMANENT UNDERGROUND AUTOMATIC IRRIGATION SYSTEM, TURF AREAS LESS THAN 25 FEET IN WIDTH ARE TO BE IRRIGATED WITH POP-UP SPRAY HEADS AND AREAS GREATER THAN 25 FEET SHALL USE A ROTOR POP-UP SPRAY SYSTEM.
3. ALL TREES, SHRUBS AND PERENNIALS OUTSIDE OF IRRIGATED TURF GRASS AREAS ARE TO BE IRRIGATED WITH A PERMANENT DRIP IRRIGATION SYSTEM.
4. IRRIGATION SYSTEM WITH SMART CONTROLLER, RAIN SENSOR, AND NECESSARY SLEEVING WILL BE DESIGNED AND BUILT BY CONTRACTOR AND ADJUSTED TO A LOW WATER REQUIREMENT, BASED ON THE NEEDS OF SELECTED PLANT MATERIAL.
5. QUICK COUPLERS SHALL BE PROVIDED AT EACH POINT OF CONNECTION AND AT REGULAR SPACING ALONG THE IRRIGATION MAINLINE. SPACING OF QUICK COUPLERS SHALL NOT EXCEED 200 FEET. LOCATE QUICK COUPLING VALVE AT A POINT OF EASY ACCESS.
6. FINAL LOCATION OF IRRIGATION HEADS MUST BE APPROVED BY OWNER'S REPRESENTATIVE PRIOR TO PLANTING. HEAD LOCATION SHALL BE COORDINATED IN THE FIELD WITH EXISTING SITE CONDITIONS AND PLANT MATERIAL.
7. ALL IRRIGATION TRENCHES SHALL BE PROPERLY WATERED AND COMPACTED TO AVOID FUTURE SETTLING. ANY SETTLING DURING WARRANTY PERIOD WILL BE REPAIRED BY THE CONTRACTOR AT NO COST TO THE OWNER.
8. COORDINATE ALL IRRIGATION WORK WITH EXISTING UTILITIES AND RESPECTIVE TRADES.
9. ALL IRRIGATION SLEEVING SHALL BE PROVIDED AND INSTALLED BY GENERAL CONTRACTOR. IRRIGATION CONTRACTOR SHALL COORDINATE SLEEVING LOCATIONS WITH GENERAL CONTRACTOR. ALL IRRIGATION SLEEVING TO BE STAKED IN THE FIELD OR LOCATED ON DIMENSIONED "AS-BUILT" DRAWING BY THE GENERAL CONTRACTOR TO ALLOW FUTURE USE AND LOCATION.
10. NATIVE SEED AREAS ARE TO RECEIVE A PERMANENT IRRIGATION SYSTEM. ONCE NATIVE SEED HAS BEEN WELL-ESTABLISHED, IRRIGATION SYSTEM MAY BE UTILIZED AT OWNER'S DISCRETION DURING TIMES OF DROUGHT, BEGINNING OF GROWING SEASONS, ETC.

PARKING SUMMARY	
REQUIRED PARKING	PROVIDED
1.5 spaces per dwelling unit 1.5 x 154 dwellings = 231	308
For all residential units without direct street frontage, an extra 0.20 spaces of off-street visitor parking per unit will be required. 71 x 0.20 = 15	44
TOTAL	
246	352

NOTES:
1. ADDITIONAL PARKING VIA ON-STREET SPACES IS NOT INCLUDED IN THESE CALCULATIONS.
2. ALLEY-LOADED HOMES WITH LESS THAN 1,250 SQ. FT. OF TOTAL FLOOR AREA (INCLUDING UNFINISHED) ARE ONLY REQUIRED ONE PARKING SPACE PER DWELLING UNIT.
3. DWELLING UNIT PARKING IS PROVIDED VIA 2-CAR GARAGES.

TB GROUP
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SEAL

PROJECT TITLE

FICKEL FARM
5TH FILING

LANDSCAPE PLAN

PREPARED FOR:

OWNER:
TRUMARK

8350 E. Crescent Pkwy.
Suite 450
Greenwood Village, CO
80111

REVISIONS — DATE

Staff Comments	05.29.25
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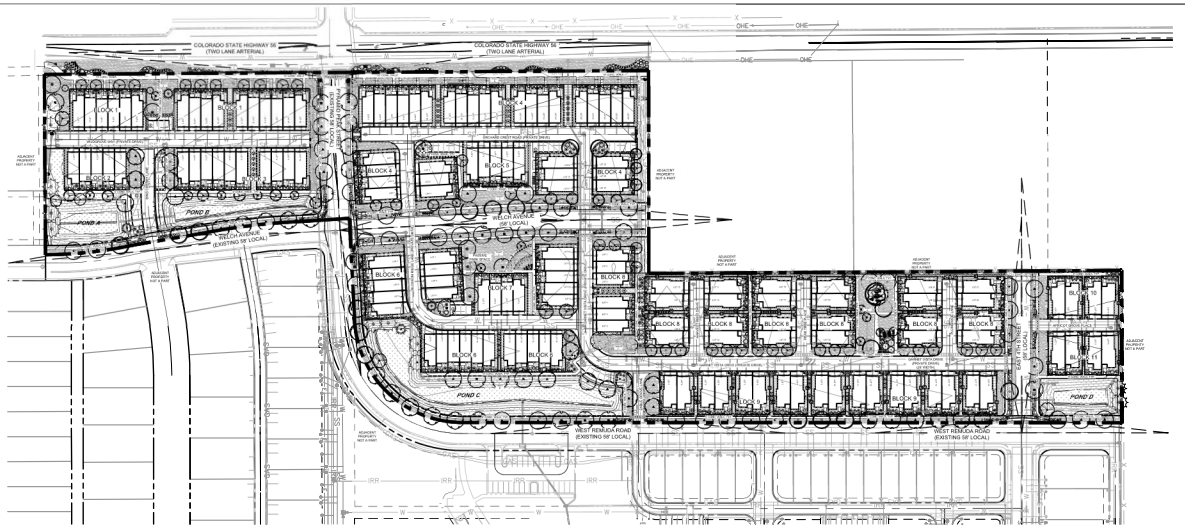
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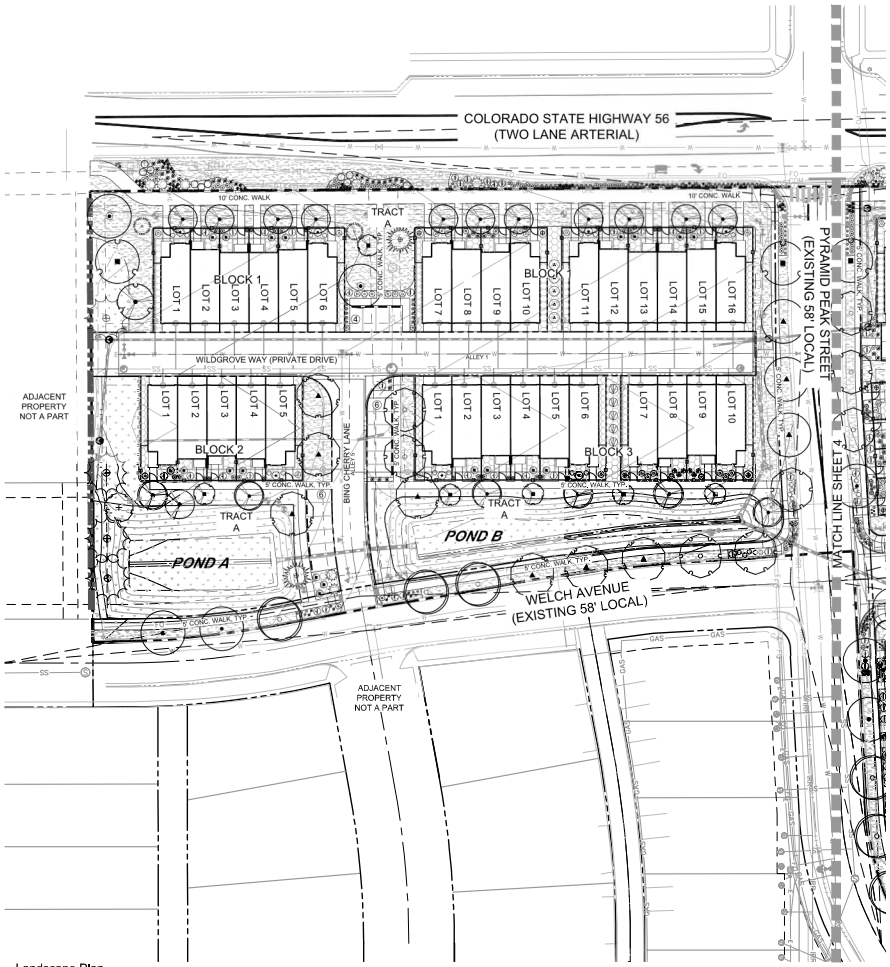
COVER SHEET

SHEET INFORMATION

Sheet Number: 1

Of: 7


COLORADO STATE HIGHWAY 56
(TWO LANE ARTERIAL)
BELLO AVENUE
(50' LOCAL)
WEST RENAISSA ROAD
(EXISTING 58' LOCAL)
EAST RENAISSA ROAD
(EXISTING 58' LOCAL)
POND A
POND B
POND C
POND D
BLOCK 1
BLOCK 2
BLOCK 3
BLOCK 4
BLOCK 5
BLOCK 6
BLOCK 7
BLOCK 8
BLOCK 9
BLOCK 10
BLOCK 11
BLOCK 12
BLOCK 13
BLOCK 14
BLOCK 15
BLOCK 16
BLOCK 17
BLOCK 18
BLOCK 19
BLOCK 20
BLOCK



Landscape Plan

Materials Legend

01 GROUND COVER		
	IRRIGATED TURF GRAFF'S RTF TALL FESCUE BLEND OR APPROVED EQUAL	79,372 sf
	NON-IRRIGATED NATIVE SEED SEE DETAILS FOR SEED MIX	73,299 sf
	1.5" WASHED RIVER ROCK COBBLE ALL SHRUB BEDS TO RECEIVE A MINIMUM 2"-3" DEPTH ROCK COBBLE	111,096 sf
	PLAYGROUND SURFACE FIBAR WOOD MULCH	1,200 sf

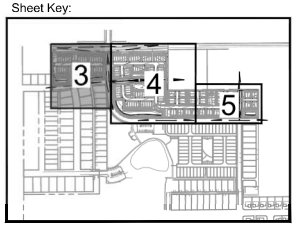
PROPERTY BOUNDARY
EASEMENTS
LANDSCAPE EDGING
6' PRIVACY FENCE
LOT FENCING & GATES
SIGHT DISTANCE TRIANGLE
LIGHT POLES

Landscape Legend

SYMBOL	BOTANICAL / COMMON NAME
DECIDUOUS TREES	
	Catalpa speciosa Western Catalpa
	Celtis occidentalis Western Hackberry
	Gleditsia triacanthos inermis 'Shademaster' Shademaster Honeylocust
	Gymnocladus dioicus 'Espresso' Seedless Kentucky Coffeetree
	Quercus macrocarpa Bur Oak
	Tilia americana 'Redmond' Redmond American Linden
	Ulmus davidiana japonica 'Discovery' Discovery Elm
EVERGREEN TREES	
	Pinus edulis Pinyon Pine
	Pinus heldreichii leucodermis Bosnian Pine
	Pinus nigra Austrian Pine
	Pinus nigra 'Frank' Columnar Austrian Pine
	Pinus ponderosa Ponderosa Pine
ORNAMENTAL TREES	
	Acer tataricum 'GarAnn' Hot Wings Tatarian Maple
	Amelanchier x grandiflora 'Autumn Brilliance' 'Autumn Brilliance' Serviceberry
	Koelreuteria paniculata Golden Rain Tree
	Prunus virginiana 'P002' Sucker Punch Chokecherry
	Syringa reticulata Japanese Tree Lilac

SYMBOL	BOTANICAL / COMMON NAME
DECIDUOUS SHRUBS	
	Agave parryi 'Neomexicana' New Mexico Agave
	Amelanchier alnifolia 'Regent' Regent Serviceberry
	Arctostaphylos x coloradoensis Panchito Manzanita
	Chrysothamnus nauseosus Rubber Rabbitbrush
	Ericameria nauseosa nauseosa Blue Rabbitbrush
	Fallugia paradoxa Apache Plume
	Frangula alnus 'Columnaris' Tall Hedge Buckthorn
	Krascheninnikovia lanata Winterfat
	Perovskia atriplicifolia 'Little Spire' TM Little Spire Russian Sage
	Philadelphus microphyllus Littleleaf Mockorage
	Physocarpus opulifolius 'Little Devil' TM Little Devil Ninebark
	Potentilla fruticosa 'Fargo' Dakota Sunspot® Bush Cinquefoil
	Potentilla fruticosa 'Mango Tango' Mango Tango Potentilla
	Prunus besseyi Western Sand Cherry
	Prunus besseyi 'Pawnee Buttes' Pawnee Buttes Sand Cherry
	Rhus aromatica 'Gro-Low' Gro-Low Fragrant Sumac
	Ribes rubrum 'Red Lake' Red Lake Red Currant
	Rosa x 'Noala' Flower Carpet® Coral Groundcover Rose
	Shepherdia argentea 'Totem' Silver Totem® Buffaloberry
	Syringa x 'Bloomerang' Bloomerang Series Lilac
	Viburnum burejaeticum 'P017S' Mini Man™ Dwarf Manchurian Viburnum
EVERGREEN SHRUBS	
	Arctostaphylos uva-ursi 'Woods Compact' Kinnikinnick
	Pinus mugo 'Slowmound' Slowmound Mugo Pine
	Pinus sylvestris 'Hillside Creeper' Hillside Creeper Pine
GRASSES	
	Bouteloua gracilis 'Blonde Ambition' Blonde Ambition Blue Grama
	Helictotrichon sempervirens Blue Avena Grass
	Panicum virgatum 'Heavy Metal' Heavy Metal Switch Grass
	Sorghastrum nutans 'Indian Steel' Indian Steel Indian Grass
PERENNIALS	
	Achillea millefolium 'Apricot Delight' Tutti Frutti Apricot Delight Common Yarrow
	Achillea x 'Coronation Gold' Coronation Gold Yarrow
	Agastache cana 'Sinning' TM Sonoran Sunset Hummingbird Mint
	Echinacea purpurea 'Bright Star' Bright Star Purple Coneflower
	Hemerocallis fulva Orange Daylily
	Hesperaloe parviflora Red Yucca
	Rudbeckia hirta fulgida Black-eyed Susan
	Sedum x 'Autumn Joy' Autumn Joy Sedum

Sheet Key:



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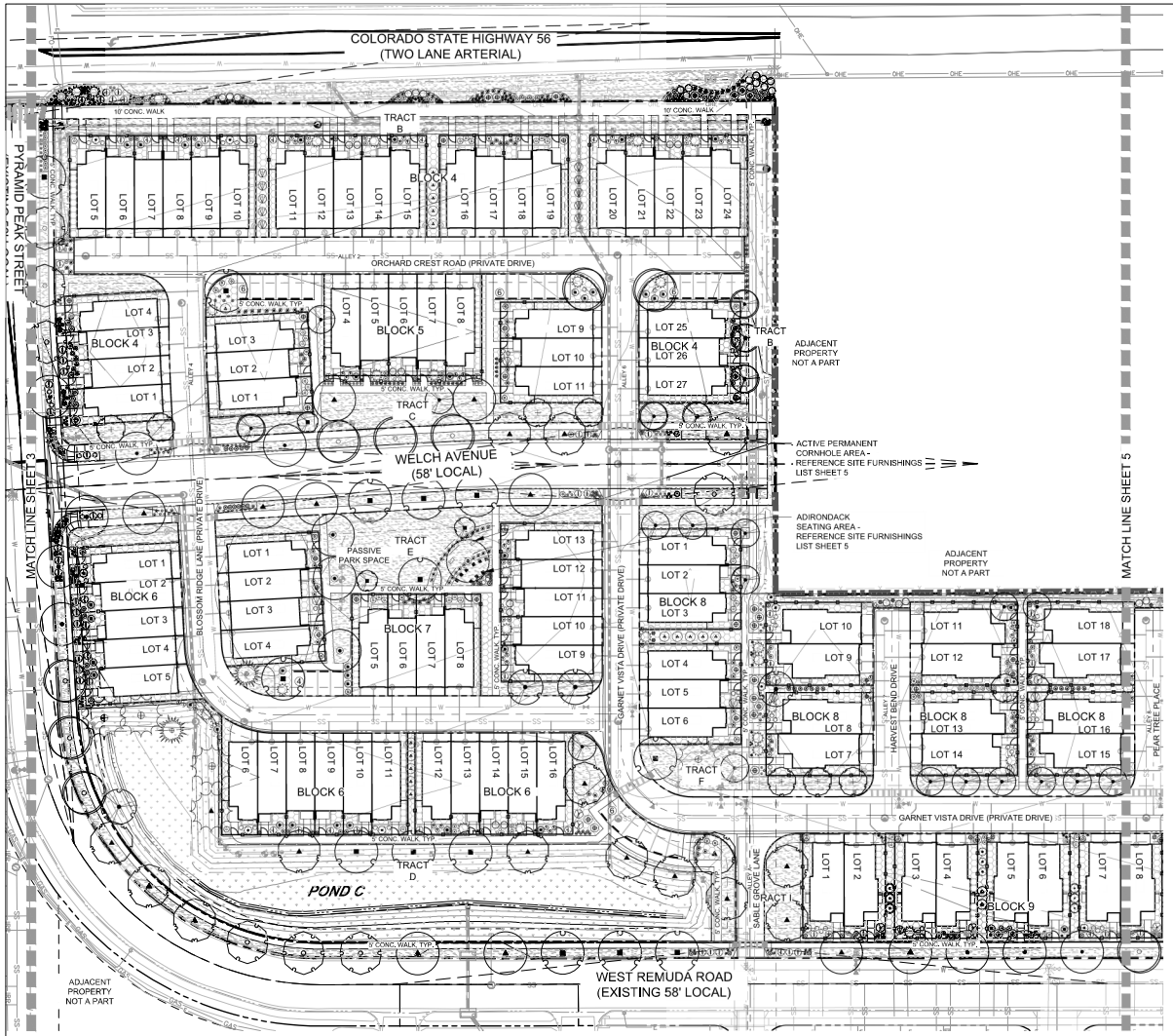
SHEET TITLE

LANDSCAPE PLAN

SHEET INFORMATION

Sheet Number: 3

Of: 7



Landscape Plan

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SCALE 1" = 40'-0"

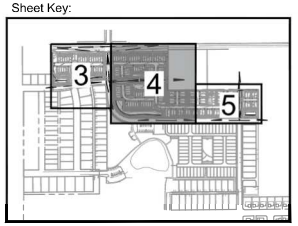
NORTH

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	Pinus sylvestris 'Hillside Creeper' Hillside Creeper Pine
GRASSES	
	Bouteloua gracilis 'Blonde Ambition' Blonde Ambition Blue Grama
	Helictotrichon sempervirens Blue Avena Grass
	Panicum virgatum 'Heavy Metal' Heavy Metal Switch Grass
	Sorghastrum nutans 'Indian Steel' Indian Steel Indian Grass
PERENNIALS	
	Achillea millefolium 'Apricot Delight' Tutti Frutti Apricot Delight Common Yarrow
	Achillea x 'Coronation Gold' Coronation Gold Yarrow
	Agastache cana 'Sinning' TM Sonoran Sunset Hummingbird Mint
	Echinacea purpurea 'Bright Star' Bright Star Purple Coneflower
	Hemerocallis fulva Orange Daylily
	Hesperaloe parviflora Red Yucca
	Rudbeckia hirta fulgida Black-eyed Susan
	Sedum x 'Autumn Joy' Autumn Joy Sedum

Sheet Key:



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SEAL

PROJECT TITLE

FICKEL FARM
5TH FILING

LANDSCAPE PLAN

PREPARED FOR

OWNER:
TRUMARK

8350 E. Crescent Pkwy.
Suite 450
Greenwood Village, CO
80111

REVISIONS | DATE

Staff Comments	05.29.25
Staff Comments	08.04.25
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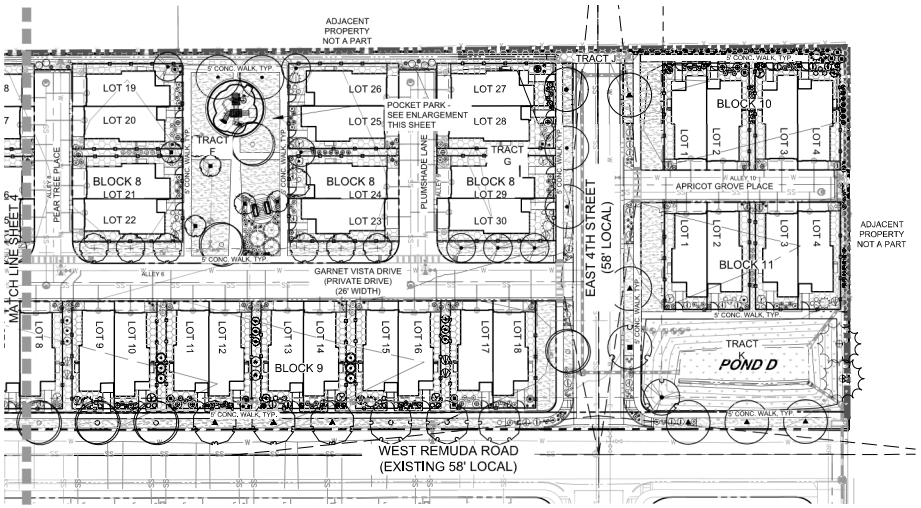
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LANDSCAPE PLAN

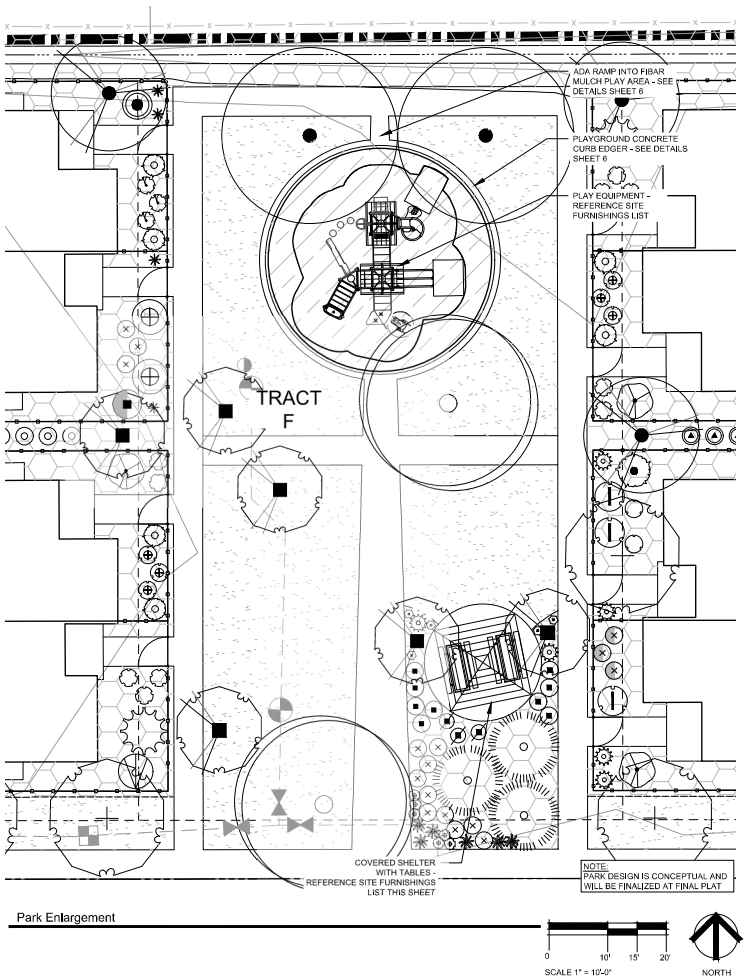
SHEET INFORMATION

Sheet Number: 4

Of: 7



Landscape Plan



Park Enlargement

SCALE 1" = 10'-0"

NORTH

SCALE 1" = 40'-0"

NORTH

Landscape Legend

SYMBOL	BOTANICAL / COMMON NAME
DECIDUOUS TREES	
	Catalpa speciosa Western Catalpa
	Celtis occidentalis Western Hackberry
	Gleditsia triacanthos inermis 'Shademaster' Shademaster Honeylocust
	Gymnocladus dioicus 'Espresso' Seedless Kentucky Coffeetree
	Quercus macrocarpa Bur Oak
	Tilia americana 'Redmond' Redmond American Linden
	Ulmus davidiana japonica 'Discovery' Discovery Elm
EVERGREEN TREES	
	Pinus edulis Pinyon Pine
	Pinus heldreichii leucodermis Bosnian Pine
	Pinus nigra Austrian Pine
	Pinus nigra 'Frank' Columnar Austrian Pine
	Pinus ponderosa Ponderosa Pine
ORNAMENTAL TREES	
	Acer tataricum 'GarAnn' Hot Wings Tatarian Maple
	Amelanchier x grandiflora 'Autumn Brilliance' 'Autumn Brilliance' Serviceberry
	Koelreuteria paniculata Golden Rain Tree
	Prunus virginiana 'P002' Sucker Punch Chokecherry
	Syringa reticulata Japanese Tree Lilac

SYMBOL	BOTANICAL / COMMON NAME
DECIDUOUS SHRUBS	
	Agave parryi 'Neomexicana' New Mexico Agave
	Amelanchier alnifolia 'Regent' Regent Serviceberry
	Arctostaphylos x coloradoensis Panchito Manzanita
	Chrysothamnus nauseosus Rubber Rabbitbrush
	Ericameria nauseosa nauseosa Blue Rabbitbrush
	Fallugia paradoxa Apache Plume
	Frangula alnus 'Columnaris' Tall Hedge Buckthorn
	Kraschenninikovia lanata Winterfat
	Perovskia atriplicifolia 'Little Spire' TM Little Spire Russian Sage
	Philadelphus microphyllus Littleleaf Mockorage
	Physocarpus opulifolius 'Little Devil' TM Little Devil Ninebark
	Potentilla fruticosa 'Fargo' Dakota Sunspot® Bush Cinquefoil
	Potentilla fruticosa 'Mango Tango' Mango Tango Potentilla
	Prunus besseyi Western Sand Cherry
	Prunus besseyi 'Pawnee Buttes' Pawnee Buttes Sand Cherry
	Rhus aromatica 'Gro-Low' Gro-Low Fragrant Sumac
	Ribes rubrum 'Red Lake' Red Lake Red Currant
	Rosa x 'Noala' Flower Carpet® Coral Groundcover Rose
	Shepherdia argentea 'Totem' Silver Totem® Buffaloberry
	Syringa x 'Bloomerang' Bloomerang Series Lilac
	Viburnum burejaeticum 'P017S' Mini Man™ Dwarf Manchurian Viburnum
EVERGREEN SHRUBS	
	Arctostaphylos uva-ursi 'Woods Compact' Kinnikinnick
	Pinus mugo 'Slowmound' Slowmound Mugo Pine
	Pinus sylvestris 'Hillside Creeper' Hillside Creeper Pine
GRASSES	
	Bouteloua gracilis 'Blonde Ambition' Blonde Ambition Blue Grama
	Helictotrichon sempervirens Blue Avena Grass
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	Sorghastrum nutans 'Indian Steel' Indian Steel Indian Grass
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PERENNIALS	
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	Hesperaloe parviflora Red Yucca
	Rudbeckia hirta fulgida Black-eyed Susan
	Sedum x 'Autumn Joy' Autumn Joy Sedum

Materials Legend

	IRRIGATED TURF GRAFF'S RTF TALL FESCUE BLEND OR APPROVED EQUAL	79,372 sf
	NON-IRRIGATED NATIVE SEED SEE DETAILS FOR SEED MIX	73,299 sf
	1.5" WASHED RIVER ROCK COBBLE ALL SHRUB BEDS TO RECEIVE A MINIMUM 2"-3" DEPTH ROCK COBBLE	111,096 sf
	PLAYGROUND SURFACE FIBAR WOOD MULCH	1,200 sf

PROPERTY BOUNDARY

EASEMENTS

LANDSCAPE EDGING

6' PRIVACY FENCE

LOT FENCING & GATES

SIGHT DISTANCE TRIANGLE

LIGHT POLES

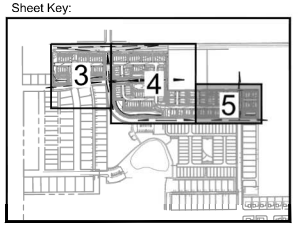
Pocket Park - Furnishing Schedule

DESCRIPTION	MANUFACTURER	MODEL	QUANTITY	MATERIAL / COLOR	MOUNT TYPE
PLAY STRUCTURE	LITTLE TIKES		1		
PARK SHELTER	ICON	SQ20M-P6	1		
TRASH RECEPTACLE	ANOVA	L2019	1	TBD	SURFACE
PARK TABLE	ANOVA	L2003	2	TBD	PORTABLE/SURFACE
BIKE RACK	ANOVA	LBR3PSURF	1	TBD	SURFACE
ADIRONDACK CHAIR	ANOVA	PLK60C	9	TBD	PORTABLE
DOG WASTE	ANOVA	D022-B	1	TBD	INGROUND
BENCH	ANOVA	L2016	1	TBD	SURFACE
PERMANENT CORNHOLE SETS	ICON				

NOTE: ALL PARK EQUIPMENT AS SPECIFIED OR APPROVED EQUAL

POCKET PARK REQUIREMENTS	
REQUIRED	PROVIDED
List A - all	All
List B - 5	Group Picnic Shelter, 2 Tables
List C - 1 High	Commercial-Grade Playground
List C - 2 Low	Passive Adirondack Seating Area Active, Permanent Cornhole Area

Sheet Key:



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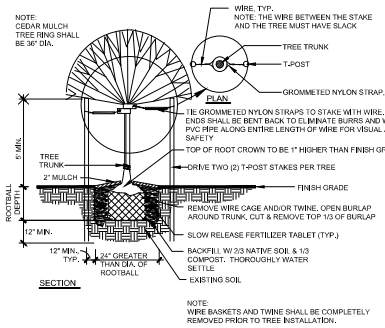
LANDSCAPE PLAN & POCKET PARK ENLARGEMENT

SHEET INFORMATION

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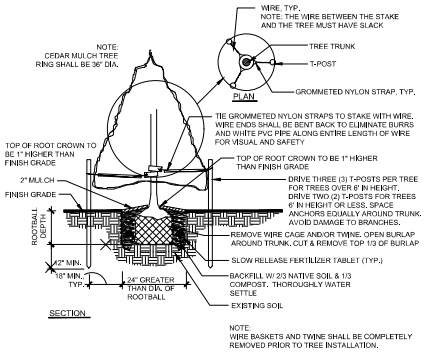
Of: 7

Planting Details



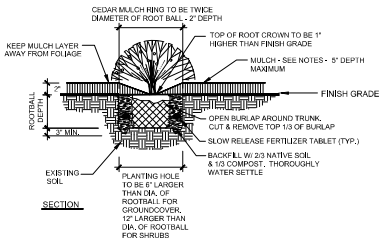
1 DECIDUOUS TREE PLANTING DETAIL

NOT TO SCALE TBG-L-02



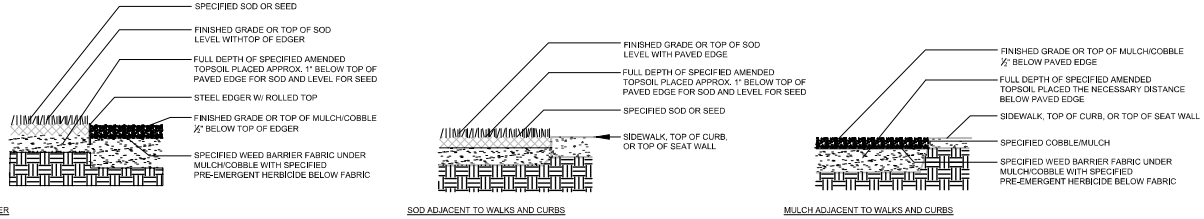
2 CONIFER TREE PLANTING DETAIL

NOT TO SCALE TBG-L-03



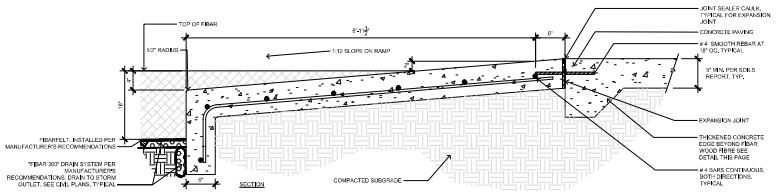
3 GROUND COVER AND SHRUB PLANTING DETAIL

NOT TO SCALE TBG-L-01



4 EDGE TREATMENT

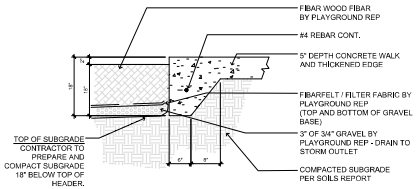
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5 CONCRETE RAMP INTO FIBAR

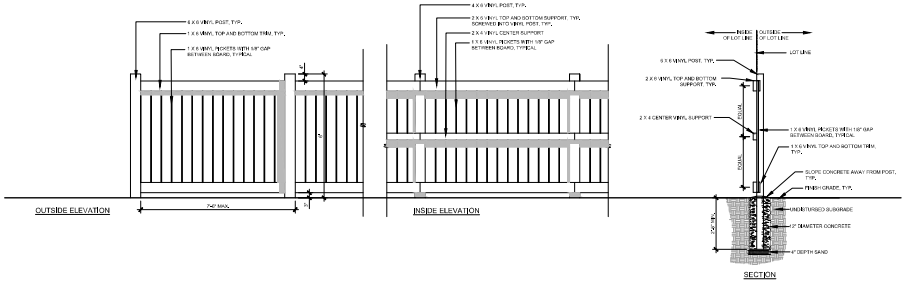
NOT TO SCALE TBG-L-CO-03

NOTES:
1. FIBAR WOOD TO BE INSTALLED AT A MINIMUM OF 15" DEEP (12" AFTER COMPACTION) INSTALLED BY PLAYGROUND REP



7 FIBAR SURFACING & THICKENED EDGE

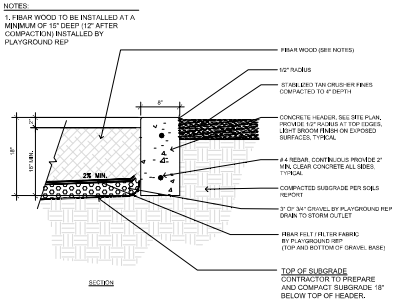
3/4" = 1'-0" TBG-L-CO-04



Fence Type 2 - 6 Foot Privacy Fence Without Column

SCALE 1/2" = 1'-0"

NOTES:
1. FIBAR WOOD TO BE INSTALLED AT A MINIMUM OF 15" DEEP (12" AFTER COMPACTION) INSTALLED BY PLAYGROUND REP



8 TYPICAL CONCRETE PLAYGROUND HEADER

1" = 1'-0" TBG-L-CO-06

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SHEET TITLE

LANDSCAPE NOTES
& DETAILS

SHEET INFORMATION

Sheet Number: 6

Of: 7



LOT FENCING AND GATE EXAMPLE

MANUFACTURER: ARBOR FENCING 4' BLACK METAL, OR APPROVED EQUAL.
PER MANUFACTURER SPECIFICATIONS

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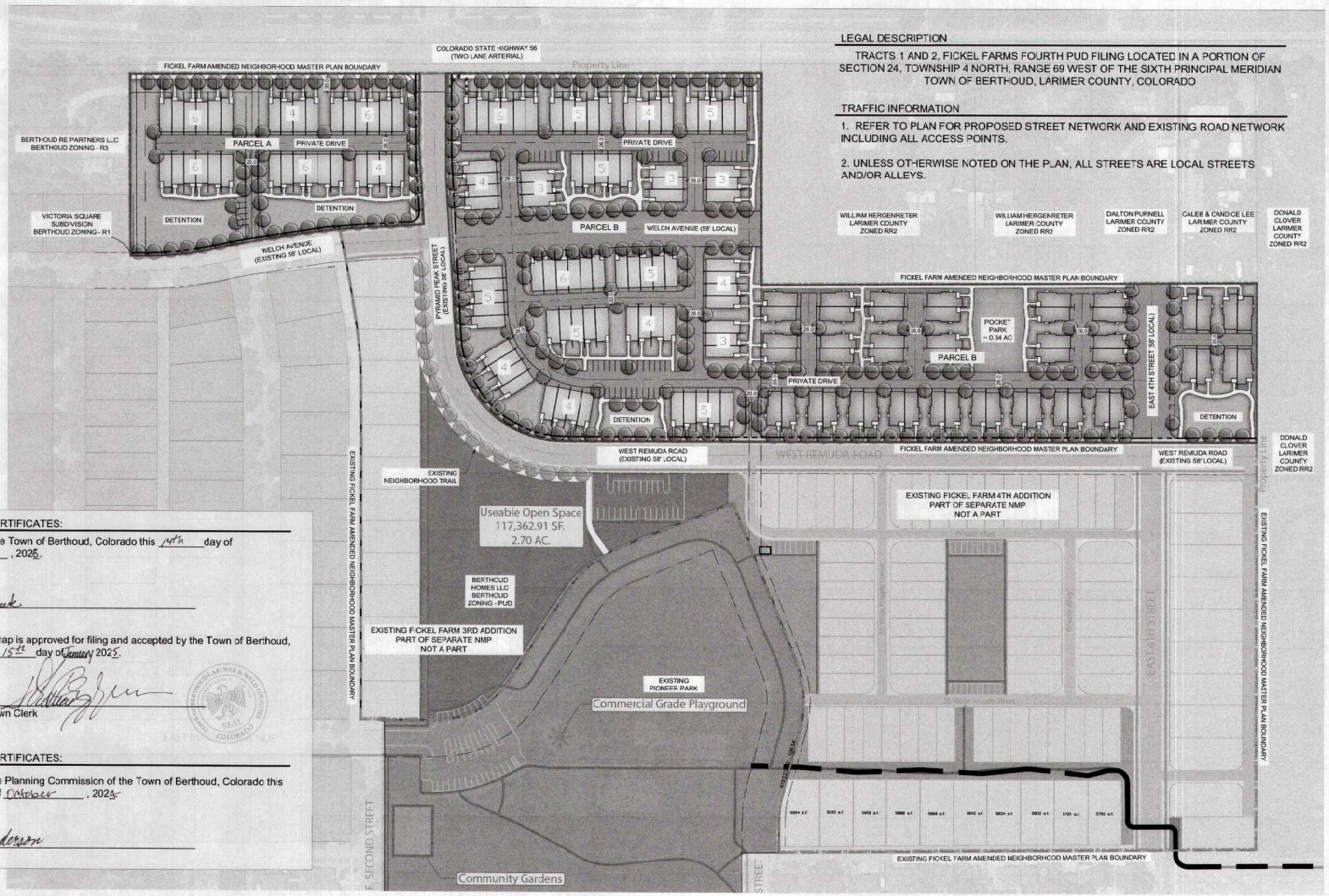
LANDSCAPE NOTES
& DETAILS

SHEET INFORMATION

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FICKEL FARM PROPERTY | SEPTEMBER 2024



LEGAL DESCRIPTION

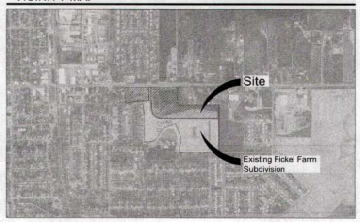
TRACTS 1 AND 2, FICKEL FARMS FOURTH PUD FILING LOCATED IN A PORTION OF SECTION 24, TOWNSHIP 4 NORTH, RANGE 69 WEST OF THE SIXTH PRINCIPAL MERIDIAN TOWN OF BERTHOUD, LARIMER COUNTY, COLORADO

TRAFFIC INFORMATION

1. REFER TO PLAN FOR PROPOSED STREET NETWORK AND EXISTING ROAD NETWORK INCLUDING ALL ACCESS POINTS.

2. UNLESS OTHERWISE NOTED ON THE PLAN, ALL STREETS ARE LOCAL STREETS AND/OR ALLEYS.

VICINITY MAP



LAND USE SUMMARY

LAND USE	DENSITY
DUPLEX	50 LOTS
TOWNHOMES	115 LOTS
TOTAL =	165 LOTS

LAND USE STATISTICS

TOTAL ACREAGE =	14.52 ACRES
ROW/PRIVATE DRIVE ACREAGE =	3.01 ACRES
% OF SITE AS ROW =	20.8%

NOTES:

- THE NEIGHBORHOOD MASTER PLAN IS BINDING ON A DEVELOPMENT, AND ALL FUTURE PLATTING/ZONING ACTIONS MUST FOLLOW THE APPROVED PLAN AS PRESENTED AND APPROVED BY THE TOWN BOARD OF TRUSTEES. SHOULD THIS NEIGHBORHOOD MASTER PLAN BE ALTERED POST-APPROVAL, A FORMAL AMENDMENT OF THE PLAN MAY BE REQUIRED.
- OVERALL LAYOUT MAY SHIFT DURING DESIGN, SO LONG AS OVERALL DENSITY, AS DEPICTED IN THIS NEIGHBORHOOD MASTER PLAN, IS NOT EXCEEDED. DENSITY WITHIN A DEVELOPMENT AREA MAY NOT EXCEED THE MAXIMUM PERMITTED PER THE UNDERLYING ZONE DISTRICT. DENSITY SHIFTS MUST ADHERE TO THE NEIGHBORHOOD MASTER PLAN REQUIREMENTS PER SECTION 30-6-106-C.5 OF THE BERTHOUD MUNICIPAL CODE.
- ZONING IS PROPOSED URBAN RESIDENTIAL (UR).
- THE NEIGHBORHOOD MASTER PLAN IS BINDING ON A DEVELOPMENT, AND ALL FUTURE PLATTING/ZONING ACTIONS MUST FOLLOW THE APPROVED PLAN AS PRESENTED AND APPROVED BY THE TOWN BOARD OF TRUSTEES. SHOULD THIS NEIGHBORHOOD MASTER PLAN BE ALTERED POST-APPROVAL, A FORMAL AMENDMENT OF THE PLAN MAY BE REQUIRED.

SHEET INDEX

SHEET 1 - NEIGHBORHOOD MASTER PLAN
SHEET 2 - OPEN SPACE, CIRCULATION, & PARKS EXHIBIT

0 80' 120' 160' NORTH
SCALE 1" = 80'-0"

APPROVAL CERTIFICATES:

Approved by the Town of Berthoud, Colorado this 14th day of January, 2025.

Mayor

The foregoing map is approved for filing and accepted by the Town of Berthoud, Colorado this 15th day of January 2025.

ATTEST:
Town Clerk

APPROVAL CERTIFICATES:

oved by the Planning Commission of the Town of Berthoud, Colorado this 4th day of October, 2024.

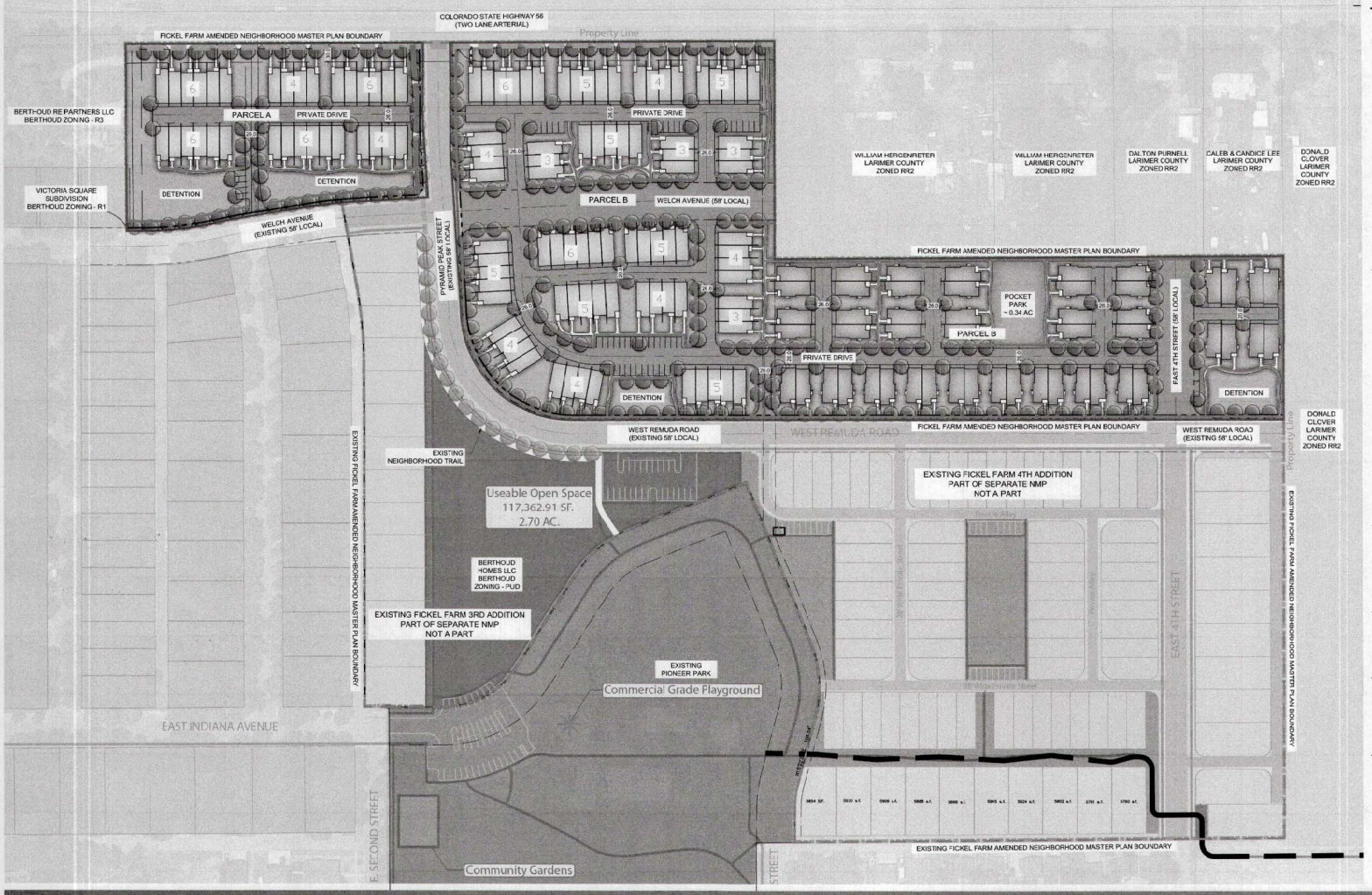
rman

RECEPTION #20250003099, 1/16/2025 3:57:50 PM
1 of 2, $23.00
Tina Harris, Clerk & Recorder, Larimer County, CO

Attachment 4

GHBORHOOD MASTER PLAN

FICKEL FARM PROPERTY | SEPTEMBER 2024



SUBDIVISION IDENTITY & RESIDENTIAL STANDARDS

THE SUBDIVISION IDENTITY ELEMENTS LISTED INCLUDE ELEMENTS AT THE EXISTING FICKEL FARM DEVELOPMENTS, IN ADDITION TO NEW AMENITIES TO BE PROVIDED. SPECIFIC AMENITIES AND LOCATIONS WERE DESIGNED AS PART OF THE MASTER PLANNING FOR THE COMMUNITY, WITH THE INTENTION OF SATISFYING TOWN REQUIREMENTS FOR THE OVERALL FICKEL FARM DEVELOPMENT.

SUBDIVISION LOT UNIT COUNTS:

• PREVIOUSLY APPROVED NMP UNITS (A/B ONLY):	70
• PROPOSED NMP UNITS (A/B ONLY):	165
• PREVIOUSLY APPROVED NMP UNITS (A-N):	171
• PROPOSED AMENDED NMP UNITS (A-N):	266
• TOTAL CHANGE IN UNITS	+95

SUBDIVISION IDENTITY ELEMENTS:

• PREVIOUSLY APPROVED SUBDIVISION IDENTITY ELEMENTS REQUIRED:	6
• AMENDED SUBDIVISION IDENTITY ELEMENTS REQUIRED:	1
TOTAL:	7

THE FOLLOWING IS A LIST OF ELEMENTS THAT IS BEING EVALUATED FOR THIS SITE, BUT IS SUBJECT TO CHANGE, SO LONG AS THE REQUIRED ELEMENT POINTS ARE ACHIEVED AT THE TIME OF PLAT.

SUBDIVISION IDENTITY ELEMENTS PROVIDED PER EXISTING/APPROVED NEIGHBORHOOD MASTER PLAN:

1.	COMMUNITY GARDENS	1
2.	USABLE OPEN SPACE	2
3.	PLAYGROUND	1
4.	ENHANCED ENTRYWAY	1
5.	ALLEY-LOADED STREETS, MAINTAINED BY TOWN	1
	SUBTOTAL:	6

PROPOSED SUBDIVISION IDENTITY ELEMENT PER AMENDED NEIGHBORHOOD MASTER PLAN:

1.	POCKET PARK	1
	FICKEL FARM DEVELOPMENT TOTAL :	7

OPEN SPACE ELEMENTS

PARK AND OPEN SPACE REQUIREMENTS APPROVED AND SATISFIED PER THE FICKEL FARM PUD.

TRAILS AND WALKS

- DETACHED CONCRETE SIDEWALK (6') - 7,734 feet
- 10' REGIONAL TRAIL W/ PARALLEL 3' SOFT SURFACE TRAIL - 1,271 feet
- NEIGHBORHOOD TRAIL - 237 feet

0 80' 120' 160' NORTH
SCALE 1" = 80'-0"

OPEN SPACE, CIRCULATION, & PARKS EXHIBIT

Attachment 5

Fickel Farm

Traffic Impact Study



1st Submittal Date: January 14, 2025

Revised: August 1, 2025

Submitted To:
Trumark Homes
8350 E Crescent Parkway, Suite 450
Greenwood Village, CO 80111

Submitted By:
Fox Tuttle Transportation Group, LLC
1580 Logan Street, Suite 600-PMB 0604
Denver, CO 80203

FOX TUTTLE

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3.3 Level of Service Capacity Analysis 2

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APPENDIX

Level of Service Definitions
Existing Traffic Data
Intersection Capacity Worksheets
Background Documentation

FICKEL FARM
TRAFFIC IMPACT STUDY

1.0 Introduction

The Fox Tuttle Transportation Group has prepared this traffic impact study update for the Fickel Farm residential development project. The project site is comprised of vacant property and is located in the Town of Berthoud, Colorado south of State Highway 56 along Pyramid Peak Street and Remuda Road. It is understood that the entire Fickel Farm development is being developed in two (2) phases and at completion will include a total of up to 35 single-family detached homes and 231 single-family attached homes. Note that the current land use proposal for the second phase is for 154 units. The internal roadway network is proposed to connect to Pyramid Peak Street, Remuda Road, 4th Street, and Welch Avenue. Adjacent land uses are comprised of residential neighborhoods and agricultural sites. **Figure 1** provides a vicinity map for the proposed project.

Phase 1 is currently under construction. Phase 2 is still in design, and the proposed number and type of dwelling units has been changed from the original study. This study focuses on Phase 2 of the Fickel Farm project and assumes all Phase 1 development to be completed and occupied in the near-term background.

The purpose of this study is to assist in identifying potential traffic impacts within the study area as a result of Phase 2 of the Fickel Farm project. The traffic study addresses existing, short-term, and long-term peak hour intersection conditions in the study area with and without the project-generated traffic. The information contained in this study is anticipated to be used by the Town of Berthoud staff in identifying any intersection or roadway deficiencies and potential improvements for the build-out condition and long-term future scenarios. This study focused on the weekday AM and PM peak hours which represent the periods of highest trip generation for the proposed use and adjacent street traffic.

2.0 Project Description

The overall Fickel Farm project plans to develop vacant land with up to 35 single-family detached homes and 231 single-family attached homes over the course of two (2) phases. Phase 2 will include up to 165 single-family attached dwelling units (note that the latest site plan is for 154 units and thus the analysis provided in this study is slightly conservative). The project proposes to construct an internal roadway

network that will connect to State Highway 56, Pyramid Peak Street, Remuda Road, 4th Street, and Welch Avenue. For the purpose of this traffic study, it was assumed that Phase 1 of the project will be completed by Year 2028 and is added into the background scenarios as it was previously approved and is currently under construction. It was assumed Phase 2 will also be completed by Year 2028 and will be analyzed as part of this study. **Figure 2** shows the Phase 2 site plan and proposed access locations.

3.0 Study Considerations

3.1 Data Collection

Intersection turning movement volumes were collected in November 2024 or July 2025 at five (5) existing intersections during the weekday AM and PM peak hours, including pedestrians and bicyclists.

The study area intersections are shown on **Figure 3**. The existing traffic volumes are illustrated on **Figure 4**. The existing intersection geometry and traffic control are also shown on this figure. Count data sheets are provided in the **Appendix**.

3.2 Evaluation Methodology

The traffic operations analysis addressed the signalized and unsignalized intersection operations using the procedures and methodologies set forth by the *Highway Capacity Manual (HCM)*[1]. Existing peak hour factors (PHF) and heavy vehicle percentages by approach and peak hour were applied to the study intersections for Year 2024 and Year 2028 scenarios. For Year 2045 scenarios, the peak hour factors were changed to 0.92 for movements on State Highway 56 and 0.88 for all other movements unless the existing PHF was higher, and heavy vehicle percentages were changed to 2% unless the existing percentage was lower. Study intersections were evaluated using Synchro software (v12).

3.3 Level of Service Capacity Analysis

A Level of Service analysis was conducted to determine the existing and future performance of the study area intersections and accesses to determine the most appropriate intersection traffic controls and auxiliary lanes for future conditions.

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1 Highway Capacity Manual, Highway Research Board Special Report 209, Transportation Research Board, National Research Council, 7th Edition (2022).

To measure and describe the operational status of the study intersections, transportation engineers and planners commonly use a system referred to as "Level of Service" (LOS) that is defined by the *HCM.* LOS characterizes the operational conditions of an intersection's traffic flow, ranging from LOS A (indicating free flow operations) and LOS F (indicating congested and sometimes oversaturated conditions). These grades represent the perspective of drivers and are an indication of the comfort and convenience associated with traveling through the intersections. The intersection LOS is based on delay in seconds per vehicle for the intersection as a whole and for each movement.

Typically, LOS D overall during peak hours is acceptable. Individual movements may be allowed to fall to LOS E or F at signalized intersections. Minor movements at unsignalized intersections, such as left turns onto a major arterial, may be allowed to fall below LOS D, specifically where there are low volumes and/or no viable alternative. The Town of Berthoud follows *Larimer County Urban Area Street Standards, Chapter 4 (LCUASS)*[2] with regard to transportation impact study standards. Table 4-1 in the current version of *LCUASS* was used to determine acceptable Levels of Service for intersections and individual movements. Criteria contained in the *HCM* was applied for these analyses in order to determine peak hour LOS for each scenario. A more detailed discussion of LOS methodology is contained in the **Appendix** for reference.

4.0 Existing Conditions

4.1 Roadways

The study area boundaries are based on the amount of traffic to be generated by the project and potential impact to the existing roadway network. The primary public roadways that serve the project site are discussed in the following text and illustrated on **Figure 1**.

> ***State Highway 56*** is a two-lane, east-west, arterial roadway that provides access to urban and rural residential neighborhoods near the project site. Regionally, the roadway provides access to US Highway 287, I-25 and Weld County. State Highway 56 extends from Larimer County Road 23 (west) to Weld County Road 23 (east). The roadway is a Colorado Department of Transportation (CDOT) managed roadway classified as NR-B (Non-Rural Arterial) from west of 1st Street to west of County Line Road, where it transitions to NR-A (Non-Rural Principal Highway). In the eastbound

[2] *Larimer County Urban Area Street Standards, Chapter 4*. Adopted August, 2021.

direction, State Highway 56 has a posted speed limit of 25 miles per hour (mph) near the 1st Street roundabout, and then transitions to 55 mph to the east, near County line Road. In the westbound direction, State Highway 56 has a posted speed limit of 55 mph just west of the County Line Road intersection, then transitions to 40 mph just east of Pyramid Peak Street, and to 25 mph just west of Pyramid Peak Street approaching the 1st Street roundabout. State Highway 56 serves approximately 7,600 vehicles per day (vpd) west of 1st Street and approximately 7,400 vpd east of County Line Road (CDOT, Year 2023).

1st Street is a two-lane, north-south, roadway that provides access to local residential and commercial neighborhoods within Berthoud. 1st Street is classified as a local roadway north of State Highway 56, and as a major collector roadway south of State Highway 56. The roadway extends from US Highway 287 (north), becomes County Road 15 south of County Road 6C, and extends to East County Line Road (south). South of State Highway 56, 1st Street serves approximately 2,950 vpd (CDOT, Year 2024).

Pyramid Peak Street is a two-lane, unstriped north-south roadway that provides local access to residential neighborhoods and will directly serve the Fickel Farm project from State Highway 56. The roadway extends from Little Bear Avenue (north) to Remuda Road (south).

Nebraska Avenue is a two-lane, east-west roadway that provides access to local residential and rural neighborhoods. The roadway extends from 1st Street (west) to Dorothy Drive (east). As the vacant land to the east develops, Nebraska Avenue will extend to County Line Road (east). Nebraska Avenue will indirectly serve the Fickel Farm project via 4th Street.

Welch Avenue is a two-lane, east-west roadway that provides access to local residential and commercial uses extending from Pyramid Peak Street to Berthoud Parkway. The posted speed limit is 25 mph.

4.2 Intersections

The study area includes five (5) existing intersections that are listed below with the current traffic control and were analyzed for existing and future year traffic operations:

1. State Highway 56 at County Line Road [side-street stop controlled]
2. State Highway 56 at 1st Street [roundabout]
3. 1st Street at Nebraska Avenue [side-street stop controlled]

4. State Highway 56 at Pyramid Peak Street [side-street stop controlled]
5. 1st Street at Welch Avenue [side-street stop controlled]

The existing lane configuration at each of the study locations is illustrated on **Figure 3**.

4.3 Pedestrian and Bicycle

Currently, there are no sidewalks along State Highway 56 east of 1st Street. 1st Street has intermittent and inconsistent sidewalks within the study area. Nebraska Avenue has sidewalks on the north side of the roadway. Pyramid Peak Street has sidewalks on both sides of the roadway north of State Highway 56, and sidewalks adjacent to developed frontage south of State Highway 56.

There are no on-street bike facilities within the project study area. Bikes are permitted to travel within the travel lanes of the study roadways.

4.4 Transit

The Town of Berthoud works with other agencies to provide public transportation to residents. Berthoud also operates the Berthoud Area Transportation Service (BATS), which provides door-to-door transit services within Berthoud or to Loveland. Berthoud is also serviced by the Transfort FLEX route, which provides regional services between Fort Collins, Loveland, Longmont and Boulder. Stops for the FLEX route in Berthoud are located at Mountain Avenue and 2nd Street, and Mountain Avenue and 3rd Street. These stops are approximately 1/3 mile west of the State Highway 56 and Pyramid Peak Street intersection.

4.5 Year 2024 Existing Intersection Capacity Analysis

The existing volumes, lane configuration, and traffic control are illustrated on **Figure 3**. The details of LOS for each movement are provided in **Table 1** and the 95th percentile queues are provided in **Table 2** (refer to **Appendix**). The intersection Level of Service worksheets are attached in the **Appendix**. **Currently, a majority of the study intersections operate overall at LOS A in both peak hours, with most individual movements operating at LOS D or better in both peak hours.** All 95th percentile queues were estimated to be contained within existing storage.

The intersection of State Highway 56 and County Line Road currently operates at LOS B in the AM peak hour and LOS F in the PM peak hour. The northbound approach operates at LOS F in both peak hours, and the southbound approach operates at LOS F in the PM peak hour. This is due to the heavy northbound traffic volume and conflicting eastbound and westbound volumes. Per discussion with Town staff, this

intersection is planned to be converted to a single-lane roundabout as part of the adjacent Farmstead development project. A roundabout is anticipated to effectively mitigate these existing delays.

5.0 Future Conditions

5.1 Annual Growth Factor and Future Volume Methodology

In order to forecast the future peak hour traffic volumes, background traffic growth assumptions were estimated based the CDOT growth rates and other traffic studies performed for the town.

Based on CDOT historic data and forecasts, the 20-year growth factor for State Highway 56 is estimated to be 1.3. This equates to an annual growth rate of **1.32%**, however does not account for the projected volume of traffic to be generated by the Farmstead development to the east. The following steps were taken to develop background traffic volumes:

- Estimated traffic volumes associated with Fickel Farm Phase 1 were added to existing volumes to develop background volumes for movements in and out of the south approach of Pyramid Peak Street at State Highway 56. No additional background growth was applied to these movements.

- Estimated traffic volumes associated with the Farmstead project were added to existing volumes to develop background volumes per the *Farmstead Traffic Impact Study*[3]. Farmstead Phase 1 volumes were used to develop Year 2028 Background volumes, and Farmstead full buildout volumes were used to develop Year 2045 Background volumes. Farmstead project-generated traffic volumes figures are in the **Appendix**. To account for any additional background growth, an annual growth rate of 1.0% was applied to the movements serving the Farmstead project.

- An annual growth rate of 1.32% was applied to existing volumes for all movements not serving the Fickel Farm or Farmstead projects.

Using these assumptions and steps, the Year 2028 background traffic is summarized on **Figure 4** and the Year 2045 background traffic is summarized on **Figure 5**.

[3] *Farmstead Traffic Impact Study.* Delich Associates. March, 2024.

5.2 Year 2028 Anticipated Transportation Network

This study assumes the construction of a single-lane roundabout at the intersection of State Highway 56 and County Line Road per Town staff and the *Farmstead Traffic Impact Study*.

This study assumes that the speed limit on State Highway 56 will be lowered to 35 mph maximum between the roundabouts at 1st Street and County Line Road. Roundabout entry speeds are typically 25 mph or lower, and it is advisable to have no more than a 10 mph differential between speed limit and entry speed.

5.3 Year 2028 Background Intersection Capacity Analysis

The study area intersections were evaluated to determine baseline operations for the Year 2028 background scenario and to identify any capacity constraints associated with background traffic (refer to **Section 5.1** for growth assumptions). It was assumed that the improvements listed in **Section 5.2** will be implemented by Year 2028 background. The background volumes, lane configuration, and traffic control are illustrated on **Figure 4**.

The Level of Service criteria discussed previously was applied to the study area intersections to determine the impacts with the short-term background volumes. The details of LOS for each movement are provided in **Table 1** and the 95th percentile queues are provided in **Table 2** (refer to **Appendix**). The intersection Level of Service worksheets are attached in the **Appendix**.

In summary, all of the study intersections were estimated to operate overall at LOS C or better, with most movements operating at LOS D or better. All 95th percentile queues were estimated to be contained within existing storage. At the intersection of State Highway 56 and Pyramid Peak Street, the following movements were estimated to operate below LOS D in one or more peak hours:

- Northbound left-turn + through operates at LOS E in the AM peak hour and LOS F in the PM peak hour. This is due to the high volume of eastbound and westbound traffic on State Highway 56. The 95th percentile queue was calculated to be 28 feet in the AM peak hour and 33 feet in the PM peak hour.

- Southbound left-turn + through + right-turn operates at LOS E in the PM peak hour. This is due to the high volume of eastbound and westbound traffic on State Highway 56. The 95th percentile queue was calculated to be 10 feet in the PM peak hour.

Recommendation: No mitigation measures are recommended. *LCUASS* Table 4-1 allows for movements at minor intersections to operate at LOS F.

5.4 Year 2045 Anticipated Transportation Network

Based on the projected 20-year background growth assumptions to include the Farmstead-added traffic growth, it is anticipated that the roundabout at State Highway 56 and County Line Road would need to be widened to include two (2) lanes on State Highway 56 eastbound and westbound through the roundabout. The projected 20-year volumes are above the capacity of single-lane roundabout entries for these approaches. For the 2045 scenarios, it is assumed that this widening would be in place.

Based on 20-year growth projections, the eastbound approach at the State Highway 56 and 1st Street roundabout would exceed single-lane entry capacity. To mitigate this long-term capacity deficiency, an eastbound right-turn bypass lane would be needed and is assumed to be in place for the long-term scenarios. The Year 2045 Background lane geometry is shown on **Figure 5**.

5.5 Year 2045 Background Intersection Capacity Analysis

The study area intersections were evaluated to determine baseline operations for the Year 2045 background scenario and to identify any capacity constraints associated with background traffic in the long-term scenario (refer to **Section 5.1** for growth assumptions). The long-term background volumes, lane configuration, and traffic control are illustrated on **Figure 5**.

The Level of Service criteria discussed previously was applied to the study area intersections to determine the impacts with the long-term background volumes. The details of LOS for each movement are provided in **Table 1** and the 95th percentile queues are provided in **Table 2** (refer to **Appendix**). The intersection Level of Service worksheets are attached in the **Appendix**.

In summary, all four (4) of the study intersections operate at LOS D or better in both peak periods, with most movements operating at LOS D or better. The following intersections have movements which operate below LOS D in one or more peak hours:

State Highway 56 at Pyramid Peak Street was estimated to operate at LOS A in both peak hours.

- Northbound left-turn + through was estimated to operate at LOS F in both peak hours. The 95th percentile queue was estimated to be up to 60 feet.

- Southbound left-turn + through + right-turn was estimated to operate at LOS E in the AM peak hour and LOS F in the PM peak hour. The 95th percentile queue was estimated to be up to 40 feet.

Recommendation: No mitigation measures are recommended. *LCUASS* Table 4-1 allows for movements at minor intersections to operate at LOS F.

6.0 Future Conditions with the Development

The Fickel Farm project will be comprised of 35 single-family detached homes and 231 single-family attached homes, constructed over two (2) phases. Phase 1 of the project is constructing 35 single-family detached homes and 66 single-family attached homes. Phase 2 proposes to construct up to 165 single-family attached homes. This study assumed that both phases will be completed by Year 2028. As Phase 1 was previously approved and is currently under construction, the traffic associated with Phase 1 has been added to the background traffic volumes for this study. The project proposes to connect its internal roadway network to State Highway 56, Pyramid Peak Street, Remuda Road, 4th Street, and Welch Avenue. **Figure 2** shows the site plan and proposed roadway connections.

6.1 Trip Generation

A trip generation estimate was performed to determine the traffic characteristics for Phase 2 of the proposed development. The trip rates contained in the Institute of Transportation Engineers (ITE) *Trip Generation Handbook and Manual*[4] were applied to estimate the traffic for the dwelling units. This study applied the trip rates for "Single-Family Attached Housing" [ITE #215] to determine Phase 2 trips.

Phase 2 of the Fickel Farm project was estimated to generate approximately 1,188 daily trips with 79 trips in the AM peak hour and 94 trips in the PM peak hour. Trip generation is described on **Table 3**.

6.2 Trip Distribution and Assignment

The estimated trip volumes were distributed onto the study area street network based on existing traffic characteristics, land uses, and traffic patterns in the area. The existing volumes were utilized to determine where vehicles are coming from and going to within the study area.

The following overall distributions were assumed for this project and are shown on **Figure 6**:

- North via 1st Street: 20%

[4] *Trip Generation Handbook and Manual, 11th Edition*, Institute of Transportation Engineers, 2021.

- South via 1st Street: 5%
- East via State Highway 56: 35%
- West via State Highway 56: 20%
- West via Welch Avenue 5%
- North via County Line Road: 5%
- South via County Line Road: 10%

Using the distribution assumptions, the projected site traffic was assigned to the study area roadway network for the weekday AM and PM peak hour periods. Project-generated trips are shown on **Figure 7**.

6.3 Year 2028 Background + Project Intersection Capacity Analysis

This section discusses impacts associated with the addition of the project trips in the Year 2028 scenario. The site-generated volumes were added to the Year 2028 background volumes and are illustrated on **Figure 8**. This figure also illustrates the necessary traffic control and lane configurations for the study intersections. The recommended improvements in the Year 2028 background scenario were assumed to be implemented.

The study intersections are anticipated to operate similarly to the Year 2028 background conditions with the addition of project trips. All of the overall intersection and most of the individual movement Levels of Service remain the same. At the intersection of State Highway 56 and Pyramid Peak Street, the northbound left-turn + through (AM peak hour) and southbound left-turn + through + right-turn (PM peak hour) fall from LOS E in the background scenario to LOS F when project trips are added.

Recommendation: No mitigation measures are recommended. *LCUASS* Table 4-1 allows for movements at minor intersections to operate at LOS F. Additionally, as the northbound approach reaches capacity, it is likely vehicles will use alternative routes, such as Welch Avenue to get to 1st Street.

The details of LOS for each movement are provided in **Table 1** and the 95th percentile queues are provided in **Table 2** (refer to **Appendix**). The intersection Level of Service worksheets are attached in the **Appendix**.

6.4 Year 2045 Background + Project Intersection Capacity Analysis

This section discusses impacts associated with the addition of project trips in the Year 2045 scenario. The site-generated volumes were added to the Year 2045 background volumes and are illustrated on **Figure**

14. This figure also illustrates the necessary traffic control and lane configurations for all of the study intersections.

The recommended improvements identified for the Year 2045 Background scenario were assumed to be implemented for this scenario.

The study intersections are anticipated to operate similarly to the Year 2045 background conditions with the addition of project trips. All of the overall intersection and most of the individual movement Levels of Service remain the same. The following intersections have movements which are more significantly impacted by the addition of project traffic:

State Highway 56 at 1st Street continues to operate overall at LOS D in the AM peak hour and LOS E in the PM peak hour.

- The eastbound approach falls from LOS D to LOS E in the PM peak hour. 95th percentile queues are estimated to be up to 325 feet
- The westbound approach falls from LOS D to LOS E in the both peak hours. 95th percentile queues are estimated to be up to 400 feet.
- The southbound approach falls from LOS D to LOS E in the PM peak hour. 95th percentile queues were estimated to be up to 48 feet.

Recommendation: No mitigation measures are recommended. *LCUASS* Table 4-1 allows for movements at major intersections to operate at LOS E.

State Highway 56 at Pyramid Peak Street continues to operate overall at LOS A in both peak hours.

- The southbound left-turn + through + right-turn movement falls from LOS E to LOS F in the AM peak hour. 95th percentile queues are estimated to be up to 48 feet.

Recommendation: No mitigation measures are recommended. *LCUASS* Table 4-1 allows for movements at minor intersections to operate at LOS F.

The details of LOS for each movement are provided in **Table 1** and the 95th percentile queues are provided in **Table 2** (refer to **Appendix**). The intersection Level of Service worksheets are attached in the **Appendix**.

7.0 Queuing Analysis

A queuing analysis was performed to determine if the 95th percentile queues would be accommodated by the existing storage length, to determine the storage lengths for future auxiliary lanes, and if any of the queues would impact an upstream intersection/access. **Table 2** provides the existing storage lengths, as well as the 95th percentile queues for each existing and future scenario as calculated by Synchro (assuming each vehicle utilizes 25 feet of space). It should be noted that the 95th percentile queue length is a theoretical queue that is 1.65 standard deviations above the average queue length. In theory, the 95th percentile queue would be exceeded 5% of the time based on the average queue length, but it is also possible that a queue this long may not occur.

As shown in **Table 2**, the estimated queues are shorter than the existing storage length at the side-street stop-controlled intersections in all scenarios. The project trips have minimal impact on queues at the existing study intersections. At the roundabout controlled intersections, queues may begin to impact existing or future upstream intersections and should be monitored.

The westbound approach on State Highway 56 at Pyramid Peak Street includes a westbound left-turn deceleration lane consisting of approximately 60 feet of storage plus a 130-foot taper. The *State Highway Access Code* prescribes that a left-turn deceleration lane at a 40-mph posted speed should include storage (at 50 feet per 60 vehicles per hour) and a 12:1 taper. At 35 mph, the taper is shortened to 10:1. Since the existing westbound deceleration lane striping exceeds the *State Highway Access Code* requirement for storage plus taper for 35 mph (which is the recommended speed limit once the intersection is between two roundabouts on State Highway 56), no changes to the existing lane striping on State Highway 56 is proposed for this project.

8.0 Conclusions

The Fickel Farm project plans to develop vacant land with 35 single-family detached homes and 231 single-family attached homes over the course of two (2) phases. Phase 1 was previously approved and is currently under construction. Phase 1 consists of 35 single-family detached homes and 66 single-family attached homes. Phase 2 was evaluated through this study and proposes to construct up to 165 single-family attached homes. The project proposes to construct an internal roadway network that will connect to State Highway 56, Pyramid Peak Street, Remuda Road, 4th Street, and Welch Avenue. For the purpose of this traffic study, it was assumed that both phases will be completed by Year 2028.

The Fickel Farm Phase 2 project is estimated to generate approximately 1,188 daily trips with 79 trips occurring in the AM peak hour and 94 trips occurring in the PM peak hour. **It was determined that the proposed roadway system can adequately accommodate the projected traffic volumes with recommended improvements.**

Existing/Background Conditions (Non-Project Related):

- **State Highway 56 at County line Road**
  - Construct single-lane roundabout at the intersection. *[Implemented prior to Year 2028 Background based on Farmstead Traffic Impact Study* found *in the **Appendix**]*
  - Widen roundabout to two lanes for eastbound and westbound traffic. *[Year 2045 Background]*

- **State Highway 56 from 1st Street to County Line Road**
  - Reduce speed to 35 mph maximum. *[Year 2028 Background]*

- **State Highway 56 at 1st Street**
  - Construct eastbound right-turn bypass lane at roundabout. *[Year 2045 Background]*

Note that the traffic study provides technical information and evaluates the need for transportation mitigation as traffic grows, but it does not address infrastructure commitments or obligations of the Fickel Farm project.

Tables and Figures:

Table 1 – Peak Hour Intersection Level of Service Summary

Table 2 – Peak Hour Estimated Queues and Proposed Auxiliary Lanes

Table 3 –Trip Generation Summary

Figure 1 – Vicinity Map

Figure 2 – Conceptual Site Plan

Figure 3 – Year 2024 Existing Traffic Volumes

Figure 4 – Year 2028 Background Traffic Volumes

Figure 5 – Year 2045 Background Traffic Volumes

Figure 6 – Site Trip Distribution

Figure 7 – Site-Generated Traffic Volumes

Figure 8 – Year 2028 Background + Project Traffic Volumes

Figure 9 – Year 2045 Background + Project Traffic Volumes

Fickel Farm Traffic Impact Study

Table 1 - Peak Hour Intersection Level of Service Summary

Intersections and Lane Groups	Year 2024 Existing				Year 2028 Background				Year 2028 with Project				Year 2045 Background				Year 2045 with Project			
	AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
STOP SIGN CONTROL																				
1. State Highway 56 at County Line Road	**13**	**B**	**62**	**F**																
Eastbound Left + Through + Right	8	A	8	A	*Analyzed as Roundabout*				*Analyzed as Roundabout*				*Analyzed as Roundabout*				*Analyzed as Roundabout*			
Westbound Left + Through + Right	9	A	9	A																
Northbound Left + Through + Right	85	F	>120	F																
Southbound Left + Through + Right	26	D	52	F																
3. 1st Street at Nebraska Avenue	**3**	**A**	**2**	**A**	**3**	**A**	**2**	**A**	**3**	**A**	**3**	**A**	**3**	**A**	**2**	**A**	**3**	**A**	**2**	**A**
Westbound Left + Right	9	A	10	A	10	A	10	B	10	A	11	B	10	A	11	B	10	A	11	B
Northbound Through + Right	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A
Southbound Left + Through	7	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A
4. State Highway 56 at Pyramid Peak Street	**1**	**A**	**1**	**A**	**2**	**A**	**2**	**A**	**4**	**A**	**4**	**A**	**3**	**A**	**4**	**A**	**6**	**A**	**9**	**A**
Eastbound Left	8	A	9	A	9	A	9	A	9	A	9	A	10	A	10	A	10	A	10	A
Eastbound Through	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A
Eastbound Right	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A
Westbound Left	9	A	9	A	9	A	10	A	9	A	10	A	9	A	11	B	10	A	11	B
Westbound Through + Right	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A
Northbound Left + Through	23	C	29	D	48	E	72	F	66	F	115	F	102	F	>120	F	>120	F	>120	F
Northbound Right	12	B	12	B	14	B	15	B	15	B	16	C	15	B	18	C	16	C	20	C
Southbound Left + Through + Right	16	C	22	C	26	D	42	E	29	D	52	F	49	E	91	F	56	F	>120	F
5. 1st Street at Welch Avenue	**2**	**A**	**3**	**A**	**2**	**A**	**3**	**A**	**3**	**A**	**3**	**A**	**3**	**A**	**4**	**A**	**8**	**A**	**5**	**A**
Eastbound Left + Through + Right	12	B	14	B	12	B	14	B	13	B	14	B	15	B	19	C	15	B	20	C
Westbound Left + Through + Right	11	B	16	C	11	B	16	C	11	B	14	B	13	B	20	C	12	B	19	C
Northbound Left + Through + Right	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A
Southbound Left + Through + Right	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A	8	A
ROUNDABOUT CONTROL																				
1. State Highway 56 at County Line Road					**16**	**C**	**17**	**C**	**17**	**C**	**18**	**C**	**15**	**B**	**14**	**B**	**16**	**C**	**15**	**B**
Eastbound Left + Through + Right	*Analyzed as Stop Control*				13	B	14	B	14	B	14	B								
Eastbound Left + Through													7	A	10	A	7	A	10	A
Eastbound Through + Right													8	A	11	B	8	A	11	B
Westbound Left + Through + Right					19	C	23	C	20	C	26	D								
Westbound Left + Through													10	A	11	B	10	A	11	B
Westbound Through + Right													11	B	12	B	11	B	13	B
Northbound Left + Through + Right					18	C	13	B	19	C	13	B	28	D	22	C	31	D	24	C
Southbound Left + Through + Right					9	A	10	A	9	A	10	B	9	A	11	B	10	A	12	B
2. State Highway 56 at 1st Street	**9**	**A**	**9**	**A**	**13**	**B**	**15**	**C**	**14**	**B**	**16**	**C**	**23**	**C**	**30**	**D**	**26**	**D**	**33**	**D**
Eastbound Left + Through + Right	9	A	10	B	13	B	19	C	13	B	21	C								
Eastbound Left + Through													14	B	34	D	15	B	39	E
Eastbound Right													3	A	4	A	3	A	4	A
Westbound Left + Through + Right	9	A	9	A	15	C	14	B	17	C	15	B	33	D	32	D	39	E	35	E
Northbound Left + Through	7	A	8	A	10	A	12	B	10	B	13	B	11	B	19	C	12	B	21	C
Northbound Right	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A	0	A
Southbound Left + Through + Right	9	A	10	A	14	B	16	C	14	B	17	C	22	C	34	D	24	C	38	E

Fickel Farm Traffic Impact Study

Table 2 - Peak Hour Estimated Queues

Intersections and Lane Groups	2024 Existing 95th% Queue		2028 Background 95th% Queue		2028 with Project 95th% Queue		2045 Background 95th% Queue		2045 with Project 95th% Queue		Max. Queue	Existing Storage
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM		
1. State Highway 56 at County Line Road	*Stop Control*		*Roundabout*		*Roundabout*		*Roundabout*		*Roundabout*			
Eastbound Left + Through + Right	0'	0'	125'	125'	150'	150'					150'	-
Eastbound Left + Through							50'	75'	50'	75'	75'	-
Eastbound Through + Right							50'	75'	50'	75'	75'	-
Westbound Left + Through + Right	10'	18'	175'	250'	175'	275'					275'	-
Westbound Left + Through							50'	75'	50'	75'	75'	-
Westbound Through + Right							75'	100'	75'	100'	100'	-
Northbound Left + Through + Right	170'	423'	125'	100'	150'	100'	275'	200'	300'	225'	423'	-
Southbound Left + Through + Right	13'	28'	0'	0'	0'	25'	0'	25'	25'	25'	28'	-
2. State Highway 56 at 1st Street	*Roundabout*		*Roundabout*		*Roundabout*		*Roundabout*		*Roundabout*			
Eastbound Left + Through + Right	50'	75'	100'	175'	100'	200'					200'	-
Eastbound Left + Through							125'	300'	125'	325'	325'	-
Eastbound Right							0'	0'	0'	0'	0'	-
Westbound Left + Through + Right	75'	75'	150'	125'	175'	150'	350'	325'	400'	350'	400'	-
Northbound Left + Through	25'	25'	25'	25'	25'	50'	25'	75'	50'	75'	75'	-
Northbound Right	0'	0'	0'	0'	0'	0'	0'	0'	0'	0'	0'	50'
Southbound Left + Through + Right	50'	50'	100'	125'	100'	150'	175'	275'	175'	300'	300'	-
3. 1st Street at Nebraska Avenue	*Stop Control*		*Stop Control*		*Stop Control*		*Stop Control*		*Stop Control*			
Westbound Left + Right	5'	5'	8'	8'	8'	8'	8'	8'	10'	8'	10'	-
Northbound Through + Right	0'	0'	0'	0'	0'	0'	0'	0'	0'	0'	0'	-
Southbound Left + Through	0'	3'	0'	3'	0'	3'	0'	3'	0'	3'	3'	-
4. State Highway 56 at Pyramid Peak Street	*Stop Control*		*Stop Control*		*Stop Control*		*Stop Control*		*Stop Control*			
Eastbound Left	0'	0'	0'	0'	0'	0'	0'	3'	0'	3'	3'	35'
Eastbound Through	0'	0'	0'	0'	0'	0'	0'	0'	0'	0'	0'	-
Eastbound Right	0'	0'	0'	0'	0'	0'	0'	0'	0'	0'	0'	160'
Westbound Left	0'	0'	3'	5'	3'	8'	3'	5'	3'	8'	8'	60'
Westbound Through + Right	0'	0'	0'	0'	0'	0'	0'	0'	0'	0'	0'	-
Northbound Left + Through	5'	8'	28'	33'	58'	65'	50'	60'	90'	100'	100'	-
Northbound Right	3'	3'	8'	8'	18'	15'	8'	10'	15'	18'	18'	100'
Southbound Left + Through + Right	8'	5'	15'	10'	18'	10'	28'	40'	33'	48'	48'	-
5. 1st Street at Welch Avenue	*Stop Control*		*Stop Control*		*Stop Control*		*Stop Control*		*Stop Control*			
Eastbound Left + Through + Right	10'	15'	10'	18'	10'	18'	18'	38'	20'	40'	40'	-
Westbound Left + Through + Right	3'	3'	3'	3'	5'	5'	5'	8'	8'	10'	10'	-
Northbound Left + Through + Right	3'	5'	3'	5'	3'	5'	3'	5'	3'	5'	5'	-
Southbound Left + Through + Right	0'	0'	0'	0'	0'	0'	0'	0'	0'	0'	0'	-

FOX TUTTLE

Table 3 - Trip Generation

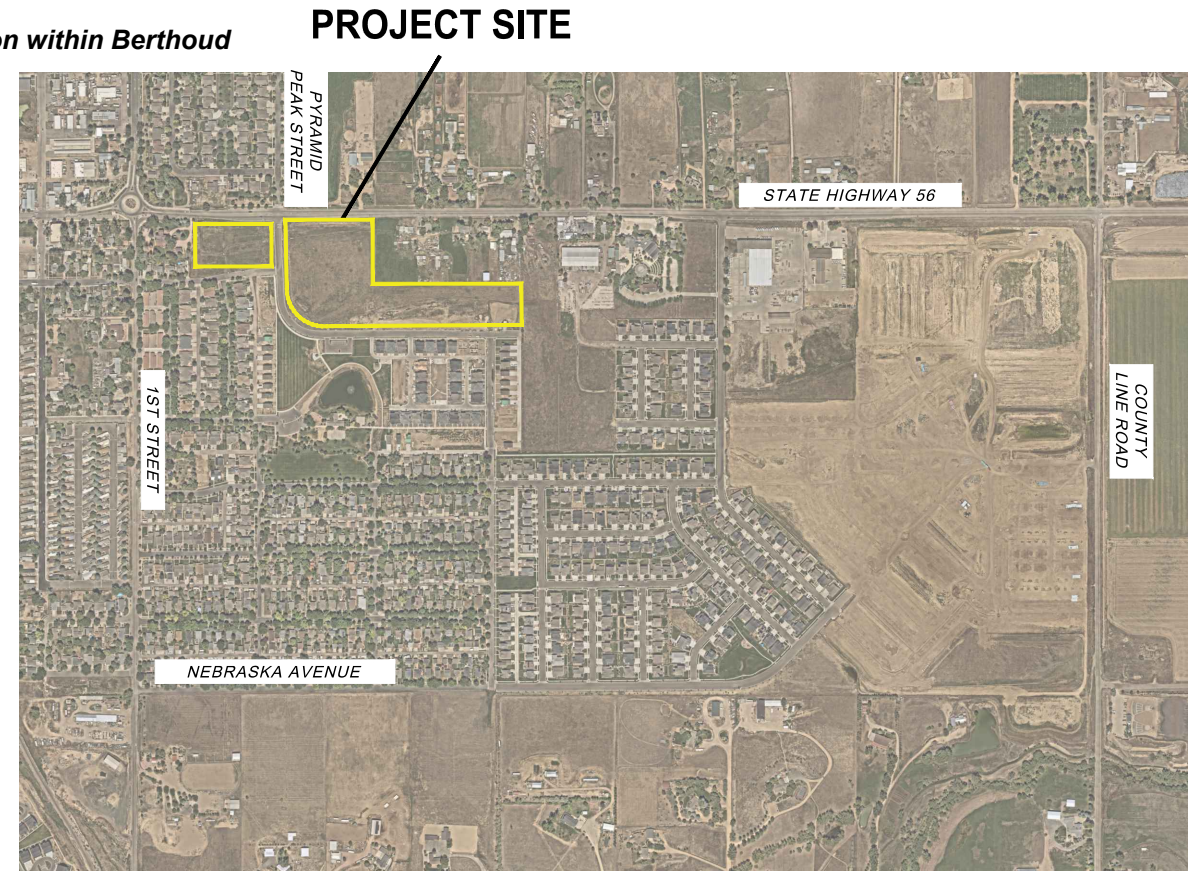
Land Use	Size	Unit	Weekday											
			Average Daily				AM Peak Hour				PM Peak Hour			
			Rate	Total	In	Out	Rate	Total	In	Out	Rate	Total	In	Out
ITE 215 - Single-Family Attached Housing	165	Dwelling Units	7.20	1188	594	594	0.48	79	20	59	0.57	94	55	39
Total				***1188***	***594***	***594***		***79***	***20***	***59***		***94***	***55***	***39***

Sources : ITE Trip Generation 11th Edition, 2021.

Area Map



Location within Berthoud



N

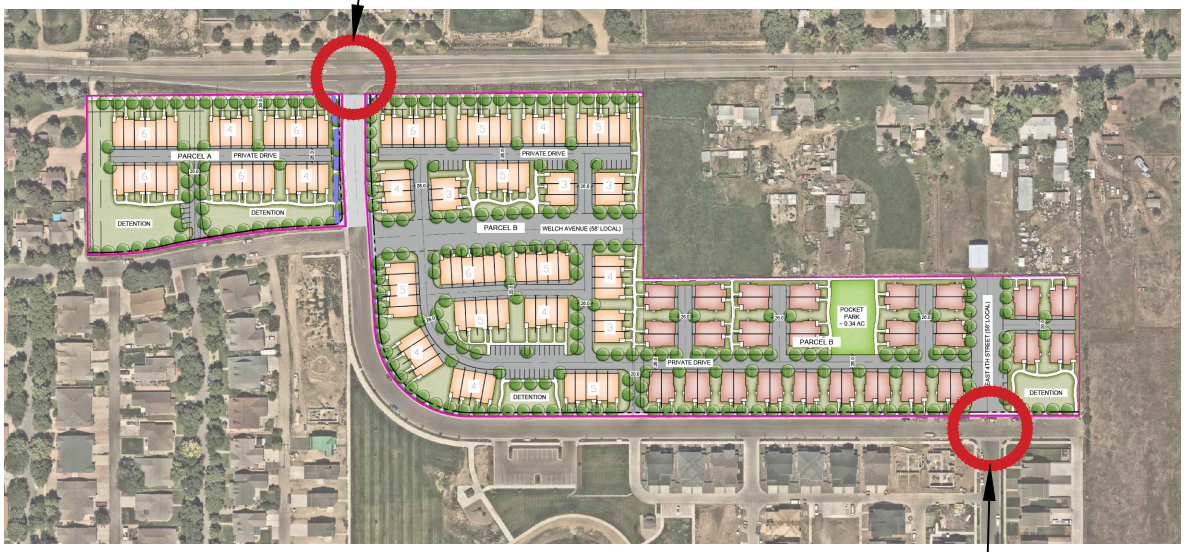
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TRANSPORTATION GROUP

FICKEL FARM TRAFFIC IMPACT STUDY

VICINITY MAP

Project #	24095	Original Scale	NTS	Date	12/12/2024	Drawn by	CAF	Figure #	1

Proposed Connection
to State Highway 56 via Pyramid Peak Street
Full Movement
Side-Street Stop Controlled



Proposed Connection
to 1st Street via 4th Street and Nebraska Avenue
Full Movement
Side-Street Stop Controlled

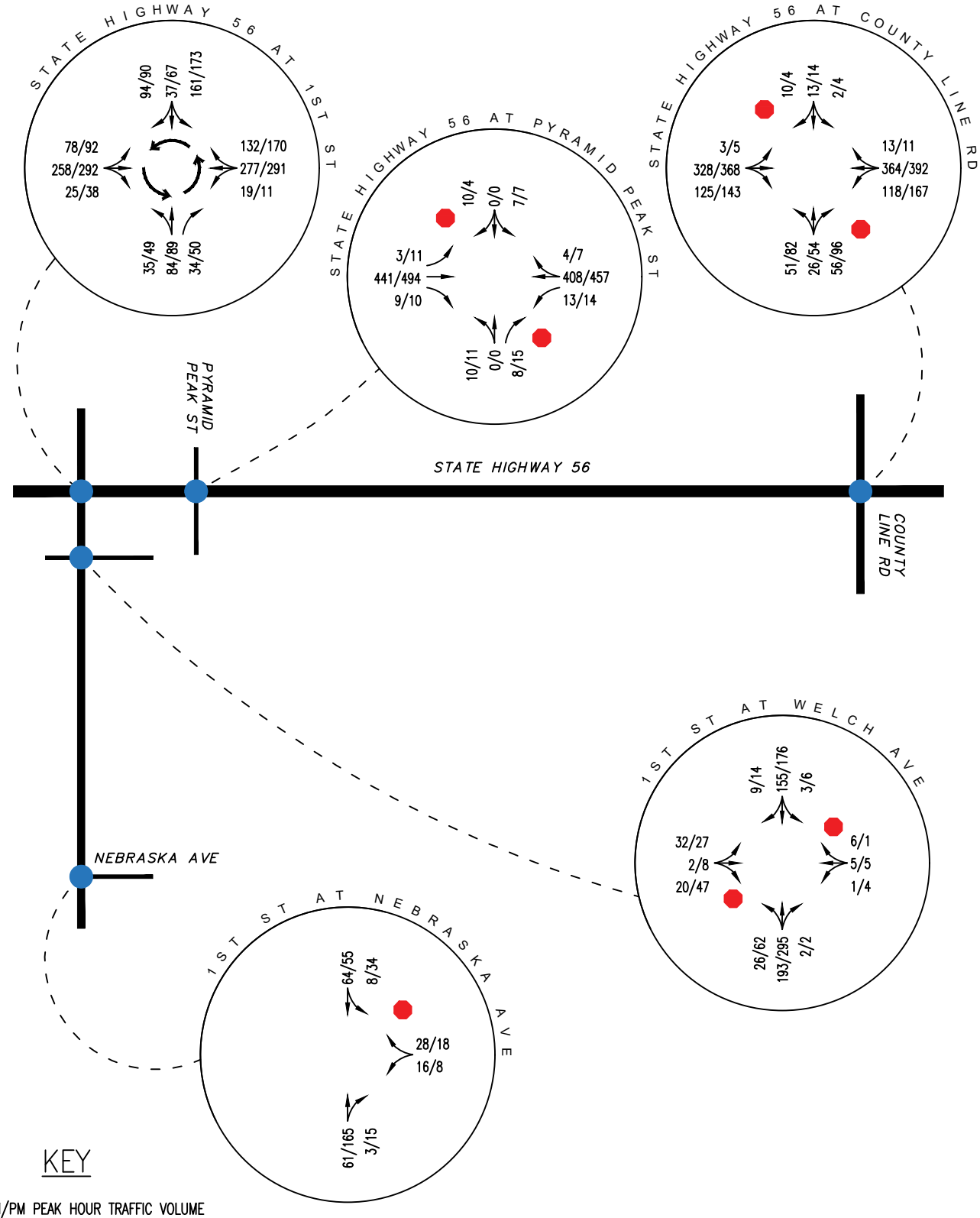
N

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FICKEL FARM TRAFFIC IMPACT STUDY

CONCEPTUAL SITE PLAN

Project #	24095	Original Scale	NTS	Date	12/12/2024	Drawn by	CAF	Figure #	2

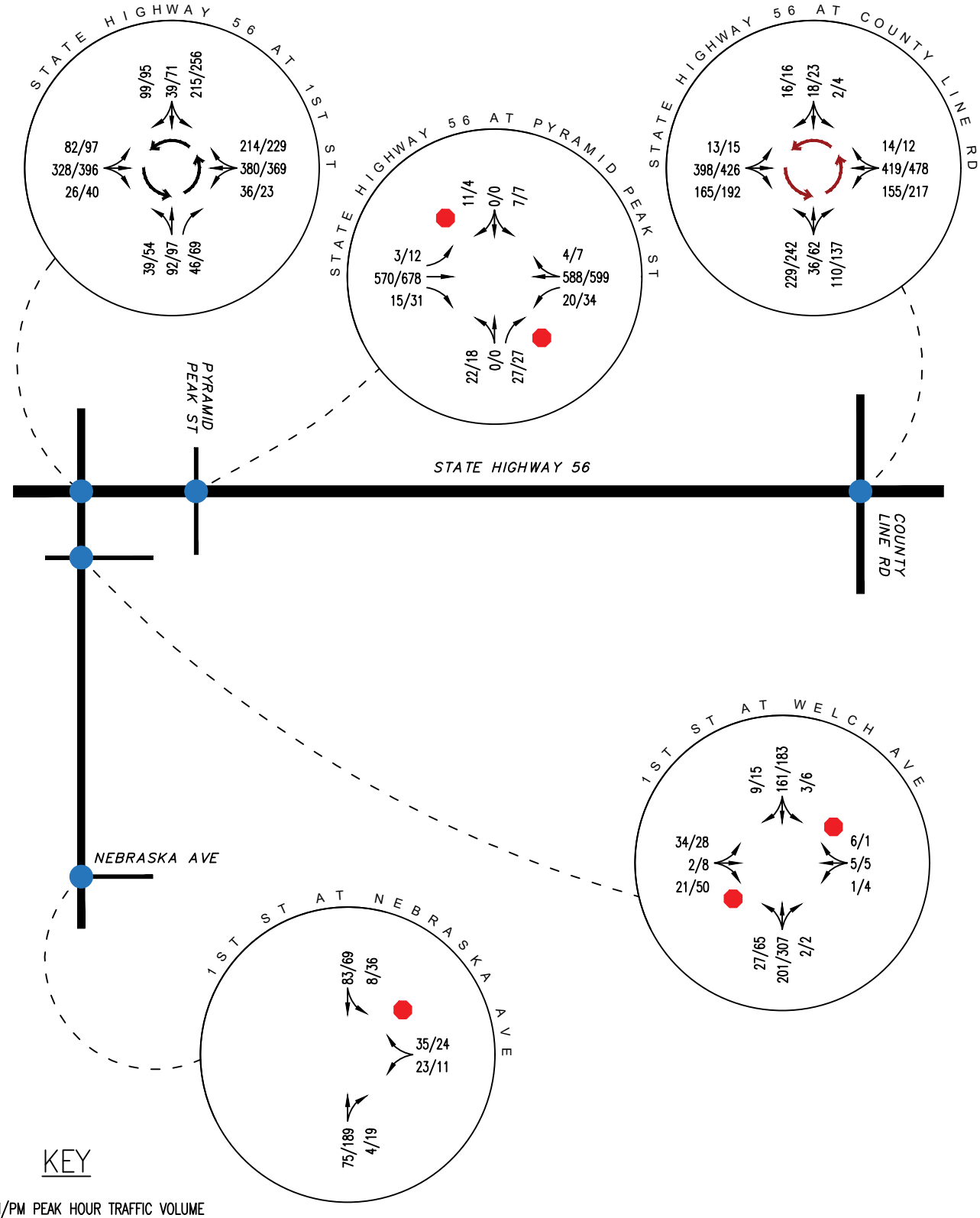


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FICKEL FARM TRAFFIC IMPACT STUDY

YEAR 2024 EXISTING TRAFFIC VOLUMES

Project #	24095	Original Scale	NTS	Date	8/1/25	Drawn by	CAF	Figure #	3

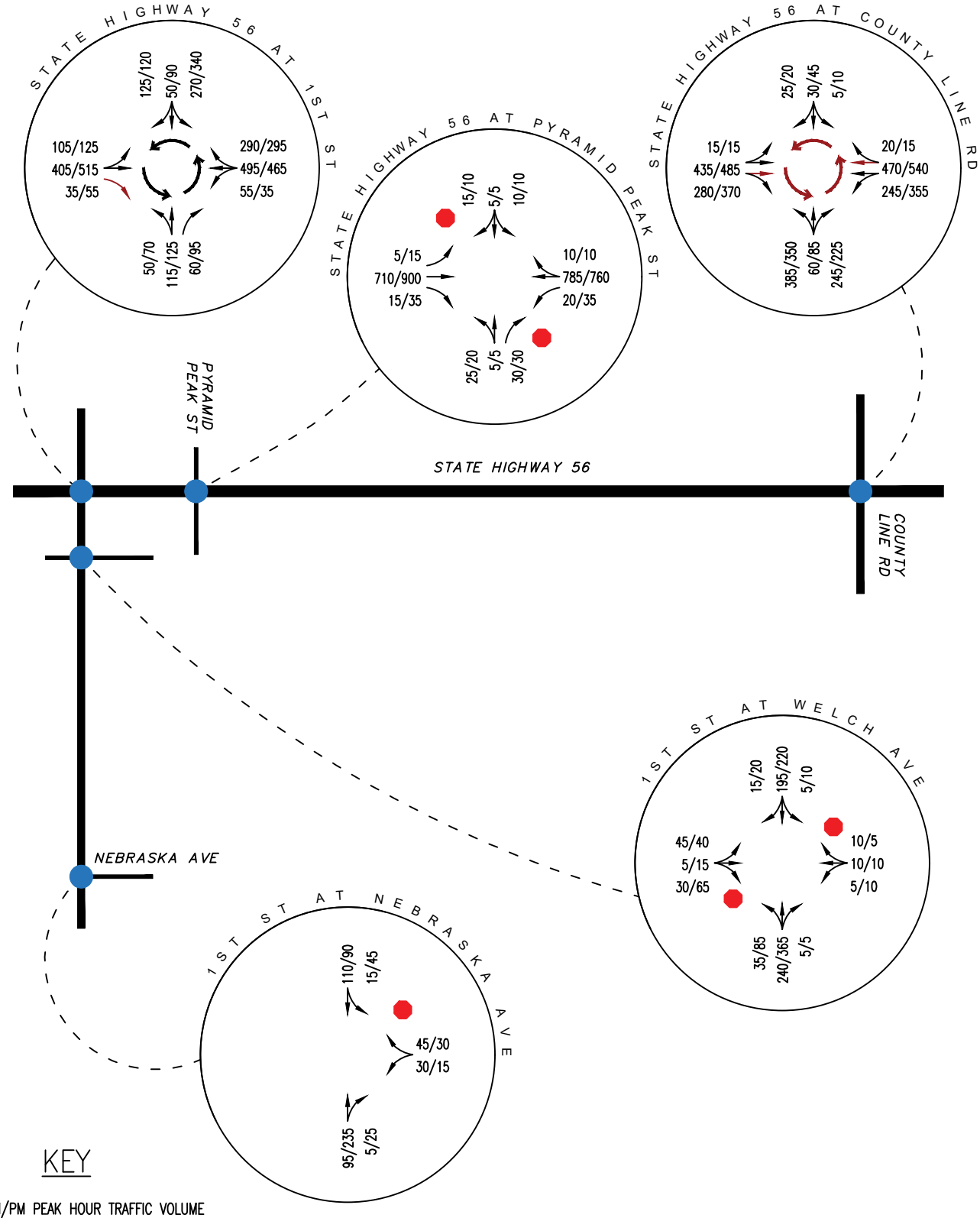


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FICKEL FARM TRAFFIC IMPACT STUDY

YEAR 2028 BACKGROUND TRAFFIC VOLUMES

Project #	24095	Original Scale	NTS	Date	8/1/25	Drawn by	CAF	Figure #	4



KEY

XX/XX AM/PM PEAK HOUR TRAFFIC VOLUME

EXISTING LANE CONFIGURATION

PROPOSED FUTURE LANE

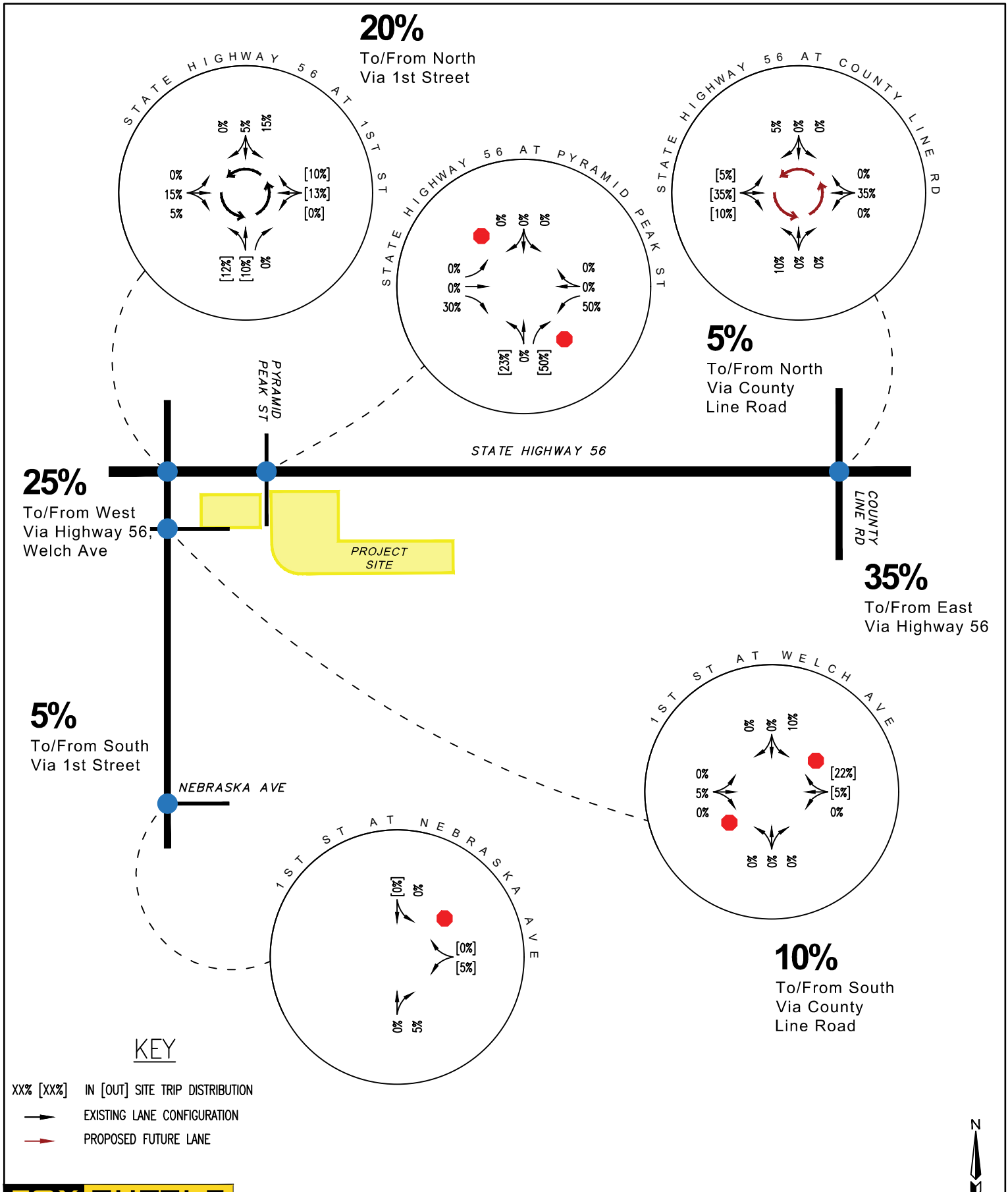
N

FOX TUTTLE TRANSPORTATION GROUP

FICKEL FARM TRAFFIC IMPACT STUDY

YEAR 2045 BACKGROUND TRAFFIC VOLUMES

Project #	24095	Original Scale	NTS	Date	8/1/25	Drawn by	CAF	Figure #	5

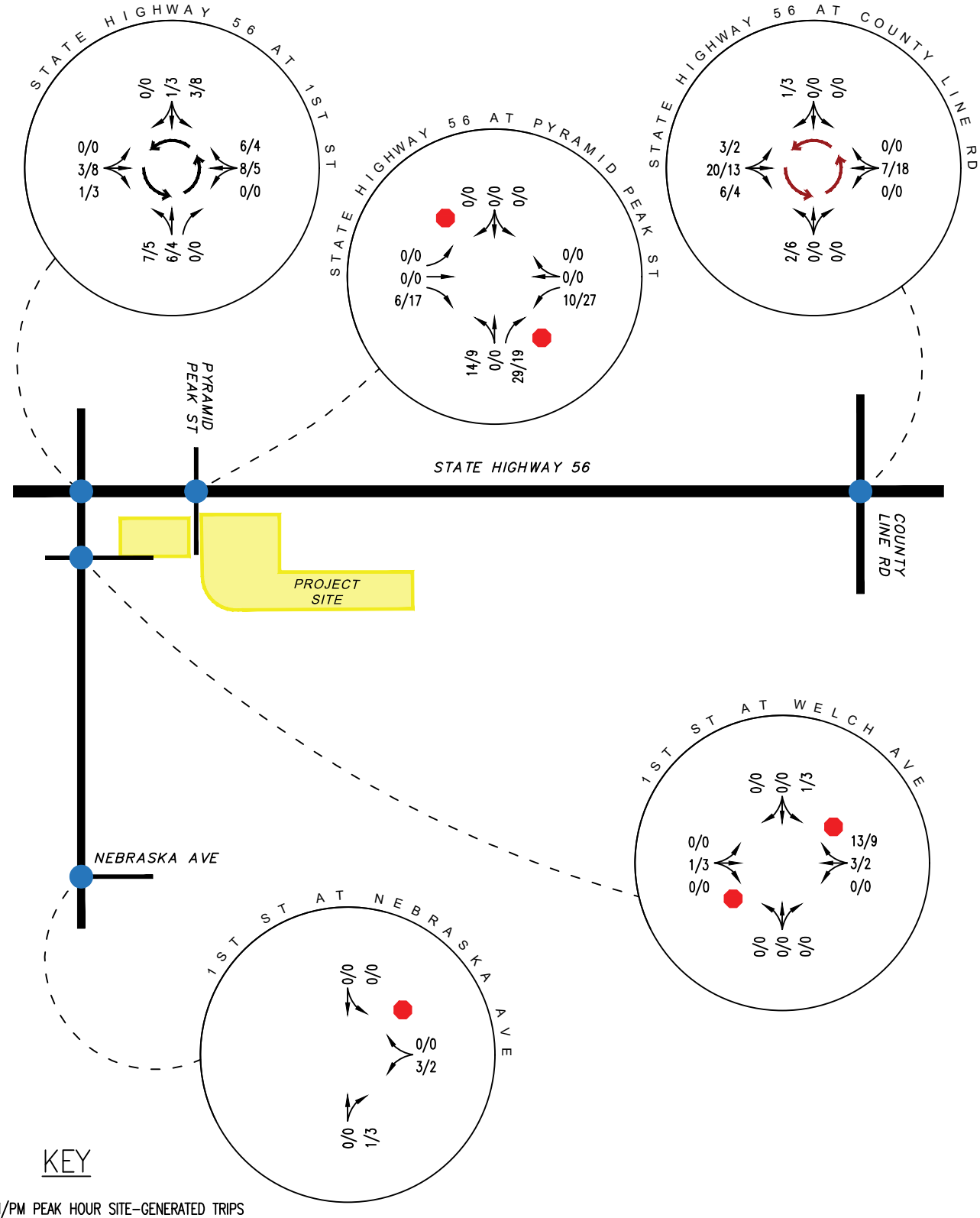


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FICKEL FARM TRAFFIC IMPACT STUDY

SITE TRIP DISTRIBUTION

Project #	24095	Original Scale	NTS	Date	8/1/25	Drawn by	CAF	Figure #	6

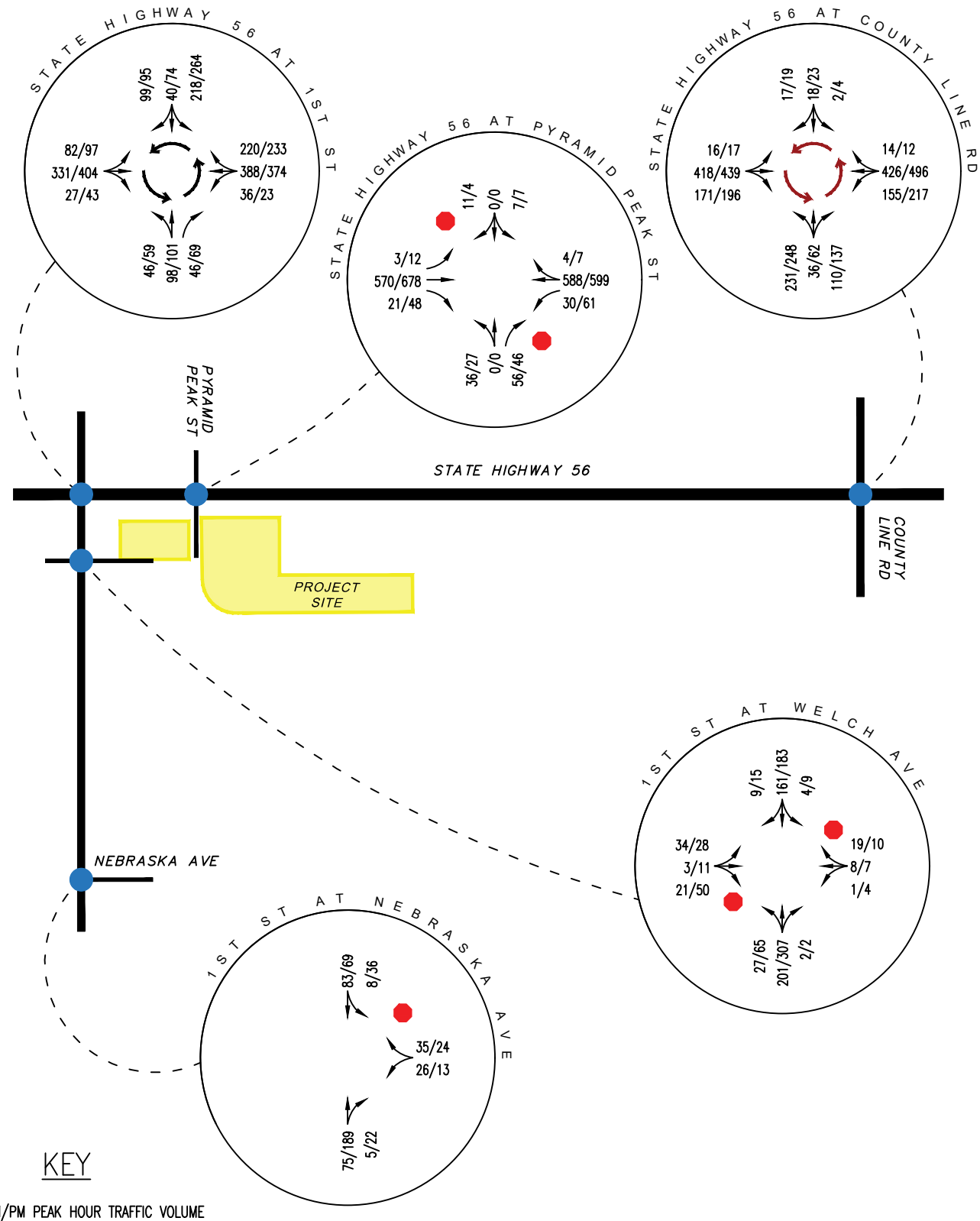


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FICKEL FARM TRAFFIC IMPACT STUDY

SITE-GENERATED TRAFFIC VOLUMES

Project #	24095	Original Scale	NTS	Date	8/1/25	Drawn by	CAF	Figure #	7

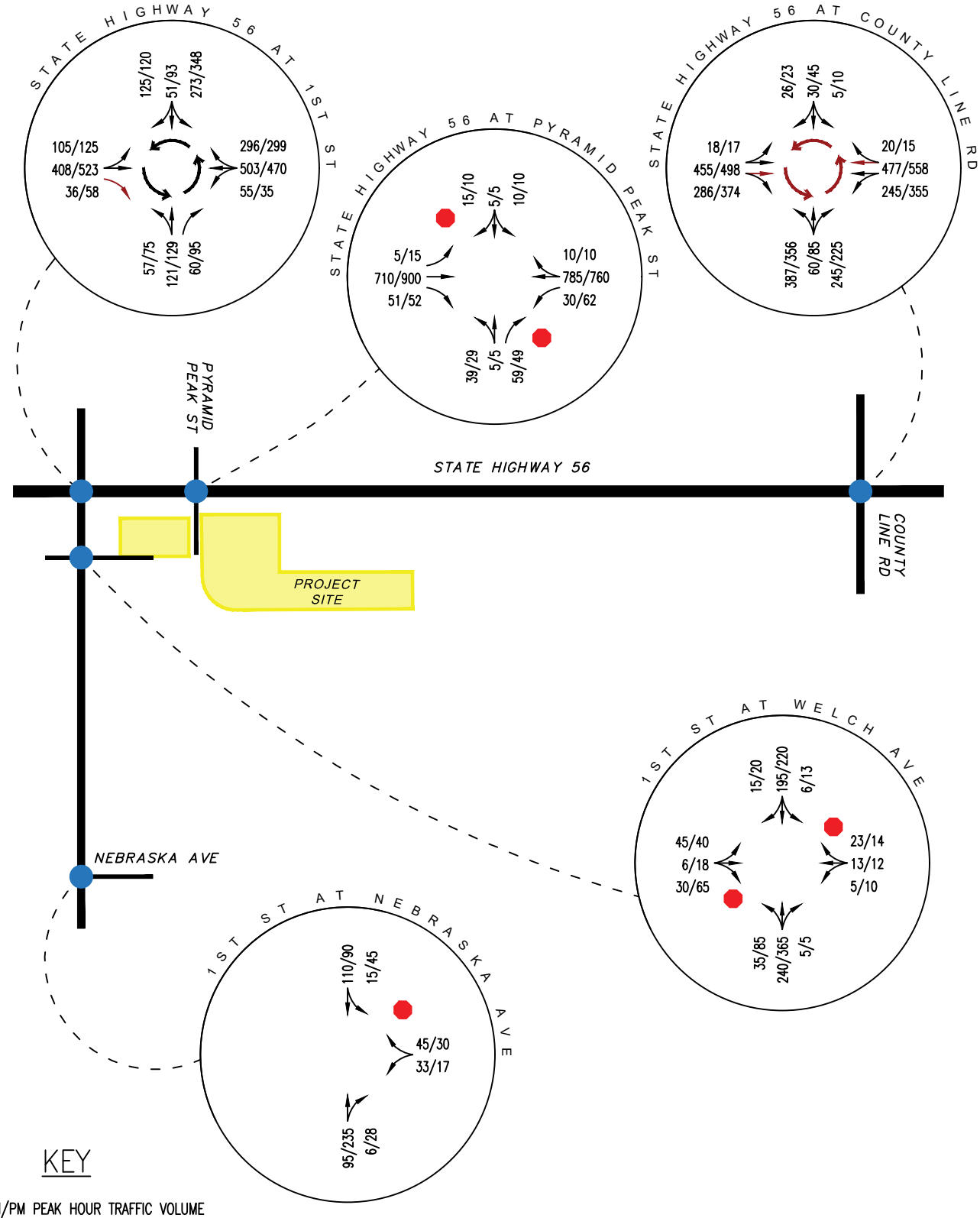


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FICKEL FARM TRAFFIC IMPACT STUDY

YEAR 2028 BACKGROUND + PROJECT TRAFFIC VOLUMES

Project #	24095	Original Scale	NTS	Date	8/1/25	Drawn by	CAF	Figure #	8



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FICKEL FARM TRAFFIC IMPACT STUDY

YEAR 2045 BACKGROUND + PROJECT TRAFFIC VOLUMES

Project #	24095	Original Scale	NTS	Date	8/1/25	Drawn by	CAF	Figure #	9

Appendix:

Level of Service Definitions

Existing Traffic Data

Intersection Capacity Worksheets

Background Documentation

Level of Service Definitions

LEVEL OF SERVICE DEFINITIONS

In rating roadway and intersection operating conditions with existing or future traffic volumes, "Levels of Service" (LOS) A through F are used, with LOS A indicating very good operation and LOS F indicating poor operation. Levels of service at signalized and unsignalized intersections are closely associated with vehicle delays experienced in seconds per vehicle. More complete level of service definitions and delay data for signal and stop sign controlled intersections are contained in the following table for reference.

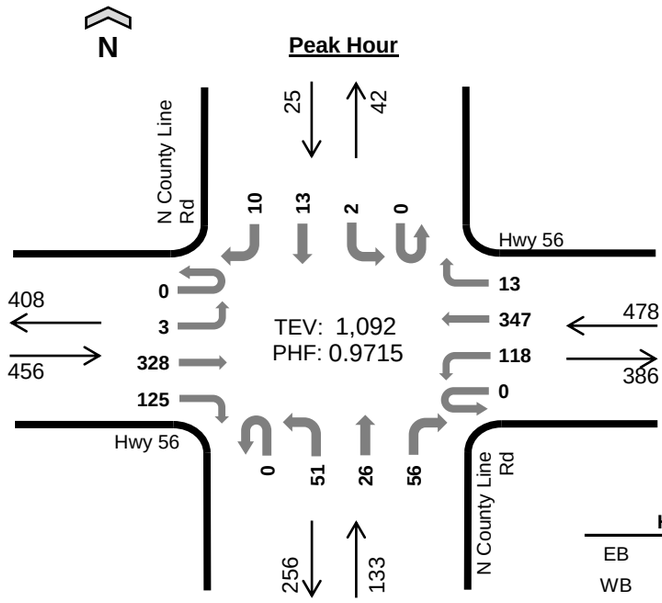
Level of Service Rating	Delay in seconds per vehicle *(a)*		Definition
	Signalized	Unsignalized	
A	0.0 to 10.0	0.0 to 10.0	Low vehicular traffic volumes; primarily free flow operations. Density is low and vehicles can freely maneuver within the traffic stream. Drivers are able to maintain their desired speeds with little or no delay.
B	10.1 to 20.0	10.1 to 15.0	Stable vehicular traffic volume flow with potential for some restriction of operating speeds due to traffic conditions. Vehicle maneuvering is only slightly restricted. The stopped delays are not bothersome and drivers are not subject to appreciable tension.
C	20.1 to 35.0	15.1 to 25.0	Stable traffic operations, however the ability for vehicles to maneuver is more restricted by the increase in traffic volumes. Relatively satisfactory operating speeds prevail, but adverse signal coordination or longer vehicle queues cause delays along the corridor.
D	35.1 to 55.0	25.1 to 35.0	Approaching unstable vehicular traffic flow where small increases in volume could cause substantial delays. Most drivers are restricted in ability to maneuver and selection of travel speeds due to congestion. Driver comfort and convenience are low, but tolerable.
E	55.1 to 80.0	35.1 to 50.0	Traffic operations characterized by significant approach delays and average travel speeds of one-half to one-third the free flow speed. Vehicular flow is unstable and there is potential for stoppages of brief duration. High signal density, extensive vehicle queuing, or corridor signal progression/timing are the typical causes of vehicle delays at signalized corridors.
F	> 80.0	> 50.0	Forced vehicular traffic flow and operations with high approach delays at critical intersections. Vehicle speeds are reduced substantially, and stoppages may occur for short or long periods of time because of downstream congestion.

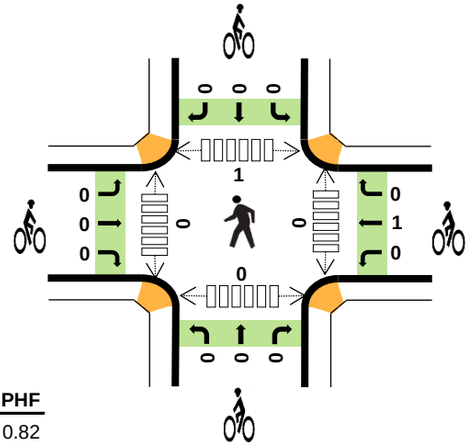
(a) Delay ranges based on Highway Capacity Manual (6th Edition, 2016) criteria.

Existing Traffic Data

N County Line Rd
Hwy 56

Date: 11/14/2024
Count Period: 7:00 AM to 9:00 AM
Peak Hour: 7:15 AM to 8:15 AM





	HV%	PHF
EB	4%	0.82
WB	7%	0.92
NB	10%	0.76
SB	8%	0.78
TOTAL	6%	0.97

Peak Hour Count Summaries

Peak Hour Interval Start		Hwy 56 Eastbound				Hwy 56 Westbound				N County Line Rd Northbound				N County Line Rd Southbound				15-min Total	Rolling Hour Total
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:15 AM		0	2	95	42	0	26	77	3	0	7	5	12	0	0	4	3	276	0
7:30 AM		0	0	84	26	0	35	92	1	0	12	5	10	0	0	3	1	269	0
7:45 AM		0	1	74	32	0	33	91	6	0	15	8	15	0	0	2	4	281	0
8:00 AM		0	0	75	25	0	24	87	3	0	17	8	19	0	2	4	2	266	1,092
Pk Hr	All	0	3	328	125	0	118	347	13	0	51	26	56	0	2	13	10	1,092	
	HV	0	0	15	3	0	8	24	0	0	4	2	7	0	0	0	2	65	
	HV%	-	0%	5%	2%	-	7%	7%	0%	-	8%	8%	13%	-	0%	0%	20%	6%	

Note: For complete count summary (all intervals), see following pages.
*** Heavy Vehicle Classifications include FHWA Classes 4-13.*
*** Count Summaries include heavy vehicles, but exclude bicycles in overall count.*

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
7:15 AM	4	6	0	1	*11*	0	0	0	0	*0*	0	0	0	0	*0*
7:30 AM	4	5	2	0	*11*	0	0	0	0	*0*	0	0	0	0	*0*
7:45 AM	7	12	5	1	*25*	0	1	0	0	*1*	0	0	1	0	*1*
8:00 AM	3	9	6	0	*18*	0	0	0	0	*0*	0	0	0	0	*0*
Peak Hour	18	32	13	2	*65*	0	1	0	0	*1*	0	0	1	0	*1*

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Count Summaries - All Vehicles

Interval Start	Hwy 56 Eastbound				Hwy 56 Westbound				N County Line Rd Northbound				N County Line Rd Southbound				15-min Total	Rolling Hour Total
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	1	93	29	0	30	71	2	0	10	8	9	0	0	1	1	255	0
7:15 AM	**0**	**2**	**95**	**42**	**0**	**26**	**77**	**3**	**0**	**7**	**5**	**12**	**0**	**0**	**4**	**3**	**276**	**0**
7:30 AM	**0**	**0**	**84**	**26**	**0**	**35**	**92**	**1**	**0**	**12**	**5**	**10**	**0**	**0**	**3**	**1**	**269**	**0**
7:45 AM	**0**	**1**	**74**	**32**	**0**	**33**	**91**	**6**	**0**	**15**	**8**	**15**	**0**	**0**	**2**	**4**	**281**	**1,081**
8:00 AM	**0**	**0**	**75**	**25**	**0**	**24**	**87**	**3**	**0**	**17**	**8**	**19**	**0**	**2**	**4**	**2**	**266**	**1,092**
8:15 AM	0	2	60	26	0	24	99	1	0	10	3	8	0	1	2	1	237	1,053
8:30 AM	0	0	72	19	0	17	68	4	0	10	3	8	0	1	2	1	205	989
8:45 AM	0	1	52	19	0	20	70	3	0	11	3	11	0	1	1	1	193	901
Count Total	0	7	605	218	0	209	655	23	0	92	43	92	0	5	19	14	1,982	
Pk Hr All	**0**	**3**	**328**	**125**	**0**	**118**	**347**	**13**	**0**	**51**	**26**	**56**	**0**	**2**	**13**	**10**	**1,092**	
Pk Hr HV	**0**	**0**	**15**	**3**	**0**	**8**	**24**	**0**	**0**	**4**	**2**	**7**	**0**	**0**	**0**	**2**	**65**	
Pk Hr HV%	**-**	**0%**	**5%**	**2%**	**-**	**7%**	**7%**	**0%**	**-**	**8%**	**8%**	**13%**	**-**	**0%**	**0%**	**20%**	**6%**	

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
7:00 AM	5	7	0	0	*12*	0	0	0	0	*0*	0	0	0	0	*0*
7:15 AM	**4**	**6**	**0**	**1**	**11**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7:30 AM	**4**	**5**	**2**	**0**	**11**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7:45 AM	**7**	**12**	**5**	**1**	**25**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**1**
8:00 AM	**3**	**9**	**6**	**0**	**18**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8:15 AM	6	2	1	0	*9*	0	0	0	0	*0*	0	0	0	0	*0*
8:30 AM	3	8	2	0	*13*	0	0	0	0	*0*	0	0	0	0	*0*
8:45 AM	5	11	3	0	*19*	0	0	0	0	*0*	0	0	0	0	*0*
Count Total	37	60	19	2	*118*	0	1	0	0	*1*	0	0	1	0	*1*
Peak Hour	**18**	**32**	**13**	**2**	***65***	**0**	**1**	**0**	**0**	***1***	**0**	**0**	**1**	**0**	**1**

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Count Summaries - Heavy Vehicles

Interval Start	Hwy 56				Hwy 56				N County Line Rd				N County Line Rd				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	1	3	1	0	0	7	0	0	0	0	0	0	0	0	0	12	0
7:15 AM	**0**	**0**	**2**	**2**	**0**	**0**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**11**	**0**
7:30 AM	**0**	**0**	**4**	**0**	**0**	**1**	**4**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**11**	**0**
7:45 AM	**0**	**0**	**6**	**1**	**0**	**7**	**5**	**0**	**0**	**1**	**1**	**3**	**0**	**0**	**0**	**1**	**25**	**59**
8:00 AM	**0**	**0**	**3**	**0**	**0**	**0**	**9**	**0**	**0**	**2**	**1**	**3**	**0**	**0**	**0**	**0**	**18**	**65**
8:15 AM	0	0	6	0	0	1	1	0	0	1	0	0	0	0	0	0	9	63
8:30 AM	0	0	3	0	0	4	4	0	0	0	0	2	0	0	0	0	13	65
8:45 AM	0	0	2	3	0	6	5	0	0	1	0	2	0	0	0	0	19	59
Count Total	0	1	29	7	0	19	41	0	0	6	2	11	0	0	0	2	118	
Pk Hr Heavy	**0**	**0**	**15**	**3**	**0**	**8**	**24**	**0**	**0**	**4**	**2**	**7**	**0**	**0**	**0**	**2**	**65**	

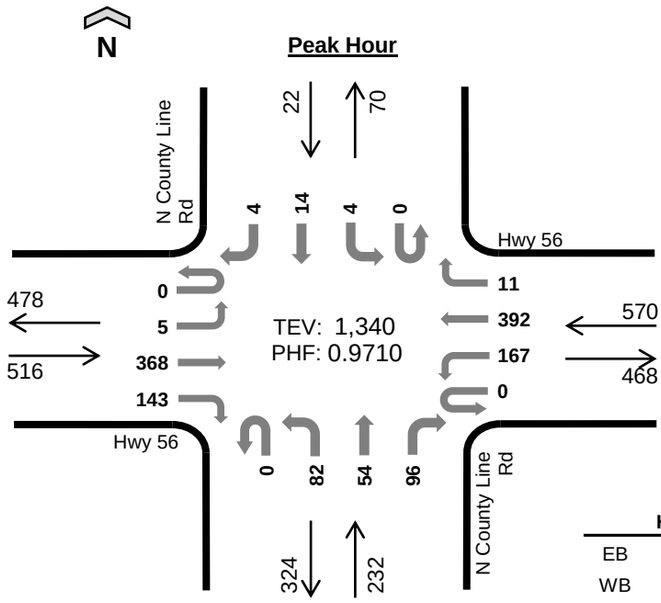
Count Summaries - Bikes

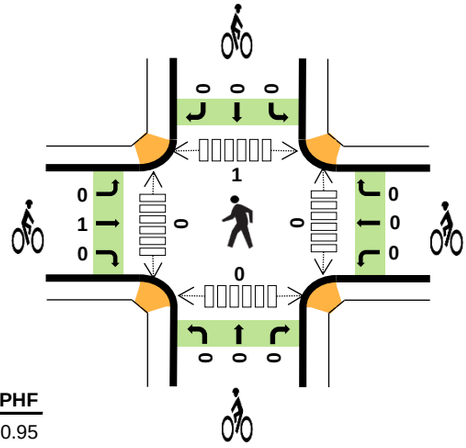
Interval Start	Hwy 56				Hwy 56				N County Line Rd				N County Line Rd				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7:30 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7:45 AM	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
8:00 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	
Pk Hr Bike	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	

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N County Line Rd
Hwy 56

Date: 11/14/2024
Count Period: 4:00 PM to 6:00 PM
Peak Hour: 4:30 PM to 5:30 PM





	HV%	PHF
EB	2%	0.95
WB	2%	0.90
NB	3%	0.95
SB	5%	0.69
TOTAL	2%	0.97

Peak Hour Count Summaries

Peak Hour Interval Start		Hwy 56 Eastbound				Hwy 56 Westbound				N County Line Rd Northbound				N County Line Rd Southbound				15-min Total	Rolling Hour Total
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:30 PM		0	0	83	37	0	41	96	3	0	19	17	24	0	2	3	1	326	0
4:45 PM		0	3	93	40	0	47	98	2	0	23	13	22	0	1	3	0	345	0
5:00 PM		0	2	96	34	0	36	85	4	0	16	16	29	0	0	6	2	326	0
5:15 PM		0	0	96	32	0	43	113	2	0	24	8	21	0	1	2	1	343	1,340
Pk Hr	All	0	5	368	143	0	167	392	11	0	82	54	96	0	4	14	4	1,340	
	HV	0	0	8	0	0	2	11	0	0	2	2	2	0	1	0	0	28	
	HV%	-	0%	2%	0%	-	1%	3%	0%	-	2%	4%	2%	-	25%	0%	0%	2%	

Note: For complete count summary (all intervals), see following pages.
*** Heavy Vehicle Classifications include FHWA Classes 4-13.*
*** Count Summaries include heavy vehicles, but exclude bicycles in overall count.*

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
4:30 PM	5	3	2	1	*11*	1	0	0	0	*1*	0	0	1	0	*1*
4:45 PM	1	2	1	0	*4*	0	0	0	0	*0*	0	0	0	0	*0*
5:00 PM	1	3	1	0	*5*	0	0	0	0	*0*	0	0	0	0	*0*
5:15 PM	1	5	2	0	*8*	0	0	0	0	*0*	0	0	0	0	*0*
Peak Hour	8	13	6	1	*28*	1	0	0	0	*1*	0	0	1	0	*1*

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Count Summaries - All Vehicles

Interval Start	Hwy 56 Eastbound				Hwy 56 Westbound				N County Line Rd Northbound				N County Line Rd Southbound				15-min Total	Rolling Hour Total
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	1	87	19	0	43	76	1	0	23	11	8	0	0	1	5	275	0
4:15 PM	0	0	87	30	0	32	92	0	0	23	11	24	0	0	3	2	304	0
4:30 PM	**0**	**0**	**83**	**37**	**0**	**41**	**96**	**3**	**0**	**19**	**17**	**24**	**0**	**2**	**3**	**1**	**326**	**0**
4:45 PM	**0**	**3**	**93**	**40**	**0**	**47**	**98**	**2**	**0**	**23**	**13**	**22**	**0**	**1**	**3**	**0**	**345**	**1,250**
5:00 PM	**0**	**2**	**96**	**34**	**0**	**36**	**85**	**4**	**0**	**16**	**16**	**29**	**0**	**0**	**6**	**2**	**326**	**1,301**
5:15 PM	**0**	**0**	**96**	**32**	**0**	**43**	**113**	**2**	**0**	**24**	**8**	**21**	**0**	**1**	**2**	**1**	**343**	**1,340**
5:30 PM	0	0	80	24	0	43	96	2	0	21	6	24	0	0	0	1	297	1,311
5:45 PM	0	0	75	24	0	45	105	1	0	26	10	30	0	0	1	0	317	1,283
Count Total	0	6	697	240	0	330	761	15	0	175	92	182	0	4	19	12	2,533	
Pk Hr All	**0**	**5**	**368**	**143**	**0**	**167**	**392**	**11**	**0**	**82**	**54**	**96**	**0**	**4**	**14**	**4**	**1,340**	
Pk Hr HV	**0**	**0**	**8**	**0**	**0**	**2**	**11**	**0**	**0**	**2**	**2**	**2**	**0**	**1**	**0**	**0**	**28**	
Pk Hr HV%	**-**	**0%**	**2%**	**0%**	**-**	**1%**	**3%**	**0%**	**-**	**2%**	**4%**	**2%**	**-**	**25%**	**0%**	**0%**	**2%**	

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
4:00 PM	5	5	0	0	*10*	0	0	0	0	*0*	0	0	0	0	*0*
4:15 PM	8	4	1	0	*13*	0	0	0	0	*0*	0	0	0	0	*0*
4:30 PM	**5**	**3**	**2**	**1**	**11**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**1**
4:45 PM	**1**	**2**	**1**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5:00 PM	**1**	**3**	**1**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5:15 PM	**1**	**5**	**2**	**0**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5:30 PM	2	4	0	0	*6*	0	0	0	0	*0*	0	0	0	0	*0*
5:45 PM	1	7	0	0	*8*	0	0	0	0	*0*	0	0	0	0	*0*
Count Total	24	33	7	1	*65*	1	0	0	0	*1*	0	0	1	0	*1*
Peak Hour	**8**	**13**	**6**	**1**	***28***	**1**	**0**	**0**	**0**	***1***	**0**	**0**	**1**	**0**	**1**

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Count Summaries - Heavy Vehicles

Interval Start	Hwy 56				Hwy 56				N County Line Rd				N County Line Rd				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	0	4	1	0	3	2	0	0	0	0	0	0	0	0	0	10	0
4:15 PM	0	0	5	3	0	0	4	0	0	0	0	1	0	0	0	0	13	0
4:30 PM	**0**	**0**	**5**	**0**	**0**	**0**	**3**	**0**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**11**	**0**
4:45 PM	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**4**	**38**
5:00 PM	**0**	**0**	**1**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**5**	**33**
5:15 PM	**0**	**0**	**1**	**0**	**0**	**1**	**4**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**8**	**28**
5:30 PM	0	0	2	0	0	1	3	0	0	0	0	0	0	0	0	0	6	23
5:45 PM	0	0	1	0	0	0	7	0	0	0	0	0	0	0	0	0	8	27
Count Total	0	0	20	4	0	6	27	0	0	2	2	3	0	1	0	0	65	
Pk Hr Heavy	**0**	**0**	**8**	**0**	**0**	**2**	**11**	**0**	**0**	**2**	**2**	**2**	**0**	**1**	**0**	**0**	**28**	

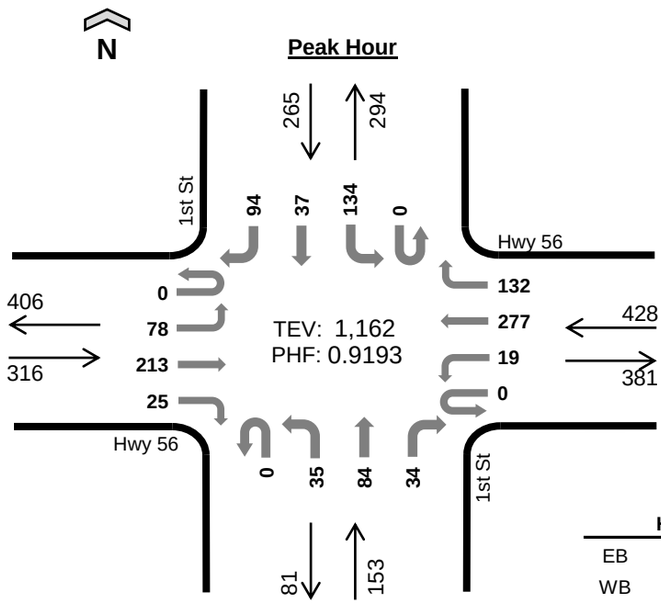
Count Summaries - Bikes

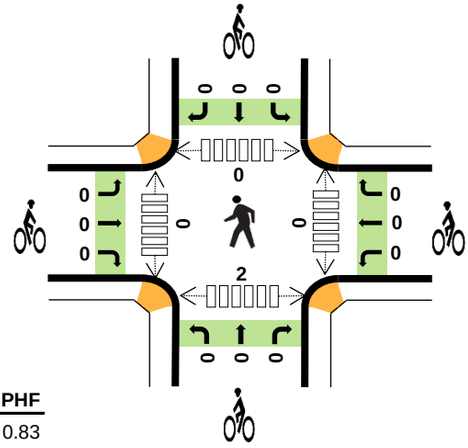
Interval Start	Hwy 56				Hwy 56				N County Line Rd				N County Line Rd				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
5:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
5:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
Pk Hr Bike	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	

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1st St
Hwy 56

Date: 11/14/2024
Count Period: 7:00 AM to 9:00 AM
Peak Hour: 7:45 AM to 8:45 AM





	HV%	PHF
EB	7%	0.83
WB	7%	0.92
NB	1%	0.80
SB	5%	0.81
TOTAL	6%	0.92

Peak Hour Count Summaries

Peak Hour Interval Start		Hwy 56 Eastbound				Hwy 56 Westbound				1st St Northbound				1st St Southbound				15-min Total	Rolling Hour Total
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:45 AM		0	18	49	3	0	6	73	37	0	8	26	6	0	48	9	25	308	0
8:00 AM		0	26	62	7	0	3	75	32	0	5	21	12	0	35	9	29	316	0
8:15 AM		0	19	42	8	0	8	71	34	0	1	19	7	0	31	14	23	277	0
8:30 AM		0	15	60	7	0	2	58	29	0	21	18	9	0	20	5	17	261	1,162
Pk Hr	All	0	78	213	25	0	19	277	132	0	35	84	34	0	134	37	94	1,162	
	HV	0	6	15	0	0	0	22	6	0	0	1	1	0	6	3	5	65	
	HV%	-	8%	7%	0%	-	0%	8%	5%	-	0%	1%	3%	-	4%	8%	5%	6%	

Note: For complete count summary (all intervals), see following pages.
*** Heavy Vehicle Classifications include FHWA Classes 4-13.*
*** Count Summaries include heavy vehicles, but exclude bicycles in overall count.*

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
7:45 AM	4	10	1	4	*19*	0	0	0	0	*0*	0	0	0	0	*0*
8:00 AM	7	12	0	6	*25*	0	0	0	0	*0*	0	0	0	0	*0*
8:15 AM	6	3	1	1	*11*	0	0	0	0	*0*	0	0	0	0	*0*
8:30 AM	4	3	0	3	*10*	0	0	0	0	*0*	0	0	0	2	*2*
Peak Hour	21	28	2	14	*65*	0	0	0	0	*0*	0	0	0	2	*2*

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Count Summaries - All Vehicles

Interval Start	Hwy 56 Eastbound				Hwy 56 Westbound				1st St Northbound				1st St Southbound				15-min Total	Rolling Hour Total
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	19	63	2	0	5	48	35	0	6	15	12	0	45	3	15	268	0
7:15 AM	0	16	51	1	0	5	52	30	0	6	23	14	0	57	8	15	278	0
7:30 AM	0	16	37	1	0	5	56	43	0	5	17	14	0	49	3	10	256	0
7:45 AM	**0**	**18**	**49**	**3**	**0**	**6**	**73**	**37**	**0**	**8**	**26**	**6**	**0**	**48**	**9**	**25**	**308**	**1,110**
8:00 AM	**0**	**26**	**62**	**7**	**0**	**3**	**75**	**32**	**0**	**5**	**21**	**12**	**0**	**35**	**9**	**29**	**316**	**1,158**
8:15 AM	**0**	**19**	**42**	**8**	**0**	**8**	**71**	**34**	**0**	**1**	**19**	**7**	**0**	**31**	**14**	**23**	**277**	**1,157**
8:30 AM	**0**	**15**	**60**	**7**	**0**	**2**	**58**	**29**	**0**	**21**	**18**	**9**	**0**	**20**	**5**	**17**	**261**	**1,162**
8:45 AM	0	19	43	6	0	2	36	40	0	13	23	15	0	24	11	19	251	1,105
Count Total	0	148	407	35	0	36	469	280	0	65	162	89	0	309	62	153	2,215	
Pk Hr All	**0**	**78**	**213**	**25**	**0**	**19**	**277**	**132**	**0**	**35**	**84**	**34**	**0**	**134**	**37**	**94**	**1,162**	
Pk Hr HV	**0**	**6**	**15**	**0**	**0**	**0**	**22**	**6**	**0**	**0**	**1**	**1**	**0**	**6**	**3**	**5**	**65**	
Pk Hr HV%	**-**	**8%**	**7%**	**0%**	**-**	**0%**	**8%**	**5%**	**-**	**0%**	**1%**	**3%**	**-**	**4%**	**8%**	**5%**	**6%**	

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
7:00 AM	1	7	3	1	*12*	0	0	0	0	*0*	0	0	0	0	*0*
7:15 AM	4	7	0	1	*12*	0	0	0	0	*0*	0	0	0	0	*0*
7:30 AM	2	4	2	1	*9*	0	0	0	0	*0*	0	0	0	2	*2*
7:45 AM	**4**	**10**	**1**	**4**	**19**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8:00 AM	**7**	**12**	**0**	**6**	**25**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8:15 AM	**6**	**3**	**1**	**1**	**11**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8:30 AM	**4**	**3**	**0**	**3**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**
8:45 AM	4	4	0	4	*12*	0	0	0	0	*0*	0	0	0	0	*0*
Count Total	32	50	7	21	*110*	0	0	0	0	*0*	0	0	0	4	*4*
Peak Hour	**21**	**28**	**2**	**14**	***65***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**2**	**2**

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Count Summaries - Heavy Vehicles

Interval Start	Hwy 56				Hwy 56				1st St				1st St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	1	0	0	0	7	0	0	1	1	1	0	0	0	1	12	0
7:15 AM	0	0	3	1	0	1	5	1	0	0	0	0	0	1	0	0	12	0
7:30 AM	0	0	2	0	0	1	2	1	0	0	0	2	0	1	0	0	9	0
7:45 AM	**0**	**2**	**2**	**0**	**0**	**0**	**6**	**4**	**0**	**0**	**1**	**0**	**0**	**3**	**1**	**0**	**19**	**52**
8:00 AM	**0**	**2**	**5**	**0**	**0**	**0**	**10**	**2**	**0**	**0**	**0**	**0**	**0**	**3**	**1**	**2**	**25**	**65**
8:15 AM	**0**	**1**	**5**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**11**	**64**
8:30 AM	**0**	**1**	**3**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**10**	**65**
8:45 AM	0	1	3	0	0	0	2	2	0	0	0	0	0	2	1	1	12	58
Count Total	0	7	24	1	0	2	38	10	0	1	2	4	0	10	4	7	110	
Pk Hr Heavy	**0**	**6**	**15**	**0**	**0**	**0**	**22**	**6**	**0**	**0**	**1**	**1**	**0**	**6**	**3**	**5**	**65**	

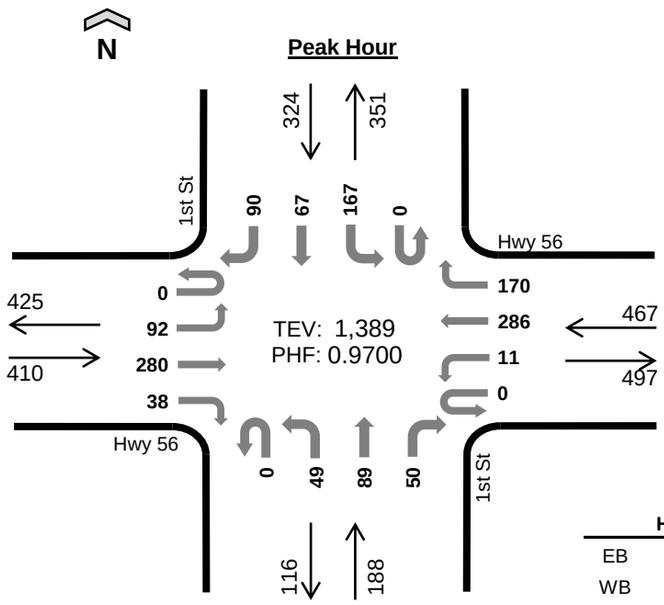
Count Summaries - Bikes

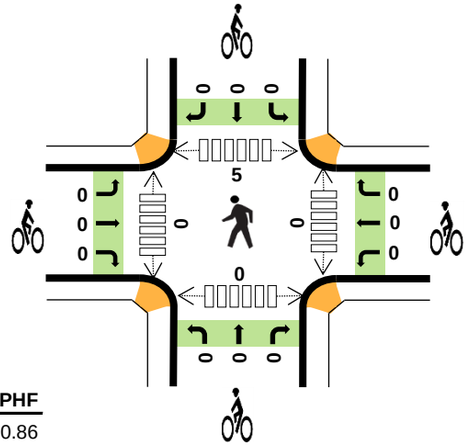
Interval Start	Hwy 56				Hwy 56				1st St				1st St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8:00 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8:15 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8:30 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pk Hr Bike	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	

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1st St
Hwy 56

Date: 11/14/2024
Count Period: 4:00 PM to 6:00 PM
Peak Hour: 4:00 PM to 5:00 PM





	HV%	PHF
EB	4%	0.86
WB	3%	0.94
NB	3%	0.89
SB	3%	0.79
TOTAL	3%	0.97

Peak Hour Count Summaries

Peak Hour Interval Start		Hwy 56 Eastbound				Hwy 56 Westbound				1st St Northbound				1st St Southbound				15-min Total	Rolling Hour Total
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM		0	38	66	15	0	3	81	40	0	12	22	11	0	29	16	25	358	0
4:15 PM		0	17	82	11	0	4	67	43	0	11	22	14	0	34	17	23	345	0
4:30 PM		0	17	59	4	0	2	74	40	0	11	23	9	0	53	24	25	341	0
4:45 PM		0	20	73	8	0	2	64	47	0	15	22	16	0	51	10	17	345	1,389
Pk Hr	All	0	92	280	38	0	11	286	170	0	49	89	50	0	167	67	90	1,389	
	HV	0	5	12	0	0	0	12	3	0	0	4	2	0	6	0	3	47	
	HV%	-	5%	4%	0%	-	0%	4%	2%	-	0%	4%	4%	-	4%	0%	3%	3%	

Note: For complete count summary (all intervals), see following pages.
*** Heavy Vehicle Classifications include FHWA Classes 4-13.*
*** Count Summaries include heavy vehicles, but exclude bicycles in overall count.*

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
4:00 PM	6	4	2	4	*16*	0	0	0	0	*0*	0	0	0	0	*0*
4:15 PM	3	3	1	2	*9*	0	0	0	0	*0*	0	0	4	0	*4*
4:30 PM	5	5	2	3	*15*	0	0	0	0	*0*	0	0	1	0	*1*
4:45 PM	3	3	1	0	*7*	0	0	0	0	*0*	0	0	0	0	*0*
Peak Hour	17	15	6	9	*47*	0	0	0	0	*0*	0	0	5	0	*5*

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Count Summaries - All Vehicles

Interval Start	Hwy 56 Eastbound				Hwy 56 Westbound				1st St Northbound				1st St Southbound				15-min Total	Rolling Hour Total
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	**0**	**38**	**66**	**15**	**0**	**3**	**81**	**40**	**0**	**12**	**22**	**11**	**0**	**29**	**16**	**25**	**358**	0
4:15 PM	**0**	**17**	**82**	**11**	**0**	**4**	**67**	**43**	**0**	**11**	**22**	**14**	**0**	**34**	**17**	**23**	**345**	**0**
4:30 PM	**0**	**17**	**59**	**4**	**0**	**2**	**74**	**40**	**0**	**11**	**23**	**9**	**0**	**53**	**24**	**25**	**341**	**0**
4:45 PM	**0**	**20**	**73**	**8**	**0**	**2**	**64**	**47**	**0**	**15**	**22**	**16**	**0**	**51**	**10**	**17**	**345**	**1,389**
5:00 PM	0	17	57	12	0	3	56	33	0	14	29	16	0	50	22	38	347	1,378
5:15 PM	0	18	67	4	0	1	81	55	0	4	20	18	0	37	18	32	355	1,388
5:30 PM	0	21	58	4	0	3	79	32	0	8	24	18	0	30	21	11	309	1,356
5:45 PM	0	14	53	8	0	2	76	48	0	6	18	9	0	25	10	22	291	1,302
Count Total	0	162	515	66	0	20	578	338	0	81	180	111	0	309	138	193	2,691	
Pk Hr All	**0**	**92**	**280**	**38**	**0**	**11**	**286**	**170**	**0**	**49**	**89**	**50**	**0**	**167**	**67**	**90**	**1,389**	
Pk Hr HV	**0**	**5**	**12**	**0**	**0**	**0**	**12**	**3**	**0**	**0**	**4**	**2**	**0**	**6**	**0**	**3**	**47**	
Pk Hr HV%	**-**	**5%**	**4%**	**0%**	**-**	**0%**	**4%**	**2%**	**-**	**0%**	**4%**	**4%**	**-**	**4%**	**0%**	**3%**	**3%**	

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
4:00 PM	**6**	**4**	**2**	**4**	**16**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4:15 PM	**3**	**3**	**1**	**2**	**9**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**4**
4:30 PM	**5**	**5**	**2**	**3**	**15**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**
4:45 PM	**3**	**3**	**1**	**0**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5:00 PM	0	3	0	1	*4*	0	0	0	0	*0*	0	0	0	0	*0*
5:15 PM	3	3	0	3	*9*	0	0	0	0	*0*	0	0	0	0	*0*
5:30 PM	3	2	1	0	*6*	0	0	0	0	*0*	0	0	0	0	*0*
5:45 PM	1	3	1	0	*5*	0	0	0	0	*0*	0	0	0	0	*0*
Count Total	24	26	8	13	*71*	0	0	0	0	*0*	0	0	5	0	*5*
Peak Hour	**17**	**15**	**6**	**9**	***47***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**5**	**0**	**5**

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Count Summaries - Heavy Vehicles

Interval Start	Hwy 56 Eastbound				Hwy 56 Westbound				1st St Northbound				1st St Southbound				15-min Total	Rolling Hour Total
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	**0**	**3**	**3**	**0**	**0**	**0**	**4**	**0**	**0**	**0**	**1**	**1**	**0**	**2**	**0**	**2**	**16**	0
4:15 PM	**0**	**0**	**3**	**0**	**0**	**0**	**2**	**1**	**0**	**0**	**0**	**1**	**0**	**2**	**0**	**0**	**9**	**0**
4:30 PM	**0**	**1**	**4**	**0**	**0**	**0**	**4**	**1**	**0**	**0**	**2**	**0**	**0**	**2**	**0**	**1**	**15**	**0**
4:45 PM	**0**	**1**	**2**	**0**	**0**	**0**	**2**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**7**	**47**
5:00 PM	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1	4	35
5:15 PM	0	0	3	0	0	0	2	1	0	0	0	0	0	2	1	0	9	35
5:30 PM	0	1	2	0	0	0	2	0	0	1	0	0	0	0	0	0	6	26
5:45 PM	0	0	1	0	0	1	0	2	0	1	0	0	0	0	0	0	5	24
Count Total	0	6	18	0	0	1	19	6	0	2	4	2	0	8	1	4	71	
Pk Hr Heavy	**0**	**5**	**12**	**0**	**0**	**0**	**12**	**3**	**0**	**0**	**4**	**2**	**0**	**6**	**0**	**3**	**47**	

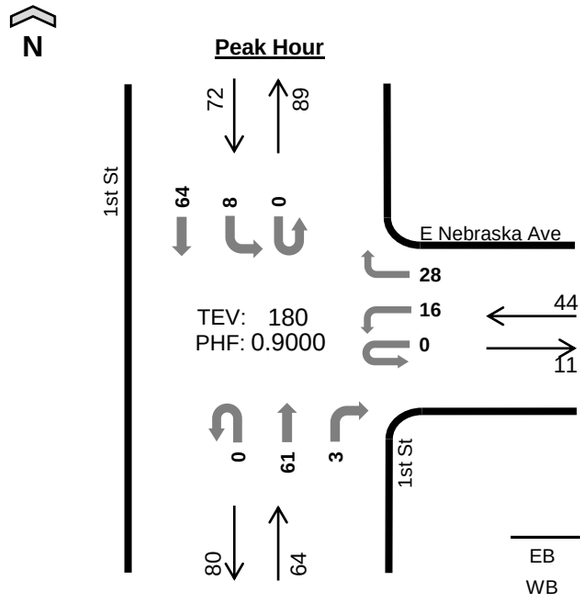
Count Summaries - Bikes

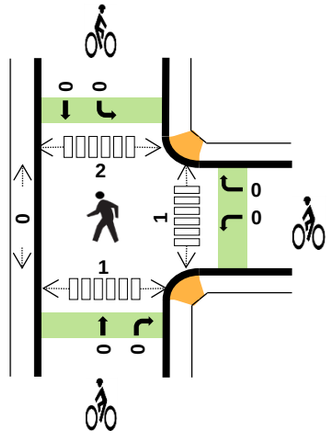
Interval Start	Hwy 56 Eastbound				Hwy 56 Westbound				1st St Northbound				1st St Southbound				15-min Total	Rolling Hour Total
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pk Hr Bike	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	

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1st St
E Nebraska Ave

Date: 11/14/2024
Count Period: 7:00 AM to 9:00 AM
Peak Hour: 7:15 AM to 8:15 AM





	HV%	PHF
EB	--	--
WB	2%	0.73
NB	3%	0.80
SB	6%	0.90
TOTAL	4%	0.90

Peak Hour Count Summaries

Peak Hour Interval Start		n/a				E Nebraska Ave				1st St				1st St				15-min Total	Rolling Hour Total
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:15 AM		0	0	0	0	0	6	0	3	0	0	11	1	0	1	19	0	41	0
7:30 AM		0	0	0	0	0	8	0	7	0	0	17	1	0	1	14	0	48	0
7:45 AM		0	0	0	0	0	1	0	9	0	0	20	0	0	2	18	0	50	0
8:00 AM		0	0	0	0	0	1	0	9	0	0	13	1	0	4	13	0	41	180
Pk Hr	All	0	0	0	0	0	16	0	28	0	0	61	3	0	8	64	0	180	
	HV	0	0	0	0	0	1	0	0	0	0	2	0	0	1	3	0	7	
	HV%	-	-	-	-	-	6%	-	0%	-	-	3%	0%	-	13%	5%	-	4%	

Note: For complete count summary (all intervals), see following pages.
*** Heavy Vehicle Classifications include FHWA Classes 4-13.*
*** Count Summaries include heavy vehicles, but exclude bicycles in overall count.*

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
7:15 AM	0	1	0	1	*2*	0	0	0	0	*0*	1	0	0	1	*2*
7:30 AM	0	0	0	1	*1*	0	0	0	0	*0*	0	0	1	0	*1*
7:45 AM	0	0	1	2	*3*	0	0	0	0	*0*	0	0	0	0	*0*
8:00 AM	0	0	1	0	*1*	0	0	0	0	*0*	0	0	1	0	*1*
Peak Hour	0	1	2	4	*7*	0	0	0	0	*0*	1	0	2	1	*4*

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Count Summaries - All Vehicles

Interval Start	n/a				E Nebraska Ave				1st St				1st St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	0	0	0	5	0	3	0	0	6	1	0	1	14	0	30	0
7:15 AM	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**3**	**0**	**0**	**11**	**1**	**0**	**1**	**19**	**0**	**41**	**0**
7:30 AM	**0**	**0**	**0**	**0**	**0**	**8**	**0**	**7**	**0**	**0**	**17**	**1**	**0**	**1**	**14**	**0**	**48**	**0**
7:45 AM	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**9**	**0**	**0**	**20**	**0**	**0**	**2**	**18**	**0**	**50**	**169**
8:00 AM	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**9**	**0**	**0**	**13**	**1**	**0**	**4**	**13**	**0**	**41**	**180**
8:15 AM	0	0	0	0	0	0	0	3	0	0	12	1	0	3	16	0	35	174
8:30 AM	0	0	0	0	0	5	0	8	0	0	12	0	0	8	9	0	42	168
8:45 AM	0	0	0	0	0	2	0	9	0	0	11	0	0	5	15	0	42	160
Count Total	0	0	0	0	0	28	0	51	0	0	102	5	0	25	118	0	329	
Pk Hr All	**0**	**0**	**0**	**0**	**0**	**16**	**0**	**28**	**0**	**0**	**61**	**3**	**0**	**8**	**64**	**0**	**180**	
Pk Hr HV	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**1**	**3**	**0**	**7**	
Pk Hr HV%	**-**	**-**	**-**	**-**	**-**	**6%**	**-**	**0%**	**-**	**-**	**3%**	**0%**	**-**	**13%**	**5%**	**-**	**4%**	

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
7:00 AM	0	0	1	0	*1*	0	0	0	0	*0*	1	0	0	0	*1*
7:15 AM	**0**	**1**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**2**
7:30 AM	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**
7:45 AM	**0**	**0**	**1**	**2**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8:00 AM	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**
8:15 AM	0	0	2	1	*3*	0	0	0	0	*0*	0	0	0	0	*0*
8:30 AM	0	0	0	0	*0*	0	0	0	0	*0*	0	0	0	0	*0*
8:45 AM	0	0	1	2	*3*	0	0	0	0	*0*	0	0	0	0	*0*
Count Total	0	1	6	7	*14*	0	0	0	0	*0*	2	0	2	1	*5*
Peak Hour	**0**	**1**	**2**	**4**	***7***	**0**	**0**	**0**	**0**	***0***	**1**	**0**	**2**	**1**	**4**

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Count Summaries - Heavy Vehicles

Interval Start	n/a				E Nebraska Ave				1st St				1st St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
7:15 AM	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**0**
7:30 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**
7:45 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**0**	**3**	**7**
8:00 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**7**
8:15 AM	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	3	8
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
8:45 AM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	3	7
Count Total	0	0	0	0	0	1	0	0	0	0	6	0	0	1	6	0	14	
Pk Hr Heavy	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**1**	**3**	**0**	**7**	

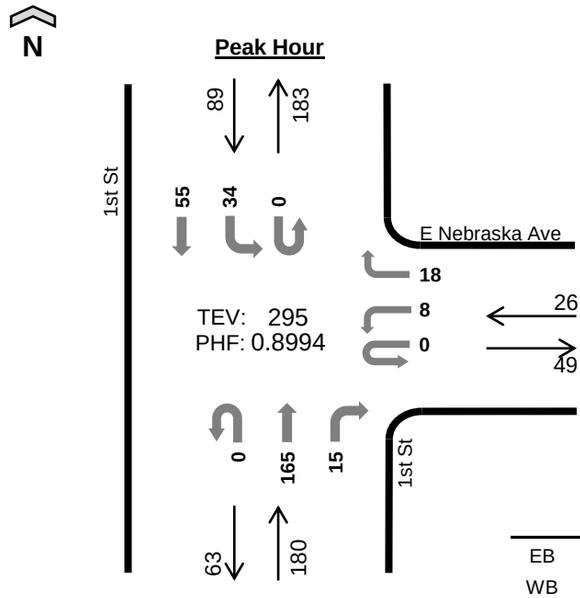
Count Summaries - Bikes

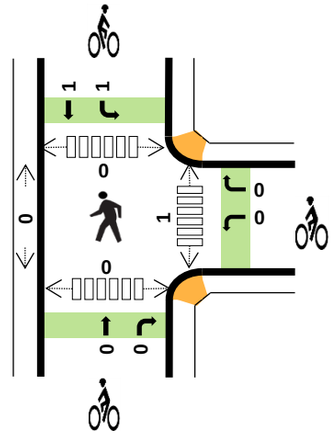
Interval Start	n/a				E Nebraska Ave				1st St				1st St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7:30 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7:45 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8:00 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pk Hr Bike	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	

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1st St
E Nebraska Ave

Date: 11/14/2024
Count Period: 4:00 PM to 6:00 PM
Peak Hour: 4:15 PM to 5:15 PM





	HV%	PHF
EB	--	--
WB	0%	0.59
NB	1%	0.88
SB	1%	0.77
TOTAL	1%	0.90

Peak Hour Count Summaries

Peak Hour Interval Start		n/a				E Nebraska Ave				1st St				1st St				15-min Total	Rolling Hour Total
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:15 PM		**0**	**0**	**0**	**0**	**0**	**3**	**0**	**4**	**0**	**0**	**42**	**4**	**0**	**11**	**18**	**0**	**82**	**0**
4:30 PM		**0**	**0**	**0**	**0**	**0**	**1**	**0**	**3**	**0**	**0**	**36**	**5**	**0**	**12**	**10**	**0**	**67**	**0**
4:45 PM		**0**	**0**	**0**	**0**	**0**	**3**	**0**	**8**	**0**	**0**	**40**	**2**	**0**	**4**	**11**	**0**	**68**	**0**
5:00 PM		**0**	**0**	**0**	**0**	**0**	**1**	**0**	**3**	**0**	**0**	**47**	**4**	**0**	**7**	**16**	**0**	**78**	**295**
Pk Hr	All	**0**	**0**	**0**	**0**	**0**	**8**	**0**	**18**	**0**	**0**	**165**	**15**	**0**	**34**	**55**	**0**	**295**	
	HV	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**0**	**3**	
	HV%	**-**	**-**	**-**	**-**	**-**	**0%**	**-**	**0%**	**-**	**-**	**1%**	**0%**	**-**	**0%**	**2%**	**-**	**1%**	

Note: For complete count summary (all intervals), see following pages.
*** Heavy Vehicle Classifications include FHWA Classes 4-13.*
*** Count Summaries include heavy vehicles, but exclude bicycles in overall count.*

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
4:15 PM	**0**	**0**	**0**	**1**	***1***	**0**	**0**	**0**	**1**	***1***	**0**	**0**	**0**	**0**	***0***
4:30 PM	**0**	**0**	**2**	**0**	***2***	**0**	**0**	**0**	**1**	***1***	**0**	**0**	**0**	**0**	***0***
4:45 PM	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***	**1**	**0**	**0**	**0**	***1***
5:00 PM	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***
Peak Hour	**0**	**0**	**2**	**1**	***3***	**0**	**0**	**0**	**2**	***2***	**1**	**0**	**0**	**0**	***1***

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Count Summaries - All Vehicles

Interval Start	n/a				E Nebraska Ave				1st St				1st St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	0	0	0	0	2	0	3	0	0	39	1	0	4	14	0	63	0
4:15 PM	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**4**	**0**	**0**	**42**	**4**	**0**	**11**	**18**	**0**	**82**	**0**
4:30 PM	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**3**	**0**	**0**	**36**	**5**	**0**	**12**	**10**	**0**	**67**	**0**
4:45 PM	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**8**	**0**	**0**	**40**	**2**	**0**	**4**	**11**	**0**	**68**	**280**
5:00 PM	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**3**	**0**	**0**	**47**	**4**	**0**	**7**	**16**	**0**	**78**	**295**
5:15 PM	0	0	0	0	0	1	0	2	0	0	50	7	0	7	4	0	71	284
5:30 PM	0	0	0	0	0	2	0	2	0	0	36	5	0	8	13	0	66	283
5:45 PM	0	0	0	0	0	0	0	1	0	0	30	5	0	6	5	0	47	262
Count Total	0	0	0	0	0	13	0	26	0	0	320	33	0	59	91	0	542	
Pk Hr All	**0**	**0**	**0**	**0**	**0**	**8**	**0**	**18**	**0**	**0**	**165**	**15**	**0**	**34**	**55**	**0**	**295**	
Pk Hr HV	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**0**	**3**	
Pk Hr HV%	**-**	**-**	**-**	**-**	**-**	**0%**	**-**	**0%**	**-**	**-**	**1%**	**0%**	**-**	**0%**	**2%**	**-**	**1%**	

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
4:00 PM	0	0	1	0	*1*	0	0	1	0	*1*	0	0	1	0	*1*
4:15 PM	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**
4:30 PM	**0**	**0**	**2**	**0**	**2**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**
5:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5:15 PM	0	0	0	1	*1*	0	0	0	0	*0*	0	0	0	0	*0*
5:30 PM	0	0	0	0	*0*	0	0	0	0	*0*	0	1	1	0	*2*
5:45 PM	0	0	0	0	*0*	0	0	0	0	*0*	0	0	0	0	*0*
Count Total	0	0	3	2	*5*	0	0	1	2	*3*	1	1	2	0	*4*
Peak Hour	**0**	**0**	**2**	**1**	***3***	**0**	**0**	**0**	**2**	***2***	**1**	**0**	**0**	**0**	**1**

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Count Summaries - Heavy Vehicles

Interval Start	n/a				E Nebraska Ave				1st St				1st St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**2**	**0**
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**
5:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	3
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Count Total	0	0	0	0	0	0	0	0	0	0	3	0	0	1	1	0	5	
Pk Hr Heavy	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**0**	**3**	

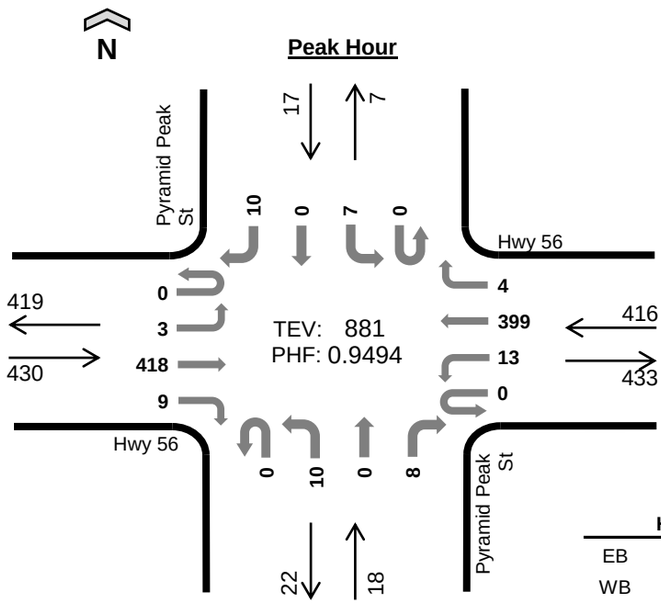
Count Summaries - Bikes

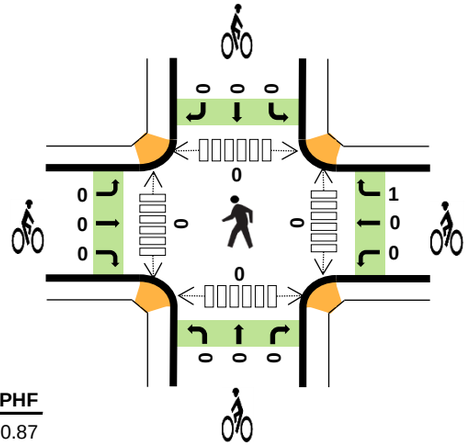
Interval Start	n/a				E Nebraska Ave				1st St				1st St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**
5:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	3	
Pk Hr Bike	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**2**	

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Pyramid Peak St
Hwy 56

Date: 11/14/2024
Count Period: 7:00 AM to 9:00 AM
Peak Hour: 7:15 AM to 8:15 AM





	HV%	PHF
EB	5%	0.87
WB	8%	0.90
NB	0%	0.64
SB	0%	0.53
TOTAL	6%	0.95

Peak Hour Count Summaries

Peak Hour Interval Start		Hwy 56 Eastbound				Hwy 56 Westbound				Pyramid Peak St Northbound				Pyramid Peak St Southbound				15-min Total	Rolling Hour Total
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:15 AM		0	0	121	2	0	2	88	0	0	1	0	2	0	4	0	4	224	0
7:30 AM		0	1	99	0	0	5	97	2	0	4	0	3	0	0	0	2	213	0
7:45 AM		0	0	97	2	0	4	102	1	0	4	0	0	0	1	0	1	212	0
8:00 AM		0	2	101	5	0	2	112	1	0	1	0	3	0	2	0	3	232	881
Pk Hr	All	0	3	418	9	0	13	399	4	0	10	0	8	0	7	0	10	881	
	HV	0	0	21	1	0	0	35	0	0	0	0	0	0	0	0	0	57	
	HV%	-	0%	5%	11%	-	0%	9%	0%	-	0%	-	0%	-	0%	-	0%	6%	

Note: For complete count summary (all intervals), see following pages.
*** Heavy Vehicle Classifications include FHWA Classes 4-13.*
*** Count Summaries include heavy vehicles, but exclude bicycles in overall count.*

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
7:15 AM	4	7	0	0	*11*	0	0	0	0	*0*	0	0	0	0	*0*
7:30 AM	5	6	0	0	*11*	0	0	0	0	*0*	0	0	0	0	*0*
7:45 AM	6	10	0	0	*16*	0	1	0	0	*1*	0	0	0	0	*0*
8:00 AM	7	12	0	0	*19*	0	0	0	0	*0*	0	0	0	0	*0*
Peak Hour	22	35	0	0	*57*	0	1	0	0	*1*	0	0	0	0	*0*

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Count Summaries - All Vehicles

Interval Start	Hwy 56 Eastbound				Hwy 56 Westbound				Pyramid Peak St Northbound				Pyramid Peak St Southbound				15-min Total	Rolling Hour Total
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	118	2	0	1	82	0	0	1	0	1	0	2	0	3	210	0
7:15 AM	**0**	**0**	**121**	**2**	**0**	**2**	**88**	**0**	**0**	**1**	**0**	**2**	**0**	**4**	**0**	**4**	**224**	**0**
7:30 AM	**0**	**1**	**99**	**0**	**0**	**5**	**97**	**2**	**0**	**4**	**0**	**3**	**0**	**0**	**0**	**2**	**213**	**0**
7:45 AM	**0**	**0**	**97**	**2**	**0**	**4**	**102**	**1**	**0**	**4**	**0**	**0**	**0**	**1**	**0**	**1**	**212**	**859**
8:00 AM	**0**	**2**	**101**	**5**	**0**	**2**	**112**	**1**	**0**	**1**	**0**	**3**	**0**	**2**	**0**	**3**	**232**	**881**
8:15 AM	0	2	75	2	0	2	99	1	0	4	1	2	0	1	0	4	193	850
8:30 AM	0	2	85	1	0	1	89	1	0	0	0	1	0	1	0	3	184	821
8:45 AM	0	1	76	1	0	4	68	0	0	4	0	1	0	0	0	1	156	765
Count Total	0	8	772	15	0	21	737	6	0	19	1	13	0	11	0	21	1,624	
Pk Hr All	**0**	**3**	**418**	**9**	**0**	**13**	**399**	**4**	**0**	**10**	**0**	**8**	**0**	**7**	**0**	**10**	**881**	
Pk Hr HV	**0**	**0**	**21**	**1**	**0**	**0**	**35**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**57**	
Pk Hr HV%	**-**	**0%**	**5%**	**11%**	**-**	**0%**	**9%**	**0%**	**-**	**0%**	**-**	**0%**	**-**	**0%**	**-**	**0%**	**6%**	

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
7:00 AM	2	7	0	0	*9*	0	0	0	0	*0*	0	0	0	0	*0*
7:15 AM	**4**	**7**	**0**	**0**	**11**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7:30 AM	**5**	**6**	**0**	**0**	**11**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7:45 AM	**6**	**10**	**0**	**0**	**16**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
8:00 AM	**7**	**12**	**0**	**0**	**19**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8:15 AM	6	2	0	0	*8*	0	0	0	0	*0*	0	0	0	0	*0*
8:30 AM	3	2	0	0	*5*	0	0	0	0	*0*	0	0	0	0	*0*
8:45 AM	6	4	0	0	*10*	0	0	0	0	*0*	0	0	0	0	*0*
Count Total	39	50	0	0	*89*	0	1	0	0	*1*	0	0	0	0	*0*
Peak Hour	**22**	**35**	**0**	**0**	***57***	**0**	**1**	**0**	**0**	***1***	**0**	**0**	**0**	**0**	**0**

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Count Summaries - Heavy Vehicles

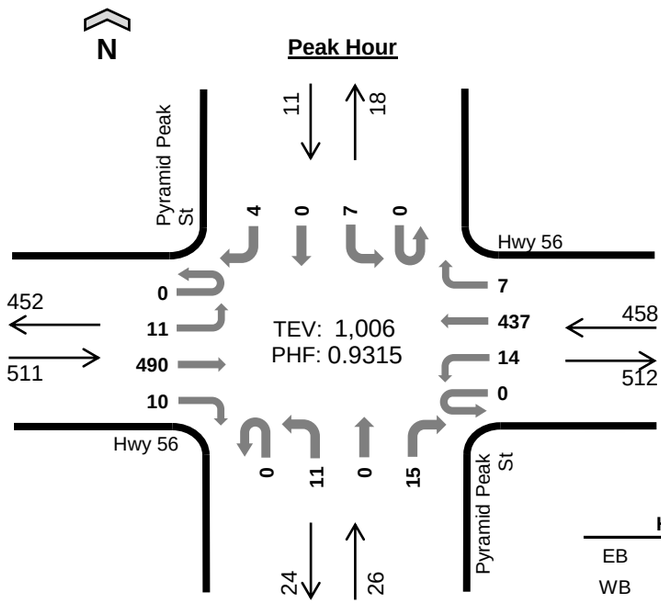
Interval Start	Hwy 56				Hwy 56				Pyramid Peak St				Pyramid Peak St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	2	0	0	0	7	0	0	0	0	0	0	0	0	0	9	0
7:15 AM	**0**	**0**	**4**	**0**	**0**	**0**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**11**	**0**
7:30 AM	**0**	**0**	**5**	**0**	**0**	**0**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**11**	**0**
7:45 AM	**0**	**0**	**5**	**1**	**0**	**0**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**16**	**47**
8:00 AM	**0**	**0**	**7**	**0**	**0**	**0**	**12**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**19**	**57**
8:15 AM	0	0	6	0	0	0	2	0	0	0	0	0	0	0	0	0	8	54
8:30 AM	0	0	3	0	0	0	2	0	0	0	0	0	0	0	0	0	5	48
8:45 AM	0	0	6	0	0	0	4	0	0	0	0	0	0	0	0	0	10	42
Count Total	0	0	38	1	0	0	50	0	0	0	0	0	0	0	0	0	89	
Pk Hr Heavy	**0**	**0**	**21**	**1**	**0**	**0**	**35**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**57**	

Count Summaries - Bikes

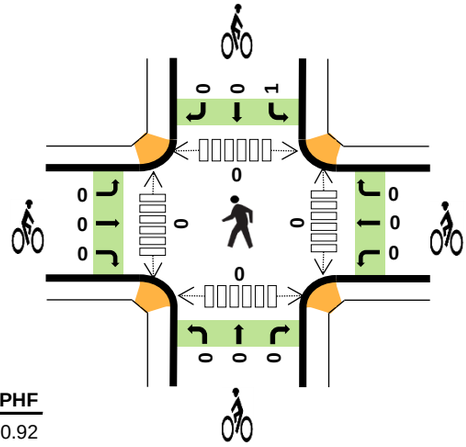
Interval Start	Hwy 56				Hwy 56				Pyramid Peak St				Pyramid Peak St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7:30 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7:45 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
8:00 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	
Pk Hr Bike	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	

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Pyramid Peak St
Hwy 56



Date: 11/14/2024
Count Period: 4:00 PM to 6:00 PM
Peak Hour: 4:30 PM to 5:30 PM



	HV%	PHF
EB	3%	0.92
WB	2%	0.84
NB	12%	0.65
SB	0%	0.92
TOTAL	3%	0.93

Peak Hour Count Summaries

Peak Hour Interval Start		Hwy 56 Eastbound				Hwy 56 Westbound				Pyramid Peak St Northbound				Pyramid Peak St Southbound				15-min Total	Rolling Hour Total
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:30 PM		0	3	114	3	0	3	111	0	0	5	0	5	0	1	0	1	246	0
4:45 PM		0	6	131	2	0	6	109	0	0	1	0	4	0	2	0	1	262	0
5:00 PM		0	0	124	2	0	3	83	6	0	3	0	4	0	1	0	2	228	0
5:15 PM		0	2	121	3	0	2	134	1	0	2	0	2	0	3	0	0	270	1,006
Pk Hr	All	0	11	490	10	0	14	437	7	0	11	0	15	0	7	0	4	1,006	
	HV	0	0	12	2	0	0	11	0	0	3	0	0	0	0	0	0	28	
	HV%	-	0%	2%	20%	-	0%	3%	0%	-	27%	-	0%	-	0%	-	0%	3%	

Note: For complete count summary (all intervals), see following pages.
*** Heavy Vehicle Classifications include FHWA Classes 4-13.*
*** Count Summaries include heavy vehicles, but exclude bicycles in overall count.*

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
4:30 PM	6	6	1	0	*13*	0	0	0	1	*1*	0	0	0	0	*0*
4:45 PM	2	1	0	0	*3*	0	0	0	0	*0*	0	0	0	0	*0*
5:00 PM	1	2	1	0	*4*	0	0	0	0	*0*	0	0	0	0	*0*
5:15 PM	5	2	1	0	*8*	0	0	0	0	*0*	0	0	0	0	*0*
Peak Hour	14	11	3	0	*28*	0	0	0	1	*1*	0	0	0	0	*0*

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Count Summaries - All Vehicles

Interval Start	Hwy 56 Eastbound				Hwy 56 Westbound				Pyramid Peak St Northbound				Pyramid Peak St Southbound				15-min Total	Rolling Hour Total
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	1	107	3	0	4	111	1	0	5	0	3	0	1	0	2	238	0
4:15 PM	0	5	126	3	0	2	108	3	0	0	0	7	0	2	0	1	257	0
4:30 PM	**0**	**3**	**114**	**3**	**0**	**3**	**111**	**0**	**0**	**5**	**0**	**5**	**0**	**1**	**0**	**1**	**246**	**0**
4:45 PM	**0**	**6**	**131**	**2**	**0**	**6**	**109**	**0**	**0**	**1**	**0**	**4**	**0**	**2**	**0**	**1**	**262**	**1,003**
5:00 PM	**0**	**0**	**124**	**2**	**0**	**3**	**83**	**6**	**0**	**3**	**0**	**4**	**0**	**1**	**0**	**2**	**228**	**993**
5:15 PM	**0**	**2**	**121**	**3**	**0**	**2**	**134**	**1**	**0**	**2**	**0**	**2**	**0**	**3**	**0**	**0**	**270**	**1,006**
5:30 PM	0	0	99	1	0	2	112	1	0	2	0	0	0	2	0	1	220	980
5:45 PM	0	0	85	1	0	2	132	3	0	3	0	1	0	1	0	1	229	947
Count Total	0	17	907	18	0	24	900	15	0	21	0	26	0	13	0	9	1,950	
Pk Hr All	**0**	**11**	**490**	**10**	**0**	**14**	**437**	**7**	**0**	**11**	**0**	**15**	**0**	**7**	**0**	**4**	**1,006**	
Pk Hr HV	**0**	**0**	**12**	**2**	**0**	**0**	**11**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**28**	
Pk Hr HV%	**-**	**0%**	**2%**	**20%**	**-**	**0%**	**3%**	**0%**	**-**	**27%**	**-**	**0%**	**-**	**0%**	**-**	**0%**	**3%**	

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
4:00 PM	6	5	1	0	*12*	0	0	0	0	*0*	0	0	0	0	*0*
4:15 PM	6	1	0	0	*7*	0	0	0	0	*0*	0	0	0	0	*0*
4:30 PM	**6**	**6**	**1**	**0**	**13**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**
4:45 PM	**2**	**1**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5:00 PM	**1**	**2**	**1**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5:15 PM	**5**	**2**	**1**	**0**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5:30 PM	1	2	0	0	*3*	0	0	0	0	*0*	0	0	0	0	*0*
5:45 PM	1	4	0	0	*5*	0	0	0	0	*0*	0	0	0	0	*0*
Count Total	28	23	4	0	*55*	0	0	0	1	*1*	0	0	0	0	*0*
Peak Hour	**14**	**11**	**3**	**0**	***28***	**0**	**0**	**0**	**1**	***1***	**0**	**0**	**0**	**0**	**0**

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Count Summaries - Heavy Vehicles

Interval Start	Hwy 56				Hwy 56				Pyramid Peak St				Pyramid Peak St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	0	6	0	0	0	5	0	0	1	0	0	0	0	0	0	12	0
4:15 PM	0	0	5	1	0	0	1	0	0	0	0	0	0	0	0	0	7	0
4:30 PM	**0**	**0**	**6**	**0**	**0**	**0**	**6**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**13**	**0**
4:45 PM	**0**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**35**
5:00 PM	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**27**
5:15 PM	**0**	**0**	**4**	**1**	**0**	**0**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**8**	**28**
5:30 PM	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	3	18
5:45 PM	0	0	1	0	0	0	4	0	0	0	0	0	0	0	0	0	5	20
Count Total	0	0	25	3	0	0	23	0	0	4	0	0	0	0	0	0	55	
Pk Hr Heavy	**0**	**0**	**12**	**2**	**0**	**0**	**11**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**28**	

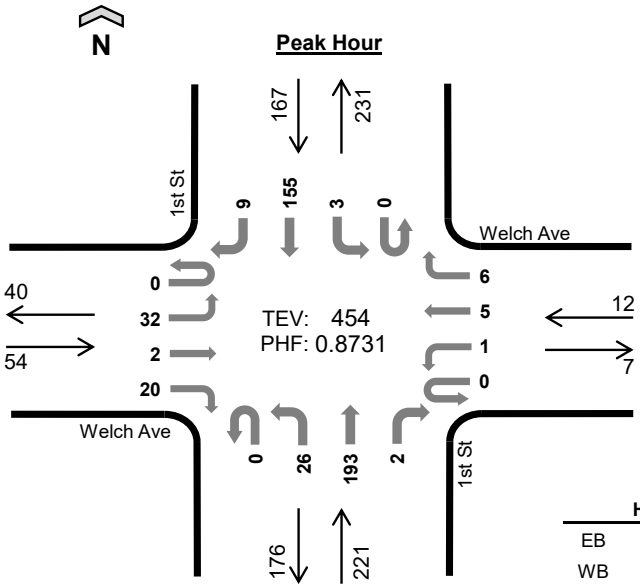
Count Summaries - Bikes

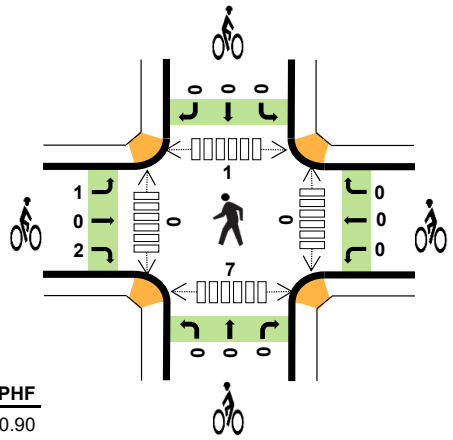
Interval Start	Hwy 56				Hwy 56				Pyramid Peak St				Pyramid Peak St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
5:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
5:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	
Pk Hr Bike	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	

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1st St
Welch Ave

Date: 7/22/2025
Count Period: 7:00 AM to 9:00 AM
Peak Hour: 7:15 AM to 8:15 AM





	HV%	PHF
EB	0%	0.90
WB	0%	0.75
NB	1%	0.94
SB	5%	0.73
TOTAL	2%	0.87

Peak Hour Count Summaries

Peak Hour Interval Start		Welch Ave Eastbound				Welch Ave Westbound				1st St Northbound				1st St Southbound				15-min Total	Rolling Hour Total
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:15 AM		**0**	**9**	**1**	**5**	**0**	**0**	**0**	**3**	**0**	**4**	**45**	**0**	**0**	**0**	**32**	**3**	**102**	**0**
7:30 AM		**0**	**9**	**0**	**3**	**0**	**0**	**2**	**0**	**0**	**6**	**52**	**1**	**0**	**0**	**56**	**1**	**130**	**0**
7:45 AM		**0**	**8**	**1**	**6**	**0**	**0**	**0**	**3**	**0**	**8**	**48**	**0**	**0**	**1**	**39**	**1**	**115**	**0**
8:00 AM		**0**	**6**	**0**	**6**	**0**	**1**	**3**	**0**	**0**	**8**	**48**	**1**	**0**	**2**	**28**	**4**	**107**	**454**
Pk Hr	All	**0**	**32**	**2**	**20**	**0**	**1**	**5**	**6**	**0**	**26**	**193**	**2**	**0**	**3**	**155**	**9**	**454**	
	HV	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**8**	**0**	**11**	
	HV%	-	**0%**	**0%**	**0%**	-	**0%**	**0%**	**0%**	-	**4%**	**1%**	**0%**	-	**0%**	**5%**	**0%**	**2%**	

Note: For complete count summary (all intervals), see following pages.
*** Heavy Vehicle Classifications include FHWA Classes 4-13.*
*** Count Summaries include heavy vehicles, but exclude bicycles in overall count.*

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
7:15 AM	**0**	**0**	**1**	**0**	***1***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**1**	**7**	***8***
7:30 AM	**0**	**0**	**0**	**3**	***3***	**2**	**0**	**0**	**0**	***2***	**0**	**0**	**0**	**0**	***0***
7:45 AM	**0**	**0**	**0**	**4**	***4***	**1**	**0**	**0**	**0**	***1***	**0**	**0**	**0**	**0**	***0***
8:00 AM	**0**	**0**	**2**	**1**	***3***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***
Peak Hour	**0**	**0**	**3**	**8**	***11***	**3**	**0**	**0**	**0**	***3***	**0**	**0**	**1**	**7**	***8***

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Count Summaries - All Vehicles

Interval Start	Welch Ave Eastbound				Welch Ave Westbound				1st St Northbound				1st St Southbound				15-min Total	Rolling Hour Total
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	10	0	6	0	1	1	1	0	4	26	0	0	1	34	0	84	0
7:15 AM	**0**	**9**	**1**	**5**	**0**	**0**	**0**	**3**	**0**	**4**	**45**	**0**	**0**	**0**	**32**	**3**	**102**	**0**
7:30 AM	**0**	**9**	**0**	**3**	**0**	**0**	**2**	**0**	**0**	**6**	**52**	**1**	**0**	**0**	**56**	**1**	**130**	**0**
7:45 AM	**0**	**8**	**1**	**6**	**0**	**0**	**0**	**3**	**0**	**8**	**48**	**0**	**0**	**1**	**39**	**1**	**115**	**431**
8:00 AM	**0**	**6**	**0**	**6**	**0**	**1**	**3**	**0**	**0**	**8**	**48**	**1**	**0**	**2**	**28**	**4**	**107**	**454**
8:15 AM	0	2	0	7	0	2	0	3	0	2	37	0	0	0	42	3	98	450
8:30 AM	0	7	2	4	0	0	2	1	0	7	38	1	0	0	36	1	99	419
8:45 AM	0	6	0	5	0	0	0	0	0	8	35	0	0	1	25	4	84	388
Count Total	0	57	4	42	0	4	8	11	0	47	329	3	0	5	292	17	819	
Pk Hr All	**0**	**32**	**2**	**20**	**0**	**1**	**5**	**6**	**0**	**26**	**193**	**2**	**0**	**3**	**155**	**9**	**454**	
Pk Hr HV	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**8**	**0**	**11**	
Pk Hr HV%	**-**	**0%**	**0%**	**0%**	**-**	**0%**	**0%**	**0%**	**-**	**4%**	**1%**	**0%**	**-**	**0%**	**5%**	**0%**	**2%**	

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
7:00 AM	0	0	0	0	*0*	0	0	0	1	*1*	0	0	0	1	*1*
7:15 AM	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**7**	**8**
7:30 AM	**0**	**0**	**0**	**3**	**3**	**2**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**
7:45 AM	**0**	**0**	**0**	**4**	**4**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
8:00 AM	**0**	**0**	**2**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8:15 AM	0	0	1	2	*3*	0	0	1	0	*1*	0	0	0	2	*2*
8:30 AM	0	0	0	1	*1*	0	0	0	0	*0*	0	0	0	1	*1*
8:45 AM	0	0	3	2	*5*	0	0	0	0	*0*	1	0	0	1	*2*
Count Total	0	0	7	13	*20*	3	0	1	1	*5*	1	0	1	12	*14*
Peak Hour	**0**	**0**	**3**	**8**	***11***	**3**	**0**	**0**	**0**	***3***	**0**	**0**	**1**	**7**	**8**

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Count Summaries - Heavy Vehicles

Interval Start	Welch Ave Eastbound				Welch Ave Westbound				1st St Northbound				1st St Southbound				15-min Total	Rolling Hour Total
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
7:30 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**3**	**0**
7:45 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**4**	**8**
8:00 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**3**	**11**
8:15 AM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	3	13
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	11
8:45 AM	0	0	0	0	0	0	0	0	0	1	2	0	0	0	2	0	5	12
Count Total	0	0	0	0	0	0	0	0	0	2	5	0	0	0	13	0	20	
Pk Hr Heavy	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**8**	**0**	**11**	

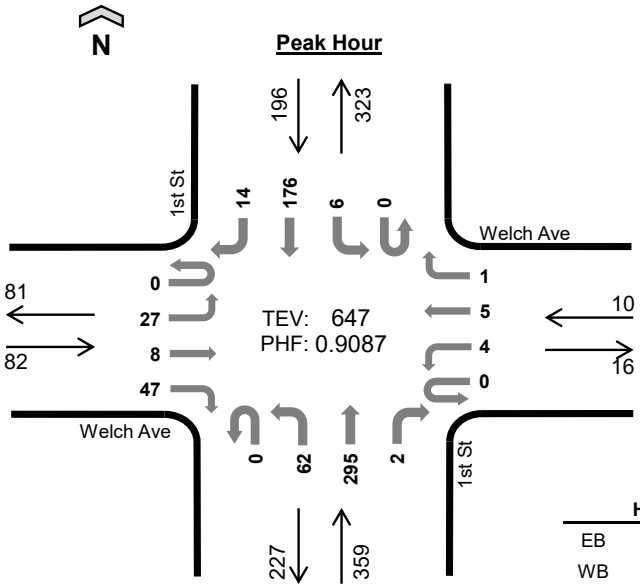
Count Summaries - Bikes

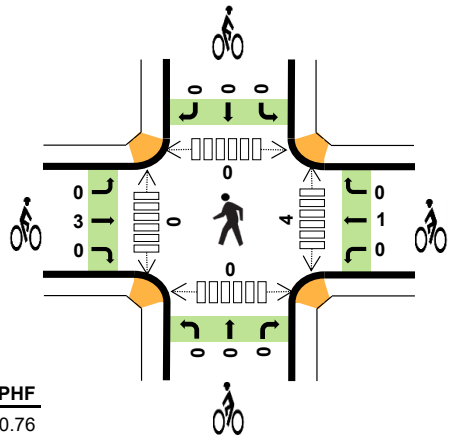
Interval Start	Welch Ave Eastbound				Welch Ave Westbound				1st St Northbound				1st St Southbound				15-min Total	Rolling Hour Total
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
7:15 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7:30 AM	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**
7:45 AM	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**4**
8:00 AM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**
8:15 AM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	4
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Count Total	0	1	0	2	0	0	0	0	0	0	1	0	0	0	1	0	5	
Pk Hr Bike	**0**	**1**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	

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1st St
Welch Ave

Date: 7/22/2025
Count Period: 4:00 PM to 6:00 PM
Peak Hour: 4:30 PM to 5:30 PM





	HV%	PHF
EB	1%	0.76
WB	0%	0.50
NB	2%	0.82
SB	0%	0.88
TOTAL	1%	0.91

Peak Hour Count Summaries

Peak Hour Interval Start		Welch Ave Eastbound				Welch Ave Westbound				1st St Northbound				1st St Southbound				15-min Total	Rolling Hour Total
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:30 PM		0	7	4	8	0	1	2	0	0	15	67	1	0	0	37	3	145	0
4:45 PM		0	12	2	13	0	2	0	0	0	17	71	0	0	2	47	7	173	0
5:00 PM		0	3	0	18	0	0	0	0	0	11	68	0	0	1	48	2	151	0
5:15 PM		0	5	2	8	0	1	3	1	0	19	89	1	0	3	44	2	178	647
Pk Hr	All	0	27	8	47	0	4	5	1	0	62	295	2	0	6	176	14	647	
	HV	0	0	1	0	0	0	0	0	0	1	7	0	0	0	0	0	9	
	HV%	-	0%	13%	0%	-	0%	0%	0%	-	2%	2%	0%	-	0%	0%	0%	1%	

Note: For complete count summary (all intervals), see following pages.
*** Heavy Vehicle Classifications include FHWA Classes 4-13.*
*** Count Summaries include heavy vehicles, but exclude bicycles in overall count.*

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
4:30 PM	1	0	1	0	*2*	0	1	0	0	*1*	2	0	0	0	*2*
4:45 PM	0	0	1	0	*1*	1	0	0	0	*1*	0	0	0	0	*0*
5:00 PM	0	0	1	0	*1*	0	0	0	0	*0*	0	0	0	0	*0*
5:15 PM	0	0	5	0	*5*	2	0	0	0	*2*	2	0	0	0	*2*
Peak Hour	1	0	8	0	*9*	3	1	0	0	*4*	4	0	0	0	*4*

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Count Summaries - All Vehicles

Interval Start	Welch Ave Eastbound				Welch Ave Westbound				1st St Northbound				1st St Southbound				15-min Total	Rolling Hour Total
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	7	0	8	0	0	3	1	0	13	54	0	0	1	49	2	138	0
4:15 PM	0	3	4	15	0	1	0	1	0	9	95	2	0	2	40	2	174	0
4:30 PM	**0**	**7**	**4**	**8**	**0**	**1**	**2**	**0**	**0**	**15**	**67**	**1**	**0**	**0**	**37**	**3**	**145**	**0**
4:45 PM	**0**	**12**	**2**	**13**	**0**	**2**	**0**	**0**	**0**	**17**	**71**	**0**	**0**	**2**	**47**	**7**	**173**	**630**
5:00 PM	**0**	**3**	**0**	**18**	**0**	**0**	**0**	**0**	**0**	**11**	**68**	**0**	**0**	**1**	**48**	**2**	**151**	**643**
5:15 PM	**0**	**5**	**2**	**8**	**0**	**1**	**3**	**1**	**0**	**19**	**89**	**1**	**0**	**3**	**44**	**2**	**178**	**647**
5:30 PM	0	7	1	3	0	0	1	0	0	9	79	1	0	0	31	6	138	640
5:45 PM	0	9	0	8	0	1	2	3	0	6	71	2	0	1	47	3	153	620
Count Total	0	53	13	81	0	6	11	6	0	99	594	7	0	10	343	27	1,250	
Pk Hr All	**0**	**27**	**8**	**47**	**0**	**4**	**5**	**1**	**0**	**62**	**295**	**2**	**0**	**6**	**176**	**14**	**647**	
Pk Hr HV	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**7**	**0**	**0**	**0**	**0**	**0**	**9**	
Pk Hr HV%	**-**	**0%**	**13%**	**0%**	**-**	**0%**	**0%**	**0%**	**-**	**2%**	**2%**	**0%**	**-**	**0%**	**0%**	**0%**	**1%**	

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	E	W	N	S	Total
4:00 PM	0	0	1	4	*5*	0	0	0	0	*0*	0	0	0	2	*2*
4:15 PM	0	0	3	2	*5*	0	0	0	0	*0*	0	0	0	0	*0*
4:30 PM	**1**	**0**	**1**	**0**	**2**	**0**	**1**	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**2**
4:45 PM	**0**	**0**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
5:00 PM	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5:15 PM	**0**	**0**	**5**	**0**	**5**	**2**	**0**	**0**	**0**	**2**	**2**	**0**	**0**	**0**	**2**
5:30 PM	0	0	4	0	*4*	0	0	0	0	*0*	1	0	0	0	*1*
5:45 PM	1	0	3	0	*4*	0	0	0	0	*0*	1	0	0	0	*1*
Count Total	2	0	19	6	*27*	3	1	0	0	*4*	6	0	0	2	*8*
Peak Hour	**1**	**0**	**8**	**0**	***9***	**3**	**1**	**0**	**0**	***4***	**4**	**0**	**0**	**0**	**4**

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Count Summaries - Heavy Vehicles

Interval Start	Welch Ave				Welch Ave				1st St				1st St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0	5	0
4:15 PM	0	0	0	0	0	0	0	0	0	1	2	0	0	0	2	0	5	0
4:30 PM	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**0**
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**13**
5:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**9**
5:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**4**	**0**	**0**	**0**	**0**	**0**	**5**	**9**
5:30 PM	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	4	11
5:45 PM	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	4	14
Count Total	0	1	1	0	0	0	0	0	0	2	17	0	0	0	6	0	27	
Pk Hr Heavy	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**7**	**0**	**0**	**0**	**0**	**0**	**9**	

Count Summaries - Bikes

Interval Start	Welch Ave				Welch Ave				1st St				1st St				15-min Total	Rolling Hour Total
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
4:45 PM	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**
5:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
5:15 PM	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**4**
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Count Total	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	4	
Pk Hr Bike	**0**	**0**	**3**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	

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Intersection Capacity Worksheets: Year 2024 Existing

Intersection	
Int Delay, s/veh	61.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	5	368	143	167	392	11	82	54	96	4	14	4
Future Vol, veh/h	5	368	143	167	392	11	82	54	96	4	14	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	95	95	95	90	90	90	95	95	95	69	69	69
Heavy Vehicles, %	2	2	2	2	2	2	3	3	3	5	5	5
Mvmt Flow	5	387	151	186	436	12	86	57	101	6	20	6

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	448	0	0	538	0	0	1290	1292	463	1239	1361	442
Stage 1	-	-	-	-	-	-	473	473	-	813	813	-
Stage 2	-	-	-	-	-	-	817	819	-	426	548	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.13	6.53	6.23	7.15	6.55	6.25
Critical Hdwy Stg 1	-	-	-	-	-	-	6.13	5.53	-	6.15	5.55	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.13	5.53	-	6.15	5.55	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.527	4.027	3.327	3.545	4.045	3.345
Pot Cap-1 Maneuver	1113	-	-	1030	-	-	140	162	597	150	146	609
Stage 1	-	-	-	-	-	-	570	557	-	368	388	-
Stage 2	-	-	-	-	-	-	369	388	-	600	512	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1113	-	-	1030	-	-	89	122	597	57	110	609
Mov Cap-2 Maneuver	-	-	-	-	-	-	89	122	-	57	110	-
Stage 1	-	-	-	-	-	-	566	553	-	280	295	-
Stage 2	-	-	-	-	-	-	259	295	-	444	508	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	0.08	2.71	$ 351.63	51.81
HCM LOS			F	F

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	153	17	-	-	525	-	-	108
HCM Lane V/C Ratio	1.601	0.005	-	-	0.18	-	-	0.296
HCM Ctrl Dly (s/v)	$ 351.6	8.3	0	-	9.3	0	-	51.8
HCM Lane LOS	F	A	A	-	A	A	-	F
HCM 95th %tile Q(veh)	16.9	0	-	-	0.7	-	-	1.1

Notes	
~: Volume exceeds capacity	$: Delay exceeds 300s
+: Computation Not Defined	*: All major volume in platoon

Intersection	
Intersection Delay, s/veh	9.3
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	491	503	211	418
Demand Flow Rate, veh/h	511	517	218	431
Vehicles Circulating, veh/h	326	271	691	388
Vehicles Exiting, veh/h	493	580	146	400
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	10.3	9.4	6.1	9.7
Approach LOS	B	A	A	A

Lane	Left	Left	Left	Bypass	Left
Designated Moves	LTR	LTR	LT	R	LTR
Assumed Moves	LTR	LTR	LT		LTR
RT Channelized				Free	
Lane Util	1.000	1.000	1.000		1.000
Follow-Up Headway, s	2.609	2.609	2.609		2.609
Critical Headway, s	4.976	4.976	4.976		4.976
A (Intercept)	1380	1380	1380		1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3		1.02e-3
Entry Flow, veh/h	511	517	160	58	431
Cap Entry Lane, veh/h	990	1047	682	1957	929
Entry HV Adj Factor	0.962	0.972	0.969	0.971	0.971
Flow Entry, veh/h	491	503	155	56	418
Cap Entry, veh/h	952	1018	661	1900	902
V/C Ratio	0.516	0.494	0.235	0.029	0.464
Control Delay, s/veh	10.3	9.4	8.3	0.0	9.7
LOS	B	A	A	A	A
95th %tile Queue, veh	3	3	1	0	2

Intersection	
Int Delay, s/veh	2.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	8	18	165	15	34	55
Future Vol, veh/h	8	18	165	15	34	55
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	59	59	88	88	77	77
Heavy Vehicles, %	1	1	1	1	1	1
Mvmt Flow	14	31	188	17	44	71

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	356	196	0	0	205	0
Stage 1	196	-	-	-	-	-
Stage 2	160	-	-	-	-	-
Critical Hdwy	6.41	6.21	-	-	4.11	-
Critical Hdwy Stg 1	5.41	-	-	-	-	-
Critical Hdwy Stg 2	5.41	-	-	-	-	-
Follow-up Hdwy	3.509	3.309	-	-	2.209	-
Pot Cap-1 Maneuver	644	848	-	-	1373	-
Stage 1	839	-	-	-	-	-
Stage 2	871	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	623	848	-	-	1373	-
Mov Cap-2 Maneuver	623	-	-	-	-	-
Stage 1	839	-	-	-	-	-
Stage 2	842	-	-	-	-	-

Approach	WB	NB	SB
HCM Ctrl Dly, s/v	10.01	0	2.95
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	763	688	-
HCM Lane V/C Ratio	-	-	0.058	0.032	-
HCM Ctrl Dly (s/v)	-	-	10	7.7	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.2	0.1	-

Intersection	
Int Delay, s/veh	1.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	11	494	10	14	457	7	11	0	15	7	0	4
Future Vol, veh/h	11	494	10	14	457	7	11	0	15	7	0	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	35	-	160	50	-	-	-	-	100	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	84	84	84	65	65	65	92	92	92
Heavy Vehicles, %	3	3	3	2	2	2	12	12	12	1	1	1
Mvmt Flow	12	537	11	17	544	8	17	0	23	8	0	4

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	552	0	0	548	0	0	1138	1147	537	1142	1153	548
Stage 1	-	-	-	-	-	-	561	561	-	582	582	-
Stage 2	-	-	-	-	-	-	577	586	-	561	572	-
Critical Hdwy	4.13	-	-	4.12	-	-	7.22	6.62	6.32	7.11	6.51	6.21
Critical Hdwy Stg 1	-	-	-	-	-	-	6.22	5.62	-	6.11	5.51	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.22	5.62	-	6.11	5.51	-
Follow-up Hdwy	2.227	-	-	2.218	-	-	3.608	4.108	3.408	3.509	4.009	3.309
Pot Cap-1 Maneuver	1013	-	-	1022	-	-	171	191	525	178	198	538
Stage 1	-	-	-	-	-	-	495	494	-	501	501	-
Stage 2	-	-	-	-	-	-	485	482	-	514	506	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1013	-	-	1022	-	-	165	185	525	166	193	538
Mov Cap-2 Maneuver	-	-	-	-	-	-	165	185	-	166	193	-
Stage 1	-	-	-	-	-	-	489	488	-	493	493	-
Stage 2	-	-	-	-	-	-	473	474	-	486	500	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	0.18	0.25	19.45	22.2
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	165	525	1013	-	-	1022	-	-	221
HCM Lane V/C Ratio	0.103	0.044	0.012	-	-	0.016	-	-	0.054
HCM Ctrl Dly (s/v)	29.4	12.2	8.6	-	-	8.6	-	-	22.2
HCM Lane LOS	D	B	A	-	-	A	-	-	C
HCM 95th %tile Q(veh)	0.3	0.1	0	-	-	0	-	-	0.2

Intersection	
Int Delay, s/veh	2.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	27	8	47	4	5	1	62	295	2	6	176	14
Future Vol, veh/h	27	8	47	4	5	1	62	295	2	6	176	14
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	91	91	91	91	91	91	91	91	91	91	91	91
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	30	9	52	4	5	1	68	324	2	7	193	15

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	677	677	201	673	684	325	209	0	0	326	0	0
Stage 1	214	214	-	462	462	-	-	-	-	-	-	-
Stage 2	463	463	-	211	222	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	366	375	840	369	371	716	1362	-	-	1233	-	-
Stage 1	788	725	-	580	565	-	-	-	-	-	-	-
Stage 2	579	564	-	791	720	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	336	350	840	316	347	716	1362	-	-	1233	-	-
Mov Cap-2 Maneuver	336	350	-	316	347	-	-	-	-	-	-	-
Stage 1	783	721	-	545	530	-	-	-	-	-	-	-
Stage 2	537	530	-	729	715	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	13.46	15.59	1.34	0.24
HCM LOS	B	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	310	-	-	515	351	54	-	-
HCM Lane V/C Ratio	0.05	-	-	0.175	0.031	0.005	-	-
HCM Ctrl Dly (s/v)	7.8	0	-	13.5	15.6	7.9	0	-
HCM Lane LOS	A	A	-	B	C	A	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0.6	0.1	0	-	-

Intersection	
Int Delay, s/veh	13

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	3	328	125	118	364	13	51	26	56	2	13	10
Future Vol, veh/h	3	328	125	118	364	13	51	26	56	2	13	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	82	82	82	92	92	92	76	76	76	78	78	78
Heavy Vehicles, %	4	4	4	7	7	7	10	10	10	8	8	8
Mvmt Flow	4	400	152	128	396	14	67	34	74	3	17	13

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	410	0	0	552	0	0	1144	1150	476	1084	1219	403
Stage 1	-	-	-	-	-	-	484	484	-	659	659	-
Stage 2	-	-	-	-	-	-	661	666	-	424	560	-
Critical Hdwy	4.14	-	-	4.17	-	-	7.2	6.6	6.3	7.18	6.58	6.28
Critical Hdwy Stg 1	-	-	-	-	-	-	6.2	5.6	-	6.18	5.58	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.2	5.6	-	6.18	5.58	-
Follow-up Hdwy	2.236	-	-	2.263	-	-	3.59	4.09	3.39	3.572	4.072	3.372
Pot Cap-1 Maneuver	1138	-	-	993	-	-	171	192	573	189	176	635
Stage 1	-	-	-	-	-	-	550	539	-	443	451	-
Stage 2	-	-	-	-	-	-	439	445	-	596	501	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1138	-	-	993	-	-	125	159	573	111	145	635
Mov Cap-2 Maneuver	-	-	-	-	-	-	125	159	-	111	145	-
Stage 1	-	-	-	-	-	-	547	537	-	369	376	-
Stage 2	-	-	-	-	-	-	342	371	-	484	499	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	0.05	2.18	85.2	26.02
HCM LOS			F	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	199	11	-	-	426	-	-	203
HCM Lane V/C Ratio	0.881	0.003	-	-	0.129	-	-	0.158
HCM Ctrl Dly (s/v)	85.2	8.2	0	-	9.2	0	-	26
HCM Lane LOS	F	A	A	-	A	A	-	D
HCM 95th %tile Q(veh)	6.8	0	-	-	0.4	-	-	0.5

Intersection	
Intersection Delay, s/veh	8.5
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	435	465	191	361
Demand Flow Rate, veh/h	466	497	192	379
Vehicles Circulating, veh/h	279	251	643	388
Vehicles Exiting, veh/h	488	542	102	360
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	8.9	9.0	5.8	8.9
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Bypass	Left
Designated Moves	LTR	LTR	LT	R	LTR
Assumed Moves	LTR	LTR	LT		LTR
RT Channelized				Free	
Lane Util	1.000	1.000	1.000		1.000
Follow-Up Headway, s	2.609	2.609	2.609		2.609
Critical Headway, s	4.976	4.976	4.976		4.976
A (Intercept)	1380	1380	1380		1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3		1.02e-3
Entry Flow, veh/h	466	497	150	42	379
Cap Entry Lane, veh/h	1038	1068	716	1919	929
Entry HV Adj Factor	0.934	0.935	0.993	0.990	0.952
Flow Entry, veh/h	435	465	149	42	361
Cap Entry, veh/h	970	999	711	1900	884
V/C Ratio	0.449	0.465	0.209	0.022	0.408
Control Delay, s/veh	8.9	9.0	7.4	0.0	8.9
LOS	A	A	A	A	A
95th %tile Queue, veh	2	3	1	0	2

Intersection	
Int Delay, s/veh	2.8

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	16	28	61	3	8	64
Future Vol, veh/h	16	28	61	3	8	64
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	73	73	80	80	90	90
Heavy Vehicles, %	2	2	3	3	6	6
Mvmt Flow	22	38	76	4	9	71

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	167	78	0	0	80	0
Stage 1	78	-	-	-	-	-
Stage 2	89	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.16	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.254	-
Pot Cap-1 Maneuver	823	983	-	-	1493	-
Stage 1	945	-	-	-	-	-
Stage 2	935	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	818	983	-	-	1493	-
Mov Cap-2 Maneuver	818	-	-	-	-	-
Stage 1	945	-	-	-	-	-
Stage 2	929	-	-	-	-	-

Approach	WB	NB	SB
HCM Ctrl Dly, s/v	9.21	0	0.83
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	916	200	-
HCM Lane V/C Ratio	-	-	0.066	0.006	-
HCM Ctrl Dly (s/v)	-	-	9.2	7.4	0
HCM Lane LOS	-	-	A	A	A
HCM 95th %tile Q(veh)	-	-	0.2	0	-

Intersection	
Int Delay, s/veh	1.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	3	441	9	13	408	4	10	0	8	7	0	10
Future Vol, veh/h	3	441	9	13	408	4	10	0	8	7	0	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	35	-	160	50	-	-	-	-	100	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	90	90	90	64	64	64	53	53	53
Heavy Vehicles, %	5	5	5	8	8	8	1	1	1	1	1	1
Mvmt Flow	3	507	10	14	453	4	16	0	13	13	0	19

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	458	0	0	517	0	0	996	1000	507	998	1009	456
Stage 1	-	-	-	-	-	-	514	514	-	484	484	-
Stage 2	-	-	-	-	-	-	482	487	-	514	524	-
Critical Hdwy	4.15	-	-	4.18	-	-	7.11	6.51	6.21	7.11	6.51	6.21
Critical Hdwy Stg 1	-	-	-	-	-	-	6.11	5.51	-	6.11	5.51	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.11	5.51	-	6.11	5.51	-
Follow-up Hdwy	2.245	-	-	2.272	-	-	3.509	4.009	3.309	3.509	4.009	3.309
Pot Cap-1 Maneuver	1087	-	-	1019	-	-	224	244	568	223	241	607
Stage 1	-	-	-	-	-	-	545	537	-	566	554	-
Stage 2	-	-	-	-	-	-	567	552	-	545	531	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1087	-	-	1019	-	-	213	240	568	215	237	607
Mov Cap-2 Maneuver	-	-	-	-	-	-	213	240	-	215	237	-
Stage 1	-	-	-	-	-	-	544	535	-	558	546	-
Stage 2	-	-	-	-	-	-	542	544	-	532	530	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	0.06	0.26	17.99	16.45
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	213	568	1087	-	-	1019	-	-	346
HCM Lane V/C Ratio	0.073	0.022	0.003	-	-	0.014	-	-	0.093
HCM Ctrl Dly (s/v)	23.2	11.5	8.3	-	-	8.6	-	-	16.4
HCM Lane LOS	C	B	A	-	-	A	-	-	C
HCM 95th %tile Q(veh)	0.2	0.1	0	-	-	0	-	-	0.3

Intersection	
Int Delay, s/veh	2.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	32	2	20	1	5	6	26	193	2	3	155	9
Future Vol, veh/h	32	2	20	1	5	6	26	193	2	3	155	9
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	87	87	87	87	87	87	87	87	87
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	37	2	23	1	6	7	30	222	2	3	178	10

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	475	474	183	469	478	223	189	0	0	224	0	0
Stage 1	190	190	-	283	283	-	-	-	-	-	-	-
Stage 2	284	284	-	186	195	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	500	489	859	505	486	817	1386	-	-	1345	-	-
Stage 1	812	743	-	724	677	-	-	-	-	-	-	-
Stage 2	723	676	-	816	739	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	477	475	859	475	473	817	1386	-	-	1345	-	-
Mov Cap-2 Maneuver	477	475	-	475	473	-	-	-	-	-	-	-
Stage 1	809	741	-	706	661	-	-	-	-	-	-	-
Stage 2	693	660	-	789	737	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	12.08	11.15	0.9	0.14
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	211	-	-	571	599	32	-	-
HCM Lane V/C Ratio	0.022	-	-	0.109	0.023	0.003	-	-
HCM Ctrl Dly (s/v)	7.7	0	-	12.1	11.1	7.7	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0.1	-	-	0.4	0.1	0	-	-

Intersection	
Intersection Delay, s/veh	17.0
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	666	785	464	62
Demand Flow Rate, veh/h	679	801	478	65
Vehicles Circulating, veh/h	287	346	479	1051
Vehicles Exiting, veh/h	829	611	487	96
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	13.5	23.0	12.7	9.9
Approach LOS	B	C	B	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
A (Intercept)	1380	1380	1380	1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3	1.02e-3
Entry Flow, veh/h	679	801	478	65
Cap Entry Lane, veh/h	1030	970	847	472
Entry HV Adj Factor	0.981	0.980	0.971	0.959
Flow Entry, veh/h	666	785	464	62
Cap Entry, veh/h	1010	951	822	453
V/C Ratio	0.659	0.826	0.565	0.138
Control Delay, s/veh	13.5	23.0	12.7	9.9
LOS	B	C	B	A
95th %tile Queue, veh	5	10	4	0

Intersection	
Intersection Delay, s/veh	15.3
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	620	661	248	534
Demand Flow Rate, veh/h	645	681	255	551
Vehicles Circulating, veh/h	452	293	930	493
Vehicles Exiting, veh/h	592	812	167	481
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	19.3	13.8	8.2	16.0
Approach LOS	C	B	A	C

Lane	Left	Left	Left	Bypass	Left
Designated Moves	LTR	LTR	LT	R	LTR
Assumed Moves	LTR	LTR	LT		LTR
RT Channelized				Free	
Lane Util	1.000	1.000	1.000		1.000
Follow-Up Headway, s	2.609	2.609	2.609		2.609
Critical Headway, s	4.976	4.976	4.976		4.976
A (Intercept)	1380	1380	1380		1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3		1.02e-3
Entry Flow, veh/h	645	681	175	80	551
Cap Entry Lane, veh/h	870	1023	534	1957	835
Entry HV Adj Factor	0.961	0.971	0.970	0.971	0.970
Flow Entry, veh/h	620	661	170	78	534
Cap Entry, veh/h	836	994	518	1900	809
V/C Ratio	0.741	0.665	0.327	0.041	0.660
Control Delay, s/veh	19.3	13.8	11.9	0.0	16.0
LOS	C	B	B	A	C
95th %tile Queue, veh	7	5	1	0	5

Intersection	
Int Delay, s/veh	2.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	11	24	189	19	36	69
Future Vol, veh/h	11	24	189	19	36	69
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	59	59	88	88	77	77
Heavy Vehicles, %	1	1	1	1	1	1
Mvmt Flow	19	41	215	22	47	90

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	409	226	0	0	236	0
Stage 1	226	-	-	-	-	-
Stage 2	183	-	-	-	-	-
Critical Hdwy	6.41	6.21	-	-	4.11	-
Critical Hdwy Stg 1	5.41	-	-	-	-	-
Critical Hdwy Stg 2	5.41	-	-	-	-	-
Follow-up Hdwy	3.509	3.309	-	-	2.209	-
Pot Cap-1 Maneuver	601	816	-	-	1337	-
Stage 1	814	-	-	-	-	-
Stage 2	851	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	579	816	-	-	1337	-
Mov Cap-2 Maneuver	579	-	-	-	-	-
Stage 1	814	-	-	-	-	-
Stage 2	819	-	-	-	-	-

Approach	WB	NB	SB
HCM Ctrl Dly, s/v	10.42	0	2.67
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	723	617	-
HCM Lane V/C Ratio	-	-	0.082	0.035	-
HCM Ctrl Dly (s/v)	-	-	10.4	7.8	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.3	0.1	-

Intersection	
Int Delay, s/veh	2.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	12	678	31	34	599	7	18	0	27	7	0	4
Future Vol, veh/h	12	678	31	34	599	7	18	0	27	7	0	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	35	-	160	50	-	-	-	-	100	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	84	84	84	65	65	65	92	92	92
Heavy Vehicles, %	3	3	3	2	2	2	12	12	12	1	1	1
Mvmt Flow	13	737	34	40	713	8	28	0	42	8	0	4

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	721	0	0	771	0	0	1557	1565	737	1561	1595	717
Stage 1	-	-	-	-	-	-	763	763	-	798	798	-
Stage 2	-	-	-	-	-	-	794	802	-	763	797	-
Critical Hdwy	4.13	-	-	4.12	-	-	7.22	6.62	6.32	7.11	6.51	6.21
Critical Hdwy Stg 1	-	-	-	-	-	-	6.22	5.62	-	6.11	5.51	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.22	5.62	-	6.11	5.51	-
Follow-up Hdwy	2.227	-	-	2.218	-	-	3.608	4.108	3.408	3.509	4.009	3.309
Pot Cap-1 Maneuver	876	-	-	844	-	-	87	106	402	91	107	431
Stage 1	-	-	-	-	-	-	382	399	-	381	399	-
Stage 2	-	-	-	-	-	-	367	382	-	398	400	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	876	-	-	844	-	-	81	99	402	77	101	431
Mov Cap-2 Maneuver	-	-	-	-	-	-	81	99	-	77	101	-
Stage 1	-	-	-	-	-	-	376	393	-	363	380	-
Stage 2	-	-	-	-	-	-	346	364	-	352	394	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	0.15	0.5	37.57	41.79
HCM LOS			E	E

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	81	402	876	-	-	844	-	-	110
HCM Lane V/C Ratio	0.344	0.103	0.015	-	-	0.048	-	-	0.109
HCM Ctrl Dly (s/v)	71.5	15	9.2	-	-	9.5	-	-	41.8
HCM Lane LOS	F	B	A	-	-	A	-	-	E
HCM 95th %tile Q(veh)	1.3	0.3	0	-	-	0.2	-	-	0.4

Intersection	
Int Delay, s/veh	2.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	28	8	50	4	5	1	65	307	2	6	183	15
Future Vol, veh/h	28	8	50	4	5	1	65	307	2	6	183	15
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	91	91	91	91	91	91	91	91	91	91	91	91
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	31	9	55	4	5	1	71	337	2	7	201	16

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	705	705	209	700	712	338	218	0	0	340	0	0
Stage 1	223	223	-	481	481	-	-	-	-	-	-	-
Stage 2	483	482	-	219	231	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	351	361	831	354	358	704	1352	-	-	1220	-	-
Stage 1	780	719	-	566	554	-	-	-	-	-	-	-
Stage 2	565	553	-	784	713	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	320	335	831	300	332	704	1352	-	-	1220	-	-
Mov Cap-2 Maneuver	320	335	-	300	332	-	-	-	-	-	-	-
Stage 1	775	715	-	529	518	-	-	-	-	-	-	-
Stage 2	522	517	-	718	709	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	13.83	16.1	1.36	0.23
HCM LOS	B	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	312	-	-	502	335	52	-	-
HCM Lane V/C Ratio	0.053	-	-	0.188	0.033	0.005	-	-
HCM Ctrl Dly (s/v)	7.8	0	-	13.8	16.1	8	0	-
HCM Lane LOS	A	A	-	B	C	A	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0.7	0.1	0	-	-

Intersection Capacity Worksheets: Year 2028 Background

Intersection	
Intersection Delay, s/veh	16.1
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	702	638	493	47
Demand Flow Rate, veh/h	730	683	543	51
Vehicles Circulating, veh/h	208	400	524	998
Vehicles Exiting, veh/h	841	667	414	85
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	12.7	19.1	17.7	9.2
Approach LOS	B	C	C	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
A (Intercept)	1380	1380	1380	1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3	1.02e-3
Entry Flow, veh/h	730	683	543	51
Cap Entry Lane, veh/h	1116	918	809	499
Entry HV Adj Factor	0.961	0.934	0.908	0.924
Flow Entry, veh/h	702	638	493	47
Cap Entry, veh/h	1073	857	735	461
V/C Ratio	0.654	0.744	0.672	0.102
Control Delay, s/veh	12.7	19.1	17.7	9.2
LOS	B	C	C	A
95th %tile Queue, veh	5	7	5	0

Intersection	
Intersection Delay, s/veh	13.2
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	525	685	222	435
Demand Flow Rate, veh/h	562	733	224	456
Vehicles Circulating, veh/h	370	271	807	533
Vehicles Exiting, veh/h	619	701	125	471
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	12.8	15.3	7.1	13.6
Approach LOS	B	C	A	B

Lane	Left	Left	Left	Bypass	Left
Designated Moves	LTR	LTR	LT	R	LTR
Assumed Moves	LTR	LTR	LT		LTR
RT Channelized				Free	
Lane Util	1.000	1.000	1.000		1.000
Follow-Up Headway, s	2.609	2.609	2.609		2.609
Critical Headway, s	4.976	4.976	4.976		4.976
A (Intercept)	1380	1380	1380		1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3		1.02e-3
Entry Flow, veh/h	562	733	165	59	456
Cap Entry Lane, veh/h	946	1047	606	1919	801
Entry HV Adj Factor	0.935	0.935	0.993	0.990	0.953
Flow Entry, veh/h	525	685	164	58	435
Cap Entry, veh/h	884	978	602	1900	764
V/C Ratio	0.594	0.700	0.272	0.031	0.569
Control Delay, s/veh	12.8	15.3	9.6	0.0	13.6
LOS	B	C	A	A	B
95th %tile Queue, veh	4	6	1	0	4

Intersection	
Int Delay, s/veh	2.9

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	23	35	75	4	8	83
Future Vol, veh/h	23	35	75	4	8	83
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	73	73	80	80	90	90
Heavy Vehicles, %	2	2	3	3	6	6
Mvmt Flow	32	48	94	5	9	92

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	206	96	0	0	99	0
Stage 1	96	-	-	-	-	-
Stage 2	110	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.16	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.254	-
Pot Cap-1 Maneuver	782	960	-	-	1469	-
Stage 1	928	-	-	-	-	-
Stage 2	915	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	777	960	-	-	1469	-
Mov Cap-2 Maneuver	777	-	-	-	-	-
Stage 1	928	-	-	-	-	-
Stage 2	909	-	-	-	-	-

Approach	WB	NB	SB
HCM Ctrl Dly, s/v	9.51	0	0.66
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	878	158	-
HCM Lane V/C Ratio	-	-	0.09	0.006	-
HCM Ctrl Dly (s/v)	-	-	9.5	7.5	0
HCM Lane LOS	-	-	A	A	A
HCM 95th %tile Q(veh)	-	-	0.3	0	-

Intersection	
Int Delay, s/veh	2.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	3	570	15	20	588	4	22	0	27	7	0	11
Future Vol, veh/h	3	570	15	20	588	4	22	0	27	7	0	11
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	35	-	160	50	-	-	-	-	100	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	90	90	90	64	64	64	53	53	53
Heavy Vehicles, %	5	5	5	8	8	8	1	1	1	1	1	1
Mvmt Flow	3	655	17	22	653	4	34	0	42	13	0	21

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	658	0	0	672	0	0	1360	1364	655	1362	1379	656
Stage 1	-	-	-	-	-	-	662	662	-	700	700	-
Stage 2	-	-	-	-	-	-	698	702	-	662	679	-
Critical Hdwy	4.15	-	-	4.18	-	-	7.11	6.51	6.21	7.11	6.51	6.21
Critical Hdwy Stg 1	-	-	-	-	-	-	6.11	5.51	-	6.11	5.51	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.11	5.51	-	6.11	5.51	-
Follow-up Hdwy	2.245	-	-	2.272	-	-	3.509	4.009	3.309	3.509	4.009	3.309
Pot Cap-1 Maneuver	916	-	-	891	-	-	126	148	468	126	145	468
Stage 1	-	-	-	-	-	-	453	461	-	431	443	-
Stage 2	-	-	-	-	-	-	433	442	-	453	453	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	916	-	-	891	-	-	117	144	468	111	141	468
Mov Cap-2 Maneuver	-	-	-	-	-	-	117	144	-	111	141	-
Stage 1	-	-	-	-	-	-	451	459	-	421	432	-
Stage 2	-	-	-	-	-	-	403	431	-	410	451	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	0.05	0.3	28.97	25.64
HCM LOS			D	D

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	117	468	916	-	-	891	-	-	208
HCM Lane V/C Ratio	0.293	0.09	0.004	-	-	0.025	-	-	0.163
HCM Ctrl Dly (s/v)	48	13.5	8.9	-	-	9.1	-	-	25.6
HCM Lane LOS	E	B	A	-	-	A	-	-	D
HCM 95th %tile Q(veh)	1.1	0.3	0	-	-	0.1	-	-	0.6

Intersection	
Int Delay, s/veh	2.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	34	2	21	1	5	6	27	201	2	3	161	9
Future Vol, veh/h	34	2	21	1	5	6	27	201	2	3	161	9
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	87	87	87	87	87	87	87	87	87
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	39	2	24	1	6	7	31	231	2	3	185	10

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	493	493	190	487	497	232	195	0	0	233	0	0
Stage 1	197	197	-	294	294	-	-	-	-	-	-	-
Stage 2	296	295	-	193	202	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	486	477	852	491	475	807	1378	-	-	1334	-	-
Stage 1	805	738	-	714	669	-	-	-	-	-	-	-
Stage 2	712	669	-	809	734	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	463	464	852	461	461	807	1378	-	-	1334	-	-
Mov Cap-2 Maneuver	463	464	-	461	461	-	-	-	-	-	-	-
Stage 1	802	736	-	696	652	-	-	-	-	-	-	-
Stage 2	682	651	-	781	732	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	12.33	11.28	0.9	0.13
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	211	-	-	556	587	31	-	-
HCM Lane V/C Ratio	0.023	-	-	0.118	0.024	0.003	-	-
HCM Ctrl Dly (s/v)	7.7	0	-	12.3	11.3	7.7	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0.1	-	-	0.4	0.1	0	-	-

Intersection Capacity Worksheets: Year 2045 Background

Intersection	
Intersection Delay, s/veh	14.8
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	2	2	1	1
Conflicting Circle Lanes	1	1	2	2
Adj Approach Flow, veh/h	793	799	784	68
Demand Flow Rate, veh/h	808	814	800	70
Vehicles Circulating, veh/h	312	532	504	1239
Vehicles Exiting, veh/h	997	772	616	107
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	7.4	10.2	27.6	9.4
Approach LOS	A	B	D	A

Lane	Left	Right	Left	Right	Left	Left
Designated Moves	LT	TR	LT	TR	LTR	LTR
Assumed Moves	LT	TR	LT	TR	LTR	LTR
RT Channelized						
Lane Util	0.470	0.530	0.471	0.529	1.000	1.000
Follow-Up Headway, s	2.535	2.535	2.535	2.535	2.535	2.535
Critical Headway, s	4.544	4.544	4.544	4.544	4.328	4.328
A (Intercept)	1420	1420	1420	1420	1420	1420
B (Slope)	9.101e-4	9.101e-4	9.101e-4	9.101e-4	8.501e-4	8.501e-4
Entry Flow, veh/h	380	428	383	431	800	70
Cap Entry Lane, veh/h	1069	1069	875	875	925	495
Entry HV Adj Factor	0.980	0.981	0.980	0.982	0.980	0.976
Flow Entry, veh/h	372	420	375	423	784	68
Cap Entry, veh/h	1048	1049	858	860	906	483
V/C Ratio	0.355	0.400	0.438	0.493	0.865	0.141
Control Delay, s/veh	7.1	7.7	9.6	10.6	27.6	9.4
LOS	A	A	A	B	D	A
95th %tile Queue, veh	2	2	2	3	11	0

Intersection	
Intersection Delay, s/veh	22.9
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	592	913	256	506
Demand Flow Rate, veh/h	604	931	259	516
Vehicles Circulating, veh/h	432	306	878	668
Vehicles Exiting, veh/h	752	762	119	569
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	13.5	33.3	8.4	22.3
Approach LOS	B	D	A	C

Lane	Left	Bypass	Left	Left	Bypass	Left
Designated Moves	LT	R	LTR	LT	R	LTR
Assumed Moves	LT		LTR	LT		LTR
RT Channelized		Yield			Free	
Lane Util	1.000		1.000	1.000		1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609		2.609
Critical Headway, s	4.976	4.976	4.976	4.976		4.976
A (Intercept)	1380	1380	1380	1380		1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3	1.02e-3		1.02e-3
Entry Flow, veh/h	565	39	931	190	69	516
Cap Entry Lane, veh/h	888	1222	1010	564	1919	698
Entry HV Adj Factor	0.981	0.980	0.981	0.988	0.990	0.980
Flow Entry, veh/h	554	38	913	188	68	506
Cap Entry, veh/h	871	1198	991	557	1900	684
V/C Ratio	0.636	0.032	0.922	0.337	0.036	0.739
Control Delay, s/veh	14.2	3.3	33.3	11.4	0.0	22.3
LOS	B	A	D	B	A	C
95th %tile Queue, veh	5	0	14	1	0	7

Intersection	
Int Delay, s/veh	2.8

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	30	45	95	5	15	110
Future Vol, veh/h	30	45	95	5	15	110
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	88	88	88	88	90	90
Heavy Vehicles, %	2	2	3	3	6	6
Mvmt Flow	34	51	108	6	17	122

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	266	111	0	0	114	0
Stage 1	111	-	-	-	-	-
Stage 2	156	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.16	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.254	-
Pot Cap-1 Maneuver	723	942	-	-	1451	-
Stage 1	914	-	-	-	-	-
Stage 2	873	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	714	942	-	-	1451	-
Mov Cap-2 Maneuver	714	-	-	-	-	-
Stage 1	914	-	-	-	-	-
Stage 2	862	-	-	-	-	-

Approach	WB	NB	SB
HCM Ctrl Dly, s/v	9.8	0	0.9
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	835	216	-
HCM Lane V/C Ratio	-	-	0.102	0.011	-
HCM Ctrl Dly (s/v)	-	-	9.8	7.5	0
HCM Lane LOS	-	-	A	A	A
HCM 95th %tile Q(veh)	-	-	0.3	0	-

Intersection	
Int Delay, s/veh	3.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	5	710	15	20	785	10	25	5	30	10	5	15
Future Vol, veh/h	5	710	15	20	785	10	25	5	30	10	5	15
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	35	-	160	50	-	-	-	-	100	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	88	88	88	88	88	88
Heavy Vehicles, %	5	5	5	8	8	8	1	1	1	1	1	1
Mvmt Flow	5	772	16	22	853	11	28	6	34	11	6	17

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	864	0	0	788	0	0	1682	1690	772	1688	1701	859
Stage 1	-	-	-	-	-	-	783	783	-	902	902	-
Stage 2	-	-	-	-	-	-	900	908	-	785	799	-
Critical Hdwy	4.15	-	-	4.18	-	-	7.11	6.51	6.21	7.11	6.51	6.21
Critical Hdwy Stg 1	-	-	-	-	-	-	6.11	5.51	-	6.11	5.51	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.11	5.51	-	6.11	5.51	-
Follow-up Hdwy	2.245	-	-	2.272	-	-	3.509	4.009	3.309	3.509	4.009	3.309
Pot Cap-1 Maneuver	766	-	-	805	-	-	75	94	401	75	92	358
Stage 1	-	-	-	-	-	-	389	406	-	334	358	-
Stage 2	-	-	-	-	-	-	335	356	-	387	399	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	766	-	-	805	-	-	65	91	401	62	89	358
Mov Cap-2 Maneuver	-	-	-	-	-	-	65	91	-	62	89	-
Stage 1	-	-	-	-	-	-	386	403	-	325	348	-
Stage 2	-	-	-	-	-	-	305	346	-	347	396	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	0.07	0.24	58.34	48.63
HCM LOS			F	E

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	68	401	766	-	-	805	-	-	116
HCM Lane V/C Ratio	0.5	0.085	0.007	-	-	0.027	-	-	0.295
HCM Ctrl Dly (s/v)	101.9	14.8	9.7	-	-	9.6	-	-	48.6
HCM Lane LOS	F	B	A	-	-	A	-	-	E
HCM 95th %tile Q(veh)	2	0.3	0	-	-	0.1	-	-	1.1

Intersection	
Int Delay, s/veh	3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⇕			⇕			⇕			⇕	
Traffic Vol, veh/h	45	5	30	5	10	10	35	240	5	5	195	15
Future Vol, veh/h	45	5	30	5	10	10	35	240	5	5	195	15
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	87	87	87	87	87	87	87	87	87
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	52	6	34	6	11	11	40	276	6	6	224	17

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	606	606	233	598	612	279	241	0	0	282	0	0
Stage 1	244	244	-	359	359	-	-	-	-	-	-	-
Stage 2	362	362	-	239	253	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	409	411	806	414	408	760	1325	-	-	1281	-	-
Stage 1	759	704	-	659	627	-	-	-	-	-	-	-
Stage 2	657	625	-	765	698	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	375	394	806	375	391	760	1325	-	-	1281	-	-
Mov Cap-2 Maneuver	375	394	-	375	391	-	-	-	-	-	-	-
Stage 1	755	700	-	635	604	-	-	-	-	-	-	-
Stage 2	611	603	-	722	694	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	14.49	12.97	0.98	0.18
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	224	-	-	471	480	41	-	-
HCM Lane V/C Ratio	0.03	-	-	0.195	0.06	0.004	-	-
HCM Ctrl Dly (s/v)	7.8	0	-	14.5	13	7.8	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0.1	-	-	0.7	0.2	0	-	-

Intersection	
Intersection Delay, s/veh	13.8
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	2	2	1	1
Conflicting Circle Lanes	1	1	2	2
Adj Approach Flow, veh/h	916	989	694	85
Demand Flow Rate, veh/h	934	1009	708	86
Vehicles Circulating, veh/h	457	482	548	1368
Vehicles Exiting, veh/h	997	774	843	123
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	10.3	11.7	21.9	11.1
Approach LOS	B	B	C	B

Lane	Left	Right	Left	Right	Left	Left
Designated Moves	LT	TR	LT	TR	LTR	LTR
Assumed Moves	LT	TR	LT	TR	LTR	LTR
RT Channelized						
Lane Util	0.470	0.530	0.470	0.530	1.000	1.000
Follow-Up Headway, s	2.535	2.535	2.535	2.535	2.535	2.535
Critical Headway, s	4.544	4.544	4.544	4.544	4.328	4.328
A (Intercept)	1420	1420	1420	1420	1420	1420
B (Slope)	9.101e-4	9.101e-4	9.101e-4	9.101e-4	8.501e-4	8.501e-4
Entry Flow, veh/h	439	495	474	535	708	86
Cap Entry Lane, veh/h	937	937	916	916	891	444
Entry HV Adj Factor	0.980	0.981	0.981	0.980	0.981	0.988
Flow Entry, veh/h	430	485	465	524	694	85
Cap Entry, veh/h	919	919	898	898	874	439
V/C Ratio	0.469	0.528	0.518	0.584	0.794	0.194
Control Delay, s/veh	9.7	10.9	10.8	12.4	21.9	11.1
LOS	A	B	B	B	C	B
95th %tile Queue, veh	3	3	3	4	8	1

Intersection	
Intersection Delay, s/veh	29.7
Intersection LOS	D

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	756	846	326	624
Demand Flow Rate, veh/h	771	863	333	637
Vehicles Circulating, veh/h	536	363	1104	624
Vehicles Exiting, veh/h	725	965	142	602
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	31.3	32.1	12.6	33.6
Approach LOS	D	D	B	D

Lane	Left	Bypass	Left	Left	Bypass	Left
Designated Moves	LT	R	LTR	LT	R	LTR
Assumed Moves	LT		LTR	LT		LTR
RT Channelized		Yield			Free	
Lane Util	1.000		1.000	1.000		1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609		2.609
Critical Headway, s	4.976	4.976	4.976	4.976		4.976
A (Intercept)	1380	1380	1380	1380		1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3	1.02e-3		1.02e-3
Entry Flow, veh/h	710	61	863	224	109	637
Cap Entry Lane, veh/h	799	1194	953	448	1938	730
Entry HV Adj Factor	0.980	0.980	0.980	0.979	0.980	0.980
Flow Entry, veh/h	696	60	846	219	107	624
Cap Entry, veh/h	783	1170	934	438	1900	715
V/C Ratio	0.889	0.051	0.906	0.500	0.056	0.872
Control Delay, s/veh	33.7	3.5	32.1	18.7	0.0	33.6
LOS	D	A	D	C	A	D
95th %tile Queue, veh	12	0	13	3	0	11

Intersection	
Int Delay, s/veh	1.9

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	15	30	235	25	45	90
Future Vol, veh/h	15	30	235	25	45	90
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	1	1	1	1	1	1
Mvmt Flow	17	34	267	28	51	102

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	486	281	0	0	295	0
Stage 1	281	-	-	-	-	-
Stage 2	205	-	-	-	-	-
Critical Hdwy	6.41	6.21	-	-	4.11	-
Critical Hdwy Stg 1	5.41	-	-	-	-	-
Critical Hdwy Stg 2	5.41	-	-	-	-	-
Follow-up Hdwy	3.509	3.309	-	-	2.209	-
Pot Cap-1 Maneuver	542	760	-	-	1272	-
Stage 1	769	-	-	-	-	-
Stage 2	832	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	519	760	-	-	1272	-
Mov Cap-2 Maneuver	519	-	-	-	-	-
Stage 1	769	-	-	-	-	-
Stage 2	797	-	-	-	-	-

Approach	WB	NB	SB
HCM Ctrl Dly, s/v	10.93	0	2.65
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	658	600	-
HCM Lane V/C Ratio	-	-	0.078	0.04	-
HCM Ctrl Dly (s/v)	-	-	10.9	7.9	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.3	0.1	-

Intersection	
Int Delay, s/veh	4.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	15	900	35	35	760	10	20	5	30	10	5	10
Future Vol, veh/h	15	900	35	35	760	10	20	5	30	10	5	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	35	-	160	50	-	-	-	-	100	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	88	88	88	92	92	92
Heavy Vehicles, %	3	3	3	2	2	2	12	12	12	1	1	1
Mvmt Flow	16	978	38	38	826	11	23	6	34	11	5	11

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	837	0	0	1016	0	0	1916	1924	978	1921	1957	832
Stage 1	-	-	-	-	-	-	1011	1011	-	908	908	-
Stage 2	-	-	-	-	-	-	905	913	-	1014	1049	-
Critical Hdwy	4.13	-	-	4.12	-	-	7.22	6.62	6.32	7.11	6.51	6.21
Critical Hdwy Stg 1	-	-	-	-	-	-	6.22	5.62	-	6.11	5.51	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.22	5.62	-	6.11	5.51	-
Follow-up Hdwy	2.227	-	-	2.218	-	-	3.608	4.108	3.408	3.509	4.009	3.309
Pot Cap-1 Maneuver	793	-	-	683	-	-	48	63	291	51	64	371
Stage 1	-	-	-	-	-	-	277	305	-	331	356	-
Stage 2	-	-	-	-	-	-	318	339	-	289	306	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	793	-	-	683	-	-	40	58	291	38	59	371
Mov Cap-2 Maneuver	-	-	-	-	-	-	40	58	-	38	59	-
Stage 1	-	-	-	-	-	-	271	299	-	313	336	-
Stage 2	-	-	-	-	-	-	287	320	-	245	299	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	0.15	0.46	98.2	92.1
HCM LOS			F	F

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	42	291	793	-	-	683	-	-	67
HCM Lane V/C Ratio	0.672	0.117	0.021	-	-	0.056	-	-	0.408
HCM Ctrl Dly (s/v)	193.2	19	9.6	-	-	10.6	-	-	92.1
HCM Lane LOS	F	C	A	-	-	B	-	-	F
HCM 95th %tile Q(veh)	2.5	0.4	0.1	-	-	0.2	-	-	1.6

Intersection	
Int Delay, s/veh	4.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⇕			⇕			⇕			⇕	
Traffic Vol, veh/h	40	15	65	10	10	5	85	365	5	10	220	20
Future Vol, veh/h	40	15	65	10	10	5	85	365	5	10	220	20
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	91	91	91	91	91	91	91	91	91	91	91	91
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	44	16	71	11	11	5	93	401	5	11	242	22

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	868	868	253	863	876	404	264	0	0	407	0	0
Stage 1	275	275	-	591	591	-	-	-	-	-	-	-
Stage 2	593	593	-	272	286	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	273	290	786	275	287	647	1300	-	-	1152	-	-
Stage 1	731	683	-	493	495	-	-	-	-	-	-	-
Stage 2	492	493	-	734	675	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	233	260	786	211	258	647	1300	-	-	1152	-	-
Mov Cap-2 Maneuver	233	260	-	211	258	-	-	-	-	-	-	-
Stage 1	723	675	-	448	449	-	-	-	-	-	-	-
Stage 2	431	447	-	644	668	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	19.15	20.06	1.49	0.33
HCM LOS	C	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	335	-	-	385	266	71	-	-
HCM Lane V/C Ratio	0.072	-	-	0.343	0.103	0.01	-	-
HCM Ctrl Dly (s/v)	8	0	-	19.2	20.1	8.2	0	-
HCM Lane LOS	A	A	-	C	C	A	A	-
HCM 95th %tile Q(veh)	0.2	-	-	1.5	0.3	0	-	-

Intersection Capacity Worksheets: Year 2028 Background + Project

Intersection	
Intersection Delay, s/veh	17.2
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	739	646	496	48
Demand Flow Rate, veh/h	768	691	546	52
Vehicles Circulating, veh/h	208	407	554	1009
Vehicles Exiting, veh/h	853	693	422	89
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	13.8	20.0	19.3	9.3
Approach LOS	B	C	C	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
A (Intercept)	1380	1380	1380	1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3	1.02e-3
Entry Flow, veh/h	768	691	546	52
Cap Entry Lane, veh/h	1116	911	784	493
Entry HV Adj Factor	0.962	0.934	0.909	0.926
Flow Entry, veh/h	739	646	496	48
Cap Entry, veh/h	1073	851	713	457
V/C Ratio	0.688	0.758	0.696	0.105
Control Delay, s/veh	13.8	20.0	19.3	9.3
LOS	B	C	C	A
95th %tile Queue, veh	6	7	6	0

Intersection	
Intersection Delay, s/veh	14.1
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	531	700	238	440
Demand Flow Rate, veh/h	568	750	241	461
Vehicles Circulating, veh/h	375	288	815	553
Vehicles Exiting, veh/h	639	709	128	485
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	13.1	16.8	7.7	14.4
Approach LOS	B	C	A	B

Lane	Left	Left	Left	Bypass	Left
Designated Moves	LTR	LTR	LT	R	LTR
Assumed Moves	LTR	LTR	LT		LTR
RT Channelized				Free	
Lane Util	1.000	1.000	1.000		1.000
Follow-Up Headway, s	2.609	2.609	2.609		2.609
Critical Headway, s	4.976	4.976	4.976		4.976
A (Intercept)	1380	1380	1380		1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3		1.02e-3
Entry Flow, veh/h	568	750	182	59	461
Cap Entry Lane, veh/h	941	1029	601	1919	785
Entry HV Adj Factor	0.935	0.934	0.988	0.990	0.954
Flow Entry, veh/h	531	700	180	58	440
Cap Entry, veh/h	880	961	594	1900	749
V/C Ratio	0.603	0.729	0.303	0.031	0.587
Control Delay, s/veh	13.1	16.8	10.2	0.0	14.4
LOS	B	C	B	A	B
95th %tile Queue, veh	4	7	1	0	4

Intersection	
Int Delay, s/veh	3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	26	35	75	5	8	83
Future Vol, veh/h	26	35	75	5	8	83
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	73	73	80	80	90	90
Heavy Vehicles, %	2	2	3	3	6	6
Mvmt Flow	36	48	94	6	9	92

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	207	97	0	0	100	0
Stage 1	97	-	-	-	-	-
Stage 2	110	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.16	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.254	-
Pot Cap-1 Maneuver	782	959	-	-	1468	-
Stage 1	927	-	-	-	-	-
Stage 2	915	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	777	959	-	-	1468	-
Mov Cap-2 Maneuver	777	-	-	-	-	-
Stage 1	927	-	-	-	-	-
Stage 2	909	-	-	-	-	-

Approach	WB	NB	SB
HCM Ctrl Dly, s/v	9.57	0	0.66
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	872	158	-
HCM Lane V/C Ratio	-	-	0.096	0.006	-
HCM Ctrl Dly (s/v)	-	-	9.6	7.5	0
HCM Lane LOS	-	-	A	A	A
HCM 95th %tile Q(veh)	-	-	0.3	0	-

Intersection	
Int Delay, s/veh	4.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	3	570	21	30	588	4	36	0	56	7	0	11
Future Vol, veh/h	3	570	21	30	588	4	36	0	56	7	0	11
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	35	-	160	50	-	-	-	-	100	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	90	90	90	64	64	64	53	53	53
Heavy Vehicles, %	5	5	5	8	8	8	1	1	1	1	1	1
Mvmt Flow	3	655	24	33	653	4	56	0	88	13	0	21

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	658	0	0	679	0	0	1382	1387	655	1384	1408	656
Stage 1	-	-	-	-	-	-	662	662	-	722	722	-
Stage 2	-	-	-	-	-	-	720	724	-	662	686	-
Critical Hdwy	4.15	-	-	4.18	-	-	7.11	6.51	6.21	7.11	6.51	6.21
Critical Hdwy Stg 1	-	-	-	-	-	-	6.11	5.51	-	6.11	5.51	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.11	5.51	-	6.11	5.51	-
Follow-up Hdwy	2.245	-	-	2.272	-	-	3.509	4.009	3.309	3.509	4.009	3.309
Pot Cap-1 Maneuver	916	-	-	885	-	-	122	144	468	121	139	468
Stage 1	-	-	-	-	-	-	453	461	-	419	433	-
Stage 2	-	-	-	-	-	-	421	432	-	453	449	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	916	-	-	885	-	-	112	138	468	95	134	468
Mov Cap-2 Maneuver	-	-	-	-	-	-	112	138	-	95	134	-
Stage 1	-	-	-	-	-	-	451	459	-	404	416	-
Stage 2	-	-	-	-	-	-	387	415	-	367	448	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	0.05	0.44	34.72	28.84
HCM LOS			D	D

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	112	468	916	-	-	885	-	-	185
HCM Lane V/C Ratio	0.504	0.187	0.004	-	-	0.038	-	-	0.184
HCM Ctrl Dly (s/v)	66.2	14.5	8.9	-	-	9.2	-	-	28.8
HCM Lane LOS	F	B	A	-	-	A	-	-	D
HCM 95th %tile Q(veh)	2.3	0.7	0	-	-	0.1	-	-	0.7

Intersection	
Int Delay, s/veh	2.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	34	3	21	1	8	19	27	201	2	4	161	9
Future Vol, veh/h	34	3	21	1	8	19	27	201	2	4	161	9
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	87	87	87	87	87	87	87	87	87
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	39	3	24	1	9	22	31	231	2	5	185	10

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	497	495	190	490	499	232	195	0	0	233	0	0
Stage 1	199	199	-	294	294	-	-	-	-	-	-	-
Stage 2	298	295	-	196	205	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	483	476	852	488	473	807	1378	-	-	1334	-	-
Stage 1	802	736	-	714	669	-	-	-	-	-	-	-
Stage 2	711	669	-	806	732	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	447	462	852	457	459	807	1378	-	-	1334	-	-
Mov Cap-2 Maneuver	447	462	-	457	459	-	-	-	-	-	-	-
Stage 1	799	733	-	696	652	-	-	-	-	-	-	-
Stage 2	664	651	-	776	729	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	12.58	10.84	0.9	0.18
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	211	-	-	541	649	41	-	-
HCM Lane V/C Ratio	0.023	-	-	0.123	0.05	0.003	-	-
HCM Ctrl Dly (s/v)	7.7	0	-	12.6	10.8	7.7	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0.1	-	-	0.4	0.2	0	-	-

Intersection	
Intersection Delay, s/veh	18.4
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	686	805	470	67
Demand Flow Rate, veh/h	699	821	484	70
Vehicles Circulating, veh/h	287	354	495	1077
Vehicles Exiting, veh/h	860	625	491	98
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	14.1	25.7	13.3	10.4
Approach LOS	B	D	B	B

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
A (Intercept)	1380	1380	1380	1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3	1.02e-3
Entry Flow, veh/h	699	821	484	70
Cap Entry Lane, veh/h	1030	962	833	460
Entry HV Adj Factor	0.981	0.980	0.971	0.962
Flow Entry, veh/h	686	805	470	67
Cap Entry, veh/h	1010	943	809	443
V/C Ratio	0.679	0.854	0.581	0.152
Control Delay, s/veh	14.1	25.7	13.3	10.4
LOS	B	D	B	B
95th %tile Queue, veh	6	11	4	1

Intersection	
Intersection Delay, s/veh	16.4
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	633	670	257	548
Demand Flow Rate, veh/h	659	690	264	565
Vehicles Circulating, veh/h	466	302	951	503
Vehicles Exiting, veh/h	602	833	174	489
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	21.1	14.5	8.8	17.0
Approach LOS	C	B	A	C

Lane	Left	Left	Left	Bypass	Left
Designated Moves	LTR	LTR	LT	R	LTR
Assumed Moves	LTR	LTR	LT		LTR
RT Channelized				Free	
Lane Util	1.000	1.000	1.000		1.000
Follow-Up Headway, s	2.609	2.609	2.609		2.609
Critical Headway, s	4.976	4.976	4.976		4.976
A (Intercept)	1380	1380	1380		1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3		1.02e-3
Entry Flow, veh/h	659	690	184	80	565
Cap Entry Lane, veh/h	858	1014	523	1957	826
Entry HV Adj Factor	0.961	0.971	0.971	0.971	0.970
Flow Entry, veh/h	633	670	179	78	548
Cap Entry, veh/h	824	985	508	1900	802
V/C Ratio	0.768	0.680	0.352	0.041	0.684
Control Delay, s/veh	21.1	14.5	12.6	0.0	17.0
LOS	C	B	B	A	C
95th %tile Queue, veh	8	6	2	0	6

Intersection	
Int Delay, s/veh	2.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	13	24	189	22	36	69
Future Vol, veh/h	13	24	189	22	36	69
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	59	59	88	88	77	77
Heavy Vehicles, %	1	1	1	1	1	1
Mvmt Flow	22	41	215	25	47	90

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	410	227	0	0	240	0
Stage 1	227	-	-	-	-	-
Stage 2	183	-	-	-	-	-
Critical Hdwy	6.41	6.21	-	-	4.11	-
Critical Hdwy Stg 1	5.41	-	-	-	-	-
Critical Hdwy Stg 2	5.41	-	-	-	-	-
Follow-up Hdwy	3.509	3.309	-	-	2.209	-
Pot Cap-1 Maneuver	599	815	-	-	1333	-
Stage 1	813	-	-	-	-	-
Stage 2	851	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	577	815	-	-	1333	-
Mov Cap-2 Maneuver	577	-	-	-	-	-
Stage 1	813	-	-	-	-	-
Stage 2	819	-	-	-	-	-

Approach	WB	NB	SB
HCM Ctrl Dly, s/v	10.55	0	2.67
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	712	617	-
HCM Lane V/C Ratio	-	-	0.088	0.035	-
HCM Ctrl Dly (s/v)	-	-	10.5	7.8	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.3	0.1	-

Intersection	
Int Delay, s/veh	4.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	12	678	48	61	599	7	27	0	46	7	0	4
Future Vol, veh/h	12	678	48	61	599	7	27	0	46	7	0	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	35	-	160	50	-	-	-	-	100	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	84	84	84	65	65	65	92	92	92
Heavy Vehicles, %	3	3	3	2	2	2	12	12	12	1	1	1
Mvmt Flow	13	737	52	73	713	8	42	0	71	8	0	4

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	721	0	0	789	0	0	1621	1630	737	1626	1678	717
Stage 1	-	-	-	-	-	-	763	763	-	862	862	-
Stage 2	-	-	-	-	-	-	858	867	-	763	815	-
Critical Hdwy	4.13	-	-	4.12	-	-	7.22	6.62	6.32	7.11	6.51	6.21
Critical Hdwy Stg 1	-	-	-	-	-	-	6.22	5.62	-	6.11	5.51	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.22	5.62	-	6.11	5.51	-
Follow-up Hdwy	2.227	-	-	2.218	-	-	3.608	4.108	3.408	3.509	4.009	3.309
Pot Cap-1 Maneuver	876	-	-	831	-	-	78	96	402	82	95	431
Stage 1	-	-	-	-	-	-	382	399	-	351	373	-
Stage 2	-	-	-	-	-	-	338	357	-	398	392	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	876	-	-	831	-	-	70	87	402	61	86	431
Mov Cap-2 Maneuver	-	-	-	-	-	-	70	87	-	61	86	-
Stage 1	-	-	-	-	-	-	376	393	-	320	341	-
Stage 2	-	-	-	-	-	-	305	326	-	323	387	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	0.15	0.89	52.48	51.73
HCM LOS			F	F

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	70	402	876	-	-	831	-	-	89
HCM Lane V/C Ratio	0.597	0.176	0.015	-	-	0.087	-	-	0.135
HCM Ctrl Dly (s/v)	114.9	15.8	9.2	-	-	9.7	-	-	51.7
HCM Lane LOS	F	C	A	-	-	A	-	-	F
HCM 95th %tile Q(veh)	2.6	0.6	0	-	-	0.3	-	-	0.4

Intersection	
Int Delay, s/veh	3.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	28	11	50	4	7	10	65	307	2	9	183	15
Future Vol, veh/h	28	11	50	4	7	10	65	307	2	9	183	15
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	91	91	91	91	91	91	91	91	91	91	91	91
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	31	12	55	4	8	11	71	337	2	10	201	16

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	713	712	209	708	719	338	218	0	0	340	0	0
Stage 1	229	229	-	481	481	-	-	-	-	-	-	-
Stage 2	484	482	-	227	237	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	347	358	831	349	354	704	1352	-	-	1220	-	-
Stage 1	774	715	-	566	554	-	-	-	-	-	-	-
Stage 2	564	553	-	776	709	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	309	331	831	292	328	704	1352	-	-	1220	-	-
Mov Cap-2 Maneuver	309	331	-	292	328	-	-	-	-	-	-	-
Stage 1	767	708	-	529	518	-	-	-	-	-	-	-
Stage 2	511	517	-	706	702	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	14.31	13.92	1.36	0.35
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	312	-	-	484	427	77	-	-
HCM Lane V/C Ratio	0.053	-	-	0.202	0.054	0.008	-	-
HCM Ctrl Dly (s/v)	7.8	0	-	14.3	13.9	8	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0.7	0.2	0	-	-

Intersection Capacity Worksheets: Year 2045 Background + Project

Intersection	
Intersection Delay, s/veh	15.8
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	2	2	1	1
Conflicting Circle Lanes	1	1	2	2
Adj Approach Flow, veh/h	826	806	786	70
Demand Flow Rate, veh/h	842	821	802	72
Vehicles Circulating, veh/h	312	538	531	1248
Vehicles Exiting, veh/h	1008	795	623	111
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	7.6	10.3	30.7	9.5
Approach LOS	A	B	D	A

Lane	Left	Right	Left	Right	Left	Left
Designated Moves	LT	TR	LT	TR	LTR	LTR
Assumed Moves	LT	TR	LT	TR	LTR	LTR
RT Channelized						
Lane Util	0.470	0.530	0.470	0.530	1.000	1.000
Follow-Up Headway, s	2.535	2.535	2.535	2.535	2.535	2.535
Critical Headway, s	4.544	4.544	4.544	4.544	4.328	4.328
A (Intercept)	1420	1420	1420	1420	1420	1420
B (Slope)	9.101e-4	9.101e-4	9.101e-4	9.101e-4	8.501e-4	8.501e-4
Entry Flow, veh/h	396	446	386	435	802	72
Cap Entry Lane, veh/h	1069	1069	870	870	904	492
Entry HV Adj Factor	0.980	0.982	0.981	0.982	0.980	0.977
Flow Entry, veh/h	388	438	379	427	786	70
Cap Entry, veh/h	1048	1049	854	854	886	480
V/C Ratio	0.370	0.417	0.444	0.500	0.887	0.146
Control Delay, s/veh	7.3	7.9	9.8	10.8	30.7	9.5
LOS	A	A	A	B	D	A
95th %tile Queue, veh	2	2	2	3	12	1

Intersection	
Intersection Delay, s/veh	25.6
Intersection LOS	D

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	598	929	271	510
Demand Flow Rate, veh/h	610	947	274	520
Vehicles Circulating, veh/h	436	321	888	685
Vehicles Exiting, veh/h	769	772	119	583
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	13.9	38.9	9.1	23.9
Approach LOS	B	E	A	C

Lane	Left	Bypass	Left	Left	Bypass	Left
Designated Moves	LT	R	LTR	LT	R	LTR
Assumed Moves	LT		LTR	LT		LTR
RT Channelized		Yield			Free	
Lane Util	1.000		1.000	1.000		1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609		2.609
Critical Headway, s	4.976	4.976	4.976	4.976		4.976
A (Intercept)	1380	1380	1380	1380		1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3	1.02e-3		1.02e-3
Entry Flow, veh/h	571	39	947	205	69	520
Cap Entry Lane, veh/h	885	1222	995	558	1919	686
Entry HV Adj Factor	0.981	0.980	0.981	0.988	0.990	0.981
Flow Entry, veh/h	560	38	929	203	68	510
Cap Entry, veh/h	868	1198	976	551	1900	673
V/C Ratio	0.646	0.032	0.952	0.367	0.036	0.758
Control Delay, s/veh	14.6	3.3	38.9	12.1	0.0	23.9
LOS	B	A	E	B	A	C
95th %tile Queue, veh	5	0	16	2	0	7

Intersection	
Int Delay, s/veh	2.9

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	33	45	95	6	15	110
Future Vol, veh/h	33	45	95	6	15	110
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	88	88	88	88	90	90
Heavy Vehicles, %	2	2	3	3	6	6
Mvmt Flow	38	51	108	7	17	122

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	267	111	0	0	115	0
Stage 1	111	-	-	-	-	-
Stage 2	156	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.16	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.254	-
Pot Cap-1 Maneuver	722	942	-	-	1450	-
Stage 1	913	-	-	-	-	-
Stage 2	873	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	713	942	-	-	1450	-
Mov Cap-2 Maneuver	713	-	-	-	-	-
Stage 1	913	-	-	-	-	-
Stage 2	862	-	-	-	-	-

Approach	WB	NB	SB
HCM Ctrl Dly, s/v	9.86	0	0.9
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	829	216	-
HCM Lane V/C Ratio	-	-	0.107	0.011	-
HCM Ctrl Dly (s/v)	-	-	9.9	7.5	0
HCM Lane LOS	-	-	A	A	A
HCM 95th %tile Q(veh)	-	-	0.4	0	-

Intersection	
Int Delay, s/veh	6.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	5	710	51	30	785	10	39	5	59	10	5	15
Future Vol, veh/h	5	710	51	30	785	10	39	5	59	10	5	15
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	35	-	160	50	-	-	-	-	100	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	88	88	88	88	88	88
Heavy Vehicles, %	5	5	5	8	8	8	1	1	1	1	1	1
Mvmt Flow	5	772	55	33	853	11	44	6	67	11	6	17

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	864	0	0	827	0	0	1704	1712	772	1709	1762	859
Stage 1	-	-	-	-	-	-	783	783	-	924	924	-
Stage 2	-	-	-	-	-	-	921	929	-	785	838	-
Critical Hdwy	4.15	-	-	4.18	-	-	7.11	6.51	6.21	7.11	6.51	6.21
Critical Hdwy Stg 1	-	-	-	-	-	-	6.11	5.51	-	6.11	5.51	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.11	5.51	-	6.11	5.51	-
Follow-up Hdwy	2.245	-	-	2.272	-	-	3.509	4.009	3.309	3.509	4.009	3.309
Pot Cap-1 Maneuver	766	-	-	778	-	-	73	91	401	72	85	358
Stage 1	-	-	-	-	-	-	389	406	-	324	350	-
Stage 2	-	-	-	-	-	-	325	348	-	387	383	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	766	-	-	778	-	-	61	87	401	54	81	358
Mov Cap-2 Maneuver	-	-	-	-	-	-	61	87	-	54	81	-
Stage 1	-	-	-	-	-	-	386	403	-	311	335	-
Stage 2	-	-	-	-	-	-	292	333	-	316	380	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	0.06	0.36	78.82	56.25
HCM LOS			F	F

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	64	401	766	-	-	778	-	-	103
HCM Lane V/C Ratio	0.787	0.167	0.007	-	-	0.042	-	-	0.331
HCM Ctrl Dly (s/v)	163.4	15.8	9.7	-	-	9.8	-	-	56.2
HCM Lane LOS	F	C	A	-	-	A	-	-	F
HCM 95th %tile Q(veh)	3.6	0.6	0	-	-	0.1	-	-	1.3

Intersection	
Int Delay, s/veh	3.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	45	6	30	5	13	23	35	240	5	6	195	15
Future Vol, veh/h	45	6	30	5	13	23	35	240	5	6	195	15
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	87	87	87	87	87	87	87	87	87	87	87	87
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	52	7	34	6	15	26	40	276	6	7	224	17

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	610	609	233	601	614	279	241	0	0	282	0	0
Stage 1	247	247	-	359	359	-	-	-	-	-	-	-
Stage 2	364	362	-	241	255	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	406	410	806	412	407	760	1325	-	-	1281	-	-
Stage 1	757	702	-	659	627	-	-	-	-	-	-	-
Stage 2	655	625	-	762	696	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	362	393	806	372	390	760	1325	-	-	1281	-	-
Mov Cap-2 Maneuver	362	393	-	372	390	-	-	-	-	-	-	-
Stage 1	753	698	-	635	604	-	-	-	-	-	-	-
Stage 2	595	603	-	718	692	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	14.85	12.42	0.98	0.22
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	224	-	-	458	532	49	-	-
HCM Lane V/C Ratio	0.03	-	-	0.203	0.089	0.005	-	-
HCM Ctrl Dly (s/v)	7.8	0	-	14.9	12.4	7.8	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0.1	-	-	0.8	0.3	0	-	-

Intersection	
Intersection Delay, s/veh	14.8
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	2	2	1	1
Conflicting Circle Lanes	1	1	2	2
Adj Approach Flow, veh/h	936	1009	701	88
Demand Flow Rate, veh/h	954	1029	722	93
Vehicles Circulating, veh/h	460	496	564	1399
Vehicles Exiting, veh/h	1032	790	850	126
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	10.6	12.2	24.4	12.2
Approach LOS	B	B	C	B

Lane	Left	Right	Left	Right	Left	Left
Designated Moves	LT	TR	LT	TR	LTR	LTR
Assumed Moves	LT	TR	LT	TR	LTR	LTR
RT Channelized						
Lane Util	0.470	0.530	0.470	0.530	1.000	1.000
Follow-Up Headway, s	2.535	2.535	2.535	2.535	2.535	2.535
Critical Headway, s	4.544	4.544	4.544	4.544	4.328	4.328
A (Intercept)	1420	1420	1420	1420	1420	1420
B (Slope)	9.101e-4	9.101e-4	9.101e-4	9.101e-4	8.501e-4	8.501e-4
Entry Flow, veh/h	448	506	484	545	722	93
Cap Entry Lane, veh/h	934	934	904	904	879	432
Entry HV Adj Factor	0.981	0.980	0.980	0.981	0.971	0.951
Flow Entry, veh/h	440	496	474	535	701	88
Cap Entry, veh/h	917	916	886	887	854	411
V/C Ratio	0.479	0.542	0.535	0.603	0.821	0.215
Control Delay, s/veh	9.9	11.2	11.3	13.0	24.4	12.2
LOS	A	B	B	B	C	B
95th %tile Queue, veh	3	3	3	4	9	1

Intersection	
Intersection Delay, s/veh	33.3
Intersection LOS	D

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	771	855	336	637
Demand Flow Rate, veh/h	787	872	343	650
Vehicles Circulating, veh/h	549	373	1132	634
Vehicles Exiting, veh/h	735	994	142	611
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	36.1	35.2	14.0	37.6
Approach LOS	E	E	B	E

Lane	Left	Bypass	Left	Left	Bypass	Left
Designated Moves	LT	R	LTR	LT	R	LTR
Assumed Moves	LT		LTR	LT		LTR
RT Channelized		Yield			Free	
Lane Util	1.000		1.000	1.000		1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609		2.609
Critical Headway, s	4.976	4.976	4.976	4.976		4.976
A (Intercept)	1380	1380	1380	1380		1380
B (Slope)	1.02e-3	1.02e-3	1.02e-3	1.02e-3		1.02e-3
Entry Flow, veh/h	726	61	872	234	109	650
Cap Entry Lane, veh/h	788	1194	943	435	1938	723
Entry HV Adj Factor	0.980	0.980	0.981	0.979	0.980	0.980
Flow Entry, veh/h	711	60	855	229	107	637
Cap Entry, veh/h	772	1170	925	426	1900	708
V/C Ratio	0.921	0.051	0.924	0.538	0.056	0.899
Control Delay, s/veh	38.9	3.5	35.2	20.6	0.0	37.6
LOS	E	A	E	C	A	E
95th %tile Queue, veh	13	0	14	3	0	12

Intersection	
Int Delay, s/veh	2.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	17	39	235	28	45	90
Future Vol, veh/h	17	39	235	28	45	90
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	1	1	1	1	1	1
Mvmt Flow	19	44	267	32	51	102

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	488	283	0	0	299	0
Stage 1	283	-	-	-	-	-
Stage 2	205	-	-	-	-	-
Critical Hdwy	6.41	6.21	-	-	4.11	-
Critical Hdwy Stg 1	5.41	-	-	-	-	-
Critical Hdwy Stg 2	5.41	-	-	-	-	-
Follow-up Hdwy	3.509	3.309	-	-	2.209	-
Pot Cap-1 Maneuver	541	758	-	-	1268	-
Stage 1	767	-	-	-	-	-
Stage 2	832	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	518	758	-	-	1268	-
Mov Cap-2 Maneuver	518	-	-	-	-	-
Stage 1	767	-	-	-	-	-
Stage 2	797	-	-	-	-	-

Approach	WB	NB	SB
HCM Ctrl Dly, s/v	10.99	0	2.65
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	665	600	-
HCM Lane V/C Ratio	-	-	0.096	0.04	-
HCM Ctrl Dly (s/v)	-	-	11	8	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.3	0.1	-

Intersection	
Int Delay, s/veh	9.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	15	900	52	62	760	10	29	5	49	10	5	10
Future Vol, veh/h	15	900	52	62	760	10	29	5	49	10	5	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	35	-	160	50	-	-	-	-	100	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	88	88	88	92	92	92
Heavy Vehicles, %	3	3	3	2	2	2	12	12	12	1	1	1
Mvmt Flow	16	978	57	67	826	11	33	6	56	11	5	11

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	837	0	0	1035	0	0	1974	1983	978	1980	2034	832
Stage 1	-	-	-	-	-	-	1011	1011	-	966	966	-
Stage 2	-	-	-	-	-	-	964	972	-	1014	1067	-
Critical Hdwy	4.13	-	-	4.12	-	-	7.22	6.62	6.32	7.11	6.51	6.21
Critical Hdwy Stg 1	-	-	-	-	-	-	6.22	5.62	-	6.11	5.51	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.22	5.62	-	6.11	5.51	-
Follow-up Hdwy	2.227	-	-	2.218	-	-	3.608	4.108	3.408	3.509	4.009	3.309
Pot Cap-1 Maneuver	793	-	-	672	-	-	44	58	291	46	57	371
Stage 1	-	-	-	-	-	-	277	305	-	307	334	-
Stage 2	-	-	-	-	-	-	294	318	-	289	300	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	793	-	-	672	-	-	34	51	291	30	51	371
Mov Cap-2 Maneuver	-	-	-	-	-	-	34	51	-	30	51	-
Stage 1	-	-	-	-	-	-	271	299	-	276	301	-
Stage 2	-	-	-	-	-	-	252	286	-	225	293	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	0.15	0.82	155.12	125.55
HCM LOS			F	F

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	36	291	793	-	-	672	-	-	54
HCM Lane V/C Ratio	1.087	0.191	0.021	-	-	0.1	-	-	0.502
HCM Ctrl Dly (s/v)	$ 349.4	20.3	9.6	-	-	11	-	-	125.6
HCM Lane LOS	F	C	A	-	-	B	-	-	F
HCM 95th %tile Q(veh)	4	0.7	0.1	-	-	0.3	-	-	1.9

Intersection	
Int Delay, s/veh	4.5

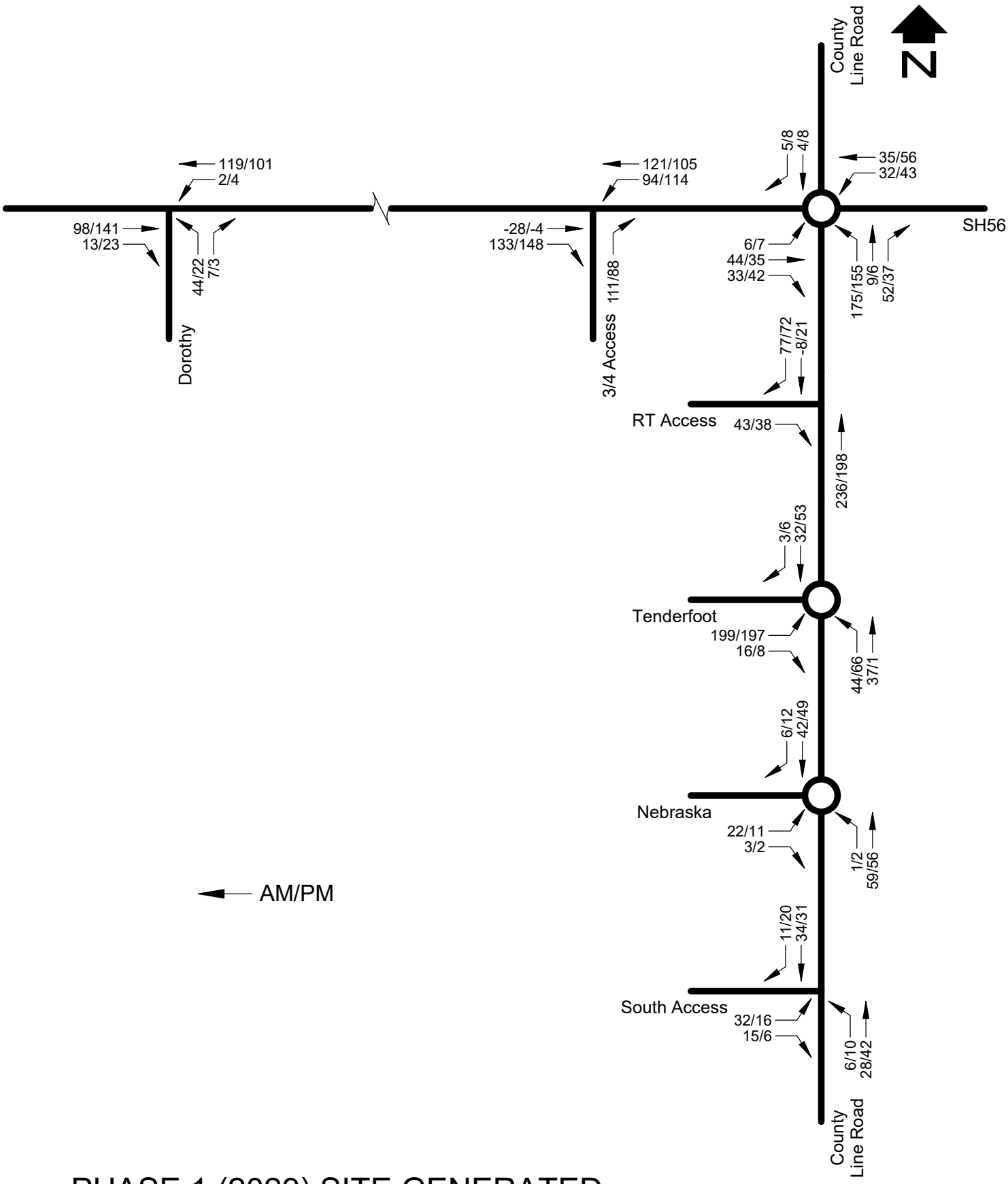
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⇕			⇕			⇕			⇕	
Traffic Vol, veh/h	40	18	65	10	12	14	85	365	5	13	220	20
Future Vol, veh/h	40	18	65	10	12	14	85	365	5	13	220	20
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	91	91	91	91	91	91	91	91	91	91	91	91
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	44	20	71	11	13	15	93	401	5	14	242	22

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	876	875	253	871	883	404	264	0	0	407	0	0
Stage 1	281	281	-	591	591	-	-	-	-	-	-	-
Stage 2	595	593	-	280	292	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	269	288	786	271	285	647	1300	-	-	1152	-	-
Stage 1	726	678	-	493	495	-	-	-	-	-	-	-
Stage 2	491	493	-	726	671	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	224	257	786	205	254	647	1300	-	-	1152	-	-
Mov Cap-2 Maneuver	224	257	-	205	254	-	-	-	-	-	-	-
Stage 1	715	668	-	448	449	-	-	-	-	-	-	-
Stage 2	422	447	-	632	661	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Ctrl Dly, s/v	20.13	18.48	1.49	0.42
HCM LOS	C	C		

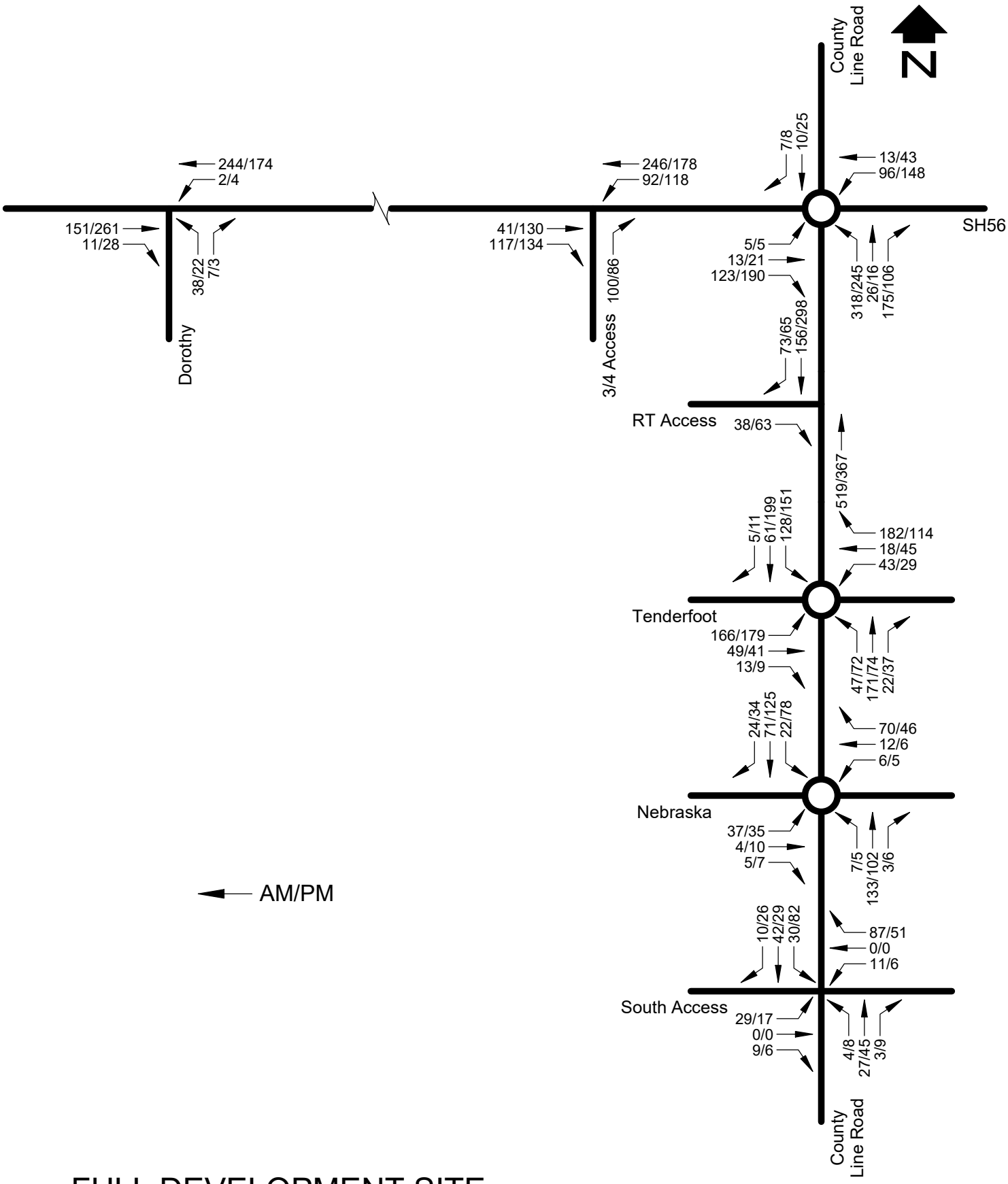
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	335	-	-	371	306	91	-	-
HCM Lane V/C Ratio	0.072	-	-	0.364	0.129	0.012	-	-
HCM Ctrl Dly (s/v)	8	0	-	20.1	18.5	8.2	0	-
HCM Lane LOS	A	A	-	C	C	A	A	-
HCM 95th %tile Q(veh)	0.2	-	-	1.6	0.4	0	-	-

Background Documentation



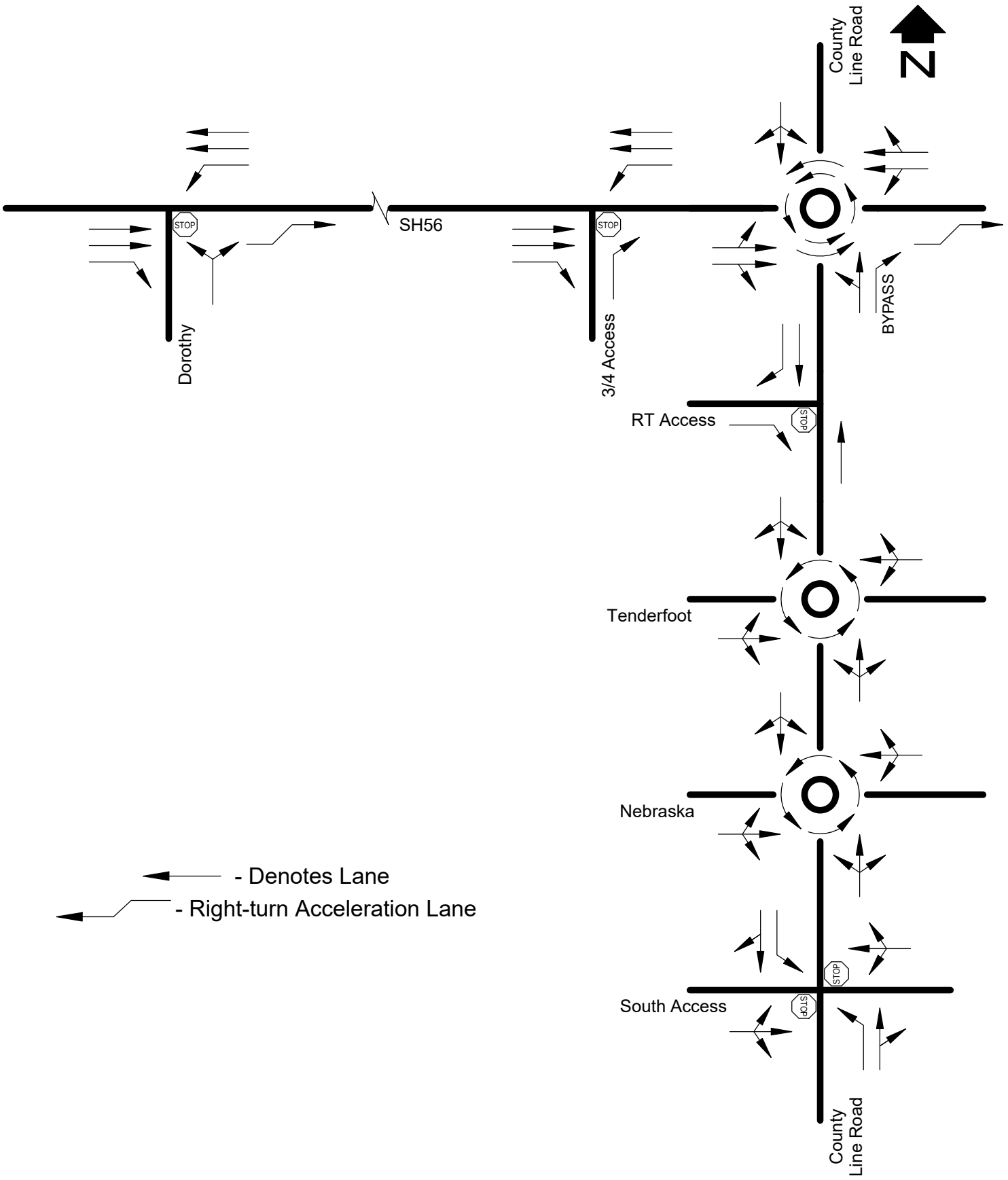
PHASE 1 (2029) SITE GENERATED PEAK HOUR TRAFFIC

Figure 7



FULL DEVELOPMENT SITE GENERATED PEAK HOUR TRAFFIC

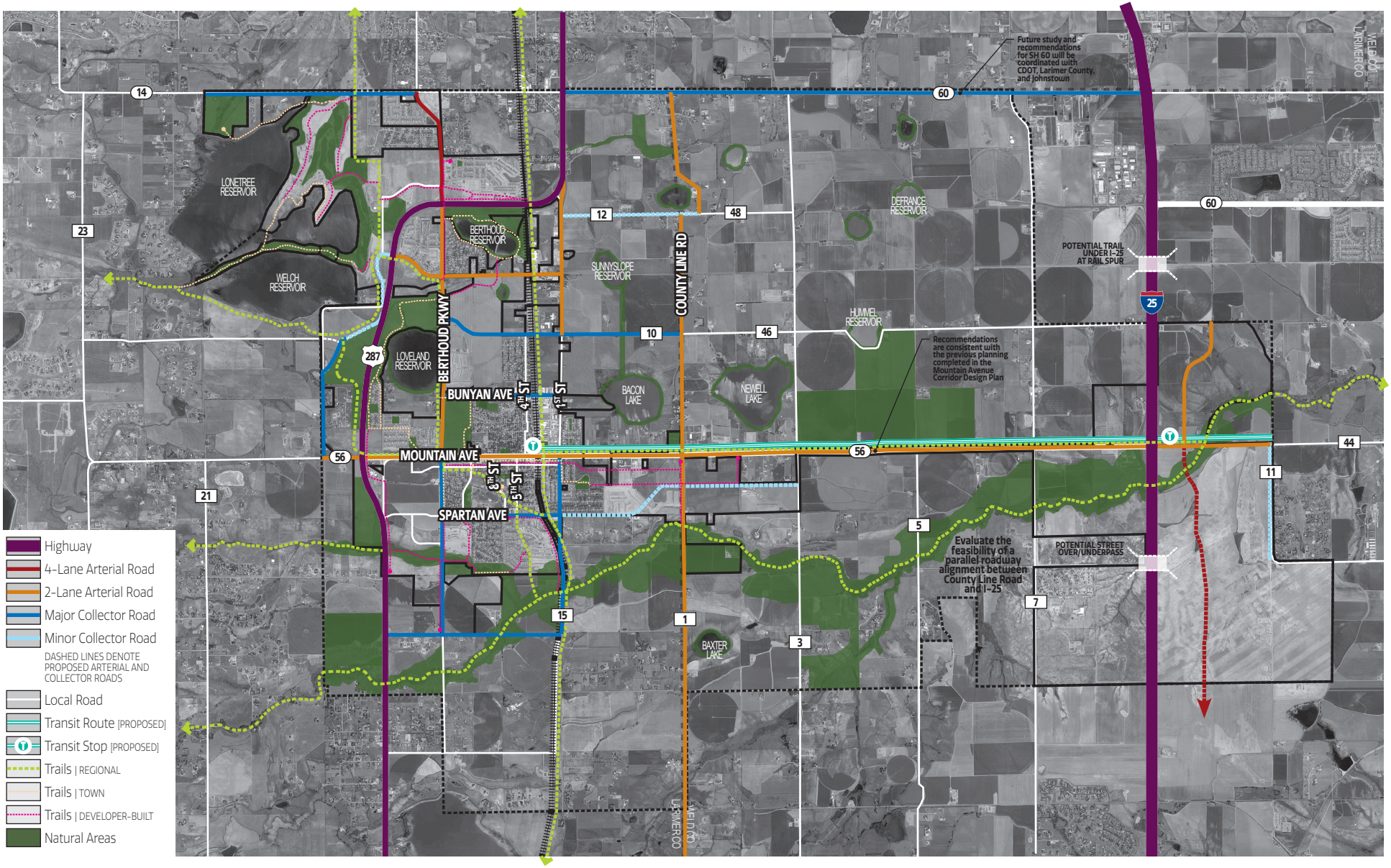
Figure 8



LONG RANGE (2045) GEOMETRY

Figure 14

DELICH ASSOCIATES



TRANSPORTATION PLAN MAP

LAST REVISED: SEPTEMBER 9, 2021

Table 4-1
Loveland (GMA and City Limits)
Motor Vehicle LOS Standards (Intersections)

Intersection Component	Major Intersection[1]	Minor Intersection[2]	Driveway
Overall (City Limits)	LOS C	LOS C	No Limit
Overall (GMAs)	LOS D	LOS D	No Limit
Any Leg	LOS D	LOS E	No Limit
Any Movement	LOS E	LOS F	No Limit

[1] Includes all signalized and unsignalized arterial/arterial and arterial/ major collector intersections.
[2] Includes all unsignalized intersections (except major intersections) and high volume driveways
[3] There are no LOS standards for I-25 Interchanges.
[4] On State Highways, overall LOS D is acceptable.

Table 4-2
Fort Collins (GMA and City Limits)
Motor Vehicle LOS Standards (Intersections)

	Overall	Any Approach leg	Any Movement
Signalized	D[1]	E	E[2]
Unsignalized Arterial / Arterial Collector / Collector	E[3]	F[4]	
Unsignalized Arterial / Collector Arterial / Local Collector / Local Local / Local	D[3]	F[4]	
Roundabout	E [3,5]	E[54]	E[5]

[1] In mixed use district including downtown as defined by structure plan, overall LOS E is acceptable
[2] Applicable with at least 5% of total entering volume
[3] Use weighted average to identify overall delay
[4] Mitigation may be required
[5] Apply unsignalized delay value thresholds to determine LOS

Attachment 6

Public Comment - 1

From: Wade Cooper <forwecooper@gmail.com>
Sent: Monday, November 3, 2025 2:38 PM
To: Tawn Hillenbrand
Subject: Fickel Farms 5th Filing Preliminary Plat
Attachments: 1000001129.jpg; 1000001128.jpg; 1000001127.jpg; 1000001126.jpg

Follow Up Flag: Follow up
Flag Status: Flagged

You don't often get email from forwecooper@gmail.com. Learn why this is important

Hello Tawn,
We are providing comments to express our concern regarding possible approval of the subject plat. We currently live in Fickel Farms 1st Filling in a duplex just south of the western portion of the proposed plat. Our main concern is that the proposed dwelling units will substantially reduce residential property values for homes currently constructed within Fickel Farms (4 filings) due to their extremely small sizes (20 ft x 71 ft= 1420 sq ft) for most of the proposed lots and the high number of lots/units (up to 6) per building (population density). Its approval will create significant parking problems and their dwelling units will likely attract lower income homeowners/renters that ultimately reduce the living conditions and property values within Fickel Farms.

The proposed lot sizes are smaller than 1/4th the size of the majority of lots within the first 3 Fickel Farms Filings (5700+ sq ft) and nearly half the size of the duplex lots within Fickel Farms 4th Filing (i.e. 2700 sq ft). The first 3 Fickel Farms Filings are all ranch type units of single family and duplex units, while the recent 4th Filing changed the type of units to all two story units with the majority being duplexes. The 4th Filing has population densities that are at least twice those of the first 3 Filings. The proposed plat would effectively be double the population density relative to the 4th Filing density, and be quadruple relative to the first 3 Filings density. This quadrupling of population density will most likely result in lower property values for the current Fickel Farms' homes.

Attached are 4 photos showing the parking problems within the duplexes of the 4th Filing, yet these lot sizes are nearly twice the size of the proposed lots. The photos were taken at 1pm on Friday afternoon, thus they represent conditions when most homeowners would have been at work, not when the parking would be the worst during weekends and in the evening. All duplex units within the 4th Filing have a double car garage 20 ft wide with a concrete driveway in front of the garage about 13 ft long. The photos show that many homeowners are parking their vehicles in front of their garages such that they partially block the "no parking" roadways. One photo shows an overflow parking area being full. This parking situation would be a nightmare for snow plows trying to clear the roadways. It is important to recognize that the parking situation for the proposed 5th Filing would be considerably worse because the lots aren't wide enough to allow the construction of 20 ft wide double car garages, and there is less outside parking area.

As additional info, we have a 20 ft wide (wall to wall) double car garage and we have to use extreme caution when parking our two vehicles into the garage. My full-size Ram 1500 truck is over 8 ft wide (including mirrors) and 20 ft long, while my Honda CRV is 6'8" wide (including mirrors) and 16 ft long. The

clearance on each of the wall sides is so limited (<18 inches) that we have to pull the car/truck out of the garage so the second person can get into the car. Whomever decided that 20 ft wide double car garages (wall to wall) are adequate was not being realistic in terms of the additional room (1 ft on each side) needed to get into and out of mid- to full-sized cars and trucks parked in the garage. Garages should minimally be 22 ft wide (wall to wall) and 22 ft long to allow access and use of mid- to full-size cars and trucks.These deficiencies in parking and garage widths, in addition to quadrupling of population density, will contribute to lower property values within Fickel Farm.

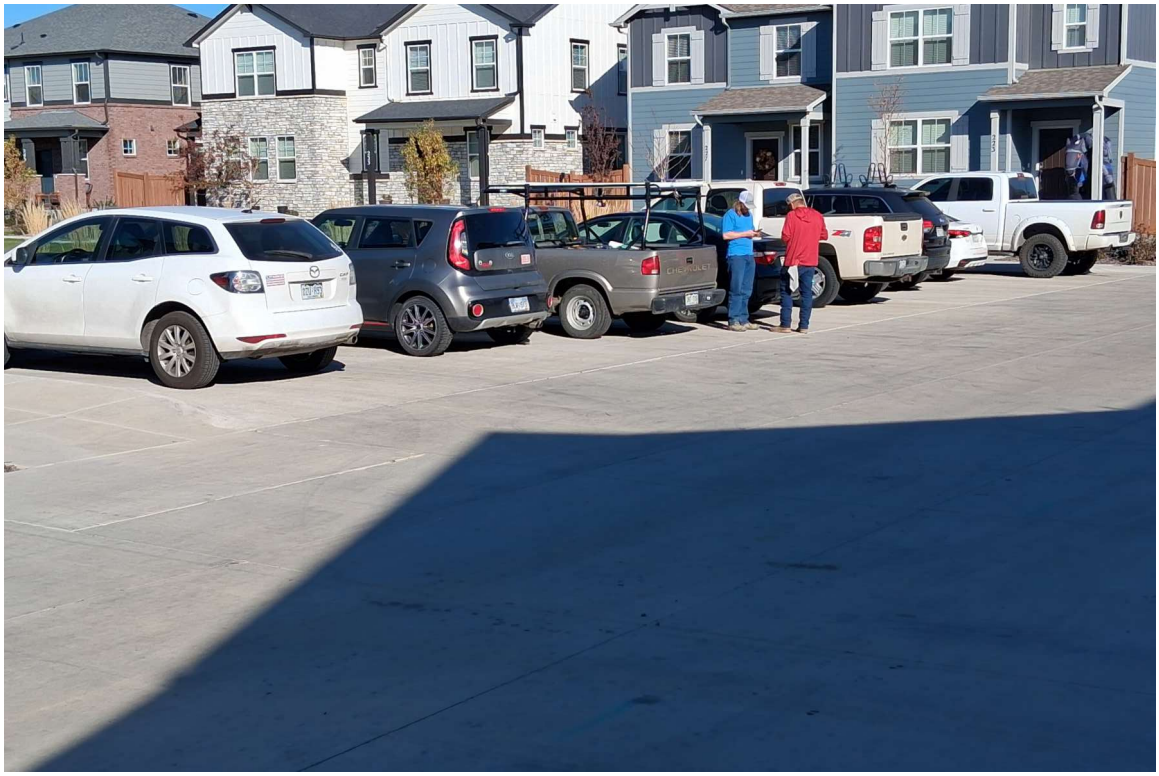
The plat is comprised mostly of 6 unit buildings with the interior lots being only 20 ft by 71 ft (1420 sq ft). As previously noted, this lot width is inadequate for constructing 2 car garages without restricting homeowners to only subcompact cars. More importantly, these interior units would be like living in a cave, narrow and dark, due to the lack of sunlight/windows into the unit except on the 20 ft wide end of the unit. With a garage constructed on one end, the lower level would have sunlight/windows on only one end of the unit. These type of living conditions, cramped and lack of sunlight/windows, are highly undesirable for the majority of homeowners/renters and would thus most likely attract lower income homeowners/renters.

We strongly believe living characteristics within Fickel Farms should be maintained to only single family or duplexes that have ample parking and do not increase current population densities. Otherwise, property values and living conditions will deteriorate for existing Fickel Farms homeowners. Accordingly, we encourage disapproval of the plat as proposed.

Please share these comments with others at the hearing, the Planning Commission, and the Town Board of Trustees.

Respectfully submitted,
Wade Cooper and Pamela Imler-Cooper






ROAD
CLOSED
ROAD
CLOSED


STOP

Public Comment - 2

From: Wade Cooper <forwecooper@gmail.com>
Sent: Tuesday, November 4, 2025 7:22 PM
To: Tawn Hillenbrand
Subject: Fickel Farms 5th Filing Preliminary Plat

You don't often get email from forwecooper@gmail.com. Learn why this is important

Dear Tawn,
I have some concerns about the pond areas that should be addressed by the developers.

The plat shows two ponds on the north side of Welch Ave on the western portion of the plat. These two ponds are located between the lots and Welch Ave. My concern is that these ponds can affect ground water tables for the existing Fickel Farm homes on the south side of Welch Ave, especially if they retain water for extended periods of time. Such an increase in ground water tables could seriously pose foundation problems and potential water seepage/flooding into the basements of these homes. Also, they are effectively creating mosquito breeding areas with these ponds.

I didn't find any information on how water, including overflow, is diverted into or out of these ponds. The developers should be required to address this to ensure the water for these ponds is safely diverted.

I also did not see any rationale as to why these ponds were included in the design in the first place. It appears that these ponds pose unnecessary additional risks such as mosquitos and drowning, especially for children who decide to play in them. This area currently does not have any water structures, so why the necessity to include them and pose additional risks. These pond areas appear to be better suited to being low sloping lawn/park areas for homeowners use, especially when there appears to be no lawn area next to the lots for homeowners use.

Please share this information in the hearing and with the Planning Commissioners and Town Board of Trustees.

Thank you for your assistance.
Sincerely,
Wade Cooper

Public Comment - 3

From: Jennifer Vander Zee <bmrjensed@gmail.com>
Sent: Wednesday, November 5, 2025 7:43 AM
To: Tawn Hillenbrand
Subject: Fickel Farms 5th Filing Preliminary Plat

[You don't often get email from bmrjensed@gmail.com. Learn why this is important at https://aka.ms/LearnAboutSenderIdentification]

Hello,
We are Berthoud homeowners since 2007, and live in Fickel Farms 1st Filling in a duplex just south of the western portion of the proposed plat. We are strongly against the new proposal for reasons below.

We have witnessed a lot of Berthoud's economic growth over the years. This comes with the expense of locals. Unlike Boulder, the allowance of a repopulation of the outside community over the years from outside state cash buyers purchasing homes outbidding locals and this has created an unbalance and disadvantage to the local community wishing to purchase a home. Many have moved away.

Now another hit to the Berthoud community is this new proposal. The small town feel will be lost. The new proposal, certainly a negative accelerant to locals desire to maintain Berthoud roots and this small town feel.

We understand change is progress. However, we will certainly be negatively affected if approved, both environmentally and financially to our property equity. The proposed lot sizes are smaller than 1/4th the size of the majority of lots within the first 3 Fickel Farms Filings (5700+ sq ft) and nearly half the size of the duplex lots within Fickel Farms 4th Filing (i.e. 2700 sq ft). The first 3 Fickel Farms Filings are all ranch type units of single family and duplex units, while the recent 4th Filing changed the type of units to all two story units with the majority being duplexes. The 4th Filing has population densities that are at least twice those of the first 3 Filings. The proposed plat would effectively be double the population density relative to the 4th Filing density, and be quadruple relative to the first 3 Filings density.

The quadrupling of population density will most likely result in lower property values for the current Fickel Farms' homes, and with cheap housing comes crime risk, as well as increased civil servant demands.

Its approval will create significant parking problems and their dwelling units will likely attract lower income homeowners/renters that ultimately reduce the living conditions and property values within Fickel Farms.

The small town charm, local community interests should take precedence. Keep Fickel Farms to single family and or duplexes. Time to start representing the people of Berthoud to maintain our living conditions and community quality. Enough is enough of outside pressure on this slice of heaven city we love and call home, Berthoud.

We encourage your disapproval of the plat as proposed.

Please share these comments with others at the hearing, the Planning Commission, and the Town Board of Trustees.

Sincerely,

Arthur John and Jennifer Vander Zee
304 Victoria St Berthoud.

RESOLUTION NUMBER ##

(SERIES 2025)

A RESOLUTION OF THE TOWN OF BERTHOUD BOARD OF TRUSTEES APPROVING A PRELIMINARY PLAT FOR A DEVELOPMENT KNOWN AS THE "FICKEL FARM 5TH FILING DEVELOPMENT" IN THE TOWN OF BERTHOUD.

WHEREAS, the property under consideration is known as the "Fickel Farm 5th Filing" development; and more particularly described in Exhibit A attached hereto; and

WHEREAS, the Town of Berthoud ("Town") approved on November 12, 2024, a Neighborhood Master Plan; and,

WHEREAS, the Town approved Ordinance No. 1345 on November 12, 2024, amending the zoning map of the Town of Berthoud to Urban Residential (UR); and

WHEREAS, the Preliminary Plat attached herein as Exhibit B has been reviewed by referral agencies to ensure the proposed development does not present a burden on service provision; and

WHEREAS, notice was properly posted in the manner required by law and a public hearing was conducted on December 9, 2025; a legal ad was published on October 29, 2025, and affected property owners within 500 feet of the site were notified by first-class mail before the Berthoud Planning Commission hearing on November 13, 2025; and

WHEREAS, after the public hearing on November 13, 2025, the Berthoud Planning Commission made a unanimous recommendation to the Town Board of Trustees to approve the Preliminary Plat; and

WHEREAS, based on the testimony and evidence presented at the public hearing on December 9, 2025, the Board of Trustees determines and finds that compliance with the Preliminary Plat review criteria as provided in Section 30-6-107(B) of the Berthoud Municipal Code has been demonstrated.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF TRUSTEES OF THE TOWN OF BERTHOUD, COLORADO:

Section 1. Preliminary Plat Approval. The Preliminary Plat is hereby approved.

Section 2. Interpretation: This Resolution shall be interpreted and construed to effectuate its general purpose.

Section 3. Effective Date: The provisions of this Resolution shall take effect upon adoption.

APPROVED AND ADOPTED this 9th day of December 2025.

TOWN OF BERTHOUD

By _____

William Karspeck, Mayor

ATTEST:

By: _____

Christian Samora, Town Clerk

Exhibit A: Legal Description

Tract 1 and Tract 2, Fickel Farm PUD Fourth Filing, Town of Berthoud, Colorado, County of Larimer, State of Colorado.

Exhibit B: Preliminary Plat

(to be inserted)

PLANNING COMMISSION INFORMATION

COMMUNITY DEVELOPMENT DEPARTMENT

Meeting Date:	**November 13, 2025**
Agenda Title/Subject:	**Public Hearing to introduce the Three-Mile Plan for the Town of Berthoud**
Type of Item:	**Public Hearing**
Purpose:	**Recommendation to the Town Board of Trustees regarding adoption of the Three Mile Plan for the Town of Berthoud**
Presented by:	**Anne Johnson, Community Development Director**

ATTACHMENTS:

[Note the Ordinance number will be assigned by the Town Clerk following the Planning Commission meeting]

- Ordinance XXXX (Series 2025)
- Appendix A, Three Mile Plan

BACKGROUND:

Colorado statutes relating to municipal annexations restrict annexations from extending any more than three miles outside of municipal boundaries each year. Colorado statutes require municipalities to create and adopt a Three-Mile Plan prior to annexing property into the Town. A Three-Mile Plan provides a general description for potential future growth and must be updated annually.

Colorado Revised Statute C.R.S. 31-12-105(1)(e) defines the Three-Mile Plan as a document that generally describes proposed location, character, and extent of streets, subways, bridges, waterways, waterfronts, parkways, playgrounds, squares, parks, aviation fields, other public ways, grounds, open spaces, public utilities, and terminals for water, light, sanitation, transportation, and power to be provided by the municipality and the proposed land uses for the area.

The attached Three-Mile Plan is the Future Land Use Map as created in the 2021 update to the Town of Berthoud Comprehensive Plan. Planning Commission reviewed the proposal at their public hearing on November 13, 2025 and will make a recommendation to the Town Board of Trustees for consideration at their November 10, 2025 introduction followed by the December 9, 2025 public hearing. The plan presented this evening has not changed since adoption of the 2021 Comprehensive Plan update or the adoption of the Three Mile Plan in 2023 and on December 10, 2024. The Three Mile Plan remains consistent with the Comprehensive Plan.

FISCAL IMPACT AND FUND SOURCE:

There is no negative fiscal impact to the Town in establishing the Three-Mile Plan.

COMMUNITY TOUCHSTONES:
Establishing a Three-Mile Plan enables the Town to implement the 2021 update to the Comprehensive Plan, to communicate transparently with neighboring communities and Larimer County and Weld County and establishes the Town's Urban Growth Boundary for future expansion.

RECOMMENDED ACTION(S):
Staff recommends the Planning Commission recommend approval of the Three-Mile Plan as presented to the Town Board of Trustees for their consideration at their November 10 and November 25, 2025 public meetings.

Suggested Motions:

Approval: *I move recommend approval of the Town of Berthoud Three-Mile Plan to the Town Board of Trustees as presented. The rationale for approval is that the proposed Plan is the same Future Land Use/Urban Growth Boundary Map prepared as part of the 2021 Comprehensive Plan Update.*

Denial: *I move to recommend denial of the Town of Berthoud Three-Mile Plan to the Town Board of Trustees for the following reasons: _____.*

TOWN OF BERTHOUD ORDINANCE
NUMBER 13XX
(SERIES 2025)

AN ORDINANCE ADOPTING THE TOWN OF BERTHOUD THREE-MILE PLAN

WHEREAS, the Town of Berthoud is a municipal corporation possessing all powers granted to a statutory town by Title 31 of the Colorado Revised Statutes; and

WHEREAS, the Town wishes to implement the vision and values expressed in the 2021 update to the Comprehensive Plan, including the Town's Urban Growth Boundary and Future Land Use Map to establish the future growth boundary of the Town; and

WHEREAS, the Colorado Revised Statutes require municipalities to annually adopt a Three-Mile Plan and record this in the records of the County Clerk and Recorder; and

WHEREAS, Colorado Revised Statute C.R.S. 31-12-105(1)(e) defines the plan as a document that generally describes proposed location, character, and extent of streets, subways, bridges, waterways, waterfronts, parkways, playgrounds, squares, parks, aviation fields, other public ways, grounds, open spaces, public utilities, and terminals for water, light, sanitation, transportation, and power to be provided by the municipality and the proposed land uses for the area; and

WHEREAS, the Town Board of Trustees adopted the same plan on December 12, 2023 and December 10, 2024; and

WHEREAS, the Three-Mile Plan has been submitted to the Board of Trustees in writing and the Board of Trustees has determined that such code and amendments thereto should be adopted as herein set forth.

NOW, THEREFORE, BE IT ORDAINED BY THE TOWN BOARD OF TRUSTEES OF THE TOWN OF BERTHOUD, COLORADO:

Section 1. The attached Town of Berthoud Three-Mile Plan has been approved for the remainder of 2025 and the year 2026.

Section 2. Interpretation: This Ordinance shall be so interpreted and construed to effectuate its general purpose.

Section 3. Effective Date: The provisions of this Ordinance shall take effect thirty (30) days following the date of public hearing to adopt the Three-Mile Plan.

[INTENTIONALLY LEFT BLANK]

INTRODUCED, READ, ADOPTED, AND APPROVED on first reading this 10th day of November, 2025.

TOWN OF BERTHOUD

By _____

William Karspeck, Mayor

ATTEST:

By: _____

Christian Samora, Town Clerk

INTRODUCED, READ, ADOPTED, AND APPROVED on second reading this 9th day of December, 2025.

TOWN OF BERTHOUD

By _____

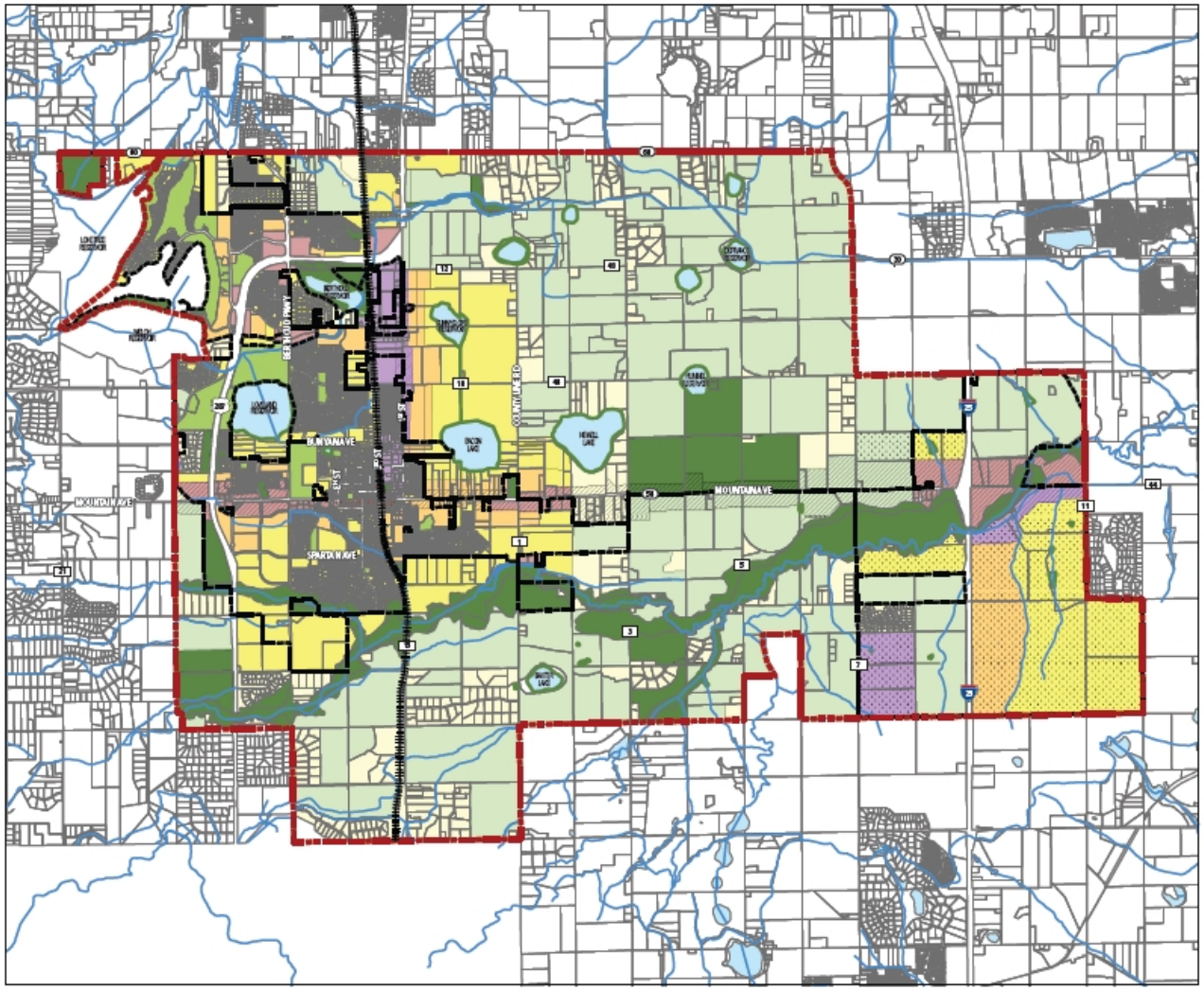
William Karspeck, Mayor

ATTEST:

By: _____

Christian Samora, Town Clerk

Appendix A Colorado Revised Statute requires/encourages municipalities to annually adopt a Three-Mile Plan and record this in the records of the County Clerk and Recorder. The Town of Berthoud is proposing to adopt the Future Land Use Map prepared with the 2021 Comprehensive Plan update as its Three Mile Plan for the remainder of 2025 and for 2026.



FUTURE LAND USE PLAN MAP

BERTHOUD COMPREHENSIVE PLAN

Last Revised: September 9, 2021

- Growth Management Area

Place Type: Natural Areas

- Environmentally Sensitive Area
- Open Space
- Parks, Recreation & Trails
- Ditch/Canal - Potential Trail Connections

Place Type: Rural Areas

- Agricultural
- Rural Residential

Place Type: Suburban Areas

- Suburban Residential
- Suburban Business

Place Type: General Urban Areas

- Urban Residential
- Innovation District

Place Type: Urban Center

- Old Town Residential
- Downtown

Place Type: Special Districts

- New Berthoud
- 1st Street Corridor
- Mountain Avenue Corridor

0 0.5 1 2 Miles

INTRODUCTION

Colorado statutes relating to municipal annexations restrict annexations from extending any more than three miles outside of municipal boundaries in any given year and require municipalities to create and adopt a Three-Mile Plan prior to annexing any property. A Three-Mile Plan gives a general description for potential future growth and must be updated yearly.

Colorado Revised Statute C.R.S. 31-12-105(1)(e) defines the plan as a document that generally describes proposed location, character, and extent of streets, subways, bridges, waterways, waterfronts, parkways, playgrounds, squares, parks, aviation fields, other public ways, grounds, open spaces, public utilities, and terminals for water, light, sanitation, transportation, and power to be provided by the municipality and the proposed land uses for the area.

TOWN OF BERTHOUD TOUCHSTONES

1. Maintain and strengthen the Town's community identity.
2. Review development plans for sustainable land use.
3. Ensure land use applications are resilient.

OPEN SPACE / PARKS / TRAILS

The Town takes pride in its park, trails, and open spaces. Future annexations will provide an opportunity to extend the trail system and include construction of additional outdoor amenities for use by all Town and community residents.

ROADS

Consideration of any proposed annexation will require scrutiny to determine the fiscal impact of road maintenance and the effect on traffic. Future annexations will require connectivity and improvement to the existing Town of Berthoud road network.

WATER, SEWER AND STORMWATER

The Town of Berthoud will protect its resources and make annexation decisions with respect to its ability to handle the water, wastewater, and stormwater quality needs of its existing residents and businesses. The Town will expect those seeking annexation to invest in the Town's infrastructure based on their level of impact.

COLLABORATIVE CONSIDERATION

As unincorporated surrounding areas continue to grow, the Town of Berthoud desires to have an open line of communication with Larimer and Weld Counties as well as its neighboring communities. In the event a proposed development is within the area of the Town's Three-Mile Plan, the Town would like consideration as to how a development fits with this Urban Growth Area as well as the Town's updated Comprehensive Plan, and requests that recommendations be made to the developer that will honor the desires of the Town. If unincorporated development is imminent, the Town may consider annexation to reap any positive impact of such development.

PLANNING COMMISSION INFORMATION

COMMUNITY DEVELOPMENT DEPARTMENT

Meeting Date:	**November 13, 2025**
Agenda Title/Subject:	**Adoption of an update to the Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specifications by reference in Section 30-6-102 of the Berthoud Municipal Code and as an insert in the 2021 Comprehensive Plan**
Type of Item:	**Public Hearing**
Purpose:	**Recommendation to the Planning Commission regarding adoption of an update to the Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specifications by reference in Chapter 30 of the Berthoud Municipal Code and in the 2021 Comprehensive Plan**
Presented by:	**Anne Johnson, Community Development Director**

ATTACHMENTS:

[note Ordinance numbers are assigned by the Town Clerk after the Planning Commission meeting]

- Ordinance XXXX (Series 2025)
  - Appendix A: Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specifications
- Ordinance XXXX (Series 2025)
  - Appendix A: Section 30-6-102
- Ordinance XXXX (Series 2025)
  - Appendix A: Page 41 of the 2021 Comprehensive Plan

BACKGROUND:

The Town's Development Review Engineering team, Public Works and Operations Team have reviewed the 2021 Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specifications and found inconsistencies between the Comprehensive Plan, LUCASS Standards, Town Standards and best management practices for industry standards. To ensure development and Town projects are implemented consistently and that the development community has access to consistent guidelines, the Town is presenting an amendment to the Specifications and Standards. This proposed amendment necessitates an amendment to Section 30-6-102 of the Land Development Code to reference the correct version of these Specifications and Standards. This proposed amendment also necessitates a slip sheet to be inserted into the 2021 Comprehensive Plan following Figure 3.6 to reference the updated version of the Specifications and Standards. This one Information Sheet provides the rationale for three Ordinances which are necessary for the adoption of these revised Specifications and Standards.

Planning Commission will hear the request for these amendments at their November 13, 2025 public hearing. Planning Commission's recommendation will be presented to the Town Board of Trustees at their November 25, 2025 and December 9, 2025 public hearings. The November 25, 2025 date is an introduction meeting.

The following list is an overview of substantive changes to the 2021 Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specifications:

- General formatting changes to entire document
- Where possible, language, standards and requirements were consolidated, clarified and simplified;
- Punctuation and spelling errors were corrected;
- Incorrect references were amended;
- Tables and Sections are referred to by name rather than by Section to reduce mistakes in referencing Section and Tables that change through time;

More specifically, the following changes were made to the Standards and Specifications:

Chapter 100 – Introduction and General Provisions

- 101.1 Added General provisions language missing from previous standards
- 103.1.H.2 Added language describing authority and duties of construction inspectors

Chapter 200 – Drawings and Design Review Submittals

- 201.1.A Removed reference to park construction plans.
- 201.2.A Removed duplicate statements and requirements for physical plan submittals
- 201.2.A.1.c Removed duplicate statement
- Removed Irrigation Plan and Landscape plan requirements, as those are covered in other documents
- 201.3 Incorrect Fire District reference changed through out
- 201.3.D.2.i Added option for additional Hydrant manufacturers per Town Engineer approval
- 201.3.D.8 Added note for tracer wire on all water mains per State requirements
- 201.3.E.13 Added note for tracer wire on all sanitary mains per State requirements
- 201.4 Relocated Stormwater/drainage report requirements from Chapter 600 to Ch. 200 to keep all submittal requirements in one area
- 202.1.A.2 Added section describing Municipal Separate Storm Sewer (MS4) permitting requirements for the Town of Berthoud

Chapter 300 – Street and Roadway Design

- 304 Changed section to Street Sections to direct developers to correct details for typical street sections to use throughout Town.
- 305 Revised formatting to match other sections
- 305.2.A.3 Added note to direct trail designers to Trail Master Plan for typical sections and trail locations
- 305.4 Revised wording for Corner Lot street frontage development requirements
- 305.5.B Revised wording for Traffic Signals
- 306.2.A.1 Added requirement for Pavement Design report to provide structural calculations if minimum pavement section used.

Chapter 400 – Sanitary Sewer Utility

- 401.1 Removed erroneous Code reference
- 402.3.C Lessened service line offset from lot lines in response to more narrow lot frontages and allow service line to be centered within utility easements
- 402.3.I.1 Updated references to Standards

- 402.3.I.2 Removed incorrect figure reference
- 402.4.B Removed duplicate information and referenced Construction Specification where manhole lid manufacturers are specified
- 402.7.B.2 Added note that sewers along section lines or major roadways shall be 12” min. and installed by developers to ensure adequate capacity for new developments
- 402.7.B.3 Added note that line sizing for phased developments may be accepted and that all funds for the ultimate improvements along with a schedule must be provided
- 402.7.C.2 Added geotechnical report requirement for sewers buried less than five feet.
- 402.7.D.1 Added pipe sizes to Table 400-1
- 402.7.E.2 Added note on preferred location of sanitary mains within roadways
- 402.7.F.2 Added provision for pressure class pipe sanitary mains sharing trench with underdrains
- 402.8 Added section regarding H_2S-Resistant Coatings for sewers subject to hydrogen sulfide exposure
- 402.9.I.2 Changed requirement for drop manholes to an interior drop unless space constraints require an outside drop connection.
- 402.9.N.3.a Added requirement that only 2 manhole risers may be used totaling less than or equal to 12”
- 402.11 Added section detailing requirements for grease and sand/oil interceptors

Chapter 500 – Water Utility

- 501.1 Removed erroneous Code reference
- 502.2.B.6 Added requirement for all waterline lowering to be approved by Town Engineer and additional requirements for sanitary crossings
- 502.2.B.8 Removed unnecessary language
- 502.2.C.1 Revised language for water main sizing requirements
- 502.2.C.2 Added requirement for 12” min. water main along section lines and major roadways
- 502.2.G.2 Added more specific information for blow-off installations
- 502.6.C Revised to include additional restraint design and construction requirements for water mains
- 502.8.D.1.b Removed pipe material option for 3/4” – 2” pipes
- 502.8.D.1.e Revised underground copper joint procedure
- 502.8.D.2 Added service manifold installation requirements
- 502.8.G.1 Added tapping saddle band material
- 502.8.H.4 Removed single strap saddle option
- 502.8.H.6 Updated service tapping requirements based on Water Ops direction
- 502.8.I.6 Revised tapping requirements based on Water Ops direction
- 502.9.B.1 Removed option for DC backflow prevention
- 502.9.D.2 Added that service may be stopped if testing and reports are not provided to Town
- 502.10.C.1.d Added more specific meter requirements
- 502.10.C.1.e Specified meter requirements for 1.5” and larger meters
- 502.10.C.1.f Updated curb stop spacing requirements
- 502.11.C.1 Added language defining meter pit/vault and curb stop locations
- 502.11.C.2 Added requirement for PRVs to be located outside meter pits
- 502.11.C.3 Updated detail reference
- 502.11.C.4.a Revised meter materials
- 502.11.C.4.d Added lid requirements
- 502.11.C.5.c Added provision to require Water Ops Manager approval
- 502.11.C.5.d Added meter vault lid requirements
- 502.11.E.4 Revised material joint requirements for vent pipes

- 502.13.B.3 Added buffer spacing around hydrants
- 502.13.B.6 Added clarifying language
- 502.13.C.2 Revised length of dead end oversizing requirements
- 502.13.C.5 Added requirement for flushing devices on all dead-end mains
- 502.13.C.6 Added requirement for backflow prevention devices
- 502.13.D.2 Updated Hydrant manufacturers
- 502.13.E.9 Added requirement for fire service valve lids to say FIRE

Chapter 600 – Stormwater Design Standards

- 601.1.A Removed erroneous Code reference
- 601.3 Removed all drainage report requirements and referenced Chapter 200
- 601.3.D.1 Specified overtopping allowances
- 601.3.D.2.b Specified that culverts shall not create excess overtopping
- 601.4.C.8 Removed outdated release rate reference
- 601.4.C.10 Added language to encourage low maintenance, low impact development techniques and that privately maintained stormwater management systems are subject to Town inspection
- 601.4.C.11 Refined language for protection of adjacent properties from erosion
- 601.5 Added section for stormwater management submittal requirements
- 601.6 Added section requiring operation and maintenance manuals stormwater management systems of new developments
- 602.2 Removed reference to an outdated rainfall table
- 602.3.B Relocated Imperviousness Table 600-2
- 602.3.B.4 Updated reference for rainfall data to use in design
- 602.3.D Removed
- 602.4.E.4 Require calculation for HGL and EGL in final stormwater reports and design considerations for HGL of Major and Minor storms
- 602.4.E.5.e Refined language for allowable storm inlets in public ROW
- 602.4.F Added section specifying design and maintenance requirements for roadside ditches
- 602.5.B Table 600-7 Updated table reference data
- 602.8.A.3 Changed language to require min. 2% culvert slopes
- 602.8.D.2.a Specified allowable culvert trash rack locations
- 602.8.E.2 Added language that privately maintained culverts are subject to oversight by Town
- 602.10 Added section describing sump pump design, allowable discharge, and maintenance requirements
- 602.10.G.2 Require sidewalks to be 6’ from detention pond embankment slopes
- 602.10.O.5 Added requirement that walls shall not be closer than 6’ from walks, curbs, structures
- 602.12 Removed erroneous references
- 602.13 Referenced Ch200 for Stormwater Management Plan requirements

Chapter 700 – Dry and Non-Town Utilities

- 701.1 Added General Provision language regarding Town Code
- 701.1.B Added utilities pertinent to this chapter
- 701.1.C Require utility company and Town engineer to determine final alignments of utilities
- 701.4 Added section informing developers of Street lighting standards

Chapter 800 – Subdivision Improvement Standards

- 801.1 Added General Provision language regarding Town Code

- 801.2 Removed section describing Improvement Guarantees and Surety. These are covered in detail in Town Code and development agreements
- 801.2 Reordered section to provide Preconstruction requirements, then erosion control timing, and inspection requirements
- 801.6 Removed section on Development Agreements as this is covered in Town Code

Appendix A – Construction Specifications

- Major formatting revisions throughout
- 31 00 00 2.1.G Updated bedding descriptions
- 31 00 00 2.1.G.7 Added section requiring same bedding for services as mainlines
- 31 00 00 3.20.C.4-7 Added requirements for compaction tests of service line bedding
- 32 12 00 1.5 Updated erroneous reference
- 32 13 00 1.5 Updated erroneous reference
- 32 13 00 3.3.D.11 Require all sidewalks to be 6” thick
- 32 13 00 3.3.K Bolstered quality standards for acceptance
- 33 10 00 3.1.I Added insulation board requirements

Appendix B – Standard Details

- D0.03 Standard Manhole – Updated references
- D4.04 Sanitary Cleanout – Updated frame and cover material in roadways vs other areas
- D4.09 Two-Way Cleanout – Added new standard detail for two-way cleanouts
- D5.11 Waterline Crossing – Revised requirements for waterlines crossing under utilities
- D5.20 Wall Penetration – Added requirements for pipe wall penetrations

FISCAL IMPACT AND FUND SOURCE:
There is no negative fiscal impact to the Town in establishing these amendments.

COMMUNITY TOUCHSTONES:
Regular review of Town specification, standards, guidelines and regulations is healthy to ensure best management practices and industry standards are deployed locally.

RECOMMENDED ACTION(S):
Staff recommends approval of the 2025 Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specifications. This approval necessitates the minor amendment to Section 30-6-102 of the Land Development Code to reference the correct version of these Specifications and Standards. This proposed amendment also necessitates a slip sheet to be inserted into the 2021 Comprehensive Plan to reference the updated version of the Specifications and Standards.

Suggested Motions:

Approval: *I move to forward our motion of approval for these Ordinances to the Town Board of Trustees for the rationale explained in this memo.*

Denial: *I move to forward our motion of denial of these Ordinances to the Town Board of Trustees for the following reasons: _____.*

TOWN OF BERTHOUD ORDINANCE
NUMBER 13XX

AN ORDINANCE AMENDING CHAPTER 30 OF THE BERTHOUD MUNICIPAL CODE, SPECIFICALLY SECTION 30-6-102, DESIGN STANDARDS AND CONSTRUCTION SPECIFICATIONS, BY ADOPTING BY REFERENCE THE 2025 EDITION OF THE TOWN OF BERTHOUGH ENGINEERING, INFRASTRUCTURE DESIGN STANDARDS AND CONSTRUCTION SPECIFICATIONS FOR THE PURPOASES OF REGULATING THE DESIGN, CONSTRUCTION, CHOICE OF MATERIALS, LOCATION, MAINTENANCE, AND USE OF ALL PUBLIC AND PRIVATE IMPROVEMENTS

WHEREAS, the Town of Berthoud is a municipal corporation possessing all powers granted to a statutory town by Title 31 of the Colorado Revised Statutes; and

WHEREAS, in furtherance of the public health, safety and welfare of the inhabitants of the Town, the Board of Trustees desires to adopt by reference Engineering and Infrastructure Design Standards and Construction Specifications, 2025 Edition as published by the Town of Berthoud, 807 Mountain Avenue, Berthoud, Colorado 80513, for review and inspection by the public; and

WHEREAS, copies of the Engineering and Infrastructure Design Standards and Construction Specifications, 2025 Edition are available at the office of the Town Clerk located at 807 Mountain Avenue, Berthoud, Colorado 80513, for review and inspection by the public; and

WHEREAS, the Town wishes to amend section 30-6-102 of the Land Development Code to reference the updated Engineering and Infrastructure Design Standards and Construction Standards; and

WHEREAS, the Planning Commission, after proper notice, has held a public hearing on November 13, 2025 on this Ordinance providing for a recommendation of approval from the Town Board of Trustees; and

WHEREAS, the Board of Trustees, after proper notice has held a public hearing on this Ordinance providing for the adoption of said code amendments pursuant to C.R.S. Section 31-16-203; and

WHEREAS, the Development Code and amendments thereto have been submitted to the Board of Trustees in writing and the Board of Trustees has determined that such code and amendments thereto should be adopted as herein set forth;

NOW, THEREFORE, BE IT ORDAINED BY THE TOWN BOARD OF TRUSTEES OF THE TOWN OF BERTHOUD, COLORADO:

Section 1. That Section 30-6-102 of the Berthoud Municipal Code has been amended as set forth in Exhibit A, attached is hereby adopted.

Section 2. That the Engineering and Infrastructure Design Standards and Construction Specifications, 2025 Edition as set forth in Exhibit B, attached is hereby adopted.

Section 3. If any section, paragraph, sentence, clause, or phrase of this Ordinance is held to be unconstitutional or invalid for any reason, such decision shall not affect the validity or constitutionality of the remaining portions of this Ordinance.

Section 4. All other Ordinances or portions thereof inconsistent or conflicting with this Ordinance or any portion hereof are hereby repealed to the extent of such inconsistency or conflict.

Section 5. The repeal or modification of any provision of the Municipal Code of the Town of Berthoud by this Ordinance shall not release, extinguish, alter, modify, or change in whole or in part any penalty, forfeiture, or liability, either civil or criminal, which shall have been incurred under such provision, and each provision shall be treated and held as still remaining in force for the purpose of sustaining any and all property actions, suits, proceedings, and prosecutions for the enforcement of the penalty, forfeiture, or liability, as well as for the purpose of sustaining any judgment, decree, or order which can or may be rendered, entered, or made in such actions, suits, proceedings, or prosecutions.

Section 6. The provisions of this ordinance shall take effect thirty days after publication as required by law, and shall apply to all development and construction permitted after such date.

INTRODUCED, READ, AND APPROVED on this 25th day of November, 2025.

TOWN OF BERTHOUD

By _____

William Karspeck, Mayor

ATTEST:

By: _____

Christian Samora, Town Clerk

READ, ADOPTED, AND APPROVED on this 9th day of December, 2025.

TOWN OF BERTHOUD

By _____

William Karspeck, Mayor

ATTEST:

By: _____

Christian Samora, Town Clerk

30-6-102 Design standards and construction specifications

Pursuant to parts 1 and 2 of article 16 of title 31, C.R.S., there is hereby adopted by reference Engineering and Infrastructure Design Standards and Construction Specifications, 2025 Edition as published by the Town of Berthoud, 807 Mountain Avenue, Berthoud, Colorado 80513 ("Standards and Specifications"); provided that any penalty provisions are expressly not adopted. These Standards and Specifications may be amended in whole or in part. The subject matter of the Standards and Specifications relates primarily to the design and construction of public and private improvements. The purpose of this Section and the Standards and Specifications adopted herein is to provide minimum standards for safety, health, and general welfare of the Town by regulating the design, construction, choice of materials, location, maintenance and use of all Public and Private Improvements. Three copies of the Standards and Specifications adopted herein are now filed in the office of the Clerk of the Town of Berthoud, Colorado, and may be inspected during regular business hours.

TOWN OF BERTHOUD

ENGINEERING AND INFRASTRUCTURE
DESIGN STANDARDS
AND
CONSTRUCTION SPECIFICATIONS

Effective ____2025
www.berthoud.org

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CHAPTER 100 INTRODUCTION AND GENERAL PROVISIONS

101 INTRODUCTION

101.1 General Provisions

A. These regulations shall be known as the Town of Berthoud Design Standards and Construction Specifications for the Design and Construction of Public and Private Improvements, 2025 Edition, as may be amended from time to time by the Town and may be cited as such and shall be referred to herein as the "Standards and Specifications" or "Standards

101.2 Purpose

A. The purpose of these Standards and Specifications is to provide minimum standards for safety, health, and general welfare of the Town by regulating the design, construction , choice of materials, location, maintenance and use of all Public and Private Improvements. These include, but are not limited to, sanitary sewer systems, water supply systems, private utility service lines for water and sewer, storm drainage systems, streets, landscape areas, open spaces, parks and recreation facilities, traffic signals and devices, parking lots and appurtenances thereto. All equipment and material used in the construction of public and private improvements shall be new unless approved by the Town.

B. These Standards and Specifications represent minimum requirements and design values. Additional requirements or higher design values, commensurate with conditions, may be required by the Town Engineer or Town Engineering Department when they are in the best interest of the Town.

101.3 Scope

A. The provisions of these Standards and Specifications shall apply to the planning, design, construction, enlargement, alteration, moving, removal, conversion, demolition, repair, and excavation of any Public or Private Improvements specifically regulated herein. These Standards and Specifications present the minimum standards for construction of Public and Private Improvements completed by Responsible Parties. These Standards and Specifications shall relate to the Town's capital improvement projects, unless specifically noted in the contract documents. With the exception of maintenance practices, the Town shall follow these Standards andSpecifications where practicable. In the case of those improvements that are required by the Town and are not specifically covered in these StandardsandSpecifications, the Responsible Party shall follow applicable local, state, and federal guidelines, or standards promulgated by professional organizations. The Town Engineer shall be consulted for guidance on proper references.

102 DEFINITIONS AND ABBREVIATIONS

102.1 Definitions

A. Refer to the Berthoud Development Code for a complete list of definitions. The following definitions are specific to these Standards and Specifications:

Approved Construction Drawings – Plans that were reviewed for compliance with Town of Berthoud Codes. The Engineer of record is responsible for adequacy of design and ensuring that the Improvements meet all Town of Berthoud Codes and these Standards and Specifications.

As-Built Plans – A modified version of the full set of the Approved Construction Drawings with

actual physical documentation of any changes based on field measurements and certified by a Professional Engineer (PE) or Professional Land Surveyor (PLS).

Best Management Practices – Practice or combination of practices that is determined to be effective and practicable means of preventing or reducing the amount of pollution generated by nonpoint sources to reach water quality goals.

Conditional Acceptance – An acknowledgement by the Town that, to the best of the Town's knowledge, all Improvements have been completed in accordance with the Approved Plans and Construction Drawings and these Standards and Specifications. Also referred to as Initial Acceptance.

Contractor – A person, partnership, corporation, subcontractor or other legally formed entity or organization that undertakes to construct, install, alter, move, demolish, repair, replace, excavate or add to any Public or Private Improvements covered by these Standards and Specifications.

Growth Management Area – The area surrounding the Town that the Town will consider annexing and developing. The Growth Management Area is delineated on the Future Land Use Map in the Berthoud Comprehensive Plan.

Impermeable Surface – An area of land that does not allow the penetration of water or liquid to dissipate into the underlying soil due to man-made coverings over the soil (examples may include, but are not limited to, asphalt paving, concrete paving, roofs, etc.)

Landowner – Any owner of a legal or equitable interest in real property, and including the heirs, successors and assigns of such ownership interests.

Letter of Completion – Letter notifying the Responsible Party that the Private Improvements were constructed in accordance with the Approved Plans and Construction Drawings, and these Standards and Specifications.

May – Permissive.

Plan – The maps and supporting documentation for a development which includes, but is not limited to, lots, blocks, easements, right-of-way, pedestrian ways, park and school sites, open space areas and conservation areas in accordance with the requirement of this code.

Private Improvements – Improvements under private ownership or control and/or maintained by the private owners, including but not limited to, portions of water systems, sewer systems, street systems and storm drainage systems, the construction of which are governed by these Standards and Specifications.

Service Area – An area, whether inside or outside Town limits, that receives water and/or sanitary sewer utility service from the Town of Berthoud.

Shall – Mandatory.

Stop Work Order – Official written notice from the Town to cease any and all construction or development activities on a site or lot due to a violation of, including but not limited to, the approved plans, the Town Code, the StandardsandSpecifications, building codes, and storm water runoff regulations. This notice will also include, but shall not be limited to, the restriction on issuance of building permits, certificates of occupancy, and additional provisions of utility services until the identified violations are corrected and approved by the Town.

Town Code – The latest, officially adopted version of the Berthoud Town Code.

Town Engineer –The Town of Berthoud Town Engineer or an authorized designee.

Warranty Period – Shall be the time frame during which the Responsible Party is held liable for all work performed and materials utilized prior to Final Acceptance by the Town of Berthoud.

102.2 Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
AC	Asbestos Cement
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
ADT	Average Daily Traffic
AISC	American Institute of Steel Construction
ALCC	Associated Landscape Contractors of Colorado
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
ATSSA	American Traffic Safety Services Association
AWWA	American Water Works Association
AWG	American Wire Gauge
BMP	Best Management Practice
CBR	California Bearing Ratio
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CDPS	Colorado Discharge Permit System
CFS	cubic feet per second
CI	Cast Iron
CP	Colorado Testing Procedures
CP-L	Colorado Lab Testing Procedures
CPSC	Consumer Product Safety Commission
CRS	Colorado Revised Statute
CUHP	Colorado Urban Hydrograph Procedure
CWCB	Colorado Water Conservation Board
DIP	Ductile Iron Pipe
DI	Ductile Iron

DRC	Dry-Rodded Condition
DU/Ac	Dwelling Units per Acre
DUE	Dwelling Unit Equivalent
EDLA	Equivalent Daily Load Application
EGL	Energy Grade Line
ESAL	Equivalent Single Axel Load
ET	Evapotranspiration
EURV	Excess Urban Runoff Volume
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FHA	Federal Housing Administration
fps	Feet per second
Gal	gallons
gpd	Gallons per day
gpm	Gallons per minute
GRC	Galvanized Rigid Conduit.
GVW	Gross Volume Weight
HDPE	High Density Polyethylene
HGL	Hydraulic Grade Line
HMA	Hot Mix Asphalt
IMSA	International Municipal Signal Association
IPC	International Plumbing Code
IPEMA	International Play Equipment Manufacturers Association
ISA	International Society of Arboriculture
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
LABCAT	Laboratory for Certification of Asphalt Technicians
lbs	pounds
PLS	Professional Land Surveyor
MAPC	Manual of Accident Prevention in Construction
MGD	Million gallons per day
MHFD	Mile High Flood District

MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PC	Point of Curvature
PCC	Portland Cement Concrete
PE	Professional Engineer
PG	Performance Grade
PI	Point of Intersection
PRC	Point of Reverse Curve
PRV	Pressure Reducing Valve
psi	Pounds per square inch
PT	Point of Tangency
PUD	Planned Unit Development
PVC	Polyvinyl Chloride
RAP	Reclaimed Asphalt Pavement
RCP	Reinforced Concrete Pipe
ROW	Right-of-way
RPS	Roller Pass Study
SDR	Standard Dimension Ratio
sf	Square Foot
SMA	Stone Mastic Asphalt
SN	Structural Number
SUE	Subsurface Utility Engineering
SWMP	Stormwater Management Plan
SZFL	School Zone Flashing Light
UDFCD	See MHFD
UL	Underwriters Laboratories, Inc.
USACE	United State Army Corps of Engineers
USGS	United States Geological Survey
VCA	Voids in the Coarse Aggregate
VFA	Voids Filled with Asphalt

VMA	Voids in the Mineral Aggregate
VTM	Voids in the Total Mix
WMA	Warm Mix Asphalt
WQCD	Water Quality Control Division
WQCV	Water Quality Capture Volume

102.3 Terms

A. Whenever, in these Standards and Specifications, the words "as ordered", "as directed", "as required", "as permitted", "as allowed", or words or phrases of like meaning are used, it shall be understood that the order, direction, requirement, permission, or allowance of the Town is intended.

B. Similarly, the words "approved", "reasonable", "suitable", "acceptable", "properly", "satisfactory", or words of like meaning, unless otherwise specified herein, shall mean approved, reasonable, suitable, acceptable, proper, or satisfactory in the judgment of the Town.

C. Whenever, in these Standards and Specifications, the words “Town Engineer” are used, it shall be understood that the Town employee named therein shall be whoever is designated by the Town Manager or Town Engineer.

103 GENERAL CONDITIONS

103.1 Authority by the Town

A. Engineering Services

1. The Responsible Party shall procure at its sole expense all engineering services necessary and appropriate in conjunction with the development of the property, which shall fully conform to the Town’s applicable ordinances, and these Standards and Specifications. Professional services shall be performed by engineers, surveyors, landscape architects, or other professionals duly licensed by the State of Colorado as may be appropriate.

B. Utility Obligations

1. The Responsible Party shall pay all installation charges for water, sanitary, sewer, lighting, communication, electric, and/or gas services required by the appropriate service provider for the property/project. Payment for streetlights shall be made in a timely fashion to ensure that streetlights within and adjacent to residential lots are installed prior to the certificate of occupancy of the adjacent lots. At the discretion of the Town Engineer, the Town may withhold inspections and/or conditional acceptance if the streetlights have not been installed prior to certificate of occupancy.

C. Variances

1. A variance may be granted by The Town Engineer in situations where it is not practical to carry out the provisions of these Standards and Specifications. The Town Engineer shall first determine that conditions exist to make impracticable the procedures set forth in these Standards and Specifications. A variance may be granted provided that it is in compliance with the intent and purpose of these Standards and Specifications. A variance shall not lessen any design requirements or degrees of integrity set forth in this document, and it shall result in a level of safety, service, and quality equal to or greater than the minimum requirements described in these Standards and Specifications. The Responsible Party shall provide a written request for variance. If approved by the Town, a variance will be issued in writing by the Town Engineer, stating what the variance is, and the reason for approval.

D. Alternate Materials and Methods of Construction
   1. The provisions of these Standards and Specifications are not intended to prevent the use of any material or method of construction not specifically prescribed by these procedures, provided any alternate to the Standards and Specifications is approved in writing by the Town Engineer, and thus authorized by the Town.

   2. The Town Engineer shall require that sufficient evidence or proof be submitted to substantiate any request that may be made regarding the alternate method or material. The details of any action granting approval of an alternate shall be recorded and filed with the Town.

E. Tests
   1. The Responsible Party shall employ at its sole expense a professionally qualified, independent third-party testing company to perform all testing of materials or construction that may be required by the Town to ensure compliance with these Standards and Specifications. The Responsible Party shall furnish the Town with certified copies of test results and agrees to release and authorize full access to the Town and its designated representatives to all work-up materials, procedures, and documents used in preparing the test results.

   2. Whenever there is insufficient evidence of compliance with any of the provisions of these Standards and Specifications or evidence that any material or construction does not conform to the requirements herein, The Town Engineer may require that test results shall be provided to establish compliance, at the expense of the Responsible Party. Such tests shall be as specified by these Standards and Specifications or by other recognized test standards approved by The Town Engineer. If there are no recognized and accepted test methods for the proposed alternate, the Town Engineer shall determine test procedures. All tests shall be made by an agency approved prior to testing by The Town Engineer.

F. Organization and Enforcement
   1. The Town Engineer shall have the power to enforce all provisions of these Standards and Specifications. The Town Engineer may appoint a project manager, construction inspector, landscape architect, technical officer or inspector, or another employee to act as an authorized representative. Said authorized representative may be a Town employee or approved consultant.

   2. Whenever any work is being done contrary to the provisions of these Standards and Specifications or approved plans, the Town Engineer may order the work stopped by a written notice which shall be served on any persons engaged in the doing or causing of such work to be done, and any such persons shall forthwith stop such work until authorized by the Town Engineer to proceed.

G. No Waiver of Legal Rights
   1. The Town shall not be precluded or stopped by any measurement, estimate, or certificate made either before or after the completion and acceptance of the work from showing the true amount and character of the work performed and materials furnished by the Responsible Party, or from showing that any such measurement, estimate or certificate is untrue or incorrectly made, or that the work or materials do not conform in fact to these Standards and Specifications

H. Control of Work
   1. Authority of Town Engineer
      a. The Town Engineer shall have the authority to stop work whenever such stoppage is deemed reasonably necessary to protect public health, safety and

welfare. The Town Engineer shall resolve all questions which arise as to the quality and acceptability of materials furnished, work performed, interpretation of the plans and specifications, and acceptable fulfillment of the requirements of these Standards and Specifications.

2. Authority and Duties of Inspector
   a. Inspectors are authorized to inspect all work completed and all material furnished. Inspections may extend to all or any part of the work and to the preparation, fabrication or manufacture of the materials to be used. The Inspector is not authorized to revoke, alter or waive any requirements of these Standards and Specifications. The Inspector shall notify the Responsible Party of any failure of the work or materials out of conformance with these Standards and Specifications. The Inspector shall have the authority to reject materials until any questions at issue can be resolved by the Town Engineer.
   b. The Inspector shall, in no case, act as foreman or perform other duties for the Responsible Party or interfere with the management of the work done by the Responsible Party. Any "advice" which the Inspector may give the Responsible Party shall not be construed as binding upon the Town in any way or release the Responsible Party from fulfilling all the terms of these Standards and Specifications.
   c. The presence or absence of the Inspector shall not relieve, to any degree, the responsibility or the obligation of the Responsible Party to follow these Standards and Specifications.
   d. The Town Engineer, or an authorized designee, shall, at all times, be provided with reasonable and safe access to inspect the work whenever it is in preparation or progress.
3. Responsibility for Work
   a. In case of suspension of work for any cause whatsoever, the Responsible Party, before leaving the job site, shall take such precautions as may be necessary to prevent damage to the work, provide for proper drainage and erect any necessary barricades, signs, or other facilities, at the Responsible Party's expense, as required by applicable standards.
4. Removal of Unacceptable Work
   a. Work which does not conform to the plans and these Standards and Specifications, and which results in an inferior or unsatisfactory product, shall be considered unacceptable work. Unacceptable work, whether the result of poor workmanship, poor design, use of defective materials, damage through carelessness, or any other cause found to exist prior to the final acceptance of the work, shall be immediately removed and replaced or corrected by, and at the expense of, the Responsible Party. This expense includes total and complete restoration of any disturbed surface to original or better than the original condition which existed before the repairs or replacement, regardless of improvements on lands where the repairs or replacement are required.
5. Requirements of Other Jurisdictions
   a. Where proposed construction will affect other agencies or utility providers such as CDOT, adjacent cities and counties, railroads, ditch companies, Xcel, Little Thompson Water District, Poudre Valley REA, Central Weld Water District, etc., said construction shall be subject to the review and approval of said agencies. Generally, where more than one requirement is imposed, the more restrictive requirement shall govern. Exceptions must be authorized by the Town Engineer in writing.

103.2 Utility Location Requirements for Design

A. Per the provisions of the Colorado Revised Statutes Section 9-1.5-101 (also referred to as Colorado Senate Bill 18-167), projects that meet the following four (4) criteria are required to meet Quality Level B for design utility locations as identified in the subsurface utility engineering (SUE) standard ASCE 38.
   1. Project involves a construction Contract with a public entity.
   2. Project involves primarily horizontal construction and does not involve primarily the construction of buildings.
   3. Anticipated excavation footprint exceeds two (2) feet in depth and is a contiguous 1000 square feet (excluding fencing and signing projects) OR involves utility boring.
   4. Project requires the design services of a licensed PE.

B. For all projects that fall under SUE the following requirements must be initiated as part of the project design.

   1. A thorough subsurface utility engineering investigation that takes the results of any comprehensive geophysical services for known and unknown utilities and integrates the results with existing records and physical evidence in a risk-based depiction
   2. Test holes where needed for utility locations
   3. Utility location data that is transmitted to the Design Engineer in order to make informed design decisions and the Quality Level of each utility is marked on the plan set.
   4. All of the utility investigations must take place under the direct responsible charge of a licensed Professional Engineer with training and a working knowledge of surface geophysics, engineering surveying, utility construction and design principles, utility conflict identification resolution, and utility risks as they pertain to the project.

C. The Standards and Specifications are not intended to alter the requirements of or to conflict with the Colorado Revised Statues Section 9-1.5-101.

CHAPTER 200 DRAWINGS AND DESIGN REVIEW SUBMITTALS

201 CONSTRUCTION PLANS

201.1 Purpose Statement

A. In addition to any other requirements for the issuance of a construction permit pursuant to the Town Code, the developer shall submit to the Town Planning Department, prior to or contemporaneously with the application for construction permit, plans, specifications, engineering calculations, traffic reports, stormwater reports, utility reports, geotechnical reports and other data as required to allow the Town Engineer to determine compliance with these Standards and Specifications. All such reports, plans, computations, and specifications shall be prepared and designed by a professional engineer licensed in the State of Colorado, in accordance with the rules and laws of the Colorado Board of Registration of Professional Engineers.

The Town Planning Department may waive the submission of plans, specifications, calculations, or other analysis, if in the Town Engineer's judgment, the nature of the work applied for is such that reviewing of plans is not necessary to obtain compliance with these Standards and Specifications.

201.2 Construction Plan Requirements

A. Construction plans shall be checked for conformance with Town design standards prior to approval by the Town. Engineering and landscaping design or needs shall remain the responsibility of the professional design engineer or landscape professional. Preliminary construction plans and all required reports shall be submitted in an electronic format to the Town Planning Department for review. Once all review comments have been addressed and the plans are final, one (1) set of plans, signed and sealed by a professional engineer or landscape architect shall be submitted in an electronic format and retained. The approval of all required reports and construction plans is valid for one (1) year. The final construction drawings shall be submitted in electronic “PDF” and AutoCAD™ formats.

1. General Requirements
   a. Plans and specifications shall be drawn to scale and shall have sufficient clarity to indicate the location, nature, and extent of the work proposed and show in detail that it shall conform to the provisions of these Standards and Specifications and all relevant laws, ordinance, rules and regulations.

   b. The following items shall be shown on all plans:

      i. Cover Sheet, including Title Block (lower right-hand corner preferred)
      ii. Scale (1"=50' horizontal and 1"=5' vertical for plans and profiles are a minimum)
      iii. Legend including all line types and symbols
      iv. Revision number and date
      v. Name of professional engineer or landscape architect and firm
      vi. Professional engineer's (PE) number, signature, landscape architect as applicable, and stamp
      vii. Town of Berthoud General Notes
      viii. Horizontal and vertical coordinate systems

   c. Sheet number(s)

d. Town of Berthoud Approval Block shall be included on the Cover Sheet.

TOWN OF BERTHOUD APPROVAL

ALL WORK SHALL BE CONSTRUCTED TO THE TOWN STANDARDS AND SPECIFICATIONS. THESE PLANS HAVE BEEN REVIEWED BY THE TOWN OF BERTHOUD FOR CONCEPT ONLY AND GENERAL CONFORMANCE WITH THE TOWN'S STANDARDS AND SPECIFICATIONS. THE REVIEW BY THE TOWN OF BERTHOUD DOES NOT IMPLY RESPONSIBILITY BY THE TOWN OF BERTHOUD OR THE TOWN ENGINEER FOR ACCURACY AND CORRECTNESS OF THE PLANS OR CALCULATIONS.

THESE PLANS ARE HEREBY APPROVED FOR ONE YEAR FROM DATE OF THE TOWN ENGINEER'S APPROVAL.

APPROVED BY:

_____

TOWN ENGINEER DATE

2.

3. Plan Details
   a. Key Map
   b. Legend of symbols
   c. North arrow, pointed to the top of the page, or to the right side of the page
   d. Property lines - Indicate lots with lot number and block number to be served by solid lines
   e. Survey monuments
   f. Ownership or subdivision information
   g. Street names, ROW, and easements with width dimensions
   h. The location of existing utility lines - water, gas, telephone, storm drain, irrigation ditches, sanitary sewers, and other pertinent details, such as houses, curbs, water courses, cable television, etc.
   i. Existing and proposed easements
   j. Vicinity map
   k. All bench marks
   l. If irrigation ditches are involved, an approval block for the ditch company shall be provided

3. Profile Details
   a. Vertical and horizontal grids with scales and stationing
   b. Ground surface existing (dashed) and proposed (solid)
   c. Existing utility lines
   d. Benchmarks (NAVD 88 datum) and project benchmark noted
   e. Existing manhole inverts and rim elevations

4. Overall Utility Plan (Single Sheet)
   a. The location of proposed and existing utility lines - water, gas, telephone, storm drain, irrigation ditches, sanitary sewers, and other pertinent details, such as houses, curbs, water courses, cable television, etc.

5. Water Construction Plan
   a. Proposed water mains (Include Profile):
      i. Size
      ii. Length
      iii. Materials, types of joints, and proposed depth
      iv. Location dimensions. Other information including elevation at/of top of valve nut, rim elevation of valve box, meter box, etc. may be required.

b. Fittings (size and type), for example:
   i. Tees
   ii. Crosses
   iii. Reducers
   iv. Bends
   v. Plugs
   vi. Blow-offs
   vii. Kickblocks

c. Valves (size and type)
d. Fire Hydrants
e. Irrigation tap locations and meter sizes with spot elevations.
f. Plan, profile, and details for offsite transmission mains, pump stations, valves, vaults, tanks, service locations, etc.
g. Complete material list included in drawings
h. Crossings Details (clearance, sleeving, if needed)
i. Detail Sheets

6. Sanitary Sewer Construction Plans
   a. Proposed sanitary sewers (Profile Sheets):
      i. Diameters
      ii. Materials and types of joints
      iii. Gradients
      iv. Length between manholes
   b. Proposed manholes and cleanouts:
      i. Stationing and other number designation
      ii. Elevation of inverts in and out of manhole
      iii. Elevation of manhole rim
   c. Location control dimension
   d. Manhole stub-outs
   e. Proposed future extensions
   f. Proposed wye and riser connection for services
   g. Proposed service connections or stub-ins
   h. Proposed underdrain
   i. Proposed concrete encasement
   j. Proposed cutoff walls

7. Storm Drainage Construction Plans
   a. Drainage area plan; an overall plan of the area under study showing:
      i. Contours on site and off site
      ii. Location and elevation of Town or USGS benchmarks
      iii. USGS datum
      iv. Property lines
      v. Boundary lines (counties, districts, tributary area, etc.)
      vi. Streets and street names and approximate grades
      vii. Subdivision (name and location by section)
      viii. Existing irrigation ditches
      ix. Existing drainage ways including gutter flow directions
      x. Drainage sub-area boundaries
      xi. Easements required
      xii. Proposed curbs and gutters and gutter flow directions
      xiii. Proposed cross pans and flow directions
      xiv. Proposed piping and open drainage ways
      xv. Major And Minor Flow volumes for storm runoff conditions. (At inlets and outfalls)
      xvi. Path of 100-year storm runoff flows delineated
      xvii. Critical minimum finished floor elevations for protection from 100-year runoff
      xviii. Proposed inlet locations and inlet sizes
      xix. Floodplain information, indicating land in floodplain, and land not in floodplain
      xx. Path of the emergency overflow spillway

xxi. High water line and overland flow path for all inlets in sags and for all culverts under inlet control conditions
xxii. Riprap size

b. Proposed storm sewers
   i. Plan showing stationing
   ii. Profile (include minor and major storm HGLs)
   iii. Size, lengths between manholes, and type material
   iv. Grades, capacity
   v. Inlet and outlet details
   vi. Manhole details (station number and invert elevations)
   vii. Utility Crossings
c. Proposed open channels and detention facilities
   i. Plan showing stationing
   ii. Profile (include minor and major HGLs)
   iii. Grades, capacities, water quality capture volume water surface elevation, major water surface elevation, top of pond elevation, and spillway details
   iv. Typical cross sections for both channels and basins
   v. Lining details
d. Proposed special structures (manholes, headwalls, trash racks, etc.)
   i. Plan
   ii. Elevation
   iii. Details of design and appurtenances
e. Retaining Walls
   i. Retaining walls four (4) feet or greater are required to be designed, stamped and signed by a registered professional engineer and must be approved and permitted through the Town.
   ii. Retaining walls must have sufficient resistance against overturning and sliding, and they must possess adequate structural strength against bending outward.
   iii. The retaining wall submittal package shall be in accordance with the following outline and contain the applicable information listed:
      (a) Plans
      (b) Spot elevations
      (c) Top and bottom of wall elevations every 10 feet or on both sides of a step
      (d) Sections
      (e) Details to include geofabric, drainage, foundation, etc.
      (f) Calculations.
      (g) A Geotechnical Report – type of soils, specific weight, allowable bearing pressure, etc.
      (h) Loading diagram - include surcharge loads and slopes
      (i) Factor of Safety against overturning shall be a minimum of 1.5 for granular soils (i.e. sand) and 2 for cohesive soils (i.e. clay)
      (j) Factor of Safety against sliding shall be a minimum of 2 which includes the passive resultant
      (k) For multiple tiered walls loads from upper wall need to be applied to the lower wall. In addition, the walls need to be analyzed as a single unit for bearing failure and slope stability.

8. Storm Water Management Plan (SWMP)
   a. Development or redevelopment projects which disturb one (1) or more acres will require both sediment and erosion control plans and a CDPHE Construction Stormwater Discharge Permit for stormwater discharges associated with construction activities at least 10 calendar days prior to the commencement of construction activities. Infill lots or sites less than one acre of disturbance will require a sediment and erosion control plan.

   b. A copy of the approved SWMP and site maps must be available at all times on the construction site unless otherwise approved by CDPHE or the Town.

c. The SWMP and site maps shall be continuously updated to reflect new or revised BMPs due to changes in design, construction, operation, or maintenance of the construction site. Updates must be made within 72 hours following the change in BMPs.

d. The Responsible Party shall inspect the construction site (including all BMPs, storage containers, and construction equipment) a minimum of every 14 calendar days and within 24 hours after a precipitation event or snow melt that cause's surface erosion. Inspections shall continue until an Inactivation Notice is filed with CDPHE and copied to the Town.

e. The Responsible Party shall keep a record of all inspections on site and available for review by CDPHE or Town staff. Inspection reports must identify any incidents of noncompliance with the terms and conditions of the Permit.

f. For all instances of noncompliance based on environmental hazards and chemical spills and releases, all needed information must be provided orally to CDPHE spill reporting line (24-hour number for environmental hazards and chemical spills and releases: 1-877-518-5608) within 24 hours from the time the Owner/Contractor comes aware of the circumstances.

9. Street Construction Plans
   a. In addition to the above general plan and profile details, all street construction plans shall conform to Larimer County Urban Area Street Standards (LCUASS).

201.3 Town of Berthoud Standard Notes

A. The following standard notes shall be included in all construction plan sets as appropriate.

B. GENERAL NOTES

1. ALL MATERIALS AND WORKMANSHIP SHALL CONFORM TO THE LATEST TOWN OF BERTHOUD STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC AND PRIVATE IMPROVEMENTS, COLORADO DEPARTMENT OF TRANSPORTATION, BERTHOUD FIRE PROTECTION DISTRICT REQUIREMENTS, *<INSERT APPROPRIATE UTILITY DISTRICTS>*, AND ALL APPLICABLE STATE AND LOCAL STANDARDS AND SPECIFICATIONS.

2. THE CONTRACTOR SHALL HAVE IN POSSESSION AT THE JOB SITE AT ALL TIMES ONE (1) SIGNED COPY OF APPROVED PLANS, STANDARDS AND SPECIFICATIONS, AND PERMITS. CONTRACTOR SHALL CONSTRUCT AND MAINTAIN EMERGENCY ACCESS ROUTES TO THE SITE AND STRUCTURE AT ALL TIMES PER THE APPLICABLE BERTHOUD FIRE PROTECTION DISTRICT REQUIREMENTS. THE CONTRACTOR SHALL OBTAIN WRITTEN APPROVAL FOR ANY VARIANCE TO THE ABOVE DOCUMENTS. THE CONTRACTOR SHALL NOTIFY THE TOWN ENGINEER OF ANY CONFLICTING STANDARDS OR SPECIFICATIONS. IN THE EVENT OF ANY CONFLICTING STANDARD OR SPECIFICATION, THE MORE STRINGENT OR HIGHER QUALITY STANDARD, DETAIL OR SPECIFICATION SHALL APPLY.

3. THE CONTRACTOR SHALL OBTAIN, AT THE CONTRACTOR'S OWN EXPENSE, ALL APPLICABLE CODES, LICENSES, STANDARD SPECIFICATIONS, PERMITS, BONDS, ETC., WHICH ARE NECESSARY TO PERFORM THE PROPOSED WORK, INCLUDING, BUT NOT LIMITED TO A LOCAL AND STATE GROUNDWATER DISCHARGE AND COLORADO DEPARTMENT OF HEALTH AND ENVIRONMENT (CDPHE) STORMWATER DISCHARGE PERMIT ASSOCIATED WITH CONSTRUCTION ACTIVITY.

4. ALL WORK SHALL BE SUBJECT TO INSPECTION AND APPROVAL BY AUTHORIZED TOWN OF BERTHOUD PERSONNEL.

5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING THE TOWN ENGINEER, GEOTECHNICAL ENGINEER, AND ALL UTILITY OWNERS, AT LEAST 48 HOURS PRIOR

TO START OF ANY CONSTRUCTION, PRIOR TO BACKFILLING, AND AS REQUIRED BY JURISDICTIONAL AUTHORITY AND/OR PROJECT SPECIFICATIONS. THE CONTRACTOR SHALL CONTINUE WITH NOTIFICATIONS THROUGHOUT THE PROJECT AS REQUIRED BY THE STANDARDS AND SPECIFICATIONS.

6. THE CONTRACTOR SHALL BE SOLELY AND COMPLETELY RESPONSIBLE FOR CONDITIONS AT AND ADJACENT TO THE JOB SITE; INCLUDING SAFETY OF PERSONS AND PROPERTY DURING THE PERFORMANCE OF WORK. THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS. THE TOWN CONSTRUCTION REVIEW OF THE CONTRACTOR'S PERFORMANCE IS NOT INTENDED TO INCLUDE REVIEW OF THE ADEQUACY OF THE CONTRACTOR'S SAFTEY MEASURES IN, ON, OR NEAR THE CONSTRUCTION SITE.

7. THE CONTRACTOR SHALL PREPARE A TRAFFIC CONTROL PLAN FOR TOWN APPROVAL BY THE TOWN OF BERTHOUD PRIOR TO CONSTRUCTION AND PROVIDE ALL LIGHTS, SIGNS, BARRICADES, FENCING, FLAGMEN OR OTHER DEVICES NECESSARY TO PROVIDE FOR PUBLIC SAFETY. THE CONTRACTOR AGREES TO COMPLY WITH THE PROVISIONS OF THE TRAFFIC CONTROL PLAN AND THE LATEST EDITION OF THE "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD)," PART VI, FOR CONSTRUCTION SIGNAGE AND TRAFFIC CONTROL. ALL TEMPORARY AND PERMANENT TRAFFIC SIGNS SHALL COMPLY TO THE MUTCD WITH REGARD TO SIGN SHAPE, COLOR, SIZE, LETTERING, ETC. UNLESS OTHERWISE SPECIFIED. IF APPLICABLE, PART NUMBERS ON SIGNAGE DETAILS REFER TO MUTCD SIGN NUMBERS.

8. THE TYPE, SIZE, LOCATION, AND NUMBER OF ALL KNOWN UNDERGROUND UTILITIES ARE APPROXIMATE AS SHOWN ON THE DRAWINGS BASED ON INFORMATION BY OTHERS. NOT ALL UTILITIES ARE SHOWN. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY THE EXISTENCE, SIZE, TYPE, AND LOCATION OF ALL UNDERGROUND UTILITIES, WHETHER SHOWN OR NOT, ALONG THE ROUTE OF THE WORK. LOCATION OF EXISTING UTILITIES SHALL BE VERIFIED BY CONTRACTOR PRIOR TO DATE OF CONSTRUCTION. IT IS THE CONTRACTOR'S RESPONSIBILITY TO FIELD VERIFY SIZE AND HORIZONTAL AND VERTICAL LOCATIONS OF EXISTING FACILITIES PRIOR TO CONSTRUCTION AND NOTIFY THE TOWN OF ANY DISCREPANCIES. THE ENGINEER AND/OR OWNER ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS SHOWNON PLANS. THE CONTRACTOR SHALL BE FULLY AND SOLELY RESPONSIBLE FOR ANY AND ALL DAMAGES AND COSTS WHICH MIGHT OCCUR BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UTILITIES. THE CONTRACTOR SHALL NOTIFY ALL PUBLIC AND PRIVATE UTILITY COMPANIES AND DETERMINE THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO PROCEEDING WITH GRADING AND CONSTRUCTION. ALL WORK PERFORMED IN THE AREA OF UTILITIES SHALL BE PERFORMED AND INSPECTED ACCORDING TO THE REQUIREMENTS OF THE UTILITY OWNER. LIKEWISE, THE CONTRACTOR SHALL BE RESPONSIBLE FOR LOCATING AND MAPPING ANY EXISTING UTILITY (INCLUDING DEPTH) WHICH MAY CONFLICT WITH THE PROPOSED CONSTRUCTION, AND FOR RELOCATING ENCOUNTERED UTILITIES AS DIRECTED BY THE ENGINEER. CONTRACTOR SHALL CONTACT AND RECEIVE APPROVAL FROM TOWN ENGINEER AND THE UTILITY OWNER BEFORE RELOCATING ANY ENCOUNTERED UTILITIES. CONTRACTOR SHALL BE RESPONSIBLE FOR SERVICE CONNECTIONS AND RELOCATING AND RECONNECTING AFFECTED UTILITIES AS COORDINATED WITH UTILITY OWNER AND/OR ENGINEER, INCLUDING NON- MUNICIPAL UTILITIES (TELEPHONE, GAS, CABLE, ETC., WHICH SHALL BE COORDINATED WITH THE UTILITY OWNER). THE CONTRACTOR SHALL IMMEDIATELY CONTACT THE TOWN ENGINEER UPON DISCOVERY OF A UTILITY DISCREPANCY OR CONFLICT. AT LEAST 48 HOURS PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL NOTIFY THE UTILITY NOTIFICATION CENTER OF COLORADO (1-800-922-1987, WWW.UNCC.ORG).

9. ALL TRENCHES SHALL BE ADEQUATELY SUPPORTED AND THE SAFETY OF WORKERS PROVIDED FOR AS REQUIRED BY THE MOST RECENT OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) "SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION." THESE REGULATIONS ARE DESCRIBED IN SUBPART P, PART 1926 OF THE CODE OF FEDERAL REGULATIONS. SHEETING AND SHORING SHALL BE UTILIZED WHERE NECESSARY TO PREVENT ANY EXCESSIVE WIDENING OR SLOUGHING OF THE TRENCH WHICH MAY BE DETRIMENTAL TO HUMAN SAFETY, TO THE PIPE BEING PLACED, TO TREES, OR TO ANY EXISTING STRUCTURE WHERE EXCAVATIONS ARE MADE UNDER SEVERE WATER CONDITIONS. THE CONTRACTOR MAY BE REQUIRED TO USE AN APPROVED PILING INSTEAD OF SHEETING AND SHORING.
10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVING ANY GROUNDWATER ENCOUNTERED DURING THE CONSTRUCTION OF ANY PORTION OF THIS PROJECT. GROUNDWATER SHALL BE PUMPED, PIPED, REMOVED AND DISPOSED OF IN A MANNER WHICH DOES NOT CAUSE FLOODING OF EXISTING STREETS NOR EROSION ON ABUTTING PROPERTIES IN ORDER TO CONSTRUCT THE IMPROVEMENTS SHOWN ON THESE PLANS. GROUNDWATER TO BE PUMPED SHALL BE TESTED, PERMITTED, AND PUMPED PER THE STATE OF COLORADO AND LOCAL GROUNDWATER DISCHARGING PERMIT REQUIREMENTS.
11. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CLEANING NEARBY PUBLIC STREETS OF MUD OR DEBRIS DUE TO CONSTRUCTION ACTIVITY INITIATED BY SAID CONTRACTOR ON A DAILY BASIS OR AS OTHERWISE DIRECTED BY AUTHORIZED TOWN PERSONNEL.
12. ALL SURPLUS MATERIALS, TOOLS, AND TEMPORARY STRUCTURES, FURNISHED BY THE CONTRACTOR, SHALL BE REMOVED FROM THE PROJECT SITE BY THE CONTRACTOR. ALL DEBRIS AND RUBBISH CAUSED BY THE OPERATIONS OF THE CONTRACTOR SHALL BE REMOVED, AND THE AREA OCCUPIED DURING CONSTRUCTION ACTIVITIES SHALL BE RESTORED TO ITS ORIGINAL CONDITION OR BETTER, WITHIN 48 HOURS OF PROJECT COMPLETION.
13. PRIOR TO THE BEGINNING OF WORK, A PRECONSTRUCTION CONFERENCE SHALL BE HELD BETWEEN THE TOWN, THE RESPONSIBLE PARTY WHO IS SCHEDULED TO PERFORM THE WORK, THE DESIGNATED ON-SITE FIELD REPRESENTATIVE, THE CONSULTING ENGINEER OR LANDSCAPE PROFESSIONAL, AND ANY OTHER ENTITIES INVOLVED IN THE CONSTRUCTION.
14. THE CONTRACTOR IS REQUIRED TO PROVIDE AND MAINTAIN EROSION AND SEDIMENT CONTROL MEASURES IN ACCORDANCE WITH THE APPROVED EROSION CONTROL PLAN, THE TOWN OF BERTHOUD STANDARDS AND SPECIFICATIONS, THE MILE HIGH FLOOD DISTRICT "URBAN STORM DRAINAGE CRITERIA MANUAL, VOLUME 3", THE M-STANDARD PLANS OF THE COLORADO DEPARTMENT OF TRANSPORTATION, AND THE STATE OF COLORADO. THE TOWN OF BERTHOUD MAY REQUIRE THE CONTRACTOR TO PROVIDE ADDITIONAL EROSION CONTROL MEASURES AT THE CONTRACTOR'S EXPENSE DUE TO UNFORESEEN ISSUES, OR IF THE PLANS DO NOT FUNCTION AS INTENDED. THE CONTRACTOR IS RESPONSIBLE FOR PROHIBITING SILT AND DEBRIS-LADEN RUNOFF FROM LEAVING THE SITE, KEEPING ALL PUBLIC AREAS FREE OF MUD AND DEBRIS, REESTABLISHING FINAL GRADES, AND REMOVING ACCUMULATED SEDIMENTATION FROM ALL AREAS, INCLUDING SWALES AND DETENTION/WATER QUALITY AREAS. CONTRACTOR SHALL REMOVE TEMPORARY EROSION CONTROL MEASURES AND REPAIR AREAS AS REQUIRED AFTER VEGETATION IS ESTABLISHED AND ACCEPTED BY THE TOWN OF BERTHOUD.
15. DEVELOPMENT PHASING OF ANY PROJECT MUST BE SHOWN ON THE CONSTRUCTION PLANS, APPROVED BY THE TOWN ENGINEER AND MADE A PART OF THE APPLICATION PROCEDURE. NO PHASING SHALL BE PERMITTED UNLESS

THIS REQUIREMENT HAS BEEN ADHERED TO.

16. NO WORK SHALL BEGIN UNTIL THE RESPONSIBLE PARTY IS IN POSSESSION OF AN APPROVED SET OF PLANS AND THE TOWN OF BERTHOUD STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC AND PRIVATE IMPROVEMENTS, AND ALL NECESSARY PERMITS FOR THE IMPROVEMENTS HAS BEEN ISSUED BY THE TOWN. TOWN ENGINEERING APPROVAL SHALL BE FOR GENERAL CONFORMITY TO THE UTILITY SPECIFICATIONS AND SHALL NOT CONSTITUTE BLANKET APPROVAL OF ALL DIMENSIONS, QUANTITIES AND DETAILS OF THE MATERIAL OR EQUIPMENT SHOWN. SUCH APPROVAL SHALL NOT RELIEVE THE RESPONSIBLE PARTY, CONSULTING ENGINEER, OR LANDSCAPE ARCHITECT OF THEIR RESPONSIBILITY FOR ERRORS CONTAINED IN THE DRAWINGS.

17. THE RESPONSIBLE PARTY SHALL FURNISH REASONABLE AID AND ASSISTANCE REQUIRED BY THE TOWN ENGINEER FOR THE PROPER EXAMINATION OF THE MATERIALS AND WORK. WORK SHALL BE PERFORMED IN ACCORDANCE WITH ACCEPTED WORKMANSHIP PRACTICES AND THE TOWN OF BERTHOUD STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC AND PRIVATE IMPROVEMENTS. ANY WORK NOT ACCEPTED BY THE TOWN ENGINEER SHALL BE REDONE UNTIL COMPLIANCE WITH THESE STANDARDS IS ACHIEVED. INSTRUCTIONS GIVEN BY THE TOWN ENGINEER RELATING TO QUALITY OF MATERIALS AND WORKMANSHIP MUST BE OBEYED AT ONCE BY THE RESPONSIBLE PARTY. THE TOWN SHALL NOT SUPERVISE SET OUT WORK OR GIVE LINE AND GRADE STAKES.

18. THE MATERIALS USED IN PROJECTS SHALL BE NEW AND SUBJECT TO THE INSPECTION AND APPROVAL OF THE INSPECTOR AT ALL TIMES. THE INSPECTOR HAS THE RIGHT TO PERFORM ANY TESTING DEEMED NECESSARY TO ENSURE COMPLIANCE OF THE MATERIAL WITH THESE STANDARDS. NO MATERIAL SHALL BE USED BEFORE BEING INSPECTED AND APPROVED BY THE INSPECTOR. FAILURE OR NEGLECT ON THE PART OF THE INSPECTOR TO CONDEMN OR REJECT INFERIOR MATERIALS OR WORK SHALL NOT BE CONSTRUED TO IMPLY THEIR ACCEPTANCE SHOULD THEIR INFERIORITY BECOME EVIDENT AT ANY TIME PRIOR TO FINAL ACCEPTANCE OF THE WORK. INSPECTORS HAVE THE AUTHORITY TO REJECT DEFECTIVE OR INFERIOR MATERIALS AND/OR DEFECTIVE WORKMANSHIP AND TO SUSPEND WORK UNTIL SUCH TIME AS THE RESPONSIBLE PARTY SHALL CORRECT THE DISCREPANCIES IN QUESTION.

19. WHENEVER DEFECTIVE MATERIALS AND WORK ARE REJECTED, THE RESPONSIBLE PARTY SHALL PROMPTLY REMOVE SUCH DEFECTIVE MATERIALS AND CONSTRUCTION FROM THE JOB SITE AND REPLACE ALL DEFECTIVE PORTIONS TO THE SATISFACTION OF THE TOWN ENGINEER. IN THE EVENT THE RESPONSIBLE PARTY FAILS TO REMOVE REJECTED ITEMS FROM THE JOB SITE WITHIN A REASONABLE LENGTH OF TIME, THE TOWN ENGINEER MAY ARRANGE FOR SUCH REMOVAL AT THE EXPENSE OF THE RESPONSIBLE PARTY.

20. INSPECTION SHALL NOT RELIEVE THE RESPONSIBLE PARTY FROM ANY OBLIGATION TO PERFORM THE WORK STRICTLY IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS OR ANY MODIFICATIONS THEREOF. WORK NOT SO CONSTRUCTED SHALL BE REMOVED AND CORRECTED BY THE RESPONSIBLE PARTY AT HIS SOLE EXPENSE, WHENEVER SO ORDERED BY THE TOWN ENGINEER, WITHOUT REFERENCE TO ANY PREVIOUS ERROR OR OVERSIGHT IN INSPECTION.

21. EXCEPT IN CASES OF EMERGENCY, MAINTENANCE, OR PROTECTION OF WORK ALREADY COMPLETED, NO WORK SHALL BE ALLOWED BETWEEN THE HOURS OF 7 P.M. AND 7 A.M.; NOR ON SATURDAY, SUNDAY, OR LEGAL HOLIDAYS UNLESS APPROVED BY THE TOWN ENGINEER IN EACH CASE. WHEN ANY INSPECTOR IS REQUIRED TO WORK OUTSIDE THE HOURS OF 7 A.M. TO 4 P.M. ON TOWN BUSINESS DAYS, OVERTIME SHALL BE CHARGED TO THE RESPONSIBLE PARTY. HOWEVER,

SUCH INSPECTORS SHALL REMAIN EMPLOYEES OF THE TOWN FOR ALL PURPOSES. REQUESTS FOR OVERTIME SHALL BE MADE TO THE TOWN ENGINEER AT LEAST 48 HOURS IN ADVANCE. PAYMENT FOR SUCH OVERTIME WORK SHALL BE MADE TO THE TOWN PRIOR TO FINAL ACCEPTANCE.

22. IN THE EVENT ONE OR MORE INSPECTORS REPRESENTING PRIVATE CONSULTING ENGINEERING FIRMS ARE ALSO INSPECTING A PROJECT ALONG WITH THE TOWN ENGINEER, THE INSTRUCTIONS GIVEN BY THE TOWN ENGINEER SHALL PREVAIL IN THE EVENT OF CONFLICTING INSTRUCTIONS.

23. ALL TREES AND VEGETATION TO REMAIN SHALL BE PROTECTED IN PLACE. CONSTRUCTION FENCING SHALL BE INSTALLED OUTSIDE THE CRITICAL ROOT ZONE (CRZ). CRZ DIAMETER SHALL BE DEFINED BY THE GREATER OF THE DRIP LINE OR 1 FOOT RADIALLY FOR EVERY 1 INCH TREE DIAMETER AT BREAST HEIGHT. HAND EXCAVATION REQUIRED WHERE WORK IS PROPOSED WITHIN CRZ. DEEP WATER TREES WEEKLY. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO REPAIR OR REPLACE ANY DAMAGE TO LANDSCAPING THAT IS NOT SPECIFIED FOR REMOVAL.

24. THE WORK SHALL BE SURVEYED AND STAKED UNDER THE SUPERVISION OF A LICENSED LAND SURVEYOR IN ACCORDANCE WITH THE APPROVED PLANS.

25. RIM AND GRATE ELEVATIONS SHOWN ON PLANS ARE APPROXIMATE ONLY AND ARE NOT TO BE TAKEN AS FINAL ELEVATIONS. THE CONTRACTOR SHALL ADJUST RIMS AND OTHER IMPROVEMENTS TO MATCH FINAL PAVEMENT AND FINISHED GRADE ELEVATIONS.

26. THE CONTRACTOR SHALL FURNISH THE ENGINEER OF RECORD A COMPLETE SET OF CONSTRUCTION RECORD DRAWINGS ("AS-BUILTS"), FOR THE CONSTRUCTED IMPROVEMENTS. THE PLANS SHALL SHOW SUFFICIENT DIMENSION TIES TO PERMANENT SURFACE FEATURES FOR ALL BURIED FACILITIES TO ALLOW FOR FUTURE LOCATING. THE PLANS SHALL SHOW FINAL PAVEMENT, FLOW LINE ELEVATIONS, CONTOURS AT POND/DRAINAGEFEATURES (AS SURVEYED AND CERTIFIED BY A COLORADO P.L.S.), MANHOLE, PIPE, AND INLET LOCATIONS, INVERTS, GRATE ELEVATIONS, SIZES OF ALL UTILITIES, AND ANY VARIATIONS FROM THE APPROVED PLAN. FINAL AS-BUILT PLANS PREPARED BY THE ENGINEER OF RECORD SHALL BE PROVIDED TO THE TOWN OF BERTHOUD.

27. IF A FOUNDATION UNDERDRAIN SYSTEM IS INSTALLED IN THE PUBLIC RIGHT-OF-WAY, THE FOLLOWING STATEMENT SHALL BE INCLUDED IN THE DRAWINGS:

    i. “THE FOUNDATION UNDERDRAIN SYSTEM IS THE RESPONSIBILITY OF THE OWNER/DEVELOPER OR ITS ASSIGNS. THE TOWN IS NOT RESPONSIBLE FOR THE MAINTENANCE OR REPAIR OF SAID SYSTEM.”

C. GRADING NOTES
1. CONSTRUCTION SHALL ADHERE TO THE FOLLOWING SEQUENCE UNLESS OTHERWISE SPECIFIED BY THE TOWN ENGINEER: SANITARY SEWER INSTALLATION, WATER MAIN INSTALLATION, CURB AND GUTTER INSTALLATION, WATER SERVICE INSTALLATION.

2. COMPACTION OF ALL TRENCHES MUST BE ATTAINED AND COMPACTION TEST RESULTS SUBMITTED TO THE ENGINEER AND THE TOWN OF BERTHOUD PRIOR TO FINAL ACCEPTANCE.

3. ALL WORK, INCLUDING CORRECTION WORK, SHALL BE INSPECTED BY A TOWN REPRESENTATIVE WHO SHALL HAVE THE AUTHORITY TO HALT CONSTRUCTION WHEN STANDARD CONSTRUCTION PRACTICES ARE NOT BEING ADHERED TO.

4. DEVELOPER AND BUILDER SHALL REGULARLY PATROL THE PUBLIC LANDS ADJACENT TO THE DEVELOPMENT TO REMOVE CONSTRUCTION DEBRIS AND KEEP THE SITE CLEAN AND SAFE.

5. ALL SITE GRADING (EXCAVATION, EMBANKMENT, AND COMPACTION) SHALL CONFORM TO THE RECOMMENDATIONS OF THE LATEST SOILS INVESTIGATION FOR THIS PROPERTY AND SHALL FURTHER BE IN CONFORMANCE WITH THE TOWN OF BERTHOUD STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC AND PRIVATE IMPROVEMENTS", LATEST EDITION. A CDPS GENERAL PERMIT FOR STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES SHALL BE OBTAINED PRIOR TO ANY GRADING BEING PERFORMED ON SITES ONE (1) ACRE OR LARGER IN SIZE. THESE PERMITS CAN BE OBTAINED FROM THE STATE WATER QUALITY CONTROL DIVISION.

6. NATURAL VEGETATION SHALL BE RETAINED AND PROTECTED WHEREVER POSSIBLE. EXPOSURE OF SOIL TO EROSION BY REMOVAL OR DISTURBANCE OF VEGETATION SHALL BE LIMITED TO THE AREA REQUIRED FOR IMMEDIATE CONSTRUCTION OPERATION AND FOR THE SHORTEST PRACTICAL PERIOD OF TIME.

7. TOPSOIL SHALL BE STOCKPILED TO THE EXTENT PRACTICABLE ON THE SITE FOR USE ON AREAS TO BE REVEGETATED. ANY AND ALL STOCKPILES SHALL BE LOCATED AND PROPER MEASURES TAKEN TO CONTROL EROSION AND SEDIMENT MOVEMENT.

8. AT ALL TIMES, THE PROPERTY SHALL BE MAINTAINED AND/OR WATERED TO PREVENT WIND-CAUSED EROSION. EARTHWORK OPERATIONS SHALL BE DISCONTINUED WHEN DUST SIGNIFICANTLY IMPACTS ADJACENT PROPERTY. IF EARTHWORK IS COMPLETE OR DISCONTINUED AND DUST FROM THE SITE CONTINUES TO CREATE PROBLEMS, THE OWNER/DEVELOPER SHALL IMMEDIATELY INSTITUTE MITIGATIVE MEASURES AND SHALL CORRECT DAMAGE TO ADJACENT PROPERTY.

9. PERMANENT SLOPES SHALL NOT EXCEED 4:1 (H:V) IN AREAS TO BE SEEDED OR SODDED. RETAINING WALLS SHALL BE REVIEWED AND APPROVED BY SEPARATE APPLICATION TO THE TOWN OF BERTHOUD.

10. THIS EROSION AND SEDIMENT CONTROL PLAN HAS BEEN SUBMITTED TO THE TOWN OF BERTHOUD AND IS IN GENERAL CONFORMANCE WITH THE TOWN'S EROSION CONTROL STANDARDS. ADDITIONAL EROSION AND SEDIMENT CONTROL MEASURES MAY BE REQUIRED OF THE OWNER AND THE OWNER'S AGENTS DUE TO UNFORESEEN EROSION PROBLEM OR IF THE PROPOSED EROSION CONTROL MEASURES DO NOT FUNCTION AS INTENDED. THE REQUIREMENTS OF THIS EROSION CONTROL PLAN AND THE OBLIGATION OF THE LANDOWNER SHALL RUN WITH THE LAND UNTIL SUCH TIME AS THE EROSION CONTROL PLAN IS PROPERLY COMPLETED, OFFICIALLY MODIFIED, OR VOIDED.

D. WATER NOTES

1. ALL WATER MATERIALS, CONSTRUCTION, AND TESTING SHALL MEET THE REQUIREMENTS OF BERTHOUD STANDARDS AND SPECIFICATIONS AND THE BERTHOUD FIRE PROTECTION DISTRICT SPECIFICATIONS.

2. FIRE HYDRANT SPECIFICATIONS:'
   i. ALL FIRE HYDRANTS WILL BE MUELLER OR SUBSTITUTE APPROVED BY THE TOWN ENGINEER.
   ii. ALL HYDRANTS WILL HAVE A FIVE AND ONE-QUARTER (5-1/4) INCH OR LARGER

VALVE OPENING, TWO (2) TWO AND ONE-HALF (2-1/2) INCH HOSE NOZZLES, ONE (1) PUMPER NOZZLE AND SIX (6) INCH OR LARGER MECHANICAL JOINT INLET.

iii. ALL NOZZLES SHALL HAVE NATIONAL STANDARD THREADS.

iv. THE HYDRANT SHALL BE OF TRAFFIC HAZARD TYPE WITH SAFETY FEATURES WHICH WILL PREVENT BARREL BREAKAGE.

v. SPECIFICATIONS FOR THE OPERATING NUT AND STUBS AND CUPS SHALL BE ONE (1) INCH SQUARE OR PENTAGON AND OPEN RIGHT.

3. WATER SERVICE LINE SPECIFICATIONS:
   i. CORPORATION STOPS SHALL HAVE INLET THREADED CC TYPE, OUTLET COPPER COMPRESSION OR FLARE, NO SOLDERING WILL BE ALLOWED.
   ii. SERVICE SADDLES SHALL BE “O” RING GASKET, DOUBLE BAND, OR HINGE PIN CC THREAD, ¾ INCH – 2 INCH COPPER.
   iii. CURB STOP STYLE SHALL BE COMPRESSION OR FLARED COPPER BOTH ENDS, MINNEAPOLIS PATTERN VALVE-THREADS AROUND TO ALLOW MINNEAPOLIS STYLE CURB BOX.
   iv. CURB BOX SHALL HAVE MINNEAPOLIS BASE EXTENSION TYPE CURB BOXES, CAST IRON LID AND BASE WITH BRASS PENTAGON HEAD PLUG USING A 1 ½ INCH UPPER SECTION.

4. ALL WATER VALVES SHALL OPEN LEFT.

5. THE MINIMUM COVER OVER THE WATER LINE IS 5 FEET AND THE MAXIMUM COVER IS 6 FEET UNLESS OTHERWISE NOTED IN THE PLANS AND APPROVED BY THE TOWN.

6. PRIOR TO INSTALLATION OF WATER MAINS, ROAD/DRIVE CONSTRUCTION MUST HAVE PROGRESSED TO AT LEAST THE “SUB-GRADE” STATE. SUB-GRADE IS DEFINED AS AN ELEVATION OF NO MORE THAN SEVEN (7) INCHES BELOW THE FINISHED STREET GRADE. ALL VALVE BOXES AND FIRE HYDRANTS WILL BE ADJUSTED TO THE FINAL FINISHED GRADE BY THE CONTRACTOR.

7. BEFORE ANY TAPS ARE MADE FROM MAINS, APPLICATIONS FOR THE TAPS MUST BE RECEIVED AND APPROVED BY THE TOWN.

8. TRACER WIRE SHALL BE USED FOR ALL WATER MAINS, REGARDLESS OF MATERIAL. TRACER WIRE SHALL BE BROUGHT UP TO TEST STATIONS AT ALL FIRE HYDRANTS

9. PVC WATER MAINS SHALL BE AWWA C900, DR 18

10. WATER SERVICES SHALL BE TYPE K COPPER.

11. CONTRACTOR TO CONTACT BUILDING DEPARTMENT PRIOR TO INSTALLATION OF METER SETTER.

E. SANITARY NOTES
1. MATERIALS AND WORKMANSHIP SHALL CONFORM TO THE LATEST EDITION OF THE TOWN OF BERTHOUD STANDARDS AND SPECIFICATIONS AND WORK SHALL BE SUBJECT TO INSPECTION AND APPROVAL BY AUTHORIZED TOWN OF BERTHOUD PERSONNEL.

2. NEW SEWER MAINS SHALL BE POLYVINYL CHLORIDE (PVC) ASTM D3034 SDR-35 PIPE AND IN ACCORDANCE WITH THE ABOVE REFERENCED SPECIFICATIONS.

3. CONTRACTOR TO VERIFY LOCATIONS AND ELEVATIONS OF EXISTING UTILITIES PRIOR TO COMMENCING ANY CONSTRUCTION.

4. THE CONTRACTOR SHALL NOTIFY THE TOWN A MINIMUM OF 48 HOURS AND A

MAXIMUM OF 96 HOURS PRIOR TO STARTING CONSTRUCTION OR PRIOR TO RESUMING CONSTRUCTION AFTER A BREAK.

5. MAINTAIN A MINIMUM OF 10 FEET HORIZONTAL SEPARATION OUTSIDE DIAMETER TO OUTSIDE DIAMETER BETWEEN WATER MAINS AND ALL SEWER MAINS AND MANHOLES.

6. ALL SEWER MAINS CROSSING WATER MAINS WITH LESS THAN 18 INCHES OF SEPARATION SHALL BE ENCASED IN CONCRETE.

7. RIM ELEVATIONS SHOWN ARE APPROXIMATE AND SHOULD NOT BE TAKEN AS FINAL. ALL MANHOLES SHALL BE FINAL ADJUSTED AFTER PAVING SUCH THAT THE RIM IS ¼ TO ½ INCH BELOW FINISHED ASPHALT. MANHOLES IN UNPAVED AREAS SHALL BE SET SO THAT THE RIM IS 0.5' ABOVE FINISHED GRADE. BURIED MANHOLES ALLOWED IN CULTIVATED FIELDS AS APPROVED BY TOWN ENGINEER. AS-BUILTS SHALL ALLOW FINAL NORTHING/EASTING AND RIM ELEVATION OF ALL BURIED MANHOLES.

8. INVERT (AS-BUILT) DATA SHALL BE COLLECTED BY A LICENSED SURVEYOR ON EACH PIPE INVERT IN A MANHOLE. CENTER OF MANHOLE SURVEYING IS NOT ACCEPTABLE FOR SLOPE CALCULATIONS. RECORD DRAWINGS (AS-BUILTS) MUST DEMONSTRATE CONFORMANCE TO TOWN STANDARDS.

9. THE CONTRACTOR SHALL HAVE A SET OF APPROVED PLANS ON SITE AT ALL TIMES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR RECORDING ACTUAL RECORD DRAWING DIMENSIONS AND DISTANCES AS WELL AS SERVICE LOCATIONS ON THESE PLANS AND SUBMITTING THEM TO THE ENGINEER FOR PREPARATION OF RECORD DRAWINGS. THESE DRAWINGS SHALL BE KEPT CURRENT AT ALL TIMES.

10. BEFORE ANY CONSTRUCTION COMMENCES, A PLUG SHALL BE INSTALLED TO PREVENT DRAINAGE THROUGH THE NEW SEWER LINE FROM ENTERING THE EXISTING SEWER LINE. THIS PLUG WILL BE INSTALLED IN THE MANHOLE, WHICH CONNECTS NEW WORK WITH THE EXISTING AND MAY NOT BE REMOVED UNTIL SUBSTANTIAL ACCEPTANCE.

11. UNDERDRAINS, IF INSTALLED, ARE THE RESPONSIBILITY OF THE DEVELOPER. THE TOWN ASSUMES NO LIABILITY FOR ANY PORTION OF OR ANY DAMAGE CAUSED BY UNDERDRAINS. ABSOLUTELY NO PART OF AN UNDERDRAIN SYSTEM, INCLUDING CLEAN OUTS, WILL BE ALLOWED INSIDE OF SANITARY SEWER MANHOLES. ALL UNDERDRAINS SHALL BE INSTALLED BELOW THE SANITARY SEWER AND OFFSET TO THE SIDE. PIPE MATERIAL SHALL BE DIFFERENT COLOR THAN SANITARY SEWER.

12. NO SERVICE LATERALS SHALL ENTER MANHOLES WITHOUT AN EXCEPTION GRANTED BY THE TOWN ENGINEER.

13. SERVICE CROSSINGS OF CURB SHALL BE MARKED WITH A CUT "S" IN CURB FACE. PAINT IS NOT ACCEPTABLE. SERVICE SHALL BE EXTENDED INTO THE LOT A MINIMUM OF 10 FEET.

14. TRACER WIRE SHALL BE USED FOR ALL SANITARY SEWER MAINS AND SERVICE LINES, REGARDLESS OF MATERIAL. TRACER WIRE SHALL BE BROUGHT UP TO ACCESS POINTS AT ALL CLEANOUTS AND MANHOLES.

15. CONTRACTOR SHALL MARK THE END OF ALL SEWER SERVICES AND MAIN STUBS WITH A CARBONITE COMPOSITE UTILITY MARKER WITH MINIMUM OF FOUR FEET ABOVE GRADE, PAINTED GREEN.

16. ALL 8-INCH PIPES SHALL HAVE SQUEEGEE (CDOT #8 BEDDING) UNLESS OTHERWISE SHOWN OR THE TOWN MAY APPROVE AN ALTERNATE BEDDING IN SPECIAL CASES. LARGER PIPES REQUIRE WASHED OR CRUSED ROCK AS SHOWN IN THE CONSTRUCTION SPECIFICATIONS

17. PRIOR TO APPROVAL, ALL SANITARY SEWER PIPES SHALL BE PRESSURE- TESTED PER ASTM C924. ALL MANHOLES SHALL BE VACUUM-TESTED PER UNI-B-98.

18. PRIOR TO REMOVAL OF PLUGS AT MANHOLES, PIPE SHALL BE JET-CLEANED AND VACUUMED TO REMOVE DEBRIS AND VIDEOED. NOTICE SHALL BE GIVEN TO THE TOWN INSPECTOR ONE (1) WEEK PRIOR TO CLEANING. INSPECTOR MUST BE PRESENT DURING THE OPERATION. ONCE APPROVAL HAS BEEN GIVEN BY INSPECTOR, PLUGS MAY ONLY BE REMOVED AFTER CONDITIONAL ACCEPTANCE BY THE TOWN.

19. THE FINAL RECORDED PLAT AND RECORDED ADDRESS PLAT SHALL BE PROVIDED TO THE TOWN FOR CONDITIONAL ACCEPTANCE.

20. TWENTY (20) MONTHS AFTER CONSTRUCTION AND PRIOR TO THE EXPIRATION OF WARRANTY, THE DEVELOPER SHALL CAMERA/VIDEO THE SANITARY SEWER LINES AND PROVIDE A DVD TO THE TOWN FOR REVIEW.

201.4 Stormwater Report Requirements

A. The purpose of the Stormwater Report is to provide a detailed study and analysis of the proposed development. It shall include calculations for all runoff and for all drainage structures of facilities within the development. Also, any change to the Preliminary concept shall be presented in the Final Report.

B. The Preliminary Drainage Report shall be submitted with the Preliminary Plat for the site or as required by the Town Municipal Code. A Preliminary Report shall also be submitted as part of the initial Site Plan submittal A Final Drainage Report will be required for final Site Plan approval.

C. The Final Stormwater Report shall be submitted with the civil construction drawings for the site. The Final Report (which updates the Preliminary Drainage Report) shall be reviewed with the submittal of the construction plans and approved by the Town Engineer prior to issuance of development permit.

D. Reports shall be electronic .pdf reports with all figures, appendices, and calculations, unless hard copies are requested by Town.

E. The report shall include a cover letter presenting the final design for review and shall be prepared by or under the direction of an engineer licensed in Colorado. The report also shall contain a Responsible Party certification sheet as follows:

1. "*(Name of Responsible Party)* hereby certifies that the drainage facilities for *(Name of Development)* will be constructed according to the design presented in this report. I understand that the Town of Berthoud does not and shall not assume liability for the drainage facilities designed and/or certified by my engineer. I understand that the Town of Berthoud reviews drainage plans but cannot, on behalf of *(Name of Development),* guarantee that final drainage design review will absolve *(Name of Responsible Party)* and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the Plat and/or Development Permit does not imply approval of my engineer's drainage design."

Attest: _____

(Name of Responsible Party)

_____

Authorized Signature

2. "I hereby certify that this report (plan) for the final drainage design of *(Name of Development)* was prepared by me (or under my direct supervision) in accordance with the provisions of the Town of Berthoud Standards and Specifications for the Design and Construction of Public and Private Improvements for the Responsible Parties thereof. I understand that the Town of Berthoud does not and shall not assume liability for drainage facilities designed by others."

_____

Registered Professional Engineer

State of Colorado No. _____ (Affix Seal)

F. Preliminary Drainage Report

1. A preliminary drainage report shall provide an overview and impacts analysis of the proposed project or development, existing and developed runoff conditions, stormwater runoff flow rates and volumes, water quality and erosion control measures, stormwater attenuations or detention ponding measures, proposed stormwater utility improvements, basic design requirements, referenced study resources, methods, and findings. The preliminary drainage report shall be prepared by the Engineer of Record and include at a minimum the following sections. Approval of a preliminary drainage report and figures shall not be construed as approval of specific design details or the final drainage report and figures.

    a. Cover letter presenting design for review
    b. Background
        i. Provide written statement and discussion describing the proposed project or development including at a minimum the following information
        ii. Site location, including legal description (county, township, range, and section) and discussion of the area characteristics identifying land development patterns and

features, transportation networks, major drainageways, facilities, and easements within and adjacent to the site and stormwater and systems including creeks, channels, irrigation ditches, and storm sewers.

iii. Site description, including total land area, total offsite land area to be disturbed and/or effected, general topography, existing ground cover, wetlands, groundwater conditions.

iv. Name(s) of surrounding development(s).

c. Development Proposal

i. Provide a general description of the proposed project or development, including land use, density, site development plans and coverage, and stormwater planning concepts.

d. Existing Stormwater Basins and Drainage Patterns

i. Include a description of the existing stormwater basins and drainage patterns that are impacted by the site development, including

(a) The tributary stormwater basin containing the project site and tributary major drainageway.

(b) The stormwater major basin(s) that are onsite, upstream and downstream of the site,

(c) Offsite drainage patterns and their effect on site development,

(d) Onsite drainage patterns, existing runoff systems, and inflow and outflow points,

(e) Previous drainage studies for the site, drainage basin, or local area that may influence drainage design, and

(f) Existing drainage problems, floodplain impacts, and groundwater conditions contributing to site runoff.

e. Conformance with Stormwater Master Plan(s)

i. Describe how the proposed stormwater system improvements conform with adopted Stormwater Collections, Major Drainageways, and Stormwater Master Plans.

f. Design Criteria

i. Hydrology Criteria:

(a) Design Rainfall,

(b) runoff calculation method,

(c) detention discharge and storage calculation method,

(d) design storm recurrence interval,

(e) justification of other criteria or calculation methods used that or not presented or referenced in these Standards.

ii. Hydraulic Criteria

(a) State calculation methodology and programs that will be used for the hydraulic design and analysis and be completed with final design and included in the Final Drainage Report.

iii. Variance from Criteria

(a) Identify provisions by section number for which a variance is requested. Provide justification.

g. Wetlands Impacts

i. Identify any delineated wetland or wetland buffer areas identified by the US Fish & Wildlife Services.

(a) If there is an area on the project site further investigation by a certified wetland delineator to determine the extents of the wetland on site.

ii. Include any discussion of any necessary analyses, avoidance and mitigation measures, and improvements needed to address wetlands permitting requirements.

h. Developed Stormwater Conditions

i. Describe and define proposed stormwater runoff conditions following development, estimated by using the proposed land use and developed patterns for the project site

based on the minor and major storm events included a discussion and summary table of the following:
(a) Acceptance and conveyance of offsite runoff through the proposed site development
(b) Proposed major basin(s) and sub-basin(s) onsite, upstream and downstream of the site,
(c) Proposed drainage rates, flow patterns, drainage facilities, detention ponds, water quality measures, and outflow points,
(d) Downstream properties and systems, such as streets, utilities, existing structures, and developments, impacted by the proposed development from the site to the receiving major drainageway

ii. Proposed stormwater systems and facility design, including discussion of the following:
iii. General concepts and alternative for site drainage improvements, such as the provision, layout, alignment of storm sewer, open swales and channels, inlets, detention ponds and outlets.
iv. Solutions and alternatives for conveying onsite and contributing offsite runoff, mitigating drainage impacts, enhancing water quality, erosion and sediment control, and maintenance.

i. Water Quality
   i. Describe mitigation measures and improvements that will be utilized to address Town Standards and how these improvements will be accommodated within the site development plan.

j. Stormwater Detention
   i. Include a technical analysis of stormwater detention proposed for the development in conformance with these Standards. Identify the approximate size and location of any required detention facilities include the location of the emergency spillway and downstream pathway.

k. Include review and analysis of the downstream pathway to ensure there are no negative effects to the downstream properties for the proposed discharge rates
   i. Provide facility outlet flow rate(s) and emergency spillway flow rate.

l. Conclusions and Recommendations
   i. Include conclusions and recommendations for proposed drainage facilities to be provided in conjunction with site development, and conformance with these Standards.

2. References
   a. Provide references used in the design and preparation of the preliminary drainage report.

3. Technical Appendices
   a. Provide all technical support material in an appendix, including without limitation, engineering equations, assumptions, calculations used in preparing the report, and hydrologic and hydraulic sources, references, and methods. The hydrologic analysis shall include areas, storm frequencies, runoff coefficients, times of concentration, and all runoff computation. Any relevant pages from previous drainage reports referenced in the report shall be included in the appendices.

   b. Hydrologic models (CUHP, EPA SWMM, etc) if required per these Standards and Specifications need to be supplied.

4. Drawings and Figures
    a. Vicinity Map
        i. Provide a general location map identifying major drainageways and surrounding development and public infrastructure system. The map shall include and identify the following
            (a) site area,
            (b) the area contributing off-site flow,
            (c) location of the final discharge system (stream, lake, reservoir, etc.), and
            (d) the pathway for flow from the site to the final discharge system.
        ii. Typically, the map should be on 8 1/2 by 11 inches at a scale ranging from 1-inch equals 400 feet to 1-inch equals 2,000 feet.

    b. Floodplain Map
        i. Identify the 100-year floodplain, conveyances and high hazard zones for the site impacted by floodplains. Identify the site on the map.

    c. Wetland Map
        i. Identify Wetlands. Identify the site on the map.

    d. Existing Drainage Plan
        i. General Property Boundaries
        ii. Topography
        iii. Stormwater Basins and Design Points
        iv. Stormwater Drainage Facilities
        v. Streets
        vi. Irrigation Ditches
        vii. Floodplains and Wetlands
        viii. Site Runoff
        ix. Existing Building Floor Elevations
        x. Stormwater Routing

    e. Developed Drainage Plan
        i. General Property Boundaries
        ii. Topography
        iii. Stormwater Basins and Design Points
        iv. Stormwater Drainage Facilities
        v. Streets
        vi. Site Runoff
        vii. Irrigation Ditches
        viii. Floodplains and Wetlands
        ix. Proposed Building Floor Elevations
        x. Stormwater Routing Systems

    f. Construction Plan Sheets
        i. Stormwater Management Plan
        ii. Erosion Control Plan
        iii. Storm Plan and Profile Plan
        iv. Storm Details

G. Final Drainage Report
    1. A final drainage report shall provide an overview and impacts analysis of the proposed project or development, historic and developed runoff conditions, stormwater runoff flow rates and columns, water quality and erosion control measures, stormwater attenuation or detention ponding measures, proposed stormwater utility improvements, basic design requirements, and referenced study data sources, methods and findings, and include the following information:
        a. Provide written statement and discussion describing the proposed project or development including at a minimum the following information

i. Site location, including legal description (county, township, range, and section)
ii. Discussion of the area characteristics identifying
(a) Land development patterns and features
(b) Transportation networks and stormwater systems (creeks, channels, irrigation ditches, and storm sewers) in the surrounding area
iii. Site description, including total land area, total offsite land area to be disturbed or effected, general topography, and existing round cover, wetlands, groundwater conditions, and stormwater and irrigation ditch systems

b. Development Proposal
i. Provide a general description of the proposed project or development, including
(a) land use
(b) density
(c) site development plans and coverage
(d) stormwater planning concepts

c. Existing Stormwater Basins and Drainage Patterns include a description of the stormwater basins and drainage pattern that are impacted by the site development, including:
i. The tributary stormwater basin containing the project site and tributary major drainageway
ii. Proposed major basin(s) and sub-basin(s) onsite upstream and downstream of the site
iii. Offsite drainage patterns and their effect on site development
iv. Onsite drainage patterns, existing runoff systems, and inflow and outflow points,
v. Previous drainage studies for the site, drainage basin, or local area that may influence drainage design
vi. Existing drainage problems, floodplain impacts, and groundwater conditions contributing to site runoff

d. Conformance with Stormwater Master Plans
i. Describe how the proposed stormwater system improvements conform with adopted Stormwater Collections, Major Drainageways, and Stormwater Master Plans.

e. Design Criteria: Discussion of the proposed calculation methods and criteria used.
i. Hydrology Criteria: Design Rainfall, runoff calculation method, detention
(a) discharge and storage calculation method, design storm recurrence interval,
(b) justification of other criteria or calculation methods used that are not presented or referenced in these Standards.
ii. Hydraulic Criteria: Inlet, pipe, swale and other conveyance system sizing calculation methods, detention pond sizing calculation methods, and justification of other criteria or calculation methods used that are not presented or referenced in these Standards.
iii. Variance from Criteria: Identify provisions by section number for which a variance is requested. Provide justification.

f. Wetlands Impacts
i. Identify any delineated wetland or wetland buffer areas identified by the US Fish & Wildlife Services.
ii. If there is an area on the project site further investigation by a certified wetland delineator to determine the extents of the wetland on site.
(a) Include any discussion of any necessary analyses, avoidance and mitigation measures, and improvements needed to address wetlands permitting requirements.

g. Developed Stormwater Conditions: Describe and define proposed stormwater runoff conditions following development, estimated by using the proposed land use and developed patterns for the project site based on the minor and major storm events included a discussion and summary table of the following:

i. Acceptance and conveyance of offsite runoff through the proposed site development
ii. Proposed major basin(s) and sub-basin(s) onsite, upstream and downstream of the site
iii. Proposed drainage rates, flow patterns, drainage facilities, detention ponds, water quality measures, and outflow points
iv. Downstream properties and systems, such as streets, utilities, existing structures, and developments, impacted by the proposed development from the site to the receiving major drainageway
v. Proposed stormwater systems and facility design, including discussion of the following
(a) General concepts and alternatives for site drainage improvements, such as the provision, layout, alignment and size of storm sewer, open swales and channels, inlets, detention ponds and outlets.
(b) Solutions and alternatives for conveying onsite and contributing offsite runoff, mitigating drainage impacts, enhancing water quality, erosion and sediment control, and maintenance.

h. Water Quality
i. Describe mitigation measures and improvements that will be utilized to address Town Standards and how these improvements will be accommodated within the site development plan.
ii. Include a stormwater quality analysis stating the required and provided water quality capture volume treated onsite.

i. Stormwater Detention
i. Include a technical analysis of stormwater detention proposed for the development in conformance with these Standards.
ii. Identify the size and location of any required detention facilities including the location of the emergency spillway and downstream pathway.

j. Include review and analysis of the downstream pathway to ensure there are no negative effects to the downstream properties for the proposed discharge rates (facility outlet flow rate(s) and emergency spillway flow rate)

k. Stormwater Management Plan and Erosion Control Plan: Include analysis and describe necessary mitigation measures and improvements that will be incorporated into the erosion control plan as part of the site development. Provide a discussion of how proposed erosion and sedimentation control measures will ensure that downstream properties and drainageways will not be adversely impacted by site development and construction activities.

l. Conclusions and Recommendations
i. Include conclusions and recommendations for proposed drainage facilities to be provided in conjunction with site development, and conformance with these Standards.

2. References
a. Provide references used in the design and preparation of the final drainage report.

3. Technical Appendices
a. Provide all technical support material in an appendix including without limitation
i. Engineering equations, assumptions, calculations used in preparing the report, and hydrologic and hydraulic sources, references, and methods.
ii. The hydrologic analysis shall include areas, storm frequencies, runoff coefficients, times of concentration, and all runoff computation.
iii. Any relevant pages from previous drainage reports referenced in the report shall be included in the appendices.
b. Hydrologic and Hydraulic models (CUHP, EPA SWMM, etc) if created need to be

supplied.

c. Final Stormwater Design Features
   i. Construction plans for any site development shall include final stormwater design features in the report and attached drawings.
   ii. The final design information in the report shall provide the technical basis and support for the proposed construction design and all detailed engineering calculations for stormwater systems.
   iii. The stormwater system(s) shall be labeled as such that the storm system features can be identified between the report, calculations, and drawings/figures.
   iv. Design features include without limitation:
      (a) Inlet sizing and design,
      (b) Storm sewer sizing, design, type, EGL and HGLs,
      (c) Open channel (swale and drainageway) design and sizing,
      (d) Routing for stormwater conveyance (storm sewer and swales) and detention pond facilities,
      (e) Curb and gutter conveyance capacities,
      (f) Detention pond outfall structures (orifices, inlets, and weirs).
      (g) Water quality measures, and
      (h) Any unique stormwater improvements design details.

4. Drawings and Figures
   a. Vicinity Map shall provide a general location map identifying major drainageways, surrounding development, and public infrastructure system. The map shall include the site area, the area contributing off-site flow, location of the final discharge system (stream, lake, reservoir, etc.) and the pathway for flow from the site to the final discharge system. Typically, the map should be on an 8 1/2 by 11-inch at a scale ranging from 1-inch equals 400 feet to 1-inch equals 2,000 feet.

   b. Floodplain Map shall identify the 100-year floodplain, conveyances and high hazard zones for the site impacted by floodplains. Identify the site on the map.

   c. Wetland Map shall identify wetlands. Identify the site on the map.

   d. Existing Drainage Figure
      i. General Property Boundaries
      ii. Topography
      iii. Stormwater Basins and Design Points
      iv. Stormwater Drainage Facilities
      v. Streets
      vi. Site Runoff
      vii. Irrigation Ditches
      viii. Floodplains and Wetlands
      ix. Building Floor Elevations
      x. Stormwater Routing

   e. Developed Drainage Figure:
      i. General Property Boundaries
      ii. Topography
      iii. Stormwater Basins and Design Points
      iv. Storm System Features
      v. Stormwater Drainage Facilities
      vi. Riprap and Embankment Protection
      vii. Streets
      viii. Site Runoff
      ix. Irrigation Ditches
      x. Floodplains and Wetlands
      xi. Building Floor Elevations
      xii. Stormwater Routing System

f. Construction Plan Sheets:
   i. Stormwater Management Plan
   ii. Erosion Control Plan
   iii. Storm Plan and Profile Plan with Storm HGL's
   iv. Storm Details

202 PERMITS AND INSPECTIONS

202.1 Permits Required

A. All Contractors, public utility agencies, and property owners installing public or private improvements, or storing materials or equipment, within any public right-of-way or easement must obtain the required permit prior to the commencement of the work.

1. State and Federal Permits
   a. Land development activity and the construction of public infrastructure often requires additional permits from state and federal agencies. Examples include an Emission Permit for fugitive dust (issued by the Colorado Department of Public Health and Environment), a Discharge Permit for storm water associated with construction activity (issued by the Colorado Department of Health), and a Section 404 Permit for impacts to wetlands or waterways (issued by the US Army Corps of Engineers). It is the responsibility of the developer to obtain all applicable State and Federal Permits.

2. MS4 (Municipal Separate Storm Sewer System) Permitting Requirements
   a. General Requirement: Any land disturbance activities that disturb one or more acres of land, or projects that are part of a common plan, such as lots within an active subdivision, must obtain an MS4 (Municipal Separate Storm Sewer System) permit through the Town of Berthoud.
   b. Permit Application: The applicant must submit an MS4 permit application to the Town of Berthoud. The application must include a detailed site plan, erosion and sediment control plan, and a stormwater management plan that outlines best management practices (BMPs) to prevent pollutants from entering the storm sewer system.
   c. Erosion and Sediment Control Plan: This plan must detail the measures to be implemented before, during, and after construction to control soil erosion and sediment. The plan must comply with the standards set by the Colorado Department of Public Health and Environment (CDPHE).
   d. Stormwater Management Plan: The stormwater management plan must include:
      i. Runoff Control Measures: Strategies to manage stormwater runoff both during and after construction.
      ii. Inspection and Maintenance: Regular inspection and maintenance procedures to ensure the effectiveness of BMPs.
      iii. Post-Construction Controls: Long-term stormwater management practices to control the quality and quantity of stormwater runoff after the project is completed.
   e. Compliance with Federal and State Regulations: The applicant must ensure compliance with all relevant federal, state, and local stormwater regulations, including obtaining any necessary permits from the Colorado Department of Public Health and Environment (CDPHE).
   f. Enforcement: The Town of Berthoud reserves the right to inspect the construction site to ensure compliance with the MS4 permit requirements. Non-compliance may result in enforcement actions including stop-work orders, fines, or other penalties as deemed appropriate by the Town.

202.2 Application

A. Applications for the various permits are available through the Town of Berthoud. Application forms must be completed and submitted to the Town along with the required items stated on the permit application or as required by the Town.

202.3 Review and Approval of Submittals

A. The application will be reviewed by the Town of Berthoud. If additional information is required, the Applicant will be contacted. The Town of Berthoud will check to make certain that the Applicant has provided the required bond(s) and when applicable the license and insurance certificates. Once the permit application and all required submittals have been reviewed and found to be complete, the Permit may be issued by the Town of Berthoud.

202.4 Issuance of Permit

A. The Permit is issued to the Applicant after all fees have been collected.

B. The Town of Berthoud may authorize a private entity to issue permits for all work described in this chapter.

202.5 Plans

A. Any plans required for permit process shall clearly indicate the proposed work and its location. Refer to Section 201.2 for all plan requirements.

202.6 Permit Standard and Conditions

A. General Requirements
B. The Applicant shall be responsible for all of the following requirements which are relevant for the Project:
   1. Approval of Permit: Permits are issued subject to the approval of the Town of Berthoud, State, or other governmental agencies having either joint supervision over the section of road, or authority to regulate land use by means of zoning and/or building regulations.

   2. Other Agency Approval: Permit Applicants are responsible for obtaining separate permits or permission as may be required. Examples may be when work is proposed within the state highway, railroad or irrigation company rights-of-way or private property.

   3. Easements: It shall be the Applicant's responsibility to determine the necessity of any easements and to obtain those easements and approvals that may be required.

   4. Submittals and Fees: Applicant shall pay all required fees, provide insurance, surety (if required), and provide appropriate plans, if necessary.

   5. Coordination of Utility Work: The Applicant shall be responsible for coordinating any utility work including relocation of the utilities (e.g., power poles, transformers, signals, etc.).

   6. Affected Area: The Applicant is responsible for returning the areas affected by construction to equal or better condition. The Applicant is responsible for repairing any damage to private or public property or other adjacent right-of-way that occurs during construction.

   7. Not Transferable: The permit may not be transferable or assignable except as designated in the Development Agreement. The Applicant may subcontract the work to be performed under a permit, provided that the Applicant remains responsible for the performance of the work identified in the permit, the insurance and Surety, and the Warranty period. If permit is transferred, a new construction coordination meeting may be required.

   8. Supplemental Permit: No work outside the scope of the approved permit may occur without the approval of the Town Engineer. It is the Applicant's responsibility to notify the Town of Berthoud of the issues and apply for a supplemental permit for the additional work.

9. Public Display: All required permits and approved plans must be available on the job site at all times during construction and placement of traffic control devices.

10. Protection of Existing Improvements: Ensure protection as follows:
    a. Existing Installations: The Contractor shall at all times take proper precautions and be responsible for the protection of existing street and alley surfaces, driveway culverts, street intersection culverts or aprons, irrigation systems, mail boxes, driveway approaches, curb, gutter, and sidewalks, and all other identifiable installations that may be encountered during construction.
    b. Utilities: The Contractor shall at all times take proper precautions for the protection of existing utilities, the presence of which are known or can be determined by field locations of the utility companies. The Contractor shall contact Colorado 811 at 1-800-922-1987 for utility locates a minimum of 2 working days prior to his proposed start of work.
    c. Existing Improvements: Existing improvements to adjacent property such as landscaping, fencing, utility services, signs, driveway surfaces, etc., that are not authorized for removal, shall be protected from injury or damage resulting from the Contractor's operations.
    d. Survey Markers. The Contractor shall at all times take proper precautions for the protection of property pins/corners and survey control monuments encountered during construction. Any damaged or disturbed survey markers shall be replaced by a registered land surveyor at the Contractor's expense.
    e. Responsibility for Repair: The repair of any damaged improvements as described above shall be the responsibility of the permit holder.
    f. Minimizing Inconvenience. The Contractor shall abide by the requirements set forth by the permit to minimize inconvenience to traffic and any inconvenience to adjacent property owners.

11. Work to be Done in Expedient Manner: All work shall be done in an expedient manner. Repairs shall be made as rapidly as is consistent with high quality workmanship and materials. Use of fast setting concrete and similar techniques may be required and are encouraged whenever possible without sacrificing the quality of repair.

12. Inspection Requests: It shall be the responsibility of the person performing the work authorized by the permit to notify the Town Engineer or authorized representatives that such work is ready for inspection. The Town Engineer requires that every request for inspection be received at least 48 hours before such inspection is desired. Such requests may be in writing or by telephoning the Town Engineer.

13. Removal and Replacement of Unsatisfactory Work: Removal and replacement of unsatisfactory work shall be completed within fifteen days of written notification of the deficiency unless deemed an emergency requiring immediate action. If deemed an emergency for health/safety reasons, the contractor must complete the work immediately. In the event the replacement work has not been completed, the Town of Berthoud will take action against the Contractor's bond to cover all related costs.

14. Road Closures: Road closures will only be allowed with the written approval of the Town Engineer. Proper posting and public notification will be required 7 days in advance of any closure. Forms of notification may include door hangers, variable message signs and press releases.

202.7 Construction Water

A. Water from the Town of Berthoud used during construction can only be acquired using a Town approved meter at a Town approved hydrant. Failure to comply with this policy could result in fines and penalties from the Town. Use of water from the Town of Berthoud without a town approved meter or at a town approved hydrant can be deemed as water theft.

202.8 Stop Work Orders

A. Any person, corporation, quasi-governmental agency, special district, public utility, or private utility company that has performed work without first having obtained a permit, or has performed work in the right-of-way that is considered a safety hazard, or has non-conforming items that have not been addressed, will be issued a notice to stop work. All specified work shall be discontinued until required repairs or permits are in place. The Town Engineer or Inspector is authorized to issue Stop Work Orders. The stop work order shall contain a written statement of the violations that caused the issuance. Immediately upon receipt of a stop work order, the Applicant shall consult with the Town Engineer to resolve the violation.

CHAPTER 300 STREET AND ROADWAY DESIGN

301 GENERAL PROVISIONS

301.1 General

A. These Standards and Specifications are promulgated by the Town Administrator in accordance with the authority contained within the Town of Berthoud Municipal Code. Improvements shall also be in conformance with the Town of Berthoud Municipal Code.

301.2 Purpose

A. This Chapter contains minimum criteria to be met on newly designed and constructed public and private streets and parking lots in the Town. Roadway design shall meet or exceed these Standards and Specifications. Improvements shall be in conformance with the Development Code and the most recent version of the Larimer County Urban Area Street Standards (LCUASS). The most recent version of LCUASS standards shall be used for the street and roadway design. When differing standards are available, the Loveland referenced design standards in LCUASS shall be followed. Policies and technical criteria not specifically addressed in this document shall follow the provisions of the American Association of State Highway and Transportation Officials (AASHTO), CDOT Standard Specifications for Road and Bridge Construction (CDOT S&S), Highway Capacity Manual, Manual on Uniform Traffic Control Devices (MUTCD), and the Colorado Department of Transportation's Standard Plans ("M-Standards").

B. These Standards and Specifications are supplementary to the most recent version of LCUASS. In the event there is a discrepancy between LCUASS and these Standards and Specifications, LCUASS should supersede the Standards and Specifications.

302 DESIGN CRITERIA

302.1 Street Classifications

A. All streets are classified as Arterial, Collector, Local streets, Lanes or Alleys. These classifications relate to the function of the streets. Lower order streets function primarily as access to individual lots, and higher order streets function primarily for the purpose of mobility (expeditious movement of people and goods).

B. Street cross sectional elements shall be determined by the Town Engineer. Collector and arterial streets shall be constructed whenever the alignment of the proposed street is generally the same as the collector and arterial streets shown on the Comprehensive Plan, Transportation Plan, or whenever a traffic engineering analysis of the future traffic volumes indicates the need for a cross section greater than that of a local residential street. The development Transportation Impact Study shall determine the required street classification based on anticipated traffic volumes.

C. Additional ROW may be required to satisfy other criteria contained in these Standardsand Specifications. Areas outside the ROW shall be contour graded, compacted, and sloped, as required for proper drainage, soil stability, and maintenance accessibility.

302.2 Traffic Impact and Access Study Report

A. LCUASS Standards for Traffic Impact Studies shall be followed.

303 CONSTRUCTION SPECIFICATIONS

303.1 General

A. All Street Construction shall be completed in accordance with the Construction Specifications included in Appendix A.

304 STREET SECTIONS

304.1 Street Detail Requirements

A. Street cross sections within the Town shall follow the LCUASS Loveland Standard sections.
   1. Where a street falls within a special district, including the Mountain Avenue Overlay District and 1st Street Overlay District, the street sections in those District documents shall supercede standard street sections.

305 STREET FRONTAGE IMPROVEMENTS

305.1 Construction Requirements

A. Street frontage improvements are required for the following development projects
   1. *New Construction.* The installation of street frontage improvements is required prior to issuance of a certificate of occupancy for all new construction projects except two or fewer single-family houses (when constructed concurrently on adjacent existing lots) or one duplex, unless otherwise required by the Town Engineer.

   2. *New Subdivisions and Short Plats.* The installation of street frontage improvements is required prior to final plat approval for subdivisions and short plats which create two or more additional/new lots, unless otherwise required by the Town Engineer.

   3. *Additions, Alterations, or Tenant Improvements - Special Provisions Apply.* Street frontage improvements shall be constructed as part of all additions, alterations or tenant improvements if one of the following conditions is met.
      a. The proposed addition, alteration, or tenant improvement, will generate an increase in traffic exceeding 12 additional/new vehicular trips per day as determined by the latest edition of the Institute of Transportation Engineers (ITE) manual.

      b. The proposed addition, alteration or tenant improvement is considered a change of use which intensifies the use of the site or significantly alters the traffic circulation within the site.

      c. The proposed addition, alteration or tenant improvement will create a traffic safety concern or exacerbate a known traffic safety concern in surrounding project vicinity.

      d. The proposed addition, alteration or tenant improvement will redevelop the property (remove/ demolish existing buildings, parking areas and improvements on site and construct new buildings, parking areas and improvements within the property).

305.2 Scope of Improvements

A. Street frontage improvements shall be installed along the entire frontage of the property, to the centerline of the street, or if a multi-lane street, the affected lane, at the sole cost of the applicant as directed by the Town Engineer. Modifications of street improvement standards may be permitted where the required street improvements are not, in the opinion of the Town Engineer, proportionate to the impact, type, scale and cost of the proposed development action.
   1. Street frontage improvements may include the following.
      a. Curb and gutter
      b. Sidewalks and trails
      c. Storm drainage improvements
      d. Street lighting
      e. Traffic signal equipment
      f. Utility installation, extension, or relocation
      g. Street trees and landscaping,
      h. Irrigation
      i. Street widening or channelization
      j. Pavement overlay or reconstruction

2. In addition to required frontage improvements, the applicant shall provide ramps from the new sidewalk or walkway to the existing shoulder, across streets and pavement and channelization tapering back to the existing pavement and channelization as required to address safety concerns.

3. Proposed trails shown in the Trail Master Plan shall be constructed per typical sections in that plan for the specified trail as part of the street frontage requirements.

B. Frontage Improvement Pavement Requirements
   1. Half-street pavement reconstruction shall be required when
      a. Existing pavement condition rating is at or below 40, based on the pavement condition index score as calculated with DRCOG's PCI program
      b. Crown slope is greater than three percent;
      c. Street frontage is light bituminous pavement; and/or
      d. Street frontage was built with no base structure.
         i. Pavement coring and/or subsurface investigation by a geotechnical engineer shall be required to determine base condition.

   2. Half-street asphalt overlay (two-inch minimum} shall be required when the existing pavement rating is at or below 60 based on the pavement condition index score as calculated with DRCOG's PCI program.
      a. Pre-leveling and/or grinding may be required to create a uniform two percent crown slope.

   3. Minimum frontage improvement pavement requirements shall be a patch per Town standard plans and one lane grind/inlay
      a. Two (2) inches minimum

305.3 Deferral of Improvements

A. When the Town has plans for an improvement project or other similar reasons, the Town Engineer may determine that street frontage improvements cannot or should not be constructed at the time of building or subdivision construction and may allow improvements to be deferred. In these instances, the property owner shall, prior to issuance of the building permit or site development permit, at the direction of the Town Engineer

   1. Pay to the Town an amount equal to the property owner's cost of installing the required improvements prior to issuance of a building permit. The property owner shall provide documentation satisfactory to the Town Engineer that establishes the cost of the materials, labor, quantities; or

   2. Record an agreement which provides for these improvements to be installed by the property owner by a date acceptable to the Town Engineer; or

   3. Record an agreement to not protest a local improvement district to improve the street frontage.

305.4 Corner Lots

A. For corner lots or other development sites fronting multiple rights-of-way, where the impact of the proposed development does not necessitate street system improvements along all adjoining rights-of-way, such improvements shall be constructed along the right-of-way or rights-of-way as determined by the Town Engineer.

305.5 Traffic Control Devices

A. The type and location of traffic control devices used on Town streets must be approved by Town Staff.

B. Traffic signals shall be installed only where warranted. Alternative traffic control measures, such as roundabouts, shall be evaluated and considered as the preferred option prior to signal installation.

C. When it can be shown that a particular zoning action, master plan, or development plan impacts the street system to a point that a traffic signal is required according to MUTCD warrants, and the signal is approved by Town Staff, the developer shall be responsible for all or a portion of the signal installation.

305.6 Dedication of Right-of-Way

A. The Town Engineer may require the applicant to deed to the Town additional right-of-way, as necessary, from the property under consideration to create a right-of-way width which complies with state statutes, Town ordinances, and any other statutes, ordinances, or regulations as a means of mitigating any impact the project may have on the Town street system.

306 PAVEMENT DESIGN REQUIREMENTS

306.1 Pavement Design Criteria

A. The design of streets shall be based on the design period of twenty (20) years.

B. If a single pavement design is used for all streets within the development, that pavement design shall be based on the worst soil encountered from the standpoint of subgrade support.

C. The design of pavements shall be based upon the Roadway Design Manual of the State of Colorado, Department of Transportation, as modified by these specifications.
   1. The Colorado Department of Transportation methodology is accepted for both rigid and flexible street pavement designs.

   2. The strength coefficients of the various layers of the pavement structure shall be determined from the Colorado Department of Transportation Roadway Design Manual.

306.2 Concrete Pavement

A. The minimum concrete structural section shall be seven (7) inches of non-reinforced Portland Cement concrete pavement placed on six (6) inches of Class 4 or Class 5 base and compacted subgrade.
   1. If the minimum pavement section is to be used, the Soils Report and Pavement Design must demonstrate the adequacy of the structural section for the soil conditions encountered.

B. Construction plans for concrete pavement shall include a layout for locations of construction joints.

C. Concrete pavement shall not be allowed on local streets.

D. The City reserves the right to require concrete or treated subgrade in locations where traffic, utilities, type of construction, or time of construction would make asphalt on aggregate impractical.

306.3 Asphalt Pavement

A. Flyash or cement subgrade treatment shall be required with all new roads constructed in the Town of Berthoud.
   1. A pavement design shall be submitted that includes the flyash treatment of the subgrade recommended in these specifications by a Geotechnical Engineer licensed in the state of Colorado.
      a. Full-depth asphalt is not an accepted alternate of treated subgrade is used.

   2. When flyash is used, a bond breaker shall be used.
      a. The thickness and the type of bond breaker shall be recommended by the geotechnical engineer and approved by the Town Engineer.

CHAPTER 400 SANITARY SEWER UTILITY

401 GENERAL PROVISIONS

401.1 General

A. These Standards and Specifications are promulgated by the Town Administrator in accordance with the authority contained in the Town of Berthoud Municipal Code. Improvements shall also be in conformance with theTown of Berthoud Municipal Code.

401.2 Purpose

A. This Chapter pertains to all components of the sanitary sewer system. Designs are intended to provide safe, reliable sewer service to customers and serve the sewage treatment needs of customers in an efficient, cost-effective and environmentally responsible manner. Determination of the best materials and construction methods are based upon lowest life cycle costs, not necessarily upon lowest initial costs.

B. All utility installation within the Town Right-of-Way shall require a Right-of-Way Use Permit prior to any installation activity. See Chapter 200 regarding permits and permitting processes in the Town and Chapter 300 regarding road cut standards.

C. All utility installation outside of the Town Right-of-Way (private property) shall require a Grading Permit prior to any installation activity. See Chapter 200 for Grading Permit regulations.

D. All utilities must be clearly labeled on the plans and include the type, size, depth, etc.

401.3 General Specifications

A. General Process/Submittal Requirements

1. The purpose of these Standards and Specifications are to provide general criteria for the design of sanitary sewer mains and appurtenances within the Town of Berthoud sanitary sewerage service area. Any deviation from these standards must be approved by the Town and additional documentation may be required. The Town reserves the right for a submittal and review process as outlined in Chapter 200 for plan approval.

2. If construction has not commenced within one (1) year from Town approval, the plans must be resubmitted for review and comment.

3. The Town will establish and may amend procedures to be followed by the Responsible Party performing work on sanitary sewer lines. These procedures will include all requirements for documentation, submittals, fees, engineering design, construction, and acceptance.

401.4 Granting of Service

A. Sanitary sewer services shall be granted to an area, at the requestor's expense, after the following requirements have been determined. The Town must have the capability and capacity to serve the proposed area, the region being served must be located within the Town of Berthoud sanitary sewer service area, and the Responsible Party must show evidence of fee ownership of the property to be serviced. The request for service must be in compliance with stipulations contained in all utility agreements entered into by the Town and said applicant as well as in compliance with all applicable Town ordinances, codes and charter principles.

402 DESIGN CRITERIA

402.1 General Criteria

A. Sanitary sewer design and construction shall adhere to The Town of Berthoud's criteria and standards. Additional criteria may be required by the Town for the overall hydraulics of the

wastewater collection system. The Town may also have additional requirements based on the potential impact of proposed sewer facilities through affected public right-of-way or adjacent public infrastructure.

B. In general, sewer easements, proximity of sewer to other utilities, proximity of sewer within Town of Berthoud Right-of-Way, and the location of sewer service lines shall comply with Service Provider's and Town of Berthoud standards. In the event of conflict or discrepancy between standards, the more stringent standards shall apply.

C. Sewer mains shall be designed and sized through manholes at the end of cul-de-sacs or out lots to serve future upstream development as indicated in the Town's Master Plan.

D. Sanitary sewer mains and appurtenances shall be constructed in conformance with these Standards and Specifications and shall be designed by or under the direct supervision of a registered P.E. licensed to practice in the State of Colorado.

E. Refer to the checklist in Chapter 200 for construction drawing requirements related to sanitary sewer.

402.2 Sewer Location and Alignment

A. Sewer Location in Easements

1. A Non-Exclusive sewer easement dedicated to the Town must be provided when the sewer is located outside of public right-of-way or outside of an easement within a subdivision that is dedicated to the public for utility purposes on the recorded plat of that subdivision. The easement width shall depend on location but shall be a minimum of twenty (20) feet and generally need to be at least twice as wide as the depth of the sewer for future access should future replacement be needed. Sewer mains installed in easements shall ordinarily be located in the center of the easement unless stated otherwise in the easement documents and indicated in the Town approved Master plans or applicable studies. In no case shall a main or related appurtenance be located closer than 10 feet to the nearest Easement, Tract or private lot line.

2. A combined sewer and water easement shall have a minimum width of thirty (30) feet, plus ten (10) feet for each added utility in the easement. A wider width and greater separation is at the discretion of the Town Engineer to allow for future replacement as needed.

B. Sewer Proximity to Other Utilities

1. Sewer lines that parallel water lines shall be located a minimum distance of ten (10) feet horizontally from the water line, as measured from outside diameter of pipe (OD) to OD. Where sewer lines cross water mains, the sewer pipe must be a minimum vertical distance of eighteen (18) inches below the water main as measured OD to OD. If this distance is not feasible, the crossing must be designed and constructed to protect the utilities. The design must be approved by the Town Engineer.

2. If the minimum vertical separation cannot be achieved at a utility crossing, minimum protection shall consist of the installation of an impervious structural material. Sewer pipe shall be encased in reinforced concrete. The encasement on sewer line shall be at least six (6) inches thick around the entire pipe and shall extend ten (10) feet in either direction from the central point of utility crossing. In all cases, suitable backfill or other structural protection shall be provided to preclude settling and/or failure of the adjacent or perpendicular crossings.

3. Clearance from other utilities must be enough to facilitate future repairs to either utility line; minimum separation distances are eighteen (18) inches of vertical and ten (10) feet of horizontal.

402.3 Service Line Location and Alignment

A. Sanitary sewer service lines shall be designed on the shortest and straightest possible route.
   1. Sanitary sewer service lines shall not enter manholes and must connect to the mains with a wye fitting at least five (5) feet from the outer diameter of sanitary sewer manholes.

   2. A manhole connection must be approved by the Town Engineer.

B. Each structure and each subdivided lot shall be served by a separate line. Compound taps are not allowed.

C. Service lines shall be at least thirty (30) inches from the side property line, and no service line may be designed through or in front of any adjoining property. If possible, the service line should be located toward the low side of the lot.

D. Service lines shall not extend beneath driveways or intersection streets.

E. The minimum separation of sewer service from water service lines is ten horizontal (10) feet within the public ROW. If minimum horizontal separation cannot be achieved, the sewer line shall be concrete encased or otherwise protected with an impervious structural material approved by the Service Provider.

F. Service Laterals to the Property Line: service laterals shall be extended at least ten (10) feet into the property or at least five (5) feet past the easement and shall be plugged or capped.

G. All sanitary services shall be marked with an “S” chiseled into the concrete curb or other paved surface it crosses under.

I. Clean outs
   1. Building sewer cleanouts shall be installed at intervals not to exceed 100 feet and/or for each aggregate change in direction exceeding 135 degrees. Each cleanout must be inspected and approved by the Town’s inspector. Cleanouts must be the same size as the service size. Manholes must be installed in accordance with these Standards on any building sewer greater than 6 inches in diameter (i.e. no cleanouts allowed).

   2. Two-way cleanouts are required within two (2) feet to five (5) feet outside of a building (or at other location as approved by the Wastewater Management Division inspector) on sewer service lines.

J. Ejector Systems/force service lines
   1. When sewer service cannot be obtained under traditional gravity conditions, the owner may request Town approval the use of an ejector system and force service line. Force service lines less than 4 inches in diameter must connect to the public sanitary sewer through a standard tee or wye. The force service line must connect to the tee or wye in a manner to prevent leakage and to prevent sewage from entering the force service line when the main line sewer is flowing full. After the connection is inspected the connection must be concrete encased to prevent separation due to thrust. The connection must be specifically detailed for approval by the Town Engineer. Force service lines need to be installed at a minimum depth of 5 feet to prevent freezing. The force service line must be protected against freezing when it is located less than five (5) feet below grade.

K. Size
   1. The minimum allowable diameter from the main line to a building is four (4) inches.

   2. Sanitary services within a building's footprint shall adhere to the requirements set forth by the International Plumbing Code version specified in the Town Municipal Code.

402.4 Manholes

A. Below grade design and construction of manholes will adhere to Service Provider’s criteria.

1. Manhole locations within the Town Right-of-Way and exposed portions of the manholes will adhere to additional criteria of this Chapter.

2. Manholes shall not be installed in curbs, gutters, concrete pans or in the wheel path in the road.

B. Lids
   1. All sanitary sewer lids shall be forged with the following: Sanitary Sewer". Sewer manhole lids must be Denver Pick slot style model #1156 using a manufacturer specified in the Sanitary Sewer System Construction Specifications or as approvedy the Town Engineer.

C. Rings and covers shall be cast-iron. Manhole rings and covers shall be twenty-four (24) inch diameter manholes.

402.5 Future Connections

A. Sanitary utilities shall be stubbed out to the right-of-way or limits of property at all locations that are planned for future tie-ins. Other reasonable stub-outs or main extensions may be requested by the Town based on knowledge of adjacent development, Master Plans, or applicable sewer studies.

B. The end of a service stub-out shall be marked in the field with a painted green, carbonite composite utility marker reaching no less than four (4) feet above finished grade and labeled with the size and material of the sanitary service line and be sealed with a glued fitting.

C. The end of a main extension shall be marked in the field with a painted green, carbonite composite utility marker reaching no less than four (4) feet above finished grade and labeled with the size and material of the sanitary main extension. Markers shall not be located in improved surfaces.

D. All sanitary services shall be marked with an “S” chiseled into the concrete curb or other paved surface it crosses under.

402.6 Design Flow

A. Sewer infrastructure design includes consideration of providing sewer service for the entire tributary area to the outfall point.

B. Per Capita Flow/Capacity
   1. In general, sewer capacities shall be designed for the estimated maximum population in a specific drainage area or area to be served.

   2. Where future sewer infrastructure is planned, economic and engineering analysis of alternatives should accompany any request for service.

   3. In determining the required capacity of sanitary sewer, the following factors shall be considered:
      a. Maximum hourly domestic sewage flow

      b. Additional maximum sewage or wastewater flow from non-residential dischargers

      c. Inflow and groundwater infiltration

      d. Include an additional 10% of peak sewage flow to account for inflow and infiltration (I/I)

      e. Topography of area

      f. Location of sewage treatment plant

g. Depth of excavation

4. Sewer infrastructure shall be designed on the basis of ninety-five gallons per day (95 gpd) per capita. Minimum residential population density is computed using 2.55 persons per dwelling unit.

5. For initial flow approximation in a residential development, refer to the Town of Berthoud Wastewater Master Plan, Town Comprehensive Plan, and zoning maps for respective land uses.

C. Peak Design Flow
1. Sanitary sewer must be designed to carry the peak discharge with the pipe being no more than eighty percent (80%) of maximum capacity (q/Q) for mains.

2. Sewers shall have capacity for peak hourly sewage flow and adequate velocity at minimum sewer flows.

D. Combined Sewer Interceptors
1. Combined sewers are not permitted. Storm water and underdrains must be separate and isolated from the sanitary sewer system so there is no combination of the flows. No storm water or ground water shall be introduced into the sanitary sewer collection system.

402.7 Sewer Design

A. The basis of design for all sewer projects within the Town of Berthoud sanitary sewer jurisdiction shall comply with Town details and design specifications and accompany the plan documents submitted for review. Additional computations or changes may be required after plan review. All sanitary sewer main construction within the Town's sanitary sewer system, and all service line construction connecting to the Town's sewer mains, shall be completed in accordance with these Standards and Specifications. These design specifications cover all sanitary sewer service line design, construction and repairs to existing facilities within the Town.

B. Minimum Size
1. All gravity sewer mains shall be eight (8) inches or greater in diameter. Sewer service lines from residences or other facilities to Town gravity sewer may be four (4) or six (6) inches in diameter.

2. All trunk sewers located along section lines or major roadway systems within the town must have a minimum diameter of 12 inches, to be built by the developer. This requirement is subject to the discretion of the Town Engineer and any applicable sewer studies.

3. The Town Engineer may accept line sizing for interim conditions of a phased development, with the understanding that ultimate conditions will determine the final pipe sizing.

a. Funds for the installation of the ultimate condition lines will be provided to the Town at the time of approval.

b. A schedule for the remaining construction shall be provided at time of approval.

C. Bury Depth
1. In general, sewers should be sufficiently deep to receive sewage from basements and to prevent freezing. Sewers shall not be installed at depths greater than twenty (20) feet. Where pipe has less than five (5) feet of cover, provisions shall be made to protect pipe from impact, loading and freezing.

2. Sewer bury depths less than five (5) feet shall be accompanied by a geotechnical report prior to review by the Town Engineer.

3. Sewer bury depths less than five (5) feet or greater than twenty (20) feet will be at the discretion of the Town Engineer.

D. Slope
1. Sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than two feet per second (2 fps) and no greater than ten feet per second (10 fps). Table 400-1 provides minimum and maximum slopes allowable for collection and outfall mains. Whenever possible, sewers designed to carry an average design flow of less than 0.10 cfs shall not be installed at a slope of less than 0.6%.

Table 400-1: Sanitary Sewer Slope Ranges per Pipe Size

Sewer Size	Minimum Slope (%)	Maximum Slope (%)
4 inch (10 cm)	2.00	10
6 inch (15 cm)	1.00	8.0
8 inch (20 cm)	0.45	7.5
10 inch (25 cm)	0.25	5.5
12 inch (30cm)	0.20	4.5
15 inch (38 cm)	0.15	3.5
18 inch (46 cm)	0.11	2.5
21 inch (53 cm)	0.09	2.0
24 inch (61 cm)	0.08	1.8
27 inch (69 cm)	0.07	1.5
30 inch (76 cm)	0.06	1.3
33 inch (84 cm)	0.05	1.2
36 inch (91 cm)	0.05	1.0
42 inch (107 cm)	0.04	0.8
48 inch (123 cm)	0.03	0.7

E. Alignment
1. All sewers shall be designed with straight pipe and uniform slope between manholes. The drop in a manhole shall be 0.2 feet for straight runs and for changes in direction.

2. Where feasible, sewers shall be placed 5 feet south or west parallel to center of roadway.

F. Underdrains
1. Underdrain pipe may be installed when recommended by the soils/design engineer at locations shown on the accepted plans and shall only be installed at those locations where excessive groundwater is encountered.

2. Underdrain installations shall be at the discretion of the Town Engineer when in the same trench as the sewer. The Town Engineer may require use of pressure class pipe for sanitary mains designed in such a combined trench arrangement.

3. The size and extent of underdrains shall be established by a Design Engineer, registered in the State of Colorado, based on anticipated underdrain service line flow and groundwater flow in the Wastewater Main trench if applicable. The minimum size of a main line groundwater underdrain system shall be 6 inches. The underdrain service line shall be 3 inches in diameter to minimize any chance of confusion and cross-connection with wastewater service lines.

4. The slope of the underdrain main shall be a minimum of 0.5%.

5. Underdrain mains shall be located horizontally and vertically parallel to the wastewater

main, opposite to the water main.

6. Passive systems shall be laid with solid pipe using one ten (10) foot section of active pipe downstream of each manhole.

7. A trench dam shall be installed at the transition from active to passive system, see Detail D4.08.

8. Cleanouts shall be constructed outside a wastewater manhole as shown in Detail D4.08 within the concrete collar of the manhole.

9. At any point where there may be gravel to gravel contact between the underdrain trench and the sanitary sewer trench (e.g., on private property) a concrete cut off wall is required (e.g., at the property line) in order to ensure that there is no continued flow of water in the sanitary trench, so that all water is "forced" into a perforated section of underdrain pipe.

10. The design shall show that underdrains discharge to an appropriate location such as a storm sewer system or drainageway.

11. Should the Responsible Party's Contractor desire or be required to install an underdrain system to specifically collect the discharge of peripheral drain systems from individual house foundations or from sump pumps installed as a part of a peripheral drain system for house foundations, such a system shall be constructed for the exclusive advantage of the Responsible Party. Any such system will not be tied into or connected with the sanitary sewer collection system in any manner. All such underdrain systems are considered private and shall be owner maintained. The Town will not maintain private underdrain systems.

G. Cleanouts and Basement Sump Pumps
   1. All basement sump pumps intended or required to intercept groundwater shall be discharged to a private underdrain system if one exists. Otherwise, the pump must discharge to ground surface.

   2. Cleanouts shall not be installed within a sanitary sewer manhole and will not be maintained by the Town. Underdrains and associated clean outs shall not be green in color.

H. Future Connections
   1. Whenever future expansion of the system is anticipated, the stub out size and length will be at the discretion of the Town Engineer.

402.8 H2S-Resistant Coatings

A. Application of H2S-Resistant Coatings
   1. The application of H2S-resistant coatings on sewer pipes and structures shall be at the discretion of the Town Engineer. This includes areas where the sewage has longer travel distances, older sewage systems, or significant off-gassing is present.

   2. The Town Engineer may mandate the use of H2S-resistant coatings in specific projects or areas based on the potential for hydrogen sulfide gas generation and associated corrosion risks.

B. Areas of Application
   1. H2S-resistant coatings should be considered for sewer lines and manholes in areas where sewage has longer travel times, creating conditions conducive to hydrogen sulfide generation.

   2. Older sections of the sewer system that are more prone to corrosion and off-gassing should also be lined with H2S-resistant materials to extend their service life and ensure

structural integrity.

C. Material Specifications
   1. Coatings used must comply with industry standards for H2S resistance and be approved by the Town Engineer. Suitable materials include, but are not limited to, high-build epoxy coatings and other specialized anti-corrosion linings designed for sewer environments.

   2. All materials must be applied in accordance with the manufacturer's recommendations and industry best practices to ensure proper adhesion and effectiveness.

D. Inspection and Maintenance
   1. The application of H2S-resistant coatings must be inspected and approved by the Town Engineer or a designated representative. Any defects in the coating application must be repaired before the sewer system is put into service.

   2. Regular inspections should be conducted to monitor the condition of the coatings and ensure they remain effective in preventing corrosion. Maintenance procedures should be detailed in the Operation and Maintenance (O&M) Manual for the facility.

E. Submission Requirements
   1. Developers must include details of the proposed H2S-resistant coatings in the construction drawings and specifications submitted for approval. This should include information on the areas to be coated, the materials to be used, and the application procedures.

   2. An O&M Manual detailing the maintenance requirements for the H2S-resistant coatings must be submitted along with the construction drawings to guide the Homeowners Association (HOA) or the responsible maintenance entity.

402.9 Manholes

A. Location: Manholes shall be installed at the following points
   1. At the end of each line.

   2. At all changes in grade, pipe size, or alignment.

   3. At all sewer main intersections.

   4. At distances, not greater than four hundred (400) feet for sewers that are fifteen (15) inches or less in diameter, and five hundred (500) feet for sewers eighteen (18) inches to thirty (30) inches in diameter. Greater manhole spacing may be permitted in special cases based on a review and authorization by the Town Engineer.

B. All manhole exteriors shall be damp proofed.

C. Manholes shall be inspected prior to backfill.

D. Cleanouts may not be substituted for manholes.

E. Changes in pipe size shall occur at manholes to maintain energy gradient or allow for changes in energy gradient within the manhole.

F. Where varying pipe sizes enter and exit a manhole, the crown invert elevations shall match.

G. Manhole Diameter
   1. Manhole barrels shall be sized per the following table:

Table 400- 2: Sewer Manhole Sizing

Pipe Size	Barrel Size
30-inch and smaller	48-inch
33-inch to 36-inch	60-inch
42-inch and larger	As determined by Town

H. If three or more pipes at the upper limit of Pipe Size in Table 400-2 connect in a manhole, the barrel size shall be increased to a larger barrel size. Specially designed manholes/vaults are required for pipes greater than forty-two (42) inch diameter and when multiple inverts exist.

I. Drop Manholes
   1. Drop manholes shall be provided when the sewer line entering a manhole is at an elevation of eighteen (18) inches or more above the manhole invert, or where flow velocities exceed fifteen (15) feet per second in the upstream pipe segment of a manhole. Where the difference in elevation between the incoming sewer and the manhole invert is less than eighteen (18) inches, the invert is required to be filleted (shaped) to prevent solids deposition/buildup.

   2. Drop manholes shall be constructed with an inside drop connection, except where this would make maintenance access to said manhole impracticable.
      a. See Detail D4.01 for outside drop connections.

J. Flow Channel
   1. The flow channel through manholes shall be made to conform in shape and slope to that of the sewer pipe.

   2. Smooth, non-jagged surfaces are mandatory.

   3. The flow channel shall be pre-formed or cast in place grout.

K. Water Tightness
   1. Manholes on new sanitary lines shall be pre-cast concrete. Poured-in-place concrete may be used on an existing sewer line or as authorized by the Town Engineer. Inlet and outlet pipes shall be joined to the manhole by a gasketed, flexible watertight connection.

   2. Watertight manhole covers (bolt down manhole covers) shall be used wherever the manhole lids may be flooded by street runoff, high water or any other water source. The assignment of these types of manhole covers is at the sole discretion of the Town and at the Responsible Party's expense.

L. Rim Elevations and Manhole Markers
   1. If manholes are in cultivated fields, they should be left twenty (20) inches below grade unless directed otherwise by Town Engineer. Manholes in parks or detention basins must be above the flood plain. All other manholes in these types of areas should be no more than six (6) inches above grade. In these circumstances, bolt down ring and cover are to be used and properly marked by a carbonite composite utility marker (see Standard Details), located by a property line or other suitable site as close to the manhole as possible, with the off- set marked in feet to the centerline of the manhole cover.

   2. In paved roads, the manhole ring and cover shall be designed to final grade. In unpaved roads, the manhole ring and cover shall be designed to be six (6) inches below final grade.

M. Steps
   1. Manhole steps shall be manufactured of polypropylene reinforced as manufactured by M.A. Industries, spaced twelve (12) inch typical, sixteen (16) inch maximum on center, aligned away from invert.

N. Cones
1. All cones shall be eccentric. Each cone shall be rotated such that its opening is vertically aligned away from pipe openings thus maximizing the potential amount of manhole steps to the base of the manhole.

2. Only pre-cast manhole risers and cones shall be used and manufactured in accordance with ASTM Designation C-478.

3. Risers may not be used if it causes the first step to be 16-inches below the cover. Add a barrel section as need to maintain a maximum of 16-inches to the first step.
    a. No more than 2 risers will be allowed, less than or equal to 12” together.

O. Inverted Siphons
1. The use of an inverted siphon will be evaluated on a case-by-case basis and will require approval from the Town Engineer.

402.10 Sewers in Relation to Waterways

A. Alignment
1. Sewers crossing waterways shall be designed to cross the waterway as perpendicular to the waterway flow as possible. Sewer systems shall be designed to minimize the number of waterway crossings.

B. Horizontal Location
1. Sewers located parallel or horizontal to waterways shall be located beyond the top banks of the natural floodway, and at a sufficient distance from any waterway to allow for the possible widening of the channel.

2. Sanitary sewer manholes may not be located within the limits of a detention pond.

C. Structures
1. Sewer outfalls, headwalls, manholes, gate boxes, and any other structures shall be located so that they do not interfere with the free discharge of flood flows of the waterway.

D. Depth of Cover
1. The top of all sewers entering or crossing waterways shall be at a sufficient depth below the natural bottom of the waterway’s bedrock to protect the sewer line. In general, the following cover requirements shall be met:

    a. One (1) foot of cover is required when the sewer is located in bedrock.
    b. Three (3) feet of cover is required in any material other than rock. In major waterways, more than three (3) feet of cover may be required due to anticipated scour depths and pending review from the Town, Corps of Engineers and any other wetland authorities.
    c. In paved waterway channels, the top of the sewer line shall be placed three (3) feet below the bottom of the channel pavement and protected with a casing.
    d. Less cover will be approved only if the proposed sewer crossing will not interfere with any future improvements to the waterway. Reasons for requesting less cover shall be submitted for review by the Town.

E. Materials
1. Sewers crossing a waterway shall be constructed of C900 or C905 PVC or other approved, pressure class material.
    a. The pipe shall be constructed to remain watertight and free from changes in alignment or grade.

2. Material used to backfill the trench shall be as stated in the construction drawings and

shall not cause settling. Construction documents shall call out construction requirements of the trench and backfill.

3. Controlled Low Strength Material (CLSM), i.e., a lean, sand-cement slurry or "flowable fill," is the preferred method to prevent scour in utility trenches where groundwater is present.

F. Encasement of Pipe
   1. All pipe installed through natural drainage ways must be concrete encased.

   2. All Pipe installed through paved waterways shall be sleeved through a casing.

   3. Pipe encasement will extend ten (10) feet beyond either top bank of the waterway, or two times the depth of the waterway past either bank of the water waterway, whichever is greater.

G. Suspended or Exposed Crossings
   1. The Town will not approve or allow these types of crossings

      a. Aerial - suspended in air,
      b. Suspended - attached to a bridge,
      c. Exposed crossings - not covered, pipe is visible.

402.11 Sewage Lift Stations

A. On a case-by-case basis, lift stations are at the discretion of the Town Engineer either within or outside its collection system. Lift stations are not recommended by the Town and must be designed as a regional lift station with the ability to accommodate future flows. Lift Station facilities shall be located and sized in accordance with the Town's Master Plan.

B. All lift stations with capacities at 2,000 gallons per day (gpd) or greater are subject to Colorado Department of Health and Environment (CDPHE) Regulation 22

C. Lift Station locations shall be compatible with approval from the North Front Range Water Quality Planning Association (NFRWQPA).

D. The Developer shall be solely responsible for all costs associated with the design and construction of the lift station and force mains. This includes the cost of any easements, land acquisition, documents associated with permitting approval through CDPHE and NFRWQPA, and any other cost associated with the project.

E. Where additional service area outside of the proposed development is anticipated, the Town will require the lift station and associated improvements to provide capacity greater than what is necessary for the initial development. A reimbursement agreement may be appropriate in this condition.

F. Public lift stations are defined as any lift station serving more than one user and accepted by the public utility. Operations and maintenance activities shall be the responsibility of the Town for all public pumping facilities only upon completion and acceptance of the proposed improvements. The Developer shall provide operations and maintenance manuals and procedures for all equipment and processes associated with the pumping facility. The Developer shall meet with the Town during the planning and design phases on equipment operations and maintenance requirements.

G. All new pumping facilities shall be monitored by the Town's Supervisory Control and Data Acquisition (SCADA) system.

H. Private lift stations are defined as any lift station serving only one user. Operations and maintenance responsibilities for private lift stations are the sole responsibility of the owner or

private entity.

402.11 Grease and Sand/Oil Interceptors

A. General Requirements
   1. All food service establishments and other commercial facilities that discharge grease-laden wastewater shall install an appropriately sized grease interceptor.

   2. All facilities that discharge oil or sand-laden wastewater, such as vehicle service facilities, shall install an appropriately sized sand/oil interceptor.

B. Sizing Criteria
   1. Sizing to be based on International Plumbing Code (IPC) as currently adopted by the Town at time of contracting.

C. Installation Requirements
   1. Interceptors must be installed in locations that are easily accessible for inspection, cleaning, and maintenance.

   2. Interceptors should be installed in accordance with the manufacturer's instructions and applicable plumbing codes.

   3. Proper venting must be provided to ensure the interceptor operates efficiently.

D. Maintenance and Record Keeping
   1. Regular maintenance schedules must be adhered to, and maintenance logs should be kept on-site for inspection by local authorities.

   2. Grease interceptors must be cleaned every three months, or more frequently if required by the local health department.

   3. Sand/oil interceptors must be cleaned based on the accumulation of debris and at least semi-annually.

402.12 Silting and Erosion

A. Construction methods conforming to EPA-defined best management practices (BMPs) that minimize silting and erosion shall be employed.

B. The design engineer shall include in the project specifications the method(s) to be employed in the construction of sewers to control silting and erosion such that the land is restored back to its original condition. Specifications shall require the cleanup, grading, seeding, and planting or restoration of all work areas to begin immediately upon the completion of construction.

403 CONSTRUCTION SPECIFICATIONS

403.1 General

A. All Sanitary Sewer Construction shall be completed in accordance with the Construction Specifications included in Appendix A.

404 SANITARY DETAILS

404.1 Standard Details

A. The following is a list of standard details for sanitary sewer work that are part of the Town of Berthoud Standards and Specifications:

D4.01 Sanitary Drop Manhole
D4.02 Monitoring Sanitary Manhole
D4.03 Monitoring Sanitary Manhole Diagrams
D4.04 Sanitary Cleanout
D4.05 Typical Service Connection
D4.06 Tapping Saddle
D4.07 Pipe Encasement
D4.08 Concrete Collar Underdrain
D4.09 Two-Way Cleanout

CHAPTER 500 WATER UTILITY

501 GENERAL PROVISIONS

501.1 General

A. These Standards and Specifications are promulgated by the Town Administrator in accordance with the authority contained in the Town of Berthoud Municipal Code. Improvements shall also be in conformance with the Town of Berthoud Municipal Code.

501.2 Purpose

A. This section pertains to all components of the water distribution and transmission systems.
   1. Designs are intended to provide safe, reliable water supplies to customers and provide fire suppression flows where available.

B. All utility installation within the Town Right-of-Way shall require a Right-of-Way Use Permit prior to any installation activity. See Chapter 200 regarding permits and permitting processes in the Town and Chapter 300 regarding road cut standards.

C. All utility installation outside of the Town Right-of-Way (private property) shall require a Grading Permit prior to any installation activity. See Chapter 200 for Grading Permit regulations.

D. All utilities must be clearly labeled on the plans and include the type, size, depth, etc.
   1. Whenever possible, utilities shall be designed according to the typical utility layout plan (See detail drawing D4.02.)

501.3 General Specifications and District Jurisdictions

A. There are two Water Service Providers within the Town:
   1. Town of Berthoud (Town)
   2. Little Thompson Water District (LTWD)

B. Regardless of Water Service Provider, all developments within the Berthoud town boundary must follow the Berthoud Standards and Specifications for water distribution and transmission systems.

C. The Berthoud Fire Protection District (BFPD) has authority over fire protection and emergency services within the Town and the surrounding community. Responsible Party shall design and construct the water system to provide fire suppression flows as required by International Fire Code (IFC) and BFPD.

502 DESIGN CRITERIA

502.1 General

A. Water distribution design and construction shall adhere to the Town's criteria and standards.
   1. Additional criteria may be required by the Town's Engineer for the overall hydraulics of the impacted water utility system.

B. Design fire flow and line sizing must be reviewed and approved by the Berthoud Fire
   1. Protection District (BFPD).

502.2 Water Distribution System

A. General
   1. Water is delivered to the individual customer in sufficient volumes without excessive head loss. The design and layout criterion presented herein applies solely to distribution systems.

   2. The sizing and layout of a water system are elements of the total consideration of the design, operation, and maintenance of a water supply system that yields optimum quality service at the lowest total cost to the consumer.

B. Layout and Alignment
   1. Main layout shall be of such grade, alignment, and other characteristics as to permit installation and maintenance in accordance with these Standards and Specifications.

   2. Mains shall be installed in dedicated public streets.

   3. When the Town of Berthoud determines it is not feasible for an installation to be made in a dedicated street, the installation shall be made in a water easement or combined water and sewer easement.

   4. Deflections in alignment shall be made with fittings.

   5. Water and sewer lines shall be installed with a minimum ten-foot (10) horizontal separation and an eighteen-inch (18) minimum vertical separation at utility crossings, as measured from outside pipe diameter to outside pipe diameter, where water line is installed above sewer.

   6. All waterline lowering must be approved by the Town Engineer.
      a. If waterline will be below a sewer crossing, shall be restrained for ten (10) feet in either direction beyond the outside of the crossing pipe.

   7. No water mains shall be installed within fifteen (15) feet of any building, retaining wall, or structure unless approved by the Town Engineer. No building, retaining wall, or structure shall be constructed within a minimum of fifteen (15) feet from any water main, unless approved by the Town Engineer.

   8. Depth of Cover
      a. The minimum depth of cover for main lines shall be five (5) feet measured from the top of the pipe to the finished grade.

      b. The minimum depth of cover for service lines shall be five (5) feet measured from the top of the pipe to the finished grade with any necessary grade adjustments being made as close to the main line as possible.

   9. Whenever possible, water lines shall be located on the high side of any street, roadway, irrigation ditch or right of way.

   10. Waterway, railroad, highway, fiber optic or any other type of crossing, which may require boring and casing must be reviewed with the Town before final plans are prepared.

   11. Easement Width Requirements
      a. An exclusive water easement shall have a minimum width of 20-feet. Pipes that have a bury depth of more than 5.0 feet may require an easement wider than 20-feet and will be at the discretion of the Town Engineer.

      b. A combined water and sewer easement shall have a minimum width of 30-feet and may need to be wider based on the depth of the sewer.

      c. Private Roadways with Island Median
         i. Islands at the entrances to developments shall have easements that extend across the entire roadway with the island located in the middle.

         ii. The water line shall be installed on the side of the island that is at least 20-feet wide from back of curb to back of curb. Other utilities shall be confined to the opposite side of the island.

      d. Private Roadways
         i. The easement shall have a minimum width of 20-feet. The Town of Berthoud

shall have exclusive use of 20-feet thereof, except for right angle utility crossings.

e. Undeveloped Areas
   i. A water easement shall have a minimum width of 20-feet.

C. Sizing of Distribution Mains
   1. All water main lines shall be sized from a hydraulic analysis based on present and anticipated future flow demands and pressure requirements and accommodate future distribution needs as indicated in the Town's Master Plan.
      a. Developers are required to construct water mains larger than the minimum size when necessary to meet these demands.

   2. New mains shall be a minimum of 8-inch and "looped"
      a. Mains along major section lines or roadways shall be 12 inches minimum in diameter.
         i. Such installations shall be sized according to master plan specifications to ensure adequate system performance and capacity for future growth.

   3. Final main line size determination and layout shall be at the discretion of the Town Engineer and shall not be open to arbitration or negotiation.

   4. Mains shall be sized to provide for domestic, irrigation, and fire protection flows to the area requesting service but not so large as to cause water quality issues.

   5. The maximum acceptable head loss is 2-feet per 1,000-feet of main for the maximum hour flow using a C-value of 130. This does not apply under fire flow conditions.

   6. Mains shall be sized for fire protection utilizing maximum day flows and needed fire flow resulting in a minimum residual pressure of no less than 20 psi in the localized area of interest.

   7. Site fire flows for multi-family and mixed-use developments are evaluated with one side of the looped system out of service. This evaluation is used to simulate a distribution system outage that would result in a worst-case scenario for the development.

D. Operating Pressure
   1. The Pressures within the distribution system shall be
      a. A minimum of 45 psi

      b. A maximum of 100 psi

   2. The maximum pressure fluctuation at any location in the distribution system between maximum hour demand and minimum hour demand shall not exceed 30 psi.

E. Pressure Regulating Valves (PRV)
   1. PRV installations are used to control pressures within distribution systems.

   2. When main extension plans are submitted for review, the need for a PRV installation will be determined based on existing pressure zones and the existing distribution system layout. PRV settings are to be included on plans with the elevation and the upstream and downstream hydraulic grade line and pressure.

   3. PRVs shall be sized so that the velocity through the valve at maximum demand does not exceed 25 fps or shall not exceed the manufacturer's recommended velocity, whichever is less. If a wide range of flow rates is anticipated, more than one valve may be required.

   4. When pressure differentials greater than 45 psi are expected or when the downstream pressure is low relative to the differential or cavitation is likely, special valve materials, or a special valve design may be required.

5. PRVs shall be properly supported and have adequate clearance above and below the valve to facilitate servicing. A manual bypass is required for single valve installations. Telemetering of data may be required. Each PRV shall have a gate valve on both sides for isolation purposes, pressure gauges on both sides, and a valve position indicator.

6. A regulated bypass may be required for PRV installations.

7. The Town of Berthoud may require the installation of SCADA equipment for PRV installations of the type specified by the Town.

F. Valves
   1. Isolation valves are required every 600-feet in the distribution system.

   2. Where blocks exceed 600-feet in length, or if two or more hydrants are connected to the same main, additional isolation valves are required.

   3. Valves are required at the following locations
      a. Between fire hydrants

      b. Street intersections that carry heavy traffic of that contain major water distribution mains in both directions, as determined by the Town of Berthoud, require four valves, one on each extended property line

      c. Between a fire hydrant and main line

      d. River and ditch crossings

      e. Between a blow-off and main line

      f. Vaults – inside and outside on the upstream and downstream side

      g. All tees with a minimum of three (3) valves

      h. All crosses with a minimum four (4) valves

      i. Isolation valves shall be resilient seat gate valves. Valves shall be the same size as the main and shall open left (counter-clockwise)

G. Air, Blow-off and Vacuum Valves
   1. The need for blow-off or drain valves at low points and combination air valves at high points in the distribution system will be at the discretion of the Town Engineer. In no case will a dead-end main line be accepted without a blow-off or a hydrant for flushing the distal end.

   2. Air release and vacuum valve assemblies shall be installed at high points in the conduit or main, where there is an abrupt change of slope, at isolation valves where the conduit slopes away from the valve, or as determined by the Town.
      a. All above grade blow-off valves shall have an appropriate drainage path to an appropriate drainage feature.

      b. On water mains 12-inch diameter and larger, in-line blow-off valves or hydrants shall generally be placed at severe low points, lowerings and/or at crossings.

      c. 2-inch temporary construction blow-offs can be used for stubs at phase lines which have no services.

   3. The main between the temporary blow-off and the nearest inline valve shall be emptied of

water after final testing and acceptance.

4. A 2-inch tap with a 90 degree vertical bend may be made directly into the cap of the main. The bend should be connected to a short section of 2-inch diameter pipe with a 2-inch curb stop valve. This valve shall be closed after the blow has been completed.

5. All fittings for temporary 2-inch blow-offs shall be brass.

6. An adequately sized concrete thrust block shall be poured behind the stub.

7. The blow off may be buried after completion. The location of blow off shall be marked with a tee post.

502.3 Water Storage

A. Water storage tanks are not recommended by the Town, unless they are identified in a The Town Master Plan and must be designed as a regional tank with the ability to accommodate future demands. The need for water storage shall be evaluated on a case-by-case basis by the Town.

B. The Developer shall be solely responsible for all costs associated with the design and construction of the water storage tanks. This includes the cost of any easements, land acquisition, documents associated with permitting approval through CDPHE, and any other cost associated with the project.

C. Where additional service area outside of the proposed development is anticipated, the Town will require the water storage tank and associated improvements to provide additional capacity than what is necessary for the initial development. A reimbursement agreement may be appropriate in this condition.

D. Water storage shall be located and sized in accordance with the Town's Master Plan. Water storage tank design shall be approved by the Town Engineer.

E. Water storage shall have built in provisions for overflow and draining as well as access and provisions for inspecting and cleaning including a suitable source of water.

F. The Town of Berthoud may require the installation of SCADA equipment for storage facilities of the type specified by the Town.

G. Interconnections with Other Water Systems
   1. Interconnections between the Town's treated water system and another approved system will be at the discretion of the Town Engineer.

502.4 Supervisory Control and Data Acquisition (SCADA)

A. General
   1. A SCADA system will provide for remote stations being automated and signaling devices from remote station reporting the status of the remote station to a Central Processing Unit (CPU). Installation of all SCADA equipment shall conform to application state and local electrical codes and the National Electric Code (NEC).

B. Scope
   1. The Responsible Party will only be concerned with the Remote Terminal Units (RTUs) at the remote stations. The Responsible Party will be responsible for providing and totally integrating the RTUs with the complete SCADA system including required programming.

Table 500- 1: SCADA System Required Programming

	Pumping Station	Storage Tank	PRVs	Metering Station
Valve Position	-	-	X	-
Influent Position	X	-	X	-
Effluent Position	X	-	X	-
Water Level	-	X	X	-
Water on Floor	X	-	X	X
Pump Fail	X	-	-	-
Power Out	X	-	X	-
High Water	-	X	-	-
Low Water	-	X	-	-
Intruder Entry	X	X	-	-
Flow Rate	X	X	X	X
Low Temperature	X	-	X	X

C. Monitoring
1. Remote stations will require automation and/or monitoring control. Automation requirements will be as required by the Town Engineer, the equipment suppliers, and SCADA designer. Suggested monitoring requirements are shown in the table above.

2. The remote stations will require an interfacing panel with terminal block wired into the individual sending devices. The remote panel will, in turn, be required to be wired to the communication system to the CPU.

502.5 Transmission Mains

A. General
1. This section addresses transmission mains, 16-inch, 20-inch, or larger. Standards that apply to distribution mains shall also apply to transmission mains along with the following requirements or exceptions herein. In case of a conflict with any other Chapter in these Standards, this section shall govern for transmission mains.

B. Design Criteria
1. Water transmission mains shall be sized and designed in accordance with this Chapter and the following additional requirements:
   a. All transmission mains shall be ductile iron pipe.

   b. Transmission mains shall be supplied by dual feeds, unless otherwise directed by the Town.

   c. Isolation valves shall be optimally placed such that service outages during repairs or construction are minimized. This generally requires the ability to isolate and alternately supply mains extending from the transmission main; therefore, the spacing between valves shall not exceed 1,000-feet.
      i. Isolation valves used on transmission mains shall be 16-inch or 20-inch flanged end butterfly valves. The size and type of valve to be used shall be clearly indicated on the submitted plans.

   d. All joints require restraint due to line thrust shall be restrained by using a means of mechanical restraint. Restraint requirements shall be in accordance with line size. Other restraint systems will need to be approved in writing by the Town.
   e. The maximum design head loss for 16-inch mains is 2-feet per 1,000-feet of main.

The maximum design head loss for 20-inch mains is 1 1/2-feet per 1,000-feet of main. Head loss is based on a Hazen-Williams C-value of 130 at the maximum hourly demand. Head loss criterion does not apply under fire flow conditions.

f. Blow-off assemblies shall be installed at low points in transmission mains and wherever a transmission main is dead-ended; i.e., unless a fire hydrant is provided at the dead- end location. (A fire hydrant may serve as a blow-off.)

g. Cathodic protection requirements for transmission mains will be at the discretion of the Town Engineer on an individual basis. Mains installed in corrosive soils shall be protected using methods determined by the Town. This may consist of the installation of anodes, the bonding of pipe, polyethylene encasement, or other requirements.

h. Special Conditions: Each transmission main will be examined individually to determine any special conditions and/or requirements necessary (e.g., air valves and PRVs).

2. Plans
   a. Detailed plans for transmission main extensions shall be prepared for approval in accordance with Chapter 200 and shall contain a top-of-pipe profile showing the following
      i. Proposed and existing ground lines.

   b. The elevation of grade breaks, slope of pipe, locations of bends and fittings, and minimum clearances to interference.

   c. The elevation of crossing interference verified by pothole.

3. Installation
   a. The Town may allow the Owner/Developer to use prequalified Contractor to install a transmission main. The Owner/Developer shall pay the costs for extending mains whether installed by the prequalified Contractor or by the Town.

502.6 Water Main Pipe Selection, Fittings, and Protection

A. Pipe Classes and Selection
   1. Pipe Classes: The following minimum AWWA Standard pressure classes for acceptable types of pipe are required:
      a. Ductile Iron Pipe
         i. Special Thickness Class 51

      b. PVC
         i. C 900 DR 18 (6-inch and larger)

   2. Pipe Selection
      a. The selection of the type of pipe shall be left to the discretion of the registered engineer in charge of the design. However, the Town reserves the right to deny the use of certain types of materials in specific circumstances.

      b. The installation of mains through hazardous areas, at depths greater than 10-feet, and in the roadways of state and federal highways may require the selection of pressure classes in excess of the minimums stated above.

      c. All joints must be restrained.

      d. All mechanical joint fittings including: hydrants, plugs, caps, tees, and 90-degree bends shall be restrained with Mega lugs (or other approved mechanical joint restraint gland) and concrete thrust blocks supported by undisturbed ground. Thrust blocks should not be used on bends 45 degrees or less.

e. Nonmetallic pipe is not allowed in areas with soil contamination. The determination of soil contamination that consists of hazardous substances or materials or toxic substances will be at the discretion of the Town Engineer.

B. Pipe Fittings

1. Joints and fittings shall be in accordance with applicable AWWA Standards and bear the pressure rating of the straight pipe involved at a minimum.

2. Acceptable types for straight lengths of pipe are push-on, mechanical joint, and bell spigot restraint systems. Mechanical joints for straight lengths of pipe are allowed in specific situations at the discretion of the Town Engineer.

3. Fittings shall be furnished with mechanical joint ends. The use of wyes is prohibited.

4. Bolted sleeve-type couplings, in accordance with AWWA C219, shall be of a gasketed, sleeve-type with a diameter that properly fits the pipe. Table 500-1 contains the minimum center sleeve dimensions for bolted sleeve-type couplings:

Table 500-2: Minimum Center Sleeve Dimensions

Pipe Diameter (Inch)	Center Sleeve Thickness (Inch)	Center Sleeve Width (Inch)
6	0.250	5
8		
12		
16	0.375	7
20		

5. DI sleeves shall have mechanical joints of the proper size and tolerance to ensure a watertight fit.

6. Split sleeve couplings in accordance with AWWA C227 are acceptable.

7. Long bell closure pieces shall be equal in strength, at a minimum, to the straight pipe being joined and shall contain push-on joints of the proper tolerance to ensure watertight connections.

8. Where pipes of different types are connected or where pipe is connected to fittings or valves of different materials, care shall be taken to ensure the proper ring, insulating gasket, or adapter is selected.

9. Flanged adapters, plugs, end caps, bulkheads, cut-in sleeves, anchor couplings, repair fittings, and other appurtenances shall be used where appropriate throughout the system at the discretion of the Town Engineer.

C. Thrust Restraint / Devices

1. All fittings (*e.g*. bends, reducers, tees, crosses, plugs/caps, fire hydrant tees to boots, valves, etc.) shall be restrained by a concrete thrust block or an approved mechanical joint restraint device.

2. Mechanical Joint Restraint Devices
   a. A mechanical joint restraint gland is the normal mechanical joint restraint system

used in the Town's water line installations and all joints shall have a mechanical joint restraint gland.

b. Mechanical joint restraint glands, other than Megalugs (EBAA Iron, Inc.), may be approved by the Town.

c. Proprietary joint restraint systems for pipe and fittings require the approval of the Town prior to installation.

d. Harnessing of joints by harness rods must be approved by the Town prior to installation.

e. The harnessing of joints may be accomplished using one of the mechanical joint restraint systems in accordance with Town Standards or using one of the several proprietary joint restraint systems supplied by Pipe Manufacturers.

f. Where joint restraint is required on PVC pipe, the designer may use a joint restraint system of the type supplied by Pipe Manufacturers and approved by the Town or switch to a metallic pipe. The use of rods and clamps on PVC pipe are not allowed.

D. Design
1. The required restraint length shall be determined by the Design Engineer for each occurrence. The Design shall use a minimum pressure of 150 psi and a safety factor of 1.5x operating pressure (whichever is greater).

2. The required restrained length shall be designated on the plan by stationing.

3. For mains sizes larger than 12 inch: the Design Engineer shall specify the type of fitting joint, pursuant to these Standards, and in certain cases, may also be required to provide thrust/restraint calculations to determine if other and/or alternate thrust/restraint systems are necessary.

E. Corrosion Protection Systems
1. CI and DI pipes and fittings shall be protected against corrosion
   a. Polyethylene wrap shall be used on buried metallic pipe fittings, rods, and appurtenances.
   b. Electrical isolation is required at dissimilar metal connections and at corporation stops.
   c. Buried harness rods shall be covered by 4-inch flat width polyethylene tubing.
   d. The entire joint shall be covered by a wrap of 48-inch wide polyethylene sheet material over each set of lugs. Irregular shaped valves and fittings shall be covered with flat 48-inch wide polyethylene sheet material. V-Bio enhanced polyethylene wrap may be required for areas where the soil resistivity is 1,000 ohm-centimeters or less.
   e. When the installation of metallic pipe is contemplated, a soil resistivity survey of the construction area shall be performed. The survey data and calculations, coupled with the service history of other existing pipes in the area, shall be submitted by the registered engineer in charge of the design for the Town to review.
   f. When water mains are to be constructed in soils that have a resistivity of less than 1,000 ohm-centimeters or where stray current corrosion is expected to be present, an approved nonmetallic pipe system shall be selected. When water mains are to be constructed in soils that have a resistivity of more than 1,000 ohm-centimeters, metallic or nonmetallic pipe material may be selected.
   g. In areas where the soil resistivity is 1,000 ohm-centimeters or less and metallic pipe needs to be used, joints shall be bonded with HMWPE insulated stranded copper wire.
   h. Exothermic welds shall be covered by an approved weld cap.

F. Thrust Blocks
   1. Concrete thrust blocks shall be sized for working pressure plus water hammer surge pressures, and soil bearing capacity. Thrust blocks shall be constructed of Class B concrete or of a premeasured, sacked industrial mix. Refer to Standard Detail Drawings.

   2. Gravity Blocks are to be used for upper vertical bends: All vertical gravity blocks shall be sized by the Design Engineer and indicated on the plans.

G. Concrete Encasement or Pads
   1. Under unusual circumstances, it may be necessary to lay pipe at shallow depths. Concrete encasement or pads shall be used over the pipe to protect it from traffic loading when this occurs. The encasement or pads shall be designed to support loads from traffic without transmitting the load to the pipe. Approved insulation shall be required between the pipe and the concrete encasement or pad to protect the pipe from frost. Designs are subject to the Town's approval.

H. Casing Pipe
   1. Installation of mains through Town of Berthoud ROW, or the ROW or easements of others, (e.g., highways, waterways, and railroads) may require casing pipes to facilitate the installation of the main. The casing pipe may be required by the permitting agency or by the Town of Berthoud. The type of casing material and its properties shall be specified by the agency granting permission to cross.

502.7 Pumping Facilities

A. General
   1. Pumping facilities are allowed on mains or services supplying water from the Town's system only where specifically authorized by the Town. The Town will prohibit the installation of pumping facilities where such installations would be injurious to the operation, or future operation, of the Town's system. This requirement is not applicable to individual building fire sprinkler system pumps, domestic system boosters required in multi-story buildings, or irrigation system pressure boosting. Such applications require backflow prevention (BFP) to eliminate the possibility of pumping into the Town's distribution system. Materials, equipment, and construction shall be in accordance with applicable codes and standards and approved by the Town.

B. Pumping facilities are not recommended by the Town, unless identified in the Berthoud Master Plan, and must be designed as a regional pumping facility with the ability to accommodate future demands. The need for pumping facilities shall be evaluated on a case-by-case basis by the Town.

C. The Developer shall be solely responsible for all costs associated with the design and construction of the pumping facility. This includes the cost of any easements, land acquisition, and any other cost associated with the project.

D. Where additional service area outside of the proposed development is anticipated, the Town will require the pumping facility and associated improvements to provide additional capacity than what is necessary for the initial development. A reimbursement agreement may be appropriate in this condition.

E. Public pumping facilities are defined as any pumping facility serving more than one user and accepted by the public utility. Operations and maintenance activities shall be the responsibility of the Town for all public pumping facilities only upon completion and acceptance of the proposed improvements. The Developer shall provide operations and maintenance manuals and procedures for all equipment and processes associated with the pumping facility. The Developer shall coordinate with the Town during the planning and design phases on equipment operations and maintenance requirements.

F. Private booster pumping facilities are defined as any pumping facility serving only one user.

1. Operations and maintenance responsibilities for private pumping facilities are the sole responsibility of the owner or private entity.
   a. Design shall follow plumbing code.

G. Pumping facilities shall be located and sized in accordance with the Town's Master Plan.

H. All new pumping facilities shall be monitored by the Town's SCADA system.

I. General Design Criteria
   1. Pump stations receiving water from the Town of Berthoud shall
      a. Be secured against unauthorized entry.

      b. Be located and kept in a manner that allows for easy and safe access for maintenance and inspection.

      c. Provide mechanical forced ventilation in the pump station at a rate of no less than 6 air changes/hour. The intake and exhaust vents shall be designed to prevent the entry of small animals and insects. The intake vent ductwork shall include a filter rack. Vents shall have motorized dampers to prevent air infiltration into the vault when the ventilation system is not in operation. Fans, ductwork, and damper materials shall be constructed of aluminum and/or PVC. Vent stacks may be steel gooseneck type or aluminum tiered caps depending on architectural requirements.

      d. Provide heating, cooling, and humidity controls to ensure the safe, dry, and efficient operation of piping, pumping equipment, instrumentation, and alarms.

      e. Have pumping capacity sized to provide adequate flow coverage for minimum demands up to the maximum requirements as determined by fire demand, maximum day demand, maximum hour demand, or replenishment, whichever is greater.

      f. Provide a means for measuring flow on pump discharge headers.

      g. Provide corrosion protection for underground steel and iron.

      h. Provide code compliant plumbing systems that include floor drains, sump pump systems, and wash-down service water systems. Pump and valve packaging leakage shall be piped to the floor drain or sump pump system.

      i. Provide local and remote electronic telemetry equipment of the type specified by the Town for monitoring the discharge pressure and confirming the pump motor status.

      j. Provide a frost proof gravity line or sump pump for pump station drainage to the local sanitary sewer. Provide a check valve, p-trap, and cleanout on the sump discharge line.

      k. Provide a means to prevent water from backing up into the pump station from other sources (e.g., installing a check valve on the drain line).

   2. Standardize equipment to permit interchangeability with other equipment.

   3. Ensure special care is exercised in the selection of pumping units and associated components to prevent pressure surges. Ensure the suitability, flexibility, and adaptability of the units to the hydraulic conditions of the system from which water is taken and the system into which it is pumped.
   4. Ensure the horsepower rating of each pump motor will continuously carry the maximum load that may possibly develop (non-overloading at any point on the pump curve) without exceeding the motor nameplate rating and without using the service factor.

5. Provide that pumps are located to receive positive suction head and meet the Manufacturer's required net positive suction head requirements.

6. Provide steel pump and motor bases that are level, coplanar, free from internal stress, and have internal voids filled with epoxy grout above a steel reinforced concrete base.

7. Provide DI or steel piping designed according to AWWA Standards with adequate couplings for equipment, stainless steel piping supports, and drains.

8. Ensure the mechanical design, equipment selection, and installation practices are approved by the Town of Berthoud. Drawings and information shall be provided to describe the system curve and pump curve interactions, the pump operating conditions and associated efficiencies, the pumping equipment sizing and features, the valve/actuator sizing and operating requirements, and the HVAC design loads, ductwork sizing, and equipment selections. Provide the certified Manufacturer’s pump performance curves.

9. Ensure that electrical design, equipment selection, and installation practices are approved by the Town. Drawings shall show the power system, switchgear, protective devices, feeder panels, and wiring and motor controllers along with sizing, fault current, and protective device coordination calculations. The latest edition of the NEC, OSHA's Design Safety Standards for Electrical Systems, and applicable ANSI/IEEE Standards shall set the minimum standards to which the design, equipment, and installation shall conform. The Town of Berthoud may set higher standards for safety or reliability purposes.

10. Provide slow-closing, regulating and/or check valves on pumps to minimize water hammer.

11. Provide ample clearance between equipment for operation and maintenance.

12. Provide electrical outlets and lighting on walls in the pump room.

J. Conditional Design Criteria
   1. Depending on the function and the location of the pump station, the following criteria may be required by the Town
      a. Exterior and interior lighting.
      b. Access and parking for vehicles on the pump station site.
      c. Fencing for securing the area around the pump station and transformers.
      d. Space for the future addition of pumps and piping.
      e. A means to lift heavy equipment (e.g., a bridge crane or access for a boom crane).
      f. Variable speed or throttling control with the appropriate discharge valves and controls.
      g. An emergency power supply for telemetry, lights, a drain sump pump, and other necessary items.
      h. Surge control.
      i. The installation of guard valves on each side of the pumping unit.
      j. Systems capable of supplying adequate fire protection during power outages.
      k. Resistance temperature detectors in stator windings of pump motors for remote alarming in the event of overheating.
      l. A spare pump for backup capability.
      m. Pump and motor bearing high-temperature sensors for remote alarming and lock out relays to shut down the pump and the motor in the event of bearing overheating.
      n. There shall be a temperature shutdown switch on the pump to protect the pump from overheating.
      o. Reduced voltage motor starters, depending on the motor size and the electric power system.
      p. Dual transformers cross-connected with a tie breaker and separately switched for

isolation.
q. A remote control for pumps, gas engines, and filling valves (start – stop – position discharge valve).
r. Local and remote instrumentation for monitoring
s. Discharge valve positions.
t. Discharge header pressure and flow.
u. The reservoir level, if applicable.
v. Upstream pressure, if applicable.
w. Suction header pressure, if applicable.
x. The pump status (on-off).
y. Diesel engine standby generator status (on-off).
z. Total kilowatt demand (station).

2. Provide remote and local sensors and alarms to detect
a. Water on the floor.
b. Bearing high-temperature for each pumping unit.
c. Motor windings high-temperature for each pumping unit.
d. Pump building door intrusion.
e. High and low room temperature.
f. Electrical ground fault.
g. Low accumulator pressure, if applicable.
h. Power failure.
i. High and low reservoir levels, if applicable.
j. Fire and/or smoke.

502.8 Service Lines and Appurtenances

A. General

1. Water is conveyed from mains to consumers by service lines and their associated appurtenances. Except for fire service lines, water delivered to customers shall be metered.

2. Service lines shall include all pipe and fittings up to and including the connection point provided by the Town.

3. The service line from the main to the meter pit assembly shall be owned and maintained by the Town.

4. The Tapholder shall install, own, and maintain the water line from the connection point outside of the meter pit to the point-of-use.

B. Layout of Water Service Lines

1. The service line shall be arranged to provide convenient access to the curb stop and the meter pit or vault for meter reading, operation, and maintenance.

2. The service line, to a point 5-feet past the meter pit or vault, shall be a minimum of 5-feet from any side property line.

3. The service line shall be installed in a continuous straight line, perpendicular to the property line or curb, from the tap to a point 5-feet past the back wall of the meter pit or vault. Service for lots at the end of cul-de-sacs or at a corner will need be approved by the Town.

4. Service lines shall be installed 5-feet to 6-feet below the ground line.

5. Deviations to the service line standards contained in this Section will need to be approved through the Town.

6. Backfill material around service lines, stop boxes, and meter settings shall be at 90%

compaction.

7. That portion of the service line between the main and the meter pit shall not exceed a horizontal length of 85 feet. Longer service lines may be installed with the approval of the Town and may require over sizing to minimize losses.

8. Service lines may not share a trench containing conduits which carry any substance other than potable water if there is space for multiple trenches outside of the ROW. If the lot outside of the ROW is too narrow to provide separate trenching, a service line should be separated horizontally from foreign conduits by a minimum of 5 feet and shall follow plumbing code.

9. If same trench is required due to lot width, the water service pipe and building sewer shall not be horizontally separated by less than 5 feet.

C. Sizing of Service Lines
   1. Taps and service lines shall be of a size that is adequate to supply the requirements of the property being served while not being so large as to cause inaccuracies in metering low flows. The minimum size allowable for a service line shall be 3/4-inch.

   2. The tap, corporation stop, meter, and the portion of the service line between the corporation stop and 5-feet past the meter shall be the same size. The service line may only be increased one standard size to the next approved larger diameter beginning 5-feet downstream of the meter, including BFP.

   3. Taps and services shall be sized to produce a water velocity that is no greater than 10 fps at peak demand as estimated by an accredited Fixture Unit/Count methodology.

   4. The total pressure drop in the service line from the main to the building shall not exceed 25 psi without BFP or 35 psi with BFP and a minimum residual pressure of 20 psi at the building beyond any BFP under peak domestic demand flow.

   5. The manifold tap, manifold service line, manifold corporation stop, and manifold trunk line shall be the same size.

D. Pipe Material and Joints
   1. Pipe material is dependent on the size of the service line and shall extend from the tap to the first mechanical fitting inside the structure
      a. Seamless copper tube, designated as “Type K” soft, shall be used for 3/4-inch through 2-inch service lines.

      Dont allow
      b. Ductile iron pipe shall be used for 3-inch and larger service lines.

      c. PVC pipe may be used for domestic service lines two (2) inches and larger only under certain conditions approved by the Town Engineer.

      d. Service lines shall be the same type of material from beginning to end.

      e. Copper joints installed underground shall be compression

   2. Service manifolds shall be constructed of approved materials only
      a. Outside installations shall be constructed of type “k” copper

E. Pumps
   1. Pumps are only allowed on fire suppression systems for the purpose of increasing pressure as required for either insufficient initial pressure supplied from the distribution system to meet application needs or in the case where internal change in elevation

requires an additional boost to meet pressure requirements on higher floors. All pumps must be approved by the Town.

2. Pumps may not be used for the purpose of sizing calculations.

F. Tanks
   1. Tanks are not allowed for either domestic or fire suppression supply.

G. Connections for Service Lines
   1. Taps for 2-inch and smaller domestic, irrigation, or fire service lines will be made by a prequalified Contractor. The connection shall be made using a corporation stop of the same size as the service line through a bronze tapping saddle with individual stainless steel bands, both of which shall be supplied by the licensee. Taps shall be made only after satisfying the following conditions
      a. The main has been released by the Town following the completion of the conditions and tests.
      b. The license application has been completed, signed by an authorized individual, and submitted to the Town.
      c. Appropriate fees and charges have been paid to the Town.
      d. The street opening permit has been obtained from the authority having jurisdiction.
      e. Underground utilities near the tap are marked.
      f. Tapping materials are on-site.
      g. Front property corners are clearly staked, and the service address visibly posted.
      h. Water main valves are marked or staked.
      i. Safety equipment and procedures are in place including trench shoring.
      j. The tapping location on the main is excavated and the water main surface is exposed and clean.

   2. Taps to the main for 3-inch and larger service lines shall be made by a tapping sleeve.

   3. Domestic service lines connected to metallic water mains shall be electrically insulated by means approved by the Town for insulating fittings or gaskets.

   4. Care shall be taken to properly install corporation stops and provide enough slack in the service lines to protect against pullout.

   5. When tapping mains, dig out bedding material and apply two to three wraps of adhesive tape completely around the polyethylene-encased pipe to cover the area where the tapping saddle and machine is to be mounted.

   6. Multiple taps on the same side of the main shall be a minimum of 5-feet apart, measured longitudinally along the centerline of the main. Multiple taps on opposite sides of the main shall be staggered by a minimum of 2 1/2-feet, measured longitudinally along the centerline of the main. Taps shall not be made within 5-feet of any main line pipe fitting.

   7. Corporation stops shall be used to connect the service line to the main without taking the main out of service.

H. Taps, Saddles, and Sleeves
   1. Tapping saddles or sleeves shall be required for all taps on main lines.

   2. No direct tapping of any main line materials shall be allowed

   3. Taps and service lines shall be of a size, which is adequate to supply all the requirements of the property being served as determined by the Tapholder. The recommended minimum sizes for service lines are shown in the table below:

Table 500- 3: Recommended Service Line Sizes

Minimum Service Line Size			
Tap Size (Inches)	Water Line Length		
	< 85 feet	85-100 feet	> 100 feet
5/8"	3/4"	1"	Minimum 2"
3/4"	3/4"	1"	
1"	1"	1 1/2"	
1 1/2"	1 1/2"	2"	
1 1/2"	2"	2"	

4. Tapping saddles with a tap size of 2-inch and smaller for DI, Asbestos-Cement (AC) and PVC pipe shall consist of a bronze body with two stainless steel straps. They shall be made by a corporation stop that is the same size as the service line.

5. Taps 3-inch and larger, shall be made with an existing tee or a tapping sleeve and a tapping valve. Whichever method is used, care shall be exercised to select sleeves and gaskets that are properly sized to fit the type and class of pipe to be tapped. Where tapping sleeves, 3- inch and larger are used a thrust block shall be placed behind the tapping sleeve to prevent possible damage to the main from pressure shocks that develop as valves are first opened.

6. Wet taps are allowed on PVC and DI pipes containing water under pressure. AC and CI pipes may be only be tapped on dry lines.

I. Curb Stops, Valves, and Valve Boxes

1. Valve boxes, vault access lids, or other surface features of the water system that will be placed in paved areas shall not be placed in curb and gutter, concrete cross pans or edges of pavement. Surface features of the water system shall be placed a minimum of two (2) feet from outside edges of concrete curb and gutter pans, street cross pans, and edges of pavement.

2. A curb stop or gate valve of the same size as the service line shall be installed on the service line at a location in accordance with Section 502.7.

3. Deviations to the curb stop installations, 1-inch and smaller, requested in writing by the
   a. Engineer of Record may be authorized by the Meter Inspection Technician.

4. Buried valves and curb stops shall be equipped with a CI valve box
   a. Roadway box shall be used when a 3/4-inch or 1-inch curb stop is placed in paved areas.

5. Valve Boxes
   a. Buried gate valves shall be provided with a 5 -inch CI valve box
      i. The valve box shall be of a design that shall not transmit shock or stress to the valve and shall have enough extension capability to be raised to the ground line.

6. Wet taps are allowed on PVC and DI pipes containing water under pressure. AC and CI pipes may be only be tapped on dry lines.

7. Check Valves
   a. Check valves are required for meter installations, 1 1/2-inch and larger, where there is no BFP assembly downstream and at Distributor master meter locations.

   b. Check valves are not a substitute for BFP assemblies; however, they may be omitted from the meter installation in cases where a BFP assembly is within 150-feet of the meter.

8. Valve Reference Marker Posts
   a. When valves are installed where adequate physical reference points are not available, as determined by the Town, a valve reference marker post may be required.

J. Abandonment or Removal of Service Lines and Tap Cuts
   1. It may become necessary to remove or abandon a service line or a stub-in due to redevelopment and changes in water requirements for the premises, or to relocate a service line due to changes in the configuration of the premises. An abandoned or relocated service line shall have the tap cut at the main or fire service line to ensure that it cannot be used to remove water from the system. Service line tap cuts shall be witnessed by the Town's Inspector and/ or Water Operations Manager

K. Construction
   1. The Contractor shall be a licensed plumber by the authority having jurisdiction to perform work in the public ROW. The Contractor shall have a current plumbing license to install service lines in the Town of Berthoud.

502.9 Cross Connection Control and Backflow Prevention (BFP)

A. General
   1. The following Standards are to be used in conjunction with Section 6.28 of Berthoud Municipal Code.

B. The Town of Berthoud is responsible for protecting its public water system from contamination due to backflow occurrences through residential, multi-family, irrigation, and/or commercial property water service connections in accordance with CDPHE Regulation 11. The Town needs the assistance and the cooperation of the public and licensees to ensure this responsibility is met. The Town of Berthoud may request access to a property or facility to conduct an on-site cross-connection control audit.

   1. The Town of Berthoud requires the installation of a containment assembly on commercial property service lines. A RP BFP assembly shall be installed.

   2. Failure to comply with installation and annual testing requirements may result in suspension of service.

C. An approved BFP assembly shall be manufactured in accordance with AWWA C510 and C511 and meet USC FCCCHR specifications. Components in contact with potable water shall be certified to comply with NSF/ANSI 61 and NSF/ANSI 372. The BFP shall be selected and installed in accordance with the Construction Specifications.

D. Testing Requirements for BFP Assemblies Installed on Potable and Recycled Water Services: The licensee is required to have a certified ABPA or ASSE tester inspect and test an existing or newly installed containment BFP assembly on dedicated and recycled water service lines, if applicable, upon installation and annually thereafter. Tests shall be conducted at the expense of the licensee. BFP assemblies shall be repaired or replaced at the licensee's expense when found to be defective. Records of tests, repairs, and replacements shall be kept by the licensee and a copy of the annual test provided to the Town.

   1. Installed BFP assemblies that fail to meet these requirements, but were approved

assemblies at the time of installation, shall be excluded from the requirements if they have been properly maintained and pass annual testing. If the BFP assembly is replaced, the replacement shall be USC FCCCHR approved.

2. The tester is required to
   a. Complete BFP assembly testing and submit test reports within 2 days of The Town's setting of the meter and turning on of the water service. Otherwise service will be suspended.

   b. Submit a copy of the official ABPA or ASSE certification to The Town each time the certification is renewed.

   c. Submit a copy of the test kit calibration certification annually.

   d. Have a dedicated recycled water test gauge.

   e. Complete the BFP assembly test report and submit a copy of the containment BFP assembly report to The Town within 2 days. Incomplete or illegible test reports will not be accepted.

   f. Indicate containment or containment by isolation on the test report.

   g. The submission of isolation test results to the Town is not required by CDPHE.

   h. Indicate the type of usage (i.e., domestic, irrigation, fire, or recycled) on the test report.

   i. Confirm the premises ID, service address, meter number, BFP assembly serial number, and record the values on the test report.

   j. Contact the Town for discrepancies regarding the meter or BFP assembly.

   k. Sign, date, and include the time of the test on the report.

3. Failed Assemblies
   a. If the BFP assembly fails and cannot be repaired on the day of its failure, the Town shall be notified by the certified ABPA or ASSE tester within 24 hours. A copy of the failed test report shall be submitted to the Cross-Connection Control Section within 3 days.

   b. The Property Owner is responsible for coordinating the necessary repairs to the BFP assembly and retesting the unit within 15 days. The Property Owner shall submit a passing test report to the Town. Failure to comply may result in the suspension of water service.

   c. If the premises has a high hazard BFP assembly and is deemed a threat to public health (via the private plumbing system), it is at the discretion of the Town to suspend the dedicated water service line immediately. The Property Owner shall repair or replace the BFP assembly before water service will be restored.

E. Exemptions
1. Single-family residential customers are exempt from the Town's cross-connection control requirements unless the premises is served by a fire suppression system or a dual water supply.

2. Multi-family residential customers with less than 3 units per service are exempt from the Town's cross-connection control requirements unless the premises has a fire protection system or the premises has a common boiler.

F. Stop and Waste Valves
   1. Service lines shall have a stop and waste valve on the service line inside the residence (near where the line enters the residence).

   2. The stop and waste valve shall have a drain plug located on the valve body so that when the valve is shut off the drain plug can be removed and the water above the valve drained out.

502.10 Water Meters

A. General
   1. Water meters used in the Town of Berthoud's system shall be preapproved by the Town Engineer in accordance with the approved Manufacturer and model. The Town will determine the type of meter to be installed at the time of the application based upon size, service requirements, location, and other conditions that may exist. The Town may change the type of meter at any time based on the water usage patterns of the licensee.
      a. Displacement meters, 5/8-inch through 2-inch
         i. Residential, industrial, commercial, and irrigation applications requiring a 2-inch or smaller service.

      b. Compound meters larger than 3-inch
         i. Large irregular flows

      c. Turbine meters, 2 inches and larger
         i. Large, relatively constant flows

      d. Fire service type meters
         i. Used on any service including fire sprinklers, fire hydrants, or other fire protection

   2. Only town approved meters are allowed. In most cases, the Town will require all meters to be purchased from the Town's supplier.

   3. All service meters shall be owned and maintained by the Town.

   4. All Town master meters shall be owned and maintained by the Town and shall be connected to the Town's SCADA system.

   5. Multi-family, attached residential construction must employ a master meter with dedicated backflow upstream of any micro metering devices.

B. Meter installations
   1. Meter installations, 1-inch and smaller, will be inspected by The Town after final grade is established at a minimum of 5-feet radially around the meter setting.

   2. 2-inch and larger meter installations, will be inspected by the Town prior to backfilling and upon completion of the installation.

   3. Meters shall be the same size as the corporation stop or service tee and that portion of the service pipe between the meter and the corporation stop.

C. Meter Setting
   1. General
      a. The meter shall be installed in an approved coppersetter or yoke. The bypass line shall have a ball valve that may be locked in the closed position. Coppersetters for 1-inch and smaller meters shall include a lockable angle valve on the meter inlet. Coppersetters for 1 1/2-inch and 2-inch meters shall include lockable angle valves or ball valves on the meter inlet and outlet and a lockable ball valve on the bypass.

b. Meter supports shall be a solid concrete block. Fabricated metal supports or jack stands shall be used to support 3-inch and larger

c. To ensure safety, meter settings shall provide for electrical continuity in the event the meter is removed from the setting. There shall be an electrical continuity wire or strap connecting the pipe on either side of the meter setting. The wire shall be made of copper with fittings suitable for bonding jumper and water pipe material.

d. All meters shall be outside in a meter pit or vault. Refer to detail D5.13.

e. Outside meters shall be installed with the inlet and outlet spuds in a horizontal position and housed in a concrete or approved composite meter pit or vault. The meter shall sit horizontally with the meter register pointing up. Meters 1.5" largershall be installed in vaults.

f. For all meter pit settings, install a curb stop 18"feet before the meter pit or vault. The meter setting shall include an angle valve or ball valve on the inlet side of the meter. For all vaultsettings, install a curb stop 2-feet before the meter vault. The meter setting shall include angle valves or ball valves on the inlet and the outlet sides of the meter. The bypass line shall have a ball valve that may be locked in the closed position

D. Meter Bypass Lines

1. A bypass line is required for 1 1/2-inch and larger meters except those used for irrigation-only service.

2. Bypass lines shall contain an independent isolation valve and shall not contain tees, plugs, or other outlets through which water could be withdrawn. Bypass lines permit the customer to have water while the meter is being repaired or replaced and may only be activated by the Town.

3. Bypass lines for 1 1/2-inch and 2-inch meters shall be integral to the meter yoke with an appropriately sized ball valve. Bypass lines for 3-inch and larger meters shall be connected to the main line at tees before and after the meter and shall include a gate valve with wheel operator.

4. Bypass lines shall be locked in the closed position when not in use.

502.11 Manholes, Vaults, and Pits

A. General

1. Structures shall be designed to support applicable loads. Design calculations, drawings, and contract specifications shall be submitted to the Town of Berthoud for review. Concrete used in structures shall be Class A.

2. Steel reinforcement shall be deformed bars or welded steel fabric.

B. Manholes

1. Manhole base beams shall be constructed of precast, reinforced concrete.

2. All manholes shall be designed so that all joints and corners are waterproof either by construction methods or after construction by the use of sealants.

3. The manhole roof shall be designed to support the street fill and traffic loading in accordance with AASHTO Standards.

4. Manholes shall not be installed in curbs, gutters, concrete pans or in the wheel path in the road.

5. Lids
   a. All manhole lids shall be forged with the following: "Water". Manhole lids must be approved by Town Engineer.

   b. Rings and covers shall be cast-iron. Manhole rings and covers shall be twenty- four (24) inch diameter manholes

   c. Surface patterns in the lids shall be drivable and smooth. Checker patterns or other textured patterns are not allowed.

   d. The 24-inch CI manhole cover shall weigh approximately 165 lbs. The 24-inch CI ring shall weigh approximately 240 lbs.

C. Meter Pits and Vaults
1. Water meter vaults shall be located in a landscaped area between the curb and detached walk wherever size permits.

2. Pressure reducing valves (PRVs) shall not be installed within the meter pit.

3. Refer to detail D5.12 for typical meter vault assembly.

4. 3/4-inch and 1-inch Meters
   a. Meter settings for 3/4-inch and 1-inch meters shall be installed in meter pits with a 24- inch nominal diameter and a total depth of 52-inches minimum from grade. The pit shall consist of a 24-inch nominal diameter by 48-inch high cylinder of composite with a dome or bell housing holding an internal plastic frost lid and a locking top lid.

   b. Rings shall be constructed of concrete and comply with the requirements of ASTM C 478.

   c. A CI dome or bell housing shall be mounted on the top of the pit. The dome or bell housing shall have a support for an interior frost lid and a rim for locking the meter pit cover. Composite and plastic domes are not permitted.

   d. The cap-type meter pit top lid shall be constructed of CI or an approved composite material. Lids shall be of the cap-type with a 2 rececessed hole, locking screw and bolt that provides a tight locking of the cover to the dome or bell housing of the meter pit. Lids shall withstand AASHTO HS 20 highway loading plus 25% impact not to exceed 20,000 lbs. Composite lids shall be available in various colors, as required by the Town. When set in place of the dome, the top of the meter pit lid shall be set at ground line. The inner frost lid shall be high-density polyethylene.

5. 1 1/2-inch and Larger Meters
   a. Meter vaults shall be precast concrete from approved manufacturers. The roof and the walls of precast vaults shall be made waterproof after construction using sealants, membranes, or other approved methods. Access manholes shall be adjusted to be flush with the finished landscape grade or surrounding pavement.

   b. Circular vaults for 1 1/2-inch and 2-inch meters shall be 48-inch diameter and of sufficient depth to extend below the 4 1/2-feet to 6-feet depth below ground line of the service line. The wall thickness shall be at least 6-inches. The vault shall have a flat top with concrete grade rings supporting the manhole ring and 24-inch diameter manhole cover at ground line. When subject to traffic loads, vaults shall sit on reinforced concrete manhole.

   c. Rectangular vaults for 3-inch and larger meters shall be approved by the Water Operations Manager. Vaults shall be precast concrete from an approved Manufacturer. Vaults shall be designed to support the street fill and HS 20 traffic

loading in accordance with AASHTO Standards.

d. Meter vault lids shall be ASTM A 48 Class 35B CI manhole covers with a 24-inch lid with a 2” recesssed hole set into a 36-inch outer diameter ring.

6. Meter vaults shall include copolymer polypropylene plastic steps cast into the side of the vault evenly spaced at 12-inch centers, maximum.

7. AMR/AMI devices shall be mounted through the CI manhole lid or outer ring, inside the vault with a composite cover, in a remote location on the side of a building, or on a pole, as directed by the Meter Technician.

D. Sump Pits for Vaults and Manholes
1. Concrete vaults and manholes with concrete bases shall have sump pits.

2. The minimum pit opening shall be 12” x 12” square and open to gravel.

3. A gravity drain line or sump pump shall be used in conjunction with a sump where telemetry equipment is to be installed. A sump pump is not permitted in a meter vault.

4. Sumps are required for vaults and manholes where there is seepage into existing vaults, in PRV installations at the discretion of the Town Engineer.

E. Vent Pipes
1. Vent pipes shall be required on all vaults and manholes.

2. Vent pipes shall be field located at the nearest intersection of the street property line and the side lot line.

3. Installations that contain electrical equipment shall have a locally controlled, power-operated blower attached to the vent system. Electric powered blowers are not permitted in meter vaults.

4. The above ground vent pipe shall be steel pipe,4-inch nominal diameter, in accordance with ASTM A 53. The vent screen shall be No. 12 or No. 16 stainless steel mesh. The below ground vent pipe shall be 6-inch, black steel pipe – Schedule 40. Threaded joints will only be allowed above finished grade. A 6-inch threaded black steel coupling shall be used to connect the pipes at ground level.

502.12 Future Connections

A. Water utilities shall be stubbed out to the right-of-way or limits of property at all locations that are planned for future tie-ins. Other reasonable stub-outs or main extensions may be requested by the Water Service Provider or the Town based on knowledge of adjacent development.

B. Service stub-outs and main extensions shall be valved such that only one valve will need to be closed when the water line is extended. Depending on location, Town may ask for a temporary blow-off at the end of a stubbed line.

C. The end of a service stub-out shall be marked in the field with a carbonite composite utility marker painted blue and labeled with the size and material of the water main extension.

D. The end of a main extension shall be marked in the field with properly marked carbonite composite utility marker.

E. All water services (domestic and fire) shall be marked with a “W” chiseled into the concrete curb or other paved surface it crosses under.

F. When a stub-out connection is installed to permit street paving or in advance of future development, it shall be located to provide a future connection that is in accordance with applicable standards at the time of activation. There is no assurance that any stub-out will meet the requirements for conversion to a service line at the time of activation. A licensee that installs a stub-out does so with the understanding that it shall be the responsibility of the licensee to modify, reconstruct, relocate, replace, or remove the stub-in, as necessary.

502.13 Fire Hydrants and Fire Service Lines

A. General

1. The Responsible Party shall provide system improvements, including fire hydrants, for fire suppression as needed for the proposed development and its impact, if any, on adjacent properties.

2. The required number of fire hydrants and their locations shall be coordinated with the BFPD, Water Service Provider and the Town. As minimum general requirements, the number of fire hydrants, their location and spacing shall follow the latest edition of International Fire Code (IFC) Appendix C.

3. Private fire service main for use on an internal fire suppression system shall extend from the valve on the main to the base of the riser flange in the building.

4. The use of any private fire service main to supply more than one lot is not allowed.

5. There shall be two separate service lines to any building: fire and domestic. Domestic services taps shall be made off the Public Water System main and shall not be connected to any portion of a fire hydrant lead or fire service line.

6. No horizontal or vertical bends or reducers shall be used in fire hydrant or fire sprinkler branch lines unless specifically approved by the Town.

7. All fire hydrants shall be owned and maintained by the Town.

8. An approved USC FCCCHR BFP assembly shall be installed on water service connections that supply a fire protection system. On a fire service line that is required to have a detector check valve assembly, an approved DCDA or a RP BFP assembly is acceptable in lieu of a detector check valve assembly.

B. Hydrant Placement

1. Hydrants shall be located at least one (1) foot inside the right-of-way or water utility easement and five (5) feet from the side lot line and shall conform to Standard Detail D5.01.

2. Hydrants shall be located a minimum of six (6) feet from edges of driveways to the center of the hydrant.

3. Installation of fences, signposts, landscaping or other obstructions shall in no way hinder the access or operation of the fire hydrant. A 5-foot buffer must be maintained. “5 foot buffer”

4. New fire hydrants must be fed by a minimum eight (8) inch main line from two (2) directions.

5. Fire hydrants are generally installed on the Northeast corner of street intersections. If hydrants are to be installed at locations other than street intersections, they shall be located on property lot side lines that are extended to the street.

6. The fire hydrant branch line shall be set at a 90-degree angle to the street main. The hydrant shall be set at the end of the branch line facing in the direction of the branch line.

C. Dead end mains
   1. All main lines shall be “looped” when possible to minimize dead ends.

   2. Main line extensions, which are to be used, for fire protection and are dead-ended shall not be longer than 500 feet. Extensions longer than 150 feet may require oversizing and approval by the Town Engineer.

   3. Where dead-ends occur, they shall be provided with a fire hydrant if flow and pressure are sufficient, or with an approved flushing hydrant or blow-off for flushing purposes.

   4. No flushing device shall be directly connected to any sewer.

   5. All dead end mains require flushing devices.
   a. Flushing devices shall be installed at the distal end of all dead-end lines.

   6. Dead end mains shall require installation of approved backflow devices.

   7. A dead-end main may only have one fire hydrant connected to it in cases where looping is not an alternative, except as specifically approved in writing by the Town or the Distributor.

   8. Multiple fire protection appurtenances, including any combination of fire hydrants and fire service lines for any single project site, are not allowed on a dead-end main. Additional consideration will be given in the case of single-family residential homes on a cul-de-sac where fire service lines are required.

   9. Redundant hydrant installations and the unnecessarily high density of fire hydrants shall be avoided where existing hydrant function would be duplicated.

   10. Fire hydrants shall be installed within dedicated streets or in easements. When the Town of Berthoud determines it is not feasible for a hydrant to be installed in this manner, it shall be installed in an easement adjacent to the street. Fire hydrant easements shall have a minimum width of 20-feet. The easement shall extend a minimum of 5-feet beyond the center of the hydrant.

D. Public and private fire hydrants shall meet the Town’s Standards and Specifications
   1. Comply with American Water Works Association (AWWA) Specification C-502

   2. All fire hydrants shall be Mueller Waterous or AVK

   3. Open Direction: RIGHT (clockwise)

   4. Operating Nut: 1.5-inch Pentagon (5-sided)

   5. Painted yellow for Town of Berthoud

   6. Bonnet and caps painted per Town of Berthoud standards for measured fire flow rates with 20 pounds per square inch (psi) residual pressure.

   7. Five and one-quarter (5-1/4) inch or larger valve opening, two (2) two and one-half (2-1/2) inch hose nozzles, one (1) pumper nozzle (4-½") and six (6) inch or larger mechanical joint inlet.

   8. All nozzles shall have National Standard thread.

E. Fire Service Lines
   1. The size and material of fire service lines shall be determined by the BFPD and the

persons responsible for the structure. The Town of Berthoud will not size fire service lines.

2. Fire lines shall have an isolation valve at the main line.

3. Fire lines shall have an approved backflow prevention device.

4. Under no circumstances shall any size or manner of a tap be made on a fire hydrant or fire sprinkler branch line.

5. Under no circumstances shall any size or manner of a tap be made on a domestic service line for a fire service.

6. Fire service lines shall be considered privately owned and maintained from the connection of the service line into the isolation valve, continuing on to a building structure.

7. Fire service lines shall be located a minimum of five (5) feet from any domestic service line.

8. Fire service lines shall not be tapped off any portion of a fire hydrant lead.

9. Fire service valve lids must include “FIRE”.

502.14 Submittal Requirements

A. The Responsible Party is required to complete all review requirements of the appropriate service provider including Commitment Letters or will serve letter.

B. The Responsible Party is required to submit engineering plans of proposed water system improvements to the Town. All water mains shall be profiled. In addition to engineering plans, legal descriptions, agreements and exhibits for all proposed water line easements shall be submitted to the Town.

C. BFPD signature block and original signatures shall be required for development that includes or effects proposed or existing hydrants and/or fire service lines.

503 CONSTRUCTION SPECIFICATIONS

503.1 General

A. Water transmission lines, mains, services and appurtenances shall be installed per The Town of Berthoud’s standards, specifications and drawings. In general, materials, installations and testing shall be in accordance with established American Water Works Association (AWWA) standards.

503.2 Coordination of Work

A. Coordinate with Town, Service Provider and BFPD representatives for any impacts to the existing water system and provide advanced notice to impacted properties if applicable.

504 WATER DETAILS

504.1 WATER DETAILS

A. The following is a list of standard details for water utility work that are part of the Town of Berthoud Standards and Specifications:

D5.01	Fireline Connection with Main Extension
D5.02	Fire Hydrant Profile
D5.03	Fireline Tracer Wire
D5.04	PRV Rectangular Vault Plan View
D5.05	PRV Rectangular Vault Cross Section
D5.06	PRV Manhole Plan View
D5.07	PRV Manhole Cross Section
D5.08	2-inch Air and Vacuum Valve Installation
D5.09	Blow-Off Installation – 12-inch and Smaller
D5.10	Blow-Off Detail
D5.11	Crossing Over or Under Conflicting Utility
D5.12	Meter Vault Assembly
D5.13	Service Line, Stop Box, Outside Meter Installation
D5.14	Outside Setting for 3/4-inch and 1-inch Meter
D5.15	Outside Setting for 1 ½-inch and 2-inch Meter
D5.16	Direct Butterfly Valve Installation
D5.17	Gate Valve
D5.18	Floor Pipe Support
D5.19	Residential Vent Assembly
D5.20	Wall Penetration with Core Hole
D5.21	Pressure Gauge
D5.22	Mechanical Joint Restraint
D5.23	Concrete Thrust Blocks – 1of 2
D5.24	Concrete Thrust Blocks – 2 of 2
D5.25	Tapping Tee and Valve
D5.26	Insulated Joint, Rod, and Coupling
D5.27	Polyethylene Wrap

CHAPTER 600 STORMWATER DESIGN STANDARDS

601 GENERAL PROVISIONS

601.1 General

A. These Standards and Specifications are promulgated by the Town Administrator in accordance with the authority contained in the Town of Berthoud Municipal Code. Improvements shall also be in conformance with the Town of Berthoud Municipal Code.

B. All proposed construction submitted for approval by the Town shall include adequate storm drainage system analyses and appropriate drainage system design. Such analyses and design shall conform to the criteria set forth within these Standards and Specifications. Individuals using these Standards and Specifications are assumed to possess a working knowledge of hydrology and hydraulics and to have experience in storm drainage design and analysis.

C. Publications referenced in this Chapter can provide additional guidance as needed. Where the criteria in these Standards and Specifications vary from those found in other Larimer County, or Mile High Flood District (MHFD) Manual publications, the criteria in these Standards and Specifications shall govern.

D. Drainage easements or tracts, including access easements, shall be provided for all stormwater management facilities required as part of these Standards and Specifications. On-site drainage facilities that are private, affect only the individual property owner, or are not required by these Standards and Specifications need not be placed within public easements. Private detention ponds and outlet works are required by these Standards and Specifications for proper functioning of the public drainage system and therefore are required to be placed within drainage easements or tracts.

601.2 Purpose

A. This Chapter pertains to the Town drainage policy and State of Colorado law regarding drainage systems, stormwater quality control, flood control and site grading. Designs are intended to provide safe, reliable stormwater management in an efficient, cost-effective and environmentally responsible manner. Determination of the best materials and construction methods are based upon lowest life cycle costs, not necessarily upon lowest initial costs.

B. All utility installation within the Town Right-of-Way shall require a Right-of-Way Use Permit prior to any installation activity. See Chapter 200 regarding permits and permitting processes in the Town and Chapter 300 regarding road cut standards.

C. All utility installation outside of the Town Right-of-Way (private property) shall require a Grading Permit prior to any installation activity. See Chapter 200 for Grading Permit regulations.

D. All utilities must be clearly labeled on the plans and include the type, size, depth, etc. For more complete information on plan submittal requirements, refer to Chapter 200 of these Standards and Specifications.

601.3 Submittal Criteria

A. Responsible Parties of new roadways, developments, and subdivisions within the Town must submit stormwater reports and designs, construction drawings, hydrologic and hydraulic calculations, and as-built information in accordance with Chapter 200 of these Standards and Specifications.

B. The Final Drainage Report shall be submitted with the civil construction drawings for the site. The Final Report (which updates the Preliminary Drainage Study) shall be reviewed with the submittal of the construction plans and approved by the Town Engineer prior to issuance of

construction permits.

C. Stormwater reports are not needed for individual single-family-home construction sites. However, a stormwater report is needed for entire subdivisions of single-family homes.

D. Roadway Drainage Criteria
   1. Borrow ditches need to be sized to reduce the potential for roadway overtopping.
      a. Overtopping of the roadway shall not result in more than 6 inches of water on the road during the 10-year event.
      b. Overtopping of the roadway shall not result in more than 12 inches of water on the road during the 100-year event.

   2. Culverts need to be sized to reduce the potential for backwater effects on adjacent houses or businesses. Culverts passing under Town roads must be designed for the 10-year storm and have a minimum diameter of 15 inches.
      a. Culvert(s) must be sized so that road overtopping does not result in more than 6 inches of water in the flowline of the gutter in the 10-year event.

      b. Culvert(s) must be sized so that road overtopping does not result in more than 12 inches of water in the flowline of the gutter in the 100- year event.

      c. A minimum of one 12-foot wide drivable lane must be provided at all major arterials in the 100-year storm event.

   3. If the roadway is being constructed in a floodplain, all applicable floodplain regulations and codes apply, including the need to submit an LOMR to FEMA for review and acceptance if applicable.

601.4 Drainage Policy

A. Adequate drainage is necessary to preserve and promote the general health, safety, welfare, and economic wellbeing of the community. Drainage is a regional issue involving multiple governmental jurisdictions and affecting all property parcels. Therefore, drainage systems and programs shall address both public and private needs.

B. Drainage plans should adhere to generally accepted engineering principles and practices and should conform to applicable laws and regulations. Designers should reference the drainage policy chapter of the *MHFD Urban Storm Drainage Criteria Manual (Volume 1), and Larimer County Stormwater Design Standards.*

C. The Principals of the Town of Berthoud storm drainage policy are summarized below:
   1. Storm drainage design shall observe Colorado water rights law.

   2. Drainage is a regional phenomenon that does not respect the boundaries between government jurisdictions or between properties.

   3. The storm drainage system is a subsystem of the total natural water resource system.

   4. Planning and design of stormwater drainage systems should not be based on the premise that problems can be transferred from one location to another.

   5. Storm drainage strategy should be a flexible, multi-objective, and multi-means effort.

   6. In the Town of Berthoud, storm drainage design for new development shall accommodate agricultural facilities and practices.

   7. Design of the constructed stormwater drainage system should consider the features and functions of the existing natural drainage system both upstream and downstream.

8. To the maximum extent practicable, storm drainage design for new developments shall reduce stormwater runoff rates and prevent pollutant load increases. The storm drainage design shall be based on Full Spectrum detention of the 100-year developed site runoff released at or less than 90% of the pre-development 100-year maximum runoff rates as determined by the latest methods endorsed by MHFD.

9. Storm drainage design for new development shall give full consideration to downstream impacts and safe conveyance of upstream off-site flows entering the system. Prevention of harm is paramount.

10. Stormwater management systems shall receive regular maintenance. As such it is encouraged that designers employ low-maintenance, low impact design (LID) systems as is feasible.
    a. Private stormwater management systems shall be maintained by the owner to the acceptance of Town of Berthoud stormwater inspector.

11. Storm drainage design for new development shall ensure erosion prevention forup- and downstream properties.

12. Adequate floodplain capacity needs to be preserved, consistent with FEMA and Colorado Water Conservation Board (CWCB) regulations.

13. Land development should reserve sufficient floodplain width to accommodate lateral stream channel movement.

14. Retention of stormwater is discouraged and shall not be pursued without prior approval by the Town Engineer. Retention ponds are not acceptable unless there is no feasible method for draining of the pond by gravity. If a retention pond is found to be the only alternative, the minimum volume of the facility must be adequate to retain the storm runoff from twice the 100-year 24-hour developed storm event. Evaporation alone may be an accepted method for draining the pond, but percolation is not acceptable in situations where an increase in groundwater flow as a result of pond percolation could cause an adverse impact upon structures with basements down gradient of the pond site.
    a. Ponds must drain within 72 hours for storm event equal to or less than the 5-year event and 120 hours for all events greater than the 5-year event, to be consistent with Colorado Water Law.

    b. Water augmentation will be required if a retention pond is constructed on site and the site does not have soils that will allow for percolation to occur within the required time period

15. Drainage Law
    a. Refer to the drainage law chapter of the MHFD Manual (Volume 1) for more information on drainage law as it relates to stormwater runoff and floodplain management.

    b. Refer to *Larimer County Stormwater Design Criteria* for additional principles of Colorado drainage law applicable within the Town of Berthoud.

601.5 Stormwater Management Plan and Erosion Control Plan

A. Include analysis and describe necessary mitigation measures and improvements that will be incorporated into the erosion control plan as part of the site development.

B. Provide a discussion of how proposed erosion and sedimentation control measures will ensure that downstream properties and drainageways will not be adversely impacted by site development and construction activities.

601.6 Operation and Maintenance Manual for Stormwater Facilities

A. Requirements for O&M Manuals
   1. Developers must submit detailed Operation and Maintenance (O&M) Manuals for all stormwater management facilities, including detention ponds and storm lift stations, along with the construction drawings. This manual must be in accordance with both the Town of Berthoud standards and the MHFD standards.

B. Content of O&M Manuals
   1. The O&M Manual must include detailed procedures for the routine and non-routine maintenance of all stormwater facilities. This includes sediment and debris removal, inspection schedules, and procedures for repairing or replacing outlet structures, trickle channels, and related infrastructure.

   2. Specific guidance on the management and maintenance of stormwater lift stations, including operational checks, emergency procedures, and SCADA monitoring protocols if applicable.

C. Submission and Approval
   1. The O&M Manual must be submitted to the Town Engineer for review and approval as part of the final construction document submission. This ensures all stormwater facilities are maintained in a manner that meets town and regional standards.

   2. The approved O&M Manual must be provided to the Homeowners Association (HOA) or the responsible maintenance entity to ensure proper long-term management of the stormwater facilities.

D. Responsibilities of HOA
   1. The HOA or designated maintenance entity is responsible for implementing the O&M Manual. They must ensure all stormwater facilities are maintained according to the specified procedures to prevent system failures and ensure compliance with local and regional standards.

   2. Regular updates to the O&M Manual should be made to reflect any changes in procedures or regulations.

602 DESIGN CRITERIA

602.1 General Drainage Criteria and MHFD Design Aids

A. As stated in the previous section, designers are advised to reference the *USDCM* and *Larimer County Stormwater Design Standards*, as much of the criteria herein is adopted from said sources.

B. The Owner/Applicant is encouraged to use the spreadsheets and programs provided by the MHFD to assist in designing street drainage, inlets, and storm sewers. Other software programs may be used by the design engineer. The designs shall be verified using the MHFD spreadsheets and provided in the submitted Preliminary and Final Drainage Reports. The most current version of the MHFD spreadsheets can be downloaded from the MHFD website.

C. The Town will allow the use of other modeling methodologies on a case-by-case basis when complete documentation of all assumptions is provided. Approval must be provided by the Town Engineer prior to submittal of the Preliminary Drainage Report to the Town. The Town reserves the right to review alternative methods and compare with other commonly used approaches, including those discussed in the *USDCM*.

602.2 Rainfall

A. This section presents the methods used to develop rainfall information for hydrological analyses. For more information regarding the development of rainfall information, refer to the rainfall chapter of the *USDCM (Volume 1)*.

B. Design Storms
   1. Drainage designs for areas in and around the Town of Berthoud should use the depth-duration-frequency information provided in the Precipitation-Frequency Atlas of the Western United States (Volume 2 - Colorado), published by NOAA. The NOAA Atlas can be accessed on the NOAA website.

C. The Rational Method
   1. The Rational Method is one method for determining runoff from a proposed development or road construction project. Note that it should not be used for basins greater than 160 acres. The MHFD spreadsheets can also be used for basins that are no greater than 160 acres. Refer to the rainfall chapter of the *USDCM* for more information regarding the rainfall parameters required to use the Rational Method.

D. Larger Basin Rainfall Methods (Basins sizes 160 acres and greater)
   1. As noted above, the Rational Method should not be used to determine runoff for basins larger than 160 acres. Where areas are larger than 160 acres that have drainage characteristics similar to an urban area, the Colorado Urban Hydrograph Procedure (CUHP) is an acceptable model for determining runoff amounts. The CUHP model can be used for basins from 0 to 3,000 acres. The parameter adjustments provided in the runoff chapter of the *USDCM (Volume 1)* should be used when dealing with basins that are larger than 160 acres.

   2. The CUHP model is not applicable in non-urban areas, including those areas in Larimer County that are outside of the Denver metropolitan area. The U.S. Army Corps of Engineers (USACE) HEC-HMS model is more applicable for mixed suburban-agricultural areas. The HEC-HMS model can be used on watersheds and drainage basins larger than 160 acres provided the modeling follows the parameters in the HEC- HMS User's Manual, the HEC-HMS Technical Reference Manual, the HEC-HMS Application's Guide.

   3. The HEC-HMS model is also recommended for determining the peak flow of large off-site stream flows moving through a proposed development site.

   4. The stormwater report should fully describe the rationale for the chosen rainfall method of determining runoff, including the choices for all the various model parameters. The report must contain copies of all applicable tables and reference materials in an appendix as well as electronic copies of any spreadsheets prepared, and must fully document the assumptions for reviewing purposes.

602.3 Runoff

A. This section presents the methods used to develop runoff information for hydrological analyses. For more information regarding the development of runoff information, refer to the runoff chapter of the *USDCM (Volume 1)*.

B. Rational Method
   1. The Rational Method can be used for basins that are smaller than 160 acres. The Rational Method is based on the formula:

      Q = CIA, where

      Q = the maximum rate of runoff (cfs),
      C = a runoff coefficient that is the ratio between the runoff volume from an area and the average rate of rainfall depth over a given duration for that area,
      I = the average intensity of rainfall in inches per hour for a duration equal to the time of concentration, and
      A = area (acres).

2. Runoff Coefficients
   a. Table 600-2 lists recommended percentages of imperviousness for various types of land usages. If the Engineer of Record can provide data for more specific percentage of imperviousness of proposed development, the data may be considered by the Town. Examples of a project-specific imperviousness would be a green roof system or a porous paver system with manufacturers' data for a recommended imperviousness.

Table 600- 2: Recommended Percentage Imperviousness Values

Land Use or Surface Characteristics	Percentage of Imperviousness
Business:	
Commercial Areas	95
Neighborhood Area	85
Residential Lots: (lot area only)	
Single-Family, 0.25 acres or less	45
Single-Family, 0.25 - 0.75 acres	30
Single Family, 0.75 acres or larger	20
Multi-Family (attached)	60
Multi-Family (detached)	75
Apartments	80
Industrial:	
Light Areas	80
Heavy Areas	90
Parks and Cemeteries	10
Playgrounds	25
Schools	55
Railroad Yard Areas	50
Undeveloped Areas	
Historic Flow Analysis	2
Greenbelts, Agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and Walks	90
Roofs	90
Lawns, sandy soil	2
Lawns, clayey soil	2

   b. Volume-based runoff coefficients have been derived by MHFD using the calculated percentage imperviousness and the hydrologic soil groups A, B, and C/D. The equations published in the MHFD Volume 1, Chapter 6 shall be utilized to compute runoff coefficients for use in rational method calculations.

3. Time of Concentration (tc) is used to determine the average intensity of rainfall.
   a. Time of Concentration is equivalent to the amount of time needed for runoff to travel from the most hydraulically remote point of the basin to the design point. The time of concentration consists of two components, the initial or overland flow time "ti" (usually as sheet flow) and the time of travel "tt" in a concentrated form (i.e., in a storm sewer, gutter, swale, channel, etc.). The time of concentration is summarized by the equation:

tc = ti + tt, Where

tc = time of concentration (minutes)
ti = overland flow time (minutes)
tt = travel time in the ditch, channel, gutter, storm sewer, etc. (minutes)

b. The specific parameters and equations for calculating the overland travel time (ti) and the channelized travel time (tt) are provided in the *USDCM*.

c. The minimum time of concentration is as follows
   i. tc (min) = 5 minutes for urbanized watersheds
   ii. tc (min) = 10 minutes for non-urban watersheds

4. The average rainfall intensity (I), in inches per hour, for a storm duration equal to the time of concentration for the Town of Berthoud can be found using the intensity-duration-frequency information provided in the Precipitation-Frequency Atlas of the Western United States (Volume 2 - Colorado), published by NOAA. The NOAA Atlas can be accessed on the NOAA website. Once the time of concentration has been calculated, the rainfall intensity can be read from the intensity-duration curve and then used in the Rational Method equation.

5. The general procedure for using the Rational Method for basins is as follows
   a. Delineate the catchment basin and measure its area.
   b. Define the flow path from the uppermost portion of the basin to the design point. This flow path should be divided into reaches of similar flow types (overland flow, shallow swale flow, gutter flow, etc). The length and slope of each reach should be measured. Flow path parameters shall be used to determine the time of concentration, tc, for each individual basin.

   c. Find the rainfall intensity, I, for the design storm using the calculated tc and the Rainfall- Intensity-Duration Frequency Curve (Figure 600-1) included at the end of Chapter 600.

   d. Determine the runoff coefficient, C, using the imperviousness values shown in Table 600-2, NRCS hydrologic soil classification (A, B, C or D) and MHFD equations for runoff coefficients based on NRCS soil types and storm return period.

   e. Calculate the peak flow rate from the basin using the Rational Formula, Q = CIA

C. Runoff Calculation Methods for Basins 160 Acres and Greater in Size
   a. The CUHP model is based on the unit hydrograph principle. It was developed by the MHFD for use in the urban areas around Denver and Boulder. The most current version of the CUHP model can be downloaded from the MHFD website under downloads. The CUHP model is generally used for basins that are larger than 160 acres. The CUHP model is not applicable in non-urban areas that are outside of the Denver metropolitan area.

   b. The USACE HEC-HMS model or other hydrologic models are more applicable for mixed suburban-agricultural areas.

   c. The EPA's SWMM 5 model or newest version can be used to route multiple sub-basins and design detention facilities as part of the routed system for all sizes of development. The model shall not be used as a standalone design method for detention pond sizing. More information on the routing methodologies can be found in the runoff chapter of the *USDCM (Volume 1)*.

D. HEC-HMS Method
   1. The USACE HEC-HMS model can be used in areas of Larimer County where the

Rational Method and CUHP Method are not applicable. The HEC-HMS model is more applicable for the mixed suburban-agricultural areas typical of much of Larimer County. The HEC- HMS model can be used on watersheds and drainage basins larger than 160 acres. Designers must follow the parameters provided in the HEC-HMS User's Manual, the HEC- HMS Technical Reference Manual, and the HEC-HMS Application's Guide.

2. The Town of Berthoud will allow the use of other modeling methodologies on a case-by- case basis when complete documentation of all assumptions is provided. The Town of Berthoud reserves the right to review alternative methods and compare with other commonly used approaches, including those discussed in the MHFD USDCM Manual.

602.4 Roadway and Street Drainage

A. General Criteria
   1. When runoff in the street exceeds allowable limits, a storm sewer system or open channel is required to convey the excess flows.

   2. Design Criteria Based on Frequency and Magnitude
      a. The design criteria for the collection and conveyance of storm water runoff on public streets are based on an allowable frequency and magnitude of traffic interference. The primary design objective shall be to keep the depth and spread (encroachment) of stormwater on the street below an acceptable value for a given storm event.

   3. Street Function in Minor Storm Event
      a. The primary function of streets in a minor storm event is to convey the nuisance flows quickly and efficiently to the next intended drainage conveyance system with minimal disruption to street traffic.

   4. Street Function in Major (100-year) Storm Event
      a. For the major storm event, the function of streets is to provide an emergency passageway for flood flows while maintaining public safety and minimizing flood damage. In the major event, the street may become an open channel and must be analyzed to determine when flooding depths exceed acceptable levels.

   5. If the roadway is being constructed in a floodplain, all applicable floodplain regulations and codes apply including the need to submit a LOMR to FEMA for review and acceptance, if applicable.

   6. For more information regarding the geometry of street and roadway design, refer to Chapter 300 of these Standards and Specifications and LCAUSS standards.

B. Identification of Downstream Constraints
   1. Downstream constraints may affect the capacity and release rate of upstream drainage facilities. Any downstream constraints shall be considered in the drainage design and identified in the submitted drainage report.

C. Allowable Street Flow
   1. Drainage Classifications: The streets in the Town are assigned a drainage classification of Type A, B, or C based on the average daily traffic (ADT) for which the street is designed or for the roadway classification. In general, the higher the ADT or mobility that the roadway provides, the more restrictive the allowable drainage encroachment into the driving lanes. The following Table 600-3 summarizes the drainage classification for each type of roadway

Table 600- 3: Drainage Classification for Town of Berthoud Roadways

Street Classification	Drainage Classification
Local	A
Collector	B
Arterial (Major or Minor)	C

Table 600- 4: Minor Storm Allowable Street Flow

Drainage Classification	Allowable Flow Depth in Gutter Flowline	Maximum Street Encroachment
Type A	No curb overtopping.	Flow may spread to crown of street.
Type B	No curb overtopping.	Flow spread must leave at least one 10-foot lane free of water. (5-feet either side of the street crown)
Type C	No curb overtopping.	Flow spread must leave at least two 10-foot lanes free of water. (10-feet each side of the street crown or median)

Table 600- 5: Major (100-year) Storm Allowable Street Flow

Drainage Classification	Allowable Flow Depth in Gutter Flowline	Maximum Street Encroachment
Type A, B and C	The depth of water at the gutter flowline shall not exceed 12 inches 10-year within curb and gutter 6” depth	Flow must be contained within the public right-of-way or dedicated drainage easements, and all structures shall be a minimum of 1 foot above the adjacent 100-year water surface elevation.

D. Curb and Gutter
   1. See LCUASS standards for design criteria.

E. Storm Sewer Systems
   1. Introduction
      a. Storm sewers shall be designed to convey the minor storm event without surcharging the pipe.

      b. All storm sewer infrastructure in public right-of-way shall be designed for the ultimate cross section or full build-out of the roadway.

      c. The minimum allowable pipe size for all public storm sewer piping in public right-of-way shall be 18 inches in diameter or equivalent open area.

      d. Privately owned, public storm sewer in open spaces, and maintained detention pond outlet pipes which do not discharge to public right-of-way may be no smaller than 12 inches.

   2. Vertical Alignment
      a. The storm sewer grade shall be such that a minimum cover is maintained to withstand AASHTO HS- 20 loading on the pipe. The minimum cover depends upon the pipe size, type and class, and soil bedding condition, but shall be not less than 18

inches for Reinforced Concrete Pipe (RCP).

b. Refer to Chapters 400 and 500 for clearance requirements from other utilities.

c. Uniform slopes shall be maintained between structures, i.e. manholes and inlets.

3. Horizontal Alignment
   a. The minimum horizontal separation between storm sewers and water mains shall be ten (10) feet, as measured from outside diameter of pipe to outside diameter of pipe.

   b. Refer to Chapters 400 and 500 for more complete clearance requirements.

4. Hydraulic Grade Line (HGL) and Energy Grade Line (EGL) Calculations
   a. The minor and major HGL and EGL shall be calculated for each storm sewer system and shall be included in the final stormwater report.
   b. Each storm sewer system shall be profiled on the final construction drawings and shall include the routed design flow (Q) and the associated hydraulic grade line (HGL).
      i. HGL for the Minor event shall be within the pipe.
      ii. HGL for the Major event shall meet the criteria above for street conveyance and open channels.
      iii. If the 100-year event HGL is above any manhole or inlet cover, or if the manhole or inlet is located in a floodplain, manhole and inlet covers shall be bolted down.
      iv. The hydraulic grade line (HGL) for the routed design flow (Q) shall be at or below the final finished elevation of the manhole rims.

5. Inlets
   a. Inlet grates shall have a symbol of a fish with the words ”DUMP NO WASTE, DRAINS TO WATERWAYS”

   b. The design guidelines provided in the streets/inlets/storm sewers chapter of the *USDCM (Volume 1)* should be used when designing stormwater inlets. The UD-Inlet Spreadsheet shall be used for the design of streets/inlets/storm sewer unless otherwise approved by the Town Engineer.

   c. An emergency overflow path that does not encroach on residential lots shall be provided for all inlets in sump conditions. All emergency overflow paths shall be designed for a major storm with the assumption that the storm sewer system is plugged. The limits of ponding for the major storm event shall be shown on the storm drainage plans. All emergency overflows shall be armored to protect from scouring.

   d. Design measures should be taken to minimize inlet placement in areas which will be in shadow during winter months by structures, landscaping or fencing along the south side of east-west streets. This effort may require additional inlets along north-south roadways to minimize flows to the south side of an east-west roadway.

   e. The standard CDOT inlets and inlets included in the *CDOT M-Standard Plans* are permitted for use in the Town based on street conditions as follows:
      i. Grated Type C inlets are permitted in all streets with a roadside ditch or swale.
      ii. Grated Type 13 inlets are permitted in alleys or private drives with valley gutters,
      iii. Combination, Type 13 inlets or Type R inlets are permitted in all street types with

6-inch vertical curbs or mountable curbs.

f. Consistent with MHFD recommendations, inlets shall be designed with a 50% clogging factor.

g. Curb chase drains or sidewalk chases shall not be used in place of an inlet to remove runoff from street sections.

h. Maximum inlet length shall not exceed 15 feet.

6. Manholes
   a. Manholes are required where there is a change in size, direction, or grade of a storm sewer pipe. A manhole shall also be constructed where there is a junction of two or more storm drainage pipes.

   b. Manholes are required along straight segments of storm sewer pipe in order to provide maintenance access. Maximum spacing between manholes or inlets will be as follows:
      i. 400 feet maximum distance between structures for pipe diameters ranging from 18 inches to 36 inches.
      ii. 500 feet maximum distance between structures for pipe diameters greater than 36 inches.
   c. Manhole sizing shall be per Table 600-6

Table 600- 6: Required Manhole Sizes

Storm Sewer Diameter	Minimum Manhole Diameter
30-inch and smaller	48-inch
33-inch to 36-inch	60-inch
42-inch and larger	As determined by Town

Note: Larger manhole diameters or a junction structure may be required where storm sewer alignments change direction or more than two storm sewer pipes enter the manhole.

   d. The elevation of pipe crowns shall be matched when the downstream pipe is larger than upstream pipe.

   e. The manhole inverts shall be sloped between the upstream and downstream pipes.
      i. The slope shall be the average of the upstream and downstream pipe slopes or based on a fall of 0.1 feet through the manhole.

   f. Manhole covers are not allowed in concrete areas such as sidewalks, crosspans, gutters and curbs.

   g. A locking frame and cover shall be installed on manholes located below the HGL of the major (100-year) storm event.

   h. Manhole cover shall have a symbol of a fish with the words ”DUMP NO WASTE, DRAINS TO WATERWAYS”

7. Pipes
   a. The design guidelines provided in the streets/inlets/storm sewers chapter of the *USDCM (Volume 1)* should be used when designing stormwater pipes.

b. Allowable Storm Sewer Velocity and Slope
   i. Maximum flow velocity shall be limited to 18 feet per second (fps) or as allowed by manufacturer recommendations.

   ii. Minimum flow velocity shall be 4 fps with the pipe flowing 25% full.

   iii. Minimum allowable longitudinal slope shall be 0.50% for pipe sizes of 30 inches and greater and 1.00% for pipes smaller than 30 inches.

c. The minimum allowable size for a sewer within a public right-of-way shall be 18 inches.
   i. The minimum allowable size for a sewer within a public drainage easement shall be12 inches in diameter or equivalent open area.

d. The Manning's roughness coefficient "n" for all storm sewer capacity calculations shall be 0.013 regardless of pipe material (e.g., concrete, PVC, or HDPE) — with the exception of corrugated metal pipes, which shall have a coefficient of 0.025.

F. Roadside Ditches
1. The primary function of roadside ditches is to convey drainage from the right-of-way to an approved drainage system or approved drainageway. Roadside ditches are not permitted in or through developed property.

2. Roadside ditches shall be used in lieu of curb and gutter when rural street sections are approved and shall be included in the street right-of-way section. Design criteria shall include:
   a. Adequate area and side slopes

   b. Maximum side slopes of 4H:1V are preferred, although maximum side slopes of 3H:1V are acceptable if provided with permanent erosion control protection such as erosion control blanket.

   c. Minimum of 6 inches of freeboard for the minor (5-year) storm event.

   d. Maximum allowable velocity to prevent erosion for up to the minor (5-year) storm event, as determined by soil erosivity and vegetative, erosion control blanket, or riprap cover.
      i. Recommended maximum velocity is 2.5 fps during 5-year storm event in grass lined swales with erosive soils.
      ii. Recommended maximum velocity is 3.5 fps during 5-year storm event in grass lined channels with non-erosive soils.

   e. Incorporation of grade control structures as needed for velocity control.

3. Roadside Ditch Allowable Flow Criteria:
   a. The allowable flow depth and roadway encroachment in the minor and major storm events for rural roadside ditches can be found in Tables 600-4 and 600-5. Tables 600-4 and 600-5 reference allowable flow depth based on the gutter flow line. These tables should be used for rural roadside ditches by applying the depth at the edge of pavement (rather than gutter flowline). The spread of flow shall not extend outside the street right-of-way, and at least 12 inches of freeboard shall be provided from the major storm water surface elevation to the lowest point of water entry at all adjacent structures.

4. Grade control structures or soil-filled riprap linings as required to maintain velocities less than the maximum allowable in accordance with the Major Drainage section of the *USDCM*.

5. There are cases when the roadside ditch criteria may need to be more stringent due to the function of the rural road. Even if a rural road has a low traffic volume, it may be important for emergency access to several properties and therefore require special design criteria. The Town reserves the right for more stringent criteria for single point access roads.

6. Maintenance Requirements
   a. Property owners are responsible for maintaining the roadside ditches along their property frontages. This maintenance is essential to ensure proper drainage capacity and to prevent issues such as weeds and erosion.

   b. Drainage Capacity
      i. Property owners must regularly inspect and clear ditches to maintain their drainage capacity. This includes removing debris, sediment, and any other obstructions that may impede water flow.

   c. Vegetation Control
      i. Property owners must control weeds and other vegetation within the ditches to prevent overgrowth that could obstruct water flow or contribute to erosion.

   d. Erosion Prevention
      i. Property owners must implement measures to prevent erosion within the ditches. This may include installing erosion control blankets, re-seeding bare areas, and maintaining proper ditch slopes.

7. Inspection and Compliance
   a. The Town of Berthoud may conduct inspections to ensure that property owners are maintaining roadside ditches in compliance with these standards.

   b. Non-compliance may result in enforcement actions, including the Town performing the necessary maintenance at the property owner's expense.

8. Reporting Issues
   a. Property owners are encouraged to report any significant drainage issues or necessary repairs to the Town of Berthoud Public Works Department for further assistance.

602.5 Major Drainage

A. This section presents guidelines for the design of major drainage systems. For more information regarding the design of major drainage systems, refer to the major drainage chapter of the *USDCM (Volume 1)*.

B. Design Flows and Design Criteria
   1. The major drainage system must be able to convey the fully developed flow from a watershed for the 100-year storm event without significant damage to the system.
      a. The Table 600-7 below summarizes the general design guidelines and for major drainage channels. More information and design examples are provided in the major drainage chapter of the *USDCM (Volume 1)*.

Table 600- 7: Trapezoidal Channel Design Criteria

	Criteria for Various Types of Channel Lining			
	Grass: ErosiveSoils	**Grass: Erosion Resistant Soils**	**Riprap**	**Concrete**
Maximum 100-yr Velocity	3.0 ft/sec	5.0 ft/sec	12.0 ft/sec	18.0 ft/sec
Minimum Manning's n – stability check	0.030	0.030	0.030	0.011
Maximum Manning's n- capacity check	0.035	0.035	0.040	0.013
Maximum Froude number	0.5	0.8	0.8	N/A
Maximum side slope	4H:1V	4H:1V	2.5H:1V	1.5H:1V
Minimum centerline radius for a bend	2 x top width	2 x top width	2 x top width	2 x top width
Minimum freeboard	1.0 ft	1.0 ft	1.0 ft	1.0 ft

This table was obtained from Weld County Engineering and Construction Criteria, Table 5-11

C. HEC-RAS
   1. It is acceptable to use HEC-RAS to determine the hydraulics of the major drainage system. HEC-RAS is useful in sizing the major drainage system to carry the design storm. Standard modeling practices accepted by FEMA should be used when performing HEC-RAS modeling.

   2. It is not acceptable to rely on HEC-RAS output to estimate maximum velocities for erosive or hazard considerations or local scour in a channel. A more detailed hydraulic analysis of the specific cross section, accounting for variable velocities across the channel, is required.

D. FEMA Floodplain Considerations
   1. Construction of major drainage systems within FEMA floodplains must not increase the 100-year water surface elevation.

   2. Per FEMA regulations, a Flood Hazard Development Permit will be required for the construction of channels and other major drainage system components within the FEMA mapped 100-year floodplain. It may be necessary to submit to FEMA a Conditional Letter of Map Revision (CLOMR) followed by a LOMR as part of the development process.

   3. All design and engineering of the major drainage system components must follow accepted FEMA methodology.

   4. For more reference information and criteria, refer to the FEMA Floodplain Requirements section at the end of this chapter and the Town Municipal Code.

E. Erosion Protection Design Criteria
   1. Protecting major drainage channels from erosion is critical for maintaining channel stability.
      a. Channels need to be designed so that they remain stable until they are fully constructed or vegetated. It may be necessary to install riprap, straw bales, erosion control logs, or erosion control blankets in the channels to ensure that they remain stable. The best management practices (BMPs) outlined in the *USDCM (Volume 3)* should be used to ensure stability.

2. The grading and erosion control plan that is submitted with the stormwater reports and construction drawings shall include the placement of BMPs, typical installation details, and typical installation/maintenance notes for each type of BMP to be used on the site.

602.6 Minor Drainage

A. This section provides guidelines for the design of minor drainage systems.

B. Design Flows and Design Criteria
   1. New minor drainage channels and/or storm sewer systems shall be designed at a minimum to convey the storm frequencies listed in Table 600-8, below.

Table 600- 8: Minimum Design Storm Frequency by Land Use

Land Use	Design Storm Frequency
Residential	2-year
Open Space	2-year
Commercial	10-year
Public Buildings	10-year
Industrial	10-year

C. Erosion Protection Design Criteria
   1. Protecting minor drainage channels from erosion is critical for maintaining channel stability. Channels need to be designed so that they remain stable until they are fully constructed or vegetated. It may be necessary to install riprap, straw bales, erosion control logs, or erosion control blankets in the channels to ensure that they remain stable. The BMPs outlined in the *USDCM (Volume 3)* should be used to ensure stability.

   2. The grading and erosion control plan that is submitted with the stormwater report(s) and construction drawings shall include the placement of BMPs, typical installation details, and typical installation/maintenance notes for each type of BMP to be used on the site.

602.7 Hydraulic Structures

A. This section presents the guidelines for the design of hydraulic structures such as bridges, rundowns, emergency spillways, etc. For more information regarding design, refer to the hydraulic structures chapter of the *USDCM (Volume 2)*.

B. Design Flows and Design Criteria
   1. Hydraulic structures shall be designed for the 100-year storm event and other minor design discharges as applicable.

   2. The design criteria for check and drop structures, conduit outlet structures, bridges, transitions and constrictions, bends and confluences, and rundowns should follow the design criteria and recommendations outlined in the hydraulic structures chapter of the *USDCM (Volume 2).*

   3. Bridges shall be designed so that the low chord elevation of the bridge is a minimum of one (1) foot above the 100-year water course energy grade line (EGL).

   4. The Town will allow the use of other modeling methodologies on a case-by-case basis when complete documentation of all assumptions is provided. The Town reserves the right to review alternative methods and compare with other commonly used approaches, including those discussed in the *USDCM*.

   5. Seepage and Breech Analysis
      a. Seepage analysis should be considered and shall be performed on all hydraulic structures (i.e. irrigation ditches, ponds, etc.) for both existing and proposed conditions which may impact the development. Linings, cut-off walls and/or

underdrains shall be required if seepage potential exists.

b. Breech analysis should be considered and shall be performed for all hydraulic structures

C. Culvert or Storm Sewer Outlet Structures
1. Riprap or other approved methods to slow exit velocities and provide erosion protection shall be provided at all outfalls from culverts and storm sewer outfalls. The outfall protection shall be designed to minimize or eliminate standing water.

D. HEC-RAS
1. HEC-RAS is useful in sizing hydraulic structures and it is acceptable to use it to determine hydraulic characteristics of the hydraulic structure. Standard modeling practices accepted by FEMA should be used when performing HEC-RAS modeling.

2. It is not acceptable to rely on HEC-RAS output for estimating maximum velocities for erosive or hazard considerations or local scour in a channel. A more detailed hydraulic analysis of the specific cross section, accounting for variable velocities across the channel, is necessary.

E. FEMA Floodplain Considerations
1. Construction of hydraulic structures within FEMA floodplains must not increase the 100-year water surface elevation. Per FEMA regulations, a Flood Hazard Development Permit will be required for the construction of channels and other major drainage system components within the FEMA mapped 100-year floodplain. It may be necessary to submit to FEMA a Conditional Letter of Map Revision (CLOMR) followed by an LOMR as part of the development process. All design engineering of the hydraulic structures must follow accepted FEMA methodology.

2. For more reference information and criteria, refer to the FEMA Floodplain Requirements section at the end of this chapterand Town Municipal Code Chapter 30.

F. Erosion Protection Design Criteria
1. Protecting hydraulic structures and adjacent channel from erosion is critical for maintaining channel stability. Hydraulic structures need to be designed so that the adjacent channel remains stable before and after it is fully constructed or vegetated. It may be necessary to install riprap, straw bales, erosion control logs, or erosion control blankets in the channels and around the hydraulic structures to ensure that they remain stable. The BMPs outlined in the *USDCM* (Volume 3) shall be used to ensure stability.

602.8 Culverts

A. Sizing
1. The minimum culvert capacity is the capacity required to convey the 10-year storm.
a. The minimum culvert diameter allowed in public right-of-way is 15 inches.

2. The Manning's roughness coefficient "n" for all culvert capacity calculations shall be 0.025 for corrugated type pipes and 0.013 for smooth wall pipe types.

3. The minimum slope and velocity requirements for culverts are the same as for storm sewer pipes under the Roadway and Street Drainage section of this chapter and these Standards and Specifications. Minimum slope shall be 2%.

4. The Town may require additional culvert capacity in order to prevent flooding of adjacent properties.

5. Any flooding of adjacent roadways will be limited to criteria in Tables 600-4 and 600-5 to gutter flowline or edge of pavement.

6. The maximum culvert headwater-to-diameter ratio is 1.0 for the 10-year design storm and 1.5 for the 100-year design storm.

7. Culverts should be installed to the minimum slope required to prevent sediment deposition within the pipe. The slope should be checked for each design, and if the proper minimum velocity is not obtained, other design options should be evaluated.

8. The designer is encouraged to use the spreadsheets and programs provided by the MHFD to assist in culvert design. Other software programs may be used, but the designs shall be verified using the MHFD programs and spreadsheets. The most current version of the MHFD spreadsheets can be downloaded from the MHFD website.

9. The Town will allow the use of other modeling methodologies on a case-by-case basis when complete documentation of all assumptions is provided. The Town reserves the right to review alternative methods and compare with other commonly used approaches, including those discussed in the *USDCM*.

10. Culverts need to be sized to reduce the potential for backwater effects on adjacent houses, buildings or businesses. Culverts passing under Town of Berthoud roads shall be designed for the 10-year storm and have a minimum diameter of 18 inches.

B. Materials
1. The Town allows the installation and use of commonly available culvert types such as reinforced concrete pipe (RCP). The Town will allow the use of other culvert types on a case-by-case basis when complete documentation of all culvert specifications is provided and approval by the Town Engineer.

2. Culverts that are to be installed in a public right-of-way that is routinely burned must be made of either concrete or metal. Plastic pipes will not be allowed in public right-of-way that is subject to weed burning.

C. Cover
1. All culverts shall be installed with a minimum of eighteen (18) inches of cover. If minimum cover is not possible, the culvert material and bedding shall be rated for a minimum of HS-20 loading or the largest expected traffic loads crossing it, whichever is greater.

D. End Sections and Trash Racks
1. Culverts installed in public right-of-way shall be equipped with a flared end section or headwall on the culvert entrance and outlet. Erosion protection such as riprap may be required. If riprap is required, it shall be installed on top of a geotextile and properly designed filter bed. Riprap designs should use the design methodologies outlined in the hydraulic structures chapter of the *USDCM (Volume 2).*

2. The Town does not recommend trash racks on culvertsowever, the requested use of trash racks will be considered on a case-by-case basis.
a. Trash racks will only be considered on the upstream end of culverts.

3. The Town does not recommend the use of collapsible gratings.

E. Maintenance Responsibility
1. Culverts in the Town-maintained road rights-of-way are generally maintained by the Town on an as-needed basis to ensure that the roadside borrow ditches function properly.

2. Culverts located outside of public-maintained road rights-of-way are not maintained by the Town. Culverts on private land shall be maintained by their Owners. Culverts that are part of a subdivision drainage plan shall be maintained by the respective homeowner's association. Culverts that are outside of public right-of-way or public drainage easements

shall be maintained and cleaned out annually or on an as-needed basis to ensure proper drainage of the subdivision.
   a. Performance of these culverts is subject to oversight by the Town.

F. Erosion Protection Design Criteria
   1. Erosion protection for culverts is to be designed to ensure that the adjacent drainage channel remains stable until such time as it is vegetated or fully constructed. It may be necessary to install straw bales, riprap, erosion control logs, erosion control blankets, etc. in the channels impacted by the culverts to ensure that erosion does not occur at or near the culvert. The BMPs outlined in the *USDCM (Volume 3)* should be used.

602.9 Stormwater Lift Stations

A. Storm lift stations are allowed at the discretion of the Town.
   1. A lift station shall not be used in lieu of storage capacity for a detention facility.

   2. Any lift station will be privately owned and maintained by the HOA or Metropolitan District.

602.10 Sump Pumps

A. Installation
   1. Sump pumps must be installed in a dedicated sump pit with a minimum diameter of 18 inches and a depth sufficient to accommodate the pump and provide adequate water collection. The sump pit must be covered with a solid, secure lid to prevent debris from entering.

B. Capacity
   1. Sump pumps must have a minimum capacity of 1/3 horsepower and be capable of pumping at least 2,500 gallons per hour at a 10-foot head. For larger installations or areas with higher groundwater levels, the capacity should be determined by a licensed engineer based on specific site conditions.

   2. Discharge pipes must be a minimum of 1.5 inches in diameter and made of durable materials such as PVC. Discharge lines must have a check valve to prevent backflow and a gravity drain or pump system to ensure continuous operation during power outages.

C. Electrical Requirements
   1. Sump pumps must be connected to a dedicated GFCI-protected circuit. Backup battery systems or generators are recommended to ensure operation during power failures.

D. Discharge Location
   1. All basement sump pumps intended or required to intercept groundwater must discharge to a private underdrain system if one exists.
      a. If no underdrain system exists, the pump must discharge to an adjacent drainage easement.
   2. Under no circumstances shall sump pump discharge locations direct flows across pedestrian walkway surfaces.

E. Maintenance
   1. The property owner is responsible for the maintenance of sump pump systems, ensuring they are in proper working order and free of obstructions.

602.11 Detention Basins and Detention Storage

A. General Information and Criteria
   1. This section summarized evaluation methods and design criteria for flood control detention facilities, referencing the Storage chapter of the *USDCM* for much of the background information. Criteria presented in the *USDCM* shall govern except as modified or added herein.

2. Detention facilities are used both for attenuating peak flows during large flood events and for providing extended detention and sedimentation during small, frequent events to enhance stormwater quality. Extended detention facilities used for water quality management may be incorporated into flood control detention basins or kept separate when combined with other Best Management Practices (BMPs) for stormwater quality.

3. Detention storage shall be provided for new development, redevelopment or expansion as follows:
   a. <½ acre development
      i. None required – Source Control, Runoff Reduction, and Conveyance based BMPs are encouraged

   b. ½ acre - 1-acre development
      i. Source Control, Runoff Reduction and Conveyance based BMPs required

   c. >1 acre development
      i. Storage based BMPs providing WQCV or EURV in accordance with these Standards and Specifications

4. Parking lot and underground detention are not allowed in residential subdivisions.
   a. Underground detention will only be allowed on a case-by-case basis.

5. Rooftop detention is not allowed.

6. Detention basins shall be located outside of FEMA mapped 100-year floodplain.

7. For more information regarding design, refer to the storage chapter of the *USDCM (Volume 2)*.

8. Storage volume and release rate criteria are based on three design events, as follows
   a. Water quality capture volume (WQCV) is defined in *USDCM (Volume 3)*.

   b. Excess Urban Runoff Volume (EURV) is the difference between the developed and pre-developed runoff volume, a relatively constant value for a given developed imperviousness over a wide range of storm events. Use the MHFD UD-Detention spreadsheet for calculating design volume. WQCV is included in the EURV volume.

   c. The major storm event or 100-year storm event.

9. The designer is encouraged to use the spreadsheets and programs provided by the MHFD to assist in culvert design. Other software programs may be used, but the designs shall be verified using the MHFD programs and spreadsheets. The most current version of the MHFD spreadsheets can be downloaded from the MHFD website.

B. Detention Basin Design Criteria
   1. Sizing Methodology
      a. Three different procedures for sizing full-spectrum detention volumes are described in the Storage chapter of the *USDCM (Volume 2)*. A set of simplified equations or a design spreadsheet may be used for drainage areas up to 130 acres and a hydrograph approach is outlined for watershed areas up to one square mile. The maximum drain time for the Excess Urban Runoff Volume shall be 72 hours, as specified in the *USDCM*.
         i. The designer is encouraged to use the spreadsheets and programs provided by the MHFD to assist in detention basin and storage design. Other software programs may be used, but the designs shall be verified using the MHFD programs and spreadsheets. The most current version of the MHFD spreadsheets can be downloaded from the MHFD website.

2. The Water Quality Capture Volume (WQCV) and the incremental portions of the Excess Urban Runoff Volume (EURV), and the 100-year volume of a full-spectrum detention basin are normally combined into one facility with one outlet structure. However, the required volumes may be designed into separate facilities draining from a combined WQCV and EURV detention basin to the 100-year storm event detention.

3. Onsite Detention and Addressing Offsite Flows
   a. Two approaches are generally acceptable for addressing offsite flows that must be conveyed through a site, and the potential impacts to the onsite detention.

   b. Design for Offsite Flows
      i. An alternative method is to design the detention basin for the entire upstream watershed area, including the future development flows from offsite areas without giving any credit to offsite detention facilities. This method may be practical if the offsite tributary area is relatively small.

C. Multiple Small Detention Basins
   1. Extended detention basins providing Water Quality Capture Volume, Excess Urban Runoff Volume, and 100-year detention typically function best if configured in one or a few large basins as opposed to multiple small basins with very small orifices. Therefore, the minimum number of detention installations is generally preferable. The same is not necessarily true for porous landscape and porous pavement detention, which may be configured in multiple small installations.

D. Detention Basins in Series
   1. Locating two or more detention basins in series on an individual development site is generally discouraged, especially for the WQCV and the EURV portion of a full-spectrum detention facility.

   2. If site runoff is detained by two or more detention facilities in sequence before leaving the site, hydrograph approaches, as described in the Storage Chapter in *USDCM (Volume 2)*, shall be used to determine the effect of sequential detention and to determine the detention capacity that is needed to reduce runoff peaks to the specified predevelopment flow rates at the end of the system.

E. Interconnected Detention Basins
   1. When sequential ponds are located in close proximity, separated by a short culvert or pipe at a roadway crossing, or when sequential ponds have similar invert elevations, the ponds may have to be modeled as “interconnected ponds”.

   2. This situation could also occur if other downstream conditions cause variable backwater effects that influence the discharge of the detention pond outlet pipe. In these scenarios, the water surface elevation in the downstream pond can reduce the discharge rate from the upper pond and in some cases reverse flow can occur from the downstream pond into the upstream pond.

   3. It is the responsibility of the Engineer of Record to ensure that the appropriate analyses are performed and submitted when ponds are “interconnected”.

F. Outlets onto Streets
   1. Detention ponds that have an outlet pipe terminating in the gutter of a street, such as through a chase section, present potential ponding and icing problems in the gutter, and create hazards to the traveling public during periods in which the pond is emptying rapidly. Therefore, detention ponds shall be designed to outlet into a storm sewer, drainageway, or other designated drainage system that is reasonably available, as determined by the Town. It must be shown that the storm sewer, drainageway, or other designated drainage system to which the pond outlets, has the capacity to convey the detention pond flows.

2. The Town may allow an outlet to discharge into the gutter in cases where the minor storm (5-year) peak flow for the tributary area is less than 3.5-cubic feet per second and a storm sewer or other drainage system is not reasonably available. It must be demonstrated that the street has adequate capacity to convey the excess runoff within the allowable limits. A transition from the outlet pipe to a curb chase will normally be required, and the chase section shall be designed to reduce the velocity and spread of flow as much as possible. The location of the outlet shall be designed to minimize potential problems or conflicts with other improvements and shall be angled toward the downstream slope of the gutter to direct flows downstream instead of perpendicularly into the street.

G. Excavated and Embankment Slopes
   1. All excavated or embankment slopes from the pond bottom to the 100-year water surface elevation shall be no steeper than 4 (horizontal) to 1(vertical). Excavated slopes above the 100-year water surface elevation and the slope on the downstream side of embankments shall be 3 to 1 or flatter. Embankments shall be provided with a top width of at least 10 feet. An emergency overflow spillway shall be provided as described later in this chapter.

   2. Any detention pond embankment located adjacent to a sidewalk or trail shall have side slopes of 4 to 1 or flatter. All public walks shall be offset at least six (6) feet from sloped embankments.

   3. It is the responsibility of the Engineer of Record to ensure that the design of any earthen embankment is based on specific recommendations of a geotechnical engineer and that the design requirements are clearly identified within the construction plans. In addition, the construction of large embankments or dams may fall under the jurisdiction of the Office of the State Engineer and will be subject to State review and approval.

   4. All earthen slopes shall be covered with topsoil and revegetated for erosion protection.
      a. Adequate provisions for the establishment and maintenance of the vegetation, such as temporary or permanent irrigation shall be provided.

H. Freeboard Requirements.
   1. The minimum required freeboard for detention facilities is one (1) foot above the computed water surface elevation when the emergency spillway is conveying the maximum design flow. The crest of the emergency spillway may be set at or above the 100-year storm water surface elevation.

I. Low Flow Channels
   1. All grass-bottom detention basins shall include a low flow channel sized to convey a minimum of 1% of the 100-year peak inflow and be a minimum of 6-inches in depth and a minimum of 18-inches wide. The low flow channel shall be constructed of 12-inches of mitigated soil topped with 6-inch of cobbles.
      a. If accepted by the Town, an unlined low flow channel may be used. The unlined low flow channel shall be at least 1.5-feet deep below adjacent grassed benches and shall be vegetated with herbaceous wetland vegetation or riparian grasses, appropriate for the anticipated moisture conditions. The minimum longitudinal slope shall be 2% and the minimum width of the grassed bench adjacent to the low flow channel shall be 12-feet on one or both sides where equipment can access. The maximum side slope below the bench shall be 4 to 1 and the maximum bottom width of the channel shall be 12-feet if equipment can access one side of the channel and 24-feet if equipment can access both sides.

   2. The minimum longitudinal slope shall be 2% percent to ensure that non-erosive velocities are maintained adjacent to the low-flow channel when the design capacity is exceeded

J. Bottom Slope
   1. For grass-bottom detention facilities, the pond bottom shall be at least 2% to drain toward

the low flow channel or outlet, measured perpendicular to the low flow channel.

K. Forebays and Micropools
   1. Forebays and micropools are not required to be installed with a detention facility. If included, they shall be designed following MHFD criteria manual and design standards

L. Inlet Facilities
   1. Unless otherwise accepted by the Town, runoff shall enter a detention facility via a stabilized drainageway, a 100-year drop structure, or a storm sewer with energy dissipaters. Riprap rundowns or equivalent erosion control options into the detention pond are required.

M. Outlet Configuration and Safety/Debris Grates
   1. Detention basin outlets shall be functional for controlling the design release rates, provided with oversized safety/debris grates to reduce the potential for debris plugging, easy to maintain, and designed with favorable aesthetics as approved by the Town.

   2. The minimum net open area of the trash rack protecting the EURV orifices and the flood control orifice shall comply with Typical Structural Best Management Practice Details in the *USDCM (Volume 3)*. The safety grate criteria discussed in the Culverts section of the *USDCM (Volume 1)*, shall also apply.

   3. Water Quality/EURV Outlet Control Orifices
      a. If the outlet control orifices are 2.5 inches or greater in diameter or 2-inches square, standard fabricated bar grating (with nominal openings of 1 inch by 4 inches) may be used as a debris grate instead of well-screen. The larger grate may reduce the potential for clogging with debris.

      b. If approved by the Town, the vertical spacing between outlet control orifices may be increased to 8-inches or 12-inches and the orifice areas increased by a factor of two (for 8-inch spacing) or three (for 12-inch spacing) to enable larger orifices and larger trash rack openings.

   4. Water Quality/EURV Outlet Bar Grating
      a. Bar grating may be used on parallel sloping wingwalls, either as the primary debris grate (if orifices are at least 2.5 inches in diameter) or as a coarse screen and safety grate in lieu of handrail. Sloping bar grating shall have a lockable hinged section at least 2-feet square to allow access to the orifice plate or well-screen.

      b. The bearing bars for steel bar grating shall be designed to withstand hydrostatic loading up to the spillway crest (assuming the grate is clogged and bears the full hydrostatic head), but generally not designed for larger loads (like vehicular loads) so that the hinged panels are not excessively heavy.

      c. Panels of bar grating shall be no more than 3-feet wide and all parts of the grating and support frames shall be hot-dipped galvanized.

      d. Bar grating shall be fastened down to the water quality outlet structure.

   5. The flood-flow orifice shall be sized to provide the allowable 100-year release rate when the 100-year detention volume is completely full.

N. Emergency Spillway and Embankment Protection
   1. Detention basin embankments shall be protected from catastrophic failure due to overtopping. Erosion protection for the embankment may be provided in the form of a buried riprap layer on the entire downstream slope of the embankment or a separate emergency spillway constructed of buried riprap or concrete. In either case, the emergency protection shall be constructed to convey the 100-year developed flow from

the upstream watershed without accounting for any flow reduction within the detention basin.

2. The invert of the emergency spillway shall be set at or above the 100-year water surface elevation. A concrete wall or vertical curb shall be constructed at the emergency spillway crest extending at least to the bottom of the riprap and bedding layers located immediately downstream. The crest wall shall be extended at the sides up to one foot above the emergency spillway design water surface.

3. Riprap embankment protection shall be sized based on methodologies developed specifically for overtopping embankments. Two such methods have been documented by Colorado State University (USNRC, 1988) and by the US Department of Agriculture (ASAE, 1998) and designers are referred to these publications for a complete description of sizing methodology and application information. The thickness and bedding requirements shall be based on the criteria identified in the *USDCM*.

4. The emergency spillway is also needed to control the release point and direction of the overflow. The emergency spillway and the path of the emergency overflow downstream of the spillway and embankment shall be clearly depicted on the drainage plan. Structures shall not be permitted in the path of the emergency spillway or overflow. The emergency overflow water surface shall be shown on the detention facility construction drawings.

O. Retaining Walls

1. The use of retaining walls within detention basins is generally discouraged. If retaining walls are required, footings shall be located above the EURV water surface elevation. Wall heights shall not exceed 30 inches, and walls shall not be used on more than 50-percent of the pond circumference.

2. If retaining walls are terraced, a separation of at least 5-feet shall be provided between walls. Additional width may be required to address the wall design, anchoring system and maintenance requirements. The engineering analysis shall include a discussion and the necessary calculations to determine the appropriate “bench” width. The maximum ground slope between adjacent walls shall be 4-percent.

3. All detention pond retaining walls shall require a Building Permit (unless waived by the Building Department) and shall be provided with handrails or guardrails designed to meet safety criteria as well as International Building Code (IBC) requirements.

4. Retaining walls are not to be used where live loading or additional surcharge from maintenance equipment of vehicle traffic could occur unless the wall is designed to accommodate the live loading condition.

5. Foundation walls of buildings shall not be used as detention basin retaining walls. The distance between the top of any retaining wall in a detention area and any adjacent sidewalk, roadway curb or structured feature is to be a minimum of three times the height of the wall and no less than six (6) feet. The horizontal distance to any maintenance access drive not used as a sidewalk or roadway shall be at least four (4) feet.

6. Any future outfalls to the pond shall be designed and constructed with the detention basin.
   a. This reduces the likelihood of disturbing the retaining walls when constructing the “future” outfall.

7. Perimeter fencing to limit access, safety railing, or guardrail may be required depending upon the location of the wall relative to roadways, parking areas and pedestrian use areas.

8. A Professional Engineer licensed in the State of Colorado shall perform a structural analysis and design the retaining wall for the various loading conditions the wall may encounter, including the hydrostatic pressure differential between the front and the back of the wall and live loading conditions, if applicable. A drain system should be considered behind the wall to ensure that hydrostatic pressures are equalized as the water level changes in the pond.

9. The wall design and calculations shall be stamped by the Engineer of Record and submitted to the Town's Building Division for review. The design details and requirements for the retaining wall(s) shall be included in the construction drawings.

10. Retaining walls shall not be used within the limits of any impermeable lining of water quality basins or detention basins.

P. Landscaping Guidelines
   1. Refer to Town of Berthoud Development Code for allowable landscaping within and around the Detention Pond.

Q. Easement Requirements
   1. Drainage easements shall be granted to the Town for inspection and maintenance purposes, and shall be shown on the Drainage Plan, Final Plat and Final Development Plan.

   2. Drainage easements shall be kept clear of obstructions to the flow and shall allow maintenance access.

   3. The minimum requirements for detention basin easements are as required to contain storage and WQCV including freeboard, associated facilities, and adequate maintenance access around the perimeter based on any access road width. Access to the basin shall be provided in an easement.

R. Maintenance
   1. The property owner, or other party as otherwise designated by legal agreement, is responsible for the maintenance of detention facilities.

   2. Routine maintenance of detention basins shall include sediment and debris removal. Non- routine maintenance may include the repair and/or replacement of outlet structures, trickle channel, outlet pipes, channel slopes, and other related facilities. When appropriate maintenance is not provided, the Town shall provide the necessary maintenance and assess the associated cost to the property owner.

S. Design Standards for Parking Lot Detention
   1. Easement Requirements
      a. Easements shall include the area of the parking lot that is inundated by the 100-year water surface elevation, and the outlet structure and conveyance facilities.

   2. Maintenance Requirements
      a. Maintenance of parking lot detention basins and facilities shall be provided in accordance with the Maintenance paragraphs above. The property owner shall be required to ensure that the release structures are maintained.

   3. Depth Limitation
      a. The maximum allowable design depth above pavement surfaces for the EURV is 3-inches and for the 100-year flood is 9-inches. However, to account for future overlays or parking lot resurfacing, the design volumes shall be attained even with an assumed 2-inch overlay (translating to an allowable depth of 1-inch for the EURV and 7-inches for the 100-year event).

b. The WQCV shall be located entirely out of (below) the pavement area, possibly in one or more landscaped parking islands or adjacent landscaping. An emergency spillway sized for the 100-year inflow peak shall be provided with a crest set at the 100-year water surface elevation and a maximum flow depth over the emergency spillway of six (6) inches. A minimum of one (1) foot of freeboard is required above the 100-year emergency water surface to the first-floor elevation of any adjacent structures (equivalent to 18 inches over the 100-year water surface).

4. Outlet Configuration
   a. The outlet configuration shall be designed in accordance with criteria shown in *USDCM (Volume 3)*. Outlets for the EURV and 100-year events shall limit peak flows to the maximum design release rates.

T. Erosion Protection Design Criteria
1. Erosion protection for storage facilities needs to be designed to ensure that the sediment does not leave the site or impact downstream properties. It may be necessary to install straw bales, riprap, erosion control logs, erosion control blankets, etc. on the storage facility side slopes to ensure that erosion does not occur until the reseeded vegetation is established. The BMPs outlined in the *USDCM (Volume 3)* should be used.

U. State Water Rights Reporting
1. Compliance with Colorado Revised Statute (CRS) §37-92-602 (8) Water Rights reporting for Stormwater Detention and Infiltration Facilities is the responsibility of the Design Engineer. The compliance portal can be found at https://maperture.digitaldataservices.com/gvh/?viewer=cswdif

602.12 Revegetation

A. Site Preparation
1. In addition to the site preparation guidelines outlined in the revegetation chapter of the *USDCM (Volume 2),* an inventory of existing vegetation should be taken before any revegetation work is started. If noxious weeds exist on-site, the appropriate steps need to be taken before, during, and after work is completed to control their spread.

2. If soil amendments are needed, recommendations outlined in the revegetation chapter of the *USDCM (Volume 2)* should be followed.

3. See also Berthoud Municipal Code Chapter 30.

B. Seeding and Planting
1. In addition to the site preparation guidelines outlined in the revegetation chapter of the *USDCM (Volume 2),* seed mixtures should be coated with Mycorrhiza at the rate of 2 pounds per acre at the time of seeding. If mulching with straw, the straw must be free of seeds and weeds.

602.13 Stormwater Quality

A. General
1. Post construction water quality best management practices (Permanent BMPs) are required with all new development or redevelopment within the Town. The Town also recommends stormwater quality and peak flow reduction practices associated with minimizing directly connected impervious area (MDCIA).

2. Best management practices that provide water quality capture volume (WQCV) will be required for the excess runoff that remains after the volume reduction practices are accounted for.

3. Common WQCV BMPs are porous pavement detention, porous landscape detention, extended detention basins, sand filter extended detention basins, and constructed

wetland basins.

4. Issues associated with the long-term maintenance of permanent BMPs must be considered when selecting appropriate BMPs for a site. Implementation of water quality BMPs must be addressed hand in hand with the stormwater conveyance and detention storage facilities. Consult MHFD Volume 3 and the criteria in this manual for detailed design requirements, considerations, limitations, and information regarding proper implementation.

B. Sediment and Erosion Control Plans
   1. Construction sites must have a sediment and erosion control plan showing the location and type of all BMPs deployed at the project. A copy of the plan must be kept on-site, along with a copy of the Storm Water Management Plan (SWMP). Changes to the sediment and erosion control plan and BMPs are allowed as construction and site stabilization progress; notes on the drawing set should show revisions and the dates of each revision.

   2. Storm Water Management Plan requirements are included in Chapter 200 of these Standards and Specifications.

602.14 Best Management Practices

A. The Town of Berthoud uses the BMPs that are outlined in the best management practices chapter of the *USDCM (Volume 3).* The AutoCAD files for the BMPs can be downloaded from the MHFD website.

B. The Engineer of Record is encouraged to use the spreadsheets and programs provided by the MHFD to assist in designing the BMPs. Other software programs may be used, but the designs shall be verified using the MHFD programs and spreadsheets. The most current version of the MHFD spreadsheets can be downloaded from the MHFD website.

C. BMP technology is constantly changing. The Town will evaluate the use of newly developed BMPs on a case-by-case basis when complete documentation of all assumptions is provided. The Town reserves the right to review alternative methods and compare with other commonly used approaches, including those discussed in the *USDCM*.

602.15 FEMA Floodplain Requirements

A. General Information
   1. For more information regarding floodplain regulations, refer to the 2021 Colorado Water Conservation Board (CWCB) Rules and Regulations for Regulatory Floodplains in Colorado; and 44CFR 59, 60, and 65 of the FEMA NFIP regulations.

   2. For more information regarding floodplain modeling and mapping requirements, refer to FEMA's Guidelines and Specifications for Flood Hazard Mapping Partners.

B. FEMA Floodplains
   1. Refer to the Flood Insurance Rate Maps (FIRMs) and Flood Boundary and Floodway Maps that are published by FEMA to determine if a proposed project is located within a mapped floodplain. The floodplain maps can be obtained from FEMA. The Town Engineer or Town Floodplain Manager should be contacted to determine if there have been any letters of map change that have been approved by FEMA for the proposed project area.

C. Floodplain Requirements
   1. All development as defined by FEMA requires a Flood Hazard Development Permit from The Town. A copy of the application can be requested from the Town Engineer or Town Floodplain Manager.

2. The regulations and definitions for floodplain development can be found in Part 44CFR 59, 60, and 65 of the Code of Federal Regulations; and the 2021 CWCB Rules and Regulations for Regulatory Floodplains in Colorado.

3. Hydraulic modeling is required for the majority of Flood Hazard Development Permit applications. The modeling must conform to the standards outlined in FEMA's guidelines and specifications and must show compliance with the various floodplain regulations. In areas where there is a FEMA-approved model, the hydraulic model must contain the current effective model, a duplicate effective model, a corrected effective model, and the proposed conditions model. In areas where there is not a FEMA-approved model, the hydraulic model must contain the existing condition model and proposed condition model. A 0.5-foot floodway model is required for all sites where a FEMA-approved floodway has not been established. All hydraulic modeling must be certified by a registered professional engineer licensed in the State of Colorado.

4. All hydraulic models that are related to a LOMR or Physical Map Revision (PMR) must tie to a logical hydraulic control at the downstream and upstream ends of the model. It is not sufficient to start and stop the hydraulic modeling at the project boundaries.

5. A narrative outlining the modeling parameters used must be included with the Flood Hazard Development Permit application. The narrative must include a comparison of the current effective, duplicate effective, corrected effective, and proposed condition water surface elevations and floodplain top widths. The narrative must address how the warnings, errors, and notes statements generated by the hydraulic model were handled. The narrative must be stamped, signed, and dated by a registered professional engineer licensed in the State of Colorado.

6. A work map or Flood Hazard Development Permit map must be submitted with the hydraulic modeling. In addition to the information outlined in the Flood Hazard Development Permit application, the map must include the FEMA floodplain boundaries, the floodplain boundaries generated by the hydraulic modeling, cross section lines, and any proposed structures. The map must be provided at a common map scale on an 11" x 17" or 24" x 36" sheet. The floodplain top width shown on the map will be compared to the hydraulic model floodplain top width. If the difference between the two is greater than 5% of the FIRM scale, comments to review and revise the submittal will be made. The map must be stamped, signed, and dated by a registered professional engineer licensed in the State of Colorado.

7. If structures are proposed in the Flood Hazard Development Permit, elevation certificates for the proposed, under construction, and as-built conditions will be required. The proposed condition elevation certificate can be stamped, signed, and dated by a registered professional engineer licensed in the State of Colorado. The under-construction and as- built condition elevation certificates must be stamped, signed, and dated by a registered professional land surveyor licensed in the State of Colorado. Photos of the structure must be included with the under-construction and as-built elevation certificates.

8. Residential structure finished floor elevations must be a minimum of 1 foot above the base flood elevation. Commercial structure finished floor elevations must be a minimum of 1 foot above the base flood elevation or dry floodproofed. Critical facilities as defined by the CWCB must be elevated or dry floodproofed a minimum of 2 feet above the base flood elevation.

9. Structures that can float—such as fuel tanks, tank batteries, storage sheds, and the like— must be anchored. The anchoring design must be certified by a registered professional engineer licensed in the State of Colorado. Photos of the anchored structure will be required.

10. Non-habitable structures such as barns and large storage sheds can be flood vented using the FEMA requirements. If engineered flood vents are used, a registered professional engineer licensed in the State of Colorado must certify them. Photos of the flood vents will be required.

603 CONSTRUCTION SPECIFICATIONS

603.1 General

A. All Storm Sewer Construction shall be completed in accordance with the Construction Specifications included in Appendix A.

604 STORM DETAILS

604.1 General

A. The following is a list of standard details for storm sewer work that are part of the Town of Berthoud Standards and Specifications:

D6.01	Storm Cleanout
D6.02	Storm Sewer Bedding Detail
D6.03	CMP Type 1 Flared End Section
D6.04	Rip Rap Apron Sizing and Placement at Flared End Section
D6.05	Type C Inlet
D6.06A	Combination Inlet (1 Of 2)
D6.06B	Combination Inlet (2 Of 2)
D6.07B	Direct Connection RCP To PVC Connection
D6.08A	Valley Inlet (CDOT Type 13) (1 Of 2)
D6.8B	Valley Inlet (CDOT Type 13) (2 Of 2)
D6.9A	Type R Curb Inlet (1 Of 3)
D6.9B	Type R Curb Inlet (2 Of 3)
D6.9C	Type R Curb Inlet (3 Of 3)
D6.10	Small Pipe Headwall
D6.11	Headwall with Circular Pipe
D6.12	Low Flow Channel
D6.13	Emergency Overflow

CHAPTER 700 DRY AND NON-TOWN UTILITIES

701 GENERAL PROVISIONS

701.1 General

B. These Standards and Specifications are promulgated by the Town Administrator in accordance with the authority contained within the Town of Berthoud Municipal Code. Improvements shall also be in conformance with the Town of Berthoud Municipal Code.

C. This chapter sets forth the criteria and location requirements for all dry utilities, such as power (electric and natural gas), phone, CATV, traffic signals and mailboxes, within the right-of-way and/or public utility easements.

D. The appropriate utility and Town Engineer shall determine all final alignments of utilities.

701.2 Design Standards

A. Minimum Depth

1. All utilities shall be located at least two (2) feet below the scarified subgrade elevation, unless specifically approved to be less by the Town Engineer. Greater depth of cover may be specified by the Town Engineer.

B. Access Covers

1. Clearance
   a. All manhole lids, utility access covers, and range box access covers shall be flush with the roadway finished surface or depressed no more than 1/2 inch below the finished surface. If located in concrete, all access covers shall be set flush with surrounding concrete.Wheel Path
2. Manholes or valves shall not be designed or constructed in the Wheel Path of the travel lane or at any location within a bike lane.
3. Location
   a. Manhole, water valve or other utility access covers and lids shall not be located in the flowline of curbs or crosspans.
   b. Manholes and water valve covers shall be located more than 4 feet away from the curb or crosspan.

C. Trees and Large Shrubs Prohibited Over or Near Utilities

1. Trees, berms or large shrubs shall not be placed within utility easements or over buried utilities.
   a. Additional horizontal clearances from the trunk of any tree or shrub to any buried utility may be required by the Town Engineer.
2. Trees should not be planted under overhead utility lines when mature growth of the tree would come within 10 feet of the lines.

D. Use of PVC Sleeves by Franchised and Private Utilities

1. It is the intent of these standards to reduce the number of open cuts in the roadway.
2. Franchised and private utility companies shall install all utilities within a non-corrosive sleeve equivalent to Schedule 40 PVC or other sleeves encased in concrete, slurry or flow-fill material, across all public streets to accommodate future repairs without street cuts.
   a. Exceptions: Steel gas line street crossings will not require sleeves.
3. Depth
   a. Sleeves shall be installed at a minimum depth of 36 inches from the top of the pipe to the top of pavement or 24 inches from the top of pipe to the top of subgrade,

whichever is greater.

4. Locations
   a. Sleeves shall be located within 15 feet of the parallel gutter flowline of the existing street and shall be coordinated with other utilities.

   b. All sleeve locations shall be marked appropriately in the field either by marking the concrete curb or providing permanent stakes.

   c. Sleeves shall be separated for existing buried utilities in accordance with the utility owner requirements. Ten feet of separation is typically preferred.

5. Extra Sleeves: Extra PVC sleeves may be required on Collector or Arterial intersections for future traffic signalization or future utilities.

E. Poles

1. Location
   a. Poles, signs, and any other above ground streetscape (except regulatory signs) should be located within five (5)feet of the right-of-way line or ten (10)feet from the travel lane (flowline), whichever is most restrictive.

2. Clearance
   a. Light poles shall be placed no closer to the roadway than two (2) feet behind a vertical curb line and no closer than two (2) feet to any sidewalk.

3. Pole Requirements
   a. The Town Engineer may require breakaway poles on public right-of- way where speed limit is 40 m.p.h. or higher. Refer to **CDOT Roadway Design Guide, Section 15.7.4**.

4. Engineer Approval
   a. All poles within the public right-of-way must be accepted by the Town Engineer prior to the permit application for installation.

701.3 Dry Utility Construction Timing

A. Preconstruction Meeting:
   1. Developers are required to provide a detailed schedule for dry utility construction during preconstruction meetings.
      a. This schedule must outline the timing and sequencing of all dry utility installations, including but not limited to power (electric and natural gas), phone, and CATV.

   2. The construction schedule must include specific time frames and completion dates, indicating the anticipated start and end dates for each utility installation phase.

B. Coordination with Utility Companies
   1. Developers must coordinate with all relevant utility companies to ensure the timely installation of dry utilities. Documentation of these communications and agreements must be provided to the Town Engineer.

   2. Any changes to the schedule must be communicated and approved by the Town Engineer to ensure proper oversight and coordination.

C. Inspection and Compliance
   1. The Town Engineer or designated representative will inspect the utility installations to ensure compliance with the approved schedule and standards.

   2. Any deviations from the approved schedule or standards must be rectified by the

developer at their own expense before further construction activities are permitted.

3. Any public infrastructure that is damaged during dry utility installation is to be repaired as the sole cost of the utility company or the developer.

701.4 Street Lighting Standards

A. General Requirements

1. See Outdoor Lighting Requirements in Town Municipal Code.

2. Street lighting shall follow LCUASS Standards. In areas where LCUASS Lighting standards conflict with Municipal Code, the Town Code shall be followed.

CHAPTER 800 SUBDIVISION IMPROVEMENT STANDARDS

801 GENERAL PROVISIONS

801.1 General

A. These Standards and Specifications are promulgated by the Town Administrator in accordance with the authority contained within the Town of Berthoud Municipal Code. Improvements shall also be in conformance with the Town of Berthoud Municipal Code.

B. Applicability
   1. Unless otherwise exempted by this chapter, all development of land within the Town and shall be reviewed and approved according to the standards stated in the Municipal Code and these Standards and Specifications.

   2. No land shall be conveyed or developed, or lots consolidated or reconfigured, until a plat has been approved, except as specifically exempted, under the provisions of the development code and these Standards and Specifications.

   3. All subdivisions with public infrastructure or bonded improvements shall follow the improvement standards set forth in this Chapter.

801.2 Preconstruction, Erosion Control, and Inspection of Improvements

A. Developer agrees that prior to commencement of construction of any Development Improvements including alterations to existing grading contours, removal of vegetation and/or excavating, the Town-approved erosion control plan will be implemented.

B. Preconstruction Meeting
   1. Developer agrees that prior to commencement of construction of Development Improvements for each phase, a preconstruction meeting will be conducted.
      a. The preconstruction meeting shall include, at a minimum, the following participants:
         i. The Developer's construction team
         ii. Town Public Works Department
         iii. Town Engineering Department
         iv. Town Water/Sewer Department
         v. Representatives of all applicable utility companies
         vi. Additional participants may be required at the discretion of the Town

      b. At least two weeks prior to the commencement of construction, Developer shall provide a schedule, all construction specifications, and other submittal materials to the Town engineer.

      c. The construction schedule shall include time frames and completion dates and indicate the anticipated scheduling of the construction of the Development Improvements, including, but not limited to, excavating, grading, sewer, water, storm sewer, streets, sidewalks, trails, curb, gutter, landscaping, electric, cable, gas, and other utilities

C. Inspection and Notice to Town
   1. Developer agrees to notify the Town at least two full working days prior to the commencement of installation of Development Improvements.

   2. The Town shall also be given not less than 48 hours (during at least 2 working days) notice prior to the closure/covering of any infrastructure.

   3. In the event that any Development Improvements are covered and/or concealed from inspection prior to approval by the Town, the Developer shall, if requested by the Town

Engineer/Authorized Town Representative, expose any and all improvements at Developer's expense.

a. If the Town cannot complete inspections in a timely manner, the Town will use contract inspection services, the cost of which Developer shall be reimbursed to the Town.

D. Erosion Control Required

1. Town-approved erosion control plan measures shall be installed and maintained throughout the construction of Development Improvements and shall not be removed or abandoned by Developer until authorized by the Town.

2. Developer shall provide the Town with a copy of the approved storm water discharge permit issued from the State of Colorado prior to beginning construction.

E. MS4 Inspections

1. Regular inspections of erosion control measures will be conducted pursuant to the regulations adopted by Colorado Department of Public Health and Environment (CDPHE) by Developer and copies of the same delivered to the Town MS4 Department not less than every two weeks during the course of construction.

2. At all times during construction on the Property, or off-site projects associated with development of the Property, Developer shall maintain all streets, drainage and drainage facilities in an orderly and workmanlike fashion.

3. Developer shall remove all construction debris and waste, shall sweep or otherwise remove mud and debris from existing streets and shall maintain an orderly and clean construction site.

801.3 Over-lot Grading

A. Developer shall complete all development lot grading generally referred to as "over-lot" grading as depicted in the development grading and drainage plan(s) approved by the Town (the "Development Grading and Drainage Plans") prior to either Construction Acceptance or issuance of building permits for a particular phase.

B. Grading Plans

1. Upon completion of over-lot grading and prior to issuance of any building permit, Developer shall submit development grading and drainage "as-built" construction plans stamped by a qualified professional engineer licensed in the State of Colorado.

2. The Development grading and drainage as-built construction plans shall include
   a. Top of foundation wall (not finished floor) elevations at the building envelope for the primary structure and for attached and detached garages for each lot;
   b. A statement within the building envelope stating the type of lot grading (Type "A" or Type "B") intended for the lot;
   c. Finished grade elevations at all property corners;
   d. Finished grade elevations at all lot corners and at mid-points on all side lot lines; and
   e. Highest elevation points (HP) on each lot denoted with an "X" and "HP"

801.4 Timing of Installation of Improvements

A. Improvements Required

1. All public and private improvements including, as required by the Berthoud Development Code, these Standards and Specifications, and as a condition of development approval, shall be required before the release of building permits with each platted phase.

2. This shall include installation of all trails, sidewalks, Subdivision Identity Standards, Open Space Elements, Parks, common area landscaping and seeding of open space.

a. Exceptions
    i. All open space, open space and common area landscaping, and disturbed areas must be seeded or sod laid before the issuance of the first building permit if pulled from April to September; or at the beginning of the first planting season (April-Sep) if pulled from October- March.

3. All common open space trees and shrubs, and street trees and shrubs, must be planted before the issuance of the first building permit if pulled from April to September; or at the beginning of the first planting season (April-Sep) if pulled from October- March.

TOWN OF BERTHOUD

APPENDIX A
CONSTRUCTION SPECIFICATIONS

Section 31 00 00
EARTHWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Clearing, grubbing and site preparation

B. Removal and disposal of debris

C. Handling, storage, transportation, and disposal of excavated material

D. Sheeting, shoring, bracing and protection work Pumping and dewatering as required or necessary

E. Pumping and dewatering as required or necessary

F. Backfilling

G. Pipe embedment

H. Construction of fills and embankments

I. Excavation for buildings & structures

J. Pavement Subgrade preparation

K. Trench Stabilization

L. Final Grading

M. Slope Stabilization

N. Appurtenant Work

1.2 REFERENCES

A. AASHTO – American Association of State Highway and Transportation Officials

B. ASTM – American Society for Testing and Materials

1. C33 – Concrete Aggregates
2. C136 – Sieve Analysis of Fine and Coarse Aggregates
3. D698 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. Rammer and 12-Inch Drop
4. D1241 – Material for Soil Aggregate Subbase, Base and Surface Courses
5. D1557 – Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
6. D4253 – Test Methods for Maximum Index Density of Soils and Unit Weight of Soils Using a Vibratory Table
7. D4254 – Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
8. D4318 – Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
9. D6938 – Test Method for In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth)

C. ACI – American Concrete Institute

1. 229 – Controlled Low-Strength Materials

D. CABO/ANSI – Council of American Building Officials/American National Standards Institute

1. A117.1 – Accessible and Useable Buildings and Facilities Standards

E. CDOT – Colorado Department of Transportation

F. OSHA – Occupational Safety and Health Administration

1. Part 1926 – Safety and Health Regulations for Construction

1.3 SUBMITTALS

A. Product Data: Submit on all products or materials supplied herein

B. Test Reports: Indicate supplier, sieve analysis, optimum moisture content and density in accordance with ASTM D698 if appropriate for crushed rock or gravel, pipe embedment and material for fills and embankment

1.4 REGULATORY REQUIREMENTS

A. Comply with applicable requirements of CABO/ANSI A117.1 for accessibility requirements related to walks, ramps, parking areas, drives, curb ramps, etc.

B. Obtain and comply with all requirements of the Town of Berthoud Permit for all land disturbing activities and CDPHE Stormwater and/or Groundwater Discharge Permits, as required

C. Excavation work will be performed in compliance with current OSHA requirements.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Protect adjacent structures and surrounding areas from damage during excavation, filling, and backfilling

B. Protect work from erosion or other similar types of damage until the project has been accepted. Leave protection in place for subsequent contractors' use.

C. Do not backfill or construct fills during freezing weather.

D. Backfill or construct fills only when temperature is 35°F and rising

E. Do not use frozen materials, snow, or ice in any backfill or fill area

F. Do not backfill or construct fill on frozen surfaces

G. Protect excavated material from becoming frozen

H. Do not backfill or construct fills or embankments during periods of heavy rainfall or precipitation when soil moisture conditions will not allow proper compaction to be achieved

I. Provide temporary bridges for roadways, walkways, driveways, etc.

1.6 QUALITY ASSURANCE

A. All imported material to be free of hazardous and organic wastes, "clean" as defined by EPA, and approved for its intended use by the Owner or project Geotechnical Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. General - Soil materials, whether from sources on or off the site must be approved by the Geotechnical Engineer as suitable for intended use and specifically for required location or purpose.

B. Fills and Embankments

1. To the maximum extent practical use excess earth from onsite excavation for fills and

embankments.
2. Free from rocks or stones larger than 12 inch in greatest dimension and free from brush, stumps, logs, roots, debris, and organic and other deleterious materials
3. Fill and embankment material must be acceptable to Engineer
4. No rocks or stones larger than 6 inch in upper 18 inches of fill or embankment.
    a. Where allowed, distribute rocks and stones through the fill to not interfere with compaction.

C. Imported Fill for Fills and Embankments
1. The Contractor is responsible for obtaining additional material for fills and embankments as necessary to meet the requirements shown on the approved drawings
2. Imported fill conforming to the following
    a. Gradation (percent finer by weight ASTM C136):
        i. 3” – 100% passing
        ii. No. 4 Sieve – 50-100% passing
        iii. No. 200 Sieve – 35% passing (maximum)
    b. Liquid Limit: 35 (max), Plasticity Index: 15 (max), Group Index: 10 (max)

D. Structural Fill
1. Imported structural fill, such as a ½-inch minus, CDOT Class 7 Aggregate Road Base, conforming to the following:
    a. Gradation:
        i. 1” – 100% passing (percent finer by weight ASTM C136)
        ii. No. 8 Sieve – 20-85% passing
        iii. No. 200 Sieve – 15% (maximum)
    b. Liquid Limit: 30 (max), Plasticity Index: 6 (max)

E. Topsoil
1. Topsoil is defined as fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of rocks, stumps, stones larger than 2 inches in any dimension, and other extraneous or toxic matter harmful to plant growth for areas to be seeded or planted.
2. Clean topsoil free of plants and seeds will be spread to 4-inch minimum depth or as specified by approved drawings, whichever is greater, for areas of the site as detailed by the landscape plans.

F. Grubbings
1. Grubbings are defined as the first 1 inch of surface vegetation and topsoil consisting of primarily existing grass groundcover free of roots, brush, and other objectionable material and debris.
2. Reuse grubbing and surface topsoil containing plants and seeds in designated revegetation areas only.

G. Pipe Zone Bedding Materials

1. Comply with requirements for pipe embedment for public utilities. The Contractor shall provide a firm trench bottom, which is suitable for application of Pipe Zone bedding material.

2. 1-1/2” Washed rock for Reinforced Concrete Storm Sewers

Sieve Size (Inch)	Percent Passing by Weight
2”	100
1-1/2”	95-100
1”	80-95
3/4”	30-45
1/2”	10-25
3/8”	<1

3. 3/4” – 1” Public Wastewater System Bedding: shall be granular material, uniformly graded, crushed material, conforming toAASHTO 57/67

Sieve Size (Inch)	Percent Passing by Weight
1	100
3/4”	90-100
1/2”	25-60
3/8”	20-55
# 4	0-10
# 8	0-5
# 200	0-2

4. Public Water System Pipe Zone bedding: shall be granular material, uniformly graded, sand conforming to ASTM C33 or CDOT Table 703-2, for fine aggregate.

Sieve Size	Percent Passing by Weight
3/8”	100
# 4	95-100
# 8	80-100
# 16	50-85
# 30	25-60
# 50	10-30
# 100	2-10

5. Squeegee (for 8-inch pipe and smaller only)

Sieve Size	Percent Passing by Weight
1/2”	100
3/8”	85-100
#4	10-30
# 16	5-40
# 30	0-15
# 50	0-10
# 100	0-5
# 200	<1

6. Drain gravel
    1. Crushed rock, granular material with a maximum size of 1-1/2 inch
    2. Minimum 50% passing No. 4 sieve, maximum 5% retained on No. 200 sieve

7. Services:
    a. The water services should be bedded with the same material as the main line.

b. The wastewater service should be bedded with the same material as the main line.

H. Compacted Trench Backfill
1. Job excavated material finely divided, free of debris, organic material, and stones larger than 6 inches in greatest dimension without masses of moist, stiff clay, or topsoil
2. In upper 18 inches, no rock or rock excavated detritus, larger than 6 inches except with specific approval from Geotechnical Engineer.
3. No rock greater than 3 inches in greatest dimension within 3 feet of top of pipe
4. Graded gravel: as specified or shown on the approved drawings for pipe embedment.

I. Coarse Base Rock
1. Granular material, maximum 3 inches, less than 10% passing 1-inch sieve
2. Free of trash, clay and dust
3. Compaction as specified by Geotechnical Engineer

J. Road Base
1. Will meet ASTM specification for Class II aggregate base and CDOT Class 6 gradation

Sieve Size	Percent Passing by Weight
1”	100
3/4"	90-100
#4	30-65
#8	22-55
#200	3-12

K. Clay for irrigation channels, cut-off walls or clay for use as barrier material in utility trenches
1. USCS Classification: CL, CH or OH
a. Percent passing No. 200 Sieve: 30% or greater by weight
b. Plasticity Index: 15 or greater
c. Maximum Permeability: 1 x 10-5 cm/sec
d. Maximum Particle Size: 3/4-inch
e. Minimum Clay Liner Thickness: 2 feet at side slopes and end of wing walls or as specified in plans and details.
f. Maximum horizontal loose lift thickness: 12-inches or less

2.2 ACCESSORIES

a. Controlled Low Strength Material (Flow Fill)
1. Comply with Utility Provider’s specifications and ACI 229 for the use of flowable fill within the right-of-way or for public utility trench backfill.
g. Product will be a lean, sand-cement slurry, “flowable fill” or similar material with a 28-day unconfined compressive strength between 50 and 200 psi.

b. Non-woven geotextile fabric
h. Needle-punched nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that the fibers retain their relative position. Product must be inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids. Product must meet AASHTO M288-06 Class 3 for elongation >50%.

Part 3 EXECUTION

3.1 EXAMINATION

A. Field verify the location of all underground utilities, pipelines and structures prior to excavation

3.2 PERFORMANCE – GENERAL

A. Perform work in a safe and proper manner with appropriate precautions against hazard
B. Provide adequate working space and clearances for work performed within excavations and for installation and removal of utilities
C. Contain all construction activity on the designated site and within the limits of work. Cost of restoration offsite will be the responsibility of the Contractor
D. Maintain service to pipelines and utilities indicated on Approved drawings during construction

3.3 PREPARATION

A. Clearing and Grubbing
    1. Clear all site areas within the limits of work of grasses, roots, brush, and other objectionable material and debris.
    2. Strip subgrade for fills and embankments of surface vegetation, sod, tree stumps and organic topsoil. Strip and stockpile all on-site material meeting the topsoil definition for all areas receiving grading where shown on Approved drawings
    3. Remove all waste materials from site and dispose. Stockpile all acceptable grubbings for reuse in revegetation areas.
    4. Remove and dispose of tree stumps and roots over 3 inches in diameter to a minimum depth of 18 inches below the natural surface or 5 feet below finished surface level, whichever is lower.
    5. Remove debris including all demolished trees, underbrush, stumps, roots and other combustible materials from site and dispose of off-site; on-site burning is not permitted
    6. Backfill all excavated depression include grub holes with approved material

B. Preservation of Trees
    1. Do not remove trees outside fill or excavated areas, except as authorized by Engineer
    2. Protect trees and their roots within the drip line that are to remain from permanent damage by construction operation
    3. Trim standing trees in conflict with construction operations as directed by the Town.

C. Topsoil Stripping
    1. Strip onsite material meeting the topsoil definition to minimum depth of 6 inches from areas to receive grading as shown on the approved drawings.
    2. At the completion of work in each area, place and grade topsoil to maintain gradient as indicated and required. Roughen surface as required for erosion control.

D. Waste and Debris
    1. Stockpile all acceptable grubbing for reuse in native revegetation areas
    2. Remove and dispose of all waste materials and debris from clearing, grubbing, stripping and demolition off site

E. Stockpiles
    1. Segregate materials suitable for the following:
        a. Topsoil
        b. Embankments and fills
        c. Backfill
        d. Spoils and waste only

2. No excavation will be deposited or stockpiled at any time so as to endanger stability of banks or structures, health of trees and shrubs to be protected, or portions of the Work, either by direct pressure or indirectly by overloading banks contiguous to the operation
3. Stockpile soil materials away from edge of excavations
4. Do not obstruct or prevent access to roads, driveways, ditches, natural drainage channels, and utility control devices

3.4 PROTECTION OF EXISTING UTILITIES AND STRUCTURES

A. Excavation and backfill operations will be performed in such a manner to prevent cave-ins of excavations or the undermining, damage or disturbing of existing utilities and structures or of new work.

B. Backfill will be placed and compacted so as to prevent future settlement or damage to existing utilities and structures and new work

C. Any excavations improperly backfilled or where settlement occurs will be reopened to the depth required then refilled with approved materials and compacted, and the surface restored to the required grade and condition.

D. Any damage due to excavation, backfilling, or settlement of the backfill, or injury to persons or damage to property occurring as a result of such damage will be the responsibility of the Contractor. All costs to repair such damage, in a manner satisfactory to the Town, will be borne by the Contractor.

3.5 DEWATERING

A. General
   1. All dewatering activities in accordance with all federal, state, and local regulations regarding site drainage, dewatering, and erosion and sediment control including permitting requirements
   2. Dewatering to surface waterways requires Colorado Department of Public Health and Environment dewatering permit. Contractor must obtain dewatering permit and comply with discharge requirements therein, including water treatment prior to discharge, if necessary

B. Design
   1. Contractor will be responsible for the accuracy of the approved drawings, design data, and operational records required
   2. Contractor will be solely responsible for the design, installation, operation, maintenance, and any failure of any component of the system

C. Damages
   1. Contractor will be responsible for and will repair any damage to work in place, or other contractor’s equipment, utilities, residences, highways, roads, railroads, private and municipal well systems, adjacent structures, natural resources, habitat, existing wells, and the excavation including, damage to the bottom due to heave and including but not limited to, removal and pumping out of the excavated area that may resultfrom Contractor’s negligence, inadequate or improper design and operation of the dewatering system, and any mechanical or electrical failure of the dewatering system
   2. Remove sub grade materials rendered unsuitable by excessive wetting and replace with approved backfill material at no additional cost to the Town.

D. Maintaining Excavation in Dewatered Condition
   1. Dewatering will be a continuous operation. Interruptions due to power outages, or any other reason will not be permitted
   2. Continuously maintain excavation in a dry condition with positive dewatering methods during preparation of subgrade, installation of pipe, and construction of structures until the critical period of construction and/or backfill is completed to prevent damage of subgrade support, piping, structure, side slopes, or adjacent facilities from flotation or other hydrostatic pressure imbalance
   3. Provide standby equipment on site, installed, wired, and available for immediateoperation if required to maintain dewatering on a continuous basis in the event any part of the system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform such work as may be required to restore damaged structures and foundation soils at no additional cost to the Town.
   4. System maintenance will include supervision by personnel skilled in the operation, maintenance, and replacement of system components, and any other work required to maintain excavation in dewatered condition

E. System Removal
   1. Remove dewatering equipment from the site, including related temporary electrical service
   2. Wells will be removed or cut off a minimum of 3 feet below final ground surface, capped, and abandoned in accordance with regulations by agencies having jurisdiction

3.6 SHEETING, SHORING AND BRACING

A. All sheeting, shoring and bracing in accordance with OSHA and IBC requirements

B. Prevent undermining and damage to all structures, buildings, underground facilities, pavements and slabs

C. Contractor will responsible for obtaining all required permits or easements for encroachments into the public right-of-way and for coordinating any encroachments onto adjacent properties.

D. If sheet pile cut off walls are required, submit design calculations, stamped by a Colorado licensed Professional Engineer

E. Contractor will be solely responsible for proper design, installation, operation, maintenance, and any failure of any system component

F. Provide proper and substantial sheeting, shoring, and bracing, in accordance with OSHA Standards as required, to prevent caving or sliding, to protect workmen and the Work, and to protect existing structures and facilities

G. Design, furnish, build, maintain and subsequently remove, to extent required a system of temporary supports for cut and cover, open cut, temporary bypass road, or trench excavations, including bracing, dewatering, and all associated items to support the sides and ends of excavations where excavation slopes may endanger in-place or proposed improvements, extend beyond construction right-of-ways or as otherwise specified or indicated in the approved drawings.
   1. Design and build sheeting, shoring, and bracing to withstand all loads that might be caused by earth movement or pressure
   2. Design and build sheeting, shoring and bracing to be rigid, maintain shape and position under all circumstances.

H. Design excavation support system and components for the following to allow safe and expeditious construction of permanent structures without movement/settlement of the ground and to prevent damage to or movement of adjacent buildings, structures, other improvements and underground facilities
   1. To support lateral earth pressures
   2. Loads from utilities, traffic, construction, buildings and surcharge loads

I. Provide sheeting, shoring and bracing equipment and materials onsite prior to start of excavation in each section, making adjustments as required to meet unexpected conditions

J. Contractor will make his own assessment of existing conditions including adjacent property, the possible effects of his proposed temporary works and construction methods, and will select and design support systems, methods, and details as will assure safety to the public, adjacent property, and the completed Work.

K. Space and arrange sheeting and bracing as required to exclude adjacent material and according to the stability of excavation slopes

L. Do not pull trench sheeting before backfilling

M. Do not brace sheeting left in place against the pipe, but support it in a manner that precludes concentrated loads or horizontal thrusts on pipe

N. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment is completed

3.7 TRENCH STABILIZATION

A. Thoroughly compact and consolidate subgrades for concrete structures, precast structures, and utility trench bottoms so they remain firm, dense and intact during required construction activities

B. Remove all mud and muck during excavation

C. Reinforce subgrades with crushed rock or gravel if they become mucky during construction activities

D. Finished elevation of stabilized subgrades are to be at or below subgrade elevations indicated on the approved drawings

E. Allow no more than ½ inch depth of mud or muck to remain on trench bottoms when pipe bedding material is placed thereon

3.8 PAVEMENT OVEREXCAVATION AND SUBGRADE PREPARATION

A. Excavate subgrade for asphalt pavement areas per the lines, grades, and dimensions indicated on approved drawings within a tolerance of plus or minus 0.10 foot. Excavate subgrade for concrete pavement areas per the lines, grades, and dimensions indicated on Approved drawings within a tolerance of plus or minus 0.05 foot.

B. Overexcavate and scarify existing soil as required under pavement areas, slabs, curbs and walks to meet the moisture and compaction specifications herein to depth shown on approved drawings or as specified by a project Geotechnical Engineer.

C. Extend subgrade preparation a minimum of one foot beyond back of proposed pavement, slabs, curbs and walks.

D. Proof roll at a maximum of 24 hours prior to paving to locate any soft spots that exhibit instability and deflection beyond subgrade tolerances listed above. Areas that are observed to have soft spots in the subgrade, where deflection is not uniform or is excessive as determined by the Geotechnical Engineer, will be ripped, scarified, dried or wetted as necessary and recompacted to the requirements for density and moisture. After recompaction, these areas will be proof rolled again and all failures again corrected.

E. If the Contractor fails to place the sub base, base course, or initial pavement course within 24 hours or the condition of the subgrade changes due to weather or other conditions, proof rolling and correction will be performed again.

3.9 FILLS AND EMBANKMENTS

A. Using suitable approved materials, shape, trim, and finish cut slopes to conform with contours and elevations indicated on approved drawings.

B. Will not be placed on frozen surface. Do not place snow, ice or frozen materials in fill

C. Level and roll subgrade so surface materials will be compact and bond with the first layer of fill or embankment
   1. Plow and scarify subgrade to a minimum depth of 6 inches until uniform and free of large clods

D. Place in horizontal layers at maximum uncompacted depth per compaction specifications herein.

E. Spread and level material deposited in piles and windrows before compacting

F. Thoroughly compact each layer by rolling or other means acceptable to Geotechnical Engineer to meet the moisture and compaction specifications herein.

G. Alter compaction methods if material fails to meet specified density

H. Where a trench passes through a fill or embankment, place and compact fill or embankment to 12 inch above the top of the pipe before excavating the trench

I. Add water and harrow, disc, blade, or otherwise work each layer to obtain the uniform moisture content and adequate compaction

3.10 COMPACTION

A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations. Place backfill and fill uniformly along the full length of each structure as described herein.

C. Comply with a project Geotechnical Engineer's additional requirement for site development material, subexcavation, compaction and related earthwork operations.

D. Percentage of Maximum Dry Density Requirements: Moisture treat and compact soil to not less

than the following percentages of maximum dry density and to within the specified moisture content range of optimum moisture content according to ASTM D698 as follows:

Public Surface Improvement	Compaction %	Moisture
Paved Areas	95%	-2 to +2
Lawns or Unpaved Areas	90%	-2 to +2

E. Do not deposit or compact tamped or otherwise mechanically compacted backfill if frozen or if in water.

F. Take particular care to compact backfill which will be beneath slabs, pipes, drives, roads, parking areas, curb, gutters, or other surface construction.

3.11 BORROW OR SPOIL AREA

A. The location, size, shape, depth, drainage, and surfacing of borrow or spoil pits will be acceptable to the Town.

B. Make all areas regular in shape with graded and surfaced side and bottom slopes when completed

C. Cut side slopes not steeper than 1:1 and uniform for the entire length of any one side

D. Final grade disturbed areas of borrow to uniform slope (max slope = 4:1, min slope = 50:1).

E. Use material free of debris and deleterious material

F. Contractor is responsible for compliance with Colorado Discharge Permit System and local erosion control permitting requirements for any and all onsite and offsite, disturbed spoil and borrow areas. Upon completion of spoil and/or borrow operations, clean up spoil and/or borrow areas in a neat and reasonable manner to the satisfaction of the offsite property owner and the Town.

3.12 BLASTING

A. Blasting or other use of explosives is not permitted without the Town's approval

3.13 TRENCH EXCAVATION

A. Establish alignment and grade or elevation from offset stakes provided by the Contractor's surveyor.

B. Excavate trenches so pipes can be laid straight at uniform grade without dips or bumps, between the terminal elevations indicated on the approved drawings.

C. Comply with pipe specification sections regarding vertical and horizontal alignment and maximum joint deflection

D. Measure pipe cover depth vertically from top of pipe to finished ground or surface elevation

E. Do not open more trench in advance of pipe laying than is necessary to expedite the work; not more than 100 feet

F. Total length of open trench will be limited to 200 feet unless otherwise approved by the Town Engineer/Inspector.

G. Except where tunneling or boring is indicated on the approved drawings, specified, required by

jurisdictional agency or permitted by Engineer, excavate trenches by open cut from the surface

H. Limiting trench widths
   1. Excavate to a width which will provide adequate working space and pipe clearances for proper pipe installation, jointing, embedment
   2. If needed to reduce earth loads to prevent sliding, cut banks back on slopes which extend not lower than 1 foot above the top of the pipe
   3. Stipulated minimum clearances are minimum clear distances, not minimum average distances
   4. Maximum trench width from six inches above the top of pipe to trench bottom is the pipe outside diameter plus 24 inches
   5. Limiting trench widths and permissible clearances from 6 inches above top of pipe to trench bottom for installed pressure and non-pressure piping

Pipe Size (inch)	Minimum Trench Width	Maximum Trench Width
3	1’ 6”	2’ 6”
4	1’ 6”	2’ 6”
6	1’ 6”	2’ 6”
8	1’ 8”	2” 8”
10	2’ 0”	3’ 0”
12	2’ 0”	3’ 0”
16	2’ 8”	3’ 8”
18	3’ 0”	4’ 0”
24	3’ 6”	4’ 6”
36	4’ 6”	5’ 0”

   6. If the width of the lower portion of the trench exceeds the maximum permitted, provide special pipe embedment, or concrete encasement as required by loading conditions
   7. excessive trench widths will be allowed to avoid the use of sheeting or shoring and bracing

I. Trench Side Walls
   1. Will be sloped, shored, sheeted, braced, or otherwise supported by means of sufficient strength to protect workmen in accordance with applicable rules and regulations established for construction by the federal, state, and local ordinances and regulations
   2. Sheet and brace where necessary and as specified herein
   3. Excavate without undercutting

J. Trench Bottom
   1. Will be thoroughly protected and maintained when suitable natural materials are encountered
   2. Will be thoroughly compacted and in approved condition prior to placing gravel bedding, if required
   3. in earth, trench bottoms for 6 inches and smaller pipe may be excavated below pipe subgrade and granular embedment provided or the trench may be graded to provide uniform and continuous support between bell holes or end joints of the installed pipe at the Contractor's option
   4. not allow any part of bells or couplings to contact the trench bottom, walls, or granular embedment when pipe is joined
   5. PVC pipe will not be laid directly on trench bottom

K. Mechanical excavation
   1. Do not use where its operation would damage buildings, culverts, or other existing property, structures, or utilities above or below ground; hand excavate only in such areas
   2. Use mechanical equipment of a type and design which can be operated to provide the following:

a. Rough trench bottom to a controlled elevation
b. Uniform trench widths and vertical sidewalls are obtained from 1 foot above the top of the installed pipe to the bottom of the trench
c. alignment is such that pipe is accurately laid to specified alignment and is centered in the trench with adequate clearance between pipe and trench sidewalls

3. Do not undercut trench sidewalls
4. Recompact trench bottom disturbed by bucket teeth prior to placement of embedment material

L. Except as otherwise required, excavate trenches below the underside of pipes as indicated in the approved drawings to provide for installation of granular embedment pipe foundation material

M. Where in earth, trench bottoms for 6 inches and smaller pipe may be excavated below pipe subgrade and granular embedment provided or the trench may be graded to provide uniform and continuous support (between bell holes or end joints) of the installed pipe, Contractor's option

N. Do not allow any part of bells or couplings to contact the trench bottom, walls, or granular embedment when pipe is joined

O. Cuts in existing surface construction
1. No larger than necessary to provide adequate working space
2. Cut a clean groove not less than 1½ inch deep along each side of trench or around perimeter of excavation area
3. Remove pavement and base pavement to provide shoulder not less than 6 feet wide between cut edge and top edge of trench
4. Do not undercut trenches, resulting in bottom trench width greater than top widths
5. Make pavement cuts to and between straight or accurately marked curved lines parallel to trench centerline or limits of excavation
6. Remove pavement for connections to existing lines or structures only to the extent required for the installation
7. Replace the pavements between saw cuts to match original surface construction

3.14 PIPE EMBEDMENT

A. Embed pipes above and below the bottom of pipe as indicated on the approved drawings and as specified herein

B. Granular embedment
1. Spread and surface grade granular embedment to provide continuous and uniform support beneath pipe at all points between pipe joints.
a. Level bottom layer at proper grade to receive and uniformly support pipe barrel throughout length
b. Barrel of pipe will have a bearing for its full length
2. Form depressions under each joint to permit the proper jointing. No part of joint will be in contact with trench when pipe is placed in position
3. After grading, aligning, and placing pipe in final position, and shoring home, deposit and compact sufficient embedment under and around each side of the pipe to hold the pipe in proper position and alignment during subsequent operations
4. Place and compact embedment material uniformly and simultaneously on both sides of pipe to prevent displacement
5. Complete embedment promptly after jointing operations and approval to proceed by Town Engineer/Inspector
6. Granular embedment compaction by slicing with shovel or vibrating a. Maximum uncompacted thickness of layers: 6 inches
7. Compacted embedment will be compacted to 90 percent maximum density per ASTM D1557
a. Maximum uncompacted depth thickness of horizontal layers: 8-inch

C. Water Barriers and Cut-off Walls
1. To impede passage of water through bedding material, construct ground water barriers

a. Horizontally extending one (1) foot minimum past either side of the full trench width and approximately two (2) feet of minimum thickness along the length of the utility pipe.
b. Vertically, extending one (1) foot minimum from the bottom of granular bedding material and one (1) foot minimum above the top of granular bedding material.

2. Spacing:
   a. Approximately 10 feet downstream of each manhole for sanitary sewers and storm drains.
   b. Every 400 feet on water lines and force main.
   c. Place a groundwater barrier 20 feet downstream of the edge of all drainage ways, streams and water courses
3. Minimum Compaction: 95% proctor
4. Content: -1% to 2% Optimum Moisture Content

D. Arch and concrete encasement
   1. Include in locations indicated on Approved drawings or where over-width trench conditions need correction as approved by Engineer
   2. Install and form as indicated on Approved drawings or as specified
   3. Concrete will have a 28-day minimum 3,000 psi compressive strength

E. Do not backfill until tests and inspections have been made and backfilling is authorized by Engineer. Use care in backfilling to avoid damage or displacement of pipe systems

3.15 TRENCH BACKFILL

A. Backfilling will be conducted in a continuous manner to prevent damage to the pipe and its coating and kept as close to the pipe laying operation as possible.

B. Compacted Backfill
   1. Provide full depth of trench above embedment at all locations
   2. Beneath pavements, surfacing, driveways, curbs, gutters, walks or other surface construction or structures
   3. In street or highway shoulders
   4. In established sodded areas
   5. Beneath fills and embankments

C. Where the trench for one pipe passes beneath the trench of another pipe, compact the backfill for the lower trench to the bottom of the upper trench

D. Site excavated materials
   1. Place job excavated materials in 8 inches maximum uncompacted thickness, uniform layers
   2. Increased layer thickness may be permitted for incohesive material if Contractor demonstrates to the Town Engineer's/Inspector's satisfaction that specified compacted density will be achieved
   3. Use methods and equipment appropriate to the material to be compacted to prevent transmission of damaging shocks to pipe
   4. Thoroughly compact each layer to meet the moisture and compaction specifications herein.

E. Graded gravel
   1. Deposit in uniform layers of 8 inches maximum uncompacted thickness
   2. Compact with suitable vibrating roller or platform vibrator to not less than 70 percent relative density per ASTM D4253/D4254

F. Uncompacted backfill
   1. Compaction of backfill above pipe embedment in locations other than those specified, is required only to prevent future settlement
   2. May be placed by any method acceptable to Town Engineer/Inspector which will not impose excessive concentrated or unbalanced loads, shock, or impact on, and will not

result in displacement of installed pipe
3. Until compacted depth over conduit exceeds 3 feet, do not drop fill material over 5 feet. Distance may be increased 2 feet for each additional 1 foot of cover

G. Finish the top portion of backfill with at least 4 inches of topsoil or as specified by landscaping specifications, whichever is greater, corresponding to, or better than, that underlying adjoining turf areas.

H. Trench backfill within the public right-of-way will conform to municipal street and utility standards.

I. Trenchbackfills through unimproved areas should be restored to previous conditions and left 3" above adjacent grades to allow for settlement. Seed all disturbed areas according to erosion control and landscape specifications.

J. Protection of trench backfill
1. Where trenches are constructed in ditches or other water courses, protect backfill from erosion
2. Install ditch checks where the ditch grade exceeds 1 percent
   a. Minimum depth: 2 feet below the original ditch or water course bottom for the full bottom width
   b. Minimum width: 18 inches into the side slopes
   c. Minimum thickness: 12 inches

3.16 DRAINAGE MAINTENANCE

A. Do not backfill trenches across roadways, drives, walks or other trafficways adjacent to drainage ditches or water courses prior to backfilling the trench on the upstream side of the trafficway to prevent impounding water after pipe is laid

B. Backfill so that water does not accumulate in unfilled or partially filled trenches

C. Remove materials deposited in roadway ditches or other water courses crossed by the trench line immediately after backfilling is completed and restore ditches and water courses to original section, grade, and contours

D. Do not obstruct surface drainage any longer than necessary

E. Provide and maintain temporary bridges and other structures across unfilled trenches as required to maintain traffic

F. Provide adequate storm flow conveyance through the site at all times during construction to avoid flooding of any buildings or adjacent property. Provide overland drainage routing when storm sewer inlets are not fully functioning due to erosion and sediment control measures.

3.17 FINAL GRADING

A. After completion of all other outside work and after backfilling is completed and settled, bring to grade at the indicated elevations, slopes and contours, all areas being graded on site

B. Graders and other power equipment may be used for final grading and slope dressing if the result is uniform and equivalent to hand work

C. Grade all surfaces for effective drainage, provide a 2 percent minimum slope except as otherwise shown on the approved drawings

D. Provide a smooth transition between adjacent existing grades and new grades

E. Cut soft spots, fill low spots, and trim high spots to comply with required surface tolerances

F. Slope grades to direct water away from buildings and prevent ponds from forming where not intended

G. Finish subgrades at lawns and unpaved areas to required elevations within a tolerance of plus or minus one (1) inch

H. Finish grades will be no more than 0.1 foot above or below those indicated

I. Finish all ditches, swales and gutters to drain readily

J. Coordinatefinal subgrade depth with finish landscape treatment and required topsoil depths

3.18 SLOPE AND CHANNEL STABILIZATION

A. Cover channel banks, slopes, bottom and thalweg (water flowline at lowest point in channel) with erosion control fabric mat where grade is steeper than 4H to 1V and where indicated on the approved drawings

B. Lay fabric smoothly on surface, bury top end of each section in 6-inch deep excavated topsoil trench. Provide 6-inch overlap minimum of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil

C. Secure outside edges and overlaps at 48-inch intervals with 4-inch to 6-inch U-shaped type pins or wooden stakes depending on ground condition

D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil

E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches

F. Maintain integrity of erosion control fabric

G. Prior to laying fabric, seed disturbed areas under provisions of related seeding and landscaping specification sections or as specified on approved drawings.

3.19 SETTLEMENT

A. Warranty for settlement of all fills, embankments, and backfills is stipulated in the General Conditions from final completion of Contract under which Work is performed

B. Repair or replace within 30 days after notice by the Town.

3.20 FIELD QUALITY CONTROL

A. Provide under provisions of General Conditions and Division One Specifications

B. Fills and Embankment Testing
   1. Two moisture-density relationship tests, ASTM D698, on each type of fill material
   2. One in-place compaction test for each 5,000 square feet every 1.5 feet of vertical lift of material placed
   3. Additional in-place compaction tests at the discretion of the Town

C. Embedment and Backfill Testing
   1. Two moisture-density relationship tests, ASTM D698, or two relative density tests, ASTM

D4253/D4254, as appropriate for each type of embedment on backfill material proposed, except granular embedment material

2. One in-place compaction test every 200 lineal feet of trench in the compacted embedment zone and at every 1.5 feet of vertical lift of backfill materials, per ASTM D6938
3. One in-place compaction test near top of trench for trench depth of 2 feet or less, per ASTM D6938
4. At least one in-place compaction test must be conducted per private service line.
    a. The test should be conducted at the midpoint of the trench to represent the most critical area for compaction. Alternatively, the Town Engineer may specify a different location if deemed necessary based on site conditions.
5. Compacted embedment must achieve 90 percent maximum density per ASTM D1557. All backfill material around service lines, stop boxes, and meter settings must be compacted to 90 percent.
6. Compliance and Inspection:
    a. The Town Engineer or designated inspector must approve the embedment and backfill compaction before proceeding with additional layers.
7. The property owner or contractor must provide documentation of all compaction tests to the Town Engineer for review and approval.
8. Additional in-place compaction tests at the discretion of the Owner

D. Pavement and Structural Subgrade Testing
1. At a minimum, two moisture-density relationship tests, ASTM D698, or two relative density tests, ASTM D4253/D4254, as appropriate and adequate for each type backfill material proposed.
2. Perform tests for each footing, concrete site feature, and drainage structure subgrade.
3. Perform tests at every 100 linear feet of subgrade of foundation walls, retaining walls, and every 150 feet for curbing, pans, drainage features, walks, etc. (or portions thereof).
4. Perform tests every 2,000 square feet required of building slab area, exterior slabs and pavement/flatwork areas (with no less than 3 tests).
5. Test at subgrade and at every vertical lift of backfill materials placed.
6. Additional in-place compaction tests at the discretion of the Town

END OF SECTION

SECTION 31 25 00
EROSION AND SEDIMENTATION CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Minimum requirements for soil erosion and sedimentation control on all project sites where soil will be disturbed

B. Temporary measures needed to control erosion and water pollution. These temporary measures will include, but not be limited to, berms, dikes, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, slope drains, and other erosion control devices or methods. These temporary measures shall be installed at the locations where needed to control erosion and water pollution during the construction of the project and during site restoration, and as directed by Town Engineer/Inspector, and as shown on the approved drawings.

C. The Erosion Control Plan presented in the drawings serves as a minimum for the requirements of erosion control during construction.

D. Contractor has the ultimate responsibility for providing adequate erosion control and water quality throughout the duration of the project. Therefore, if the provided plan is not working sufficiently to protect the project areas, then Contractor shall provide additional measures as required to obtain the required protection.

1.2 REFERENCES

A. CDOT – Colorado Department of Transportation

B. MHFD – Mile High Flood District

C. CDPHE – Colorado Department of Public Health and Environment

D. Weld County Engineering Construction Criteria Guidelines

E. LCUASS – Larimer County Urban Area Street Standards

1.3 SUBMITTALS

A. Submit the following information:
   1. Erosion Control Plan,
   2. Construction schedule for Erosion Control per Scheduling paragraph below
   3. Sequencing Plan per Scheduling paragraph below
   4. All applicable permits for Grading and Erosion Control.

B. Product data: Submit on all products or materials supplied herein.

1.4 REGULATORY REQUIREMENTS

A. Obtain and comply with all requirements of the Town issued Grading/Construction permits and CDPHE Stormwater and/or Groundwater Discharge Permits, as required.

B. 401 Construction Dewatering Industrial Wastewater Permit
   1. Contractor shall apply for and obtain a Construction Dewatering Permit 401 from the

Colorado Department of Public Health and Environment.
2. All costs for this permit shall be the responsibility of Contractor.
3. This permit requires that specific actions be performed at designated times.
4. Contractor is legally obligated to comply with all terms and conditions of the permit including testing for effluent limitations.
5. Contractor shall allow the Colorado Department of Public Health and Environment or other representatives to enter the site to test for compliance with the permit.
6. Non-compliance with the permit can result in stoppage of all work.

C. In the event of conflict between these requirements and erosion and pollution control laws, rules, or regulations of other Federal, State, or local agencies, the more restrictive laws, rules, or regulations shall apply.

1.5 SCHEDULING

A. Sequencing Plan:
1. Contractor shall submit a sequencing plan for approval for erosion control in conformance with Contractor's overall Construction Plan for approval by the Town
2. to the Erosion Control Sequencing Plan may be considered by the Town only if presented in writing by the Contractor.

B. Temporary Erosion Control:
1. When so indicated in the Contract Documents, or when directed by the Town.
2. Contractor shall prepare construction schedules for accomplishing temporary erosion control work including all maintenance procedures.
3. B. These schedules shall be applicable to clearing and grubbing, grading, structural work, construction, etc.

C. Contractor shall submit for acceptance the proposed method of erosion control on haul roads and borrow pits and a plan for disposal of waste material.

D. Contractor shall be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in the accepted schedule. Temporary erosion control measures shall then be used to correct conditions that develop during construction.

E. Work shall not be started until the erosion control schedules and methods of operations have been accepted.

PART 2 PRODUCTS

2.1 MATERIALS

A. All materials shall be submitted for approval prior to installation.

B. Natural or biodegradable materials shall be reasonably clean, free of deleterious materials, and certified weed free. Materials may include, but are not limited to, hay bales, straw, fiber mats, fiber netting, wood cellulose, fiber fabric, gravel.

C. Grass Seed:
1. Temporary grass cover (if required) shall be a quick growing species, suitable to the area, in accordance with local criteria and permit requirements, which will provide temporary cover, and not compete with the grasses sown for permanent cover.
2. All grass seed shall be approved by the Town prior to installation

D. Fertilizer and soil conditioners shall be approved by the Town and in accordance with Section 33 47 00 of the Town of Berthoud Standards and Specifications prior to installation

E. Silt Fence Fabric: woven polypropylene
   1. Mirafi 100X, "Envirofence"
   2. Or accepted substitution

F. Temporary Slope Stabilization Mat (short term):
   1. Biodegradable
   2. Longevity of 12 months

G. Temporary Slope Stabilization Mat (extended term):
   1. Biodegradable
   2. Longevity of 24 months

PART 3 EXECUTION

3.1 GENERAL

A. All temporary and permanent erosion and sediment control practices will be maintained and repaired as needed to ensure continued performance of their intended function.

B. The Town Engineer/Inspector will monitor Contractor's erosion control methods. If the overall function and intent of erosion control is not being met, the Town will require Contractor to provide additional measures as required to obtain the desired results.

C. The erosion control features installed by Contractor shall be adequately maintained by Contractor until the project is accepted.

3.2 WORKING IN OR CROSSING WATERCOURSES AND WETLANDS

A. Construction vehicles shall be kept out of watercourses to the extent possible.

B. Where in-channel work is necessary, precautions shall be taken to stabilize the work area during construction to minimize erosion.
   1. The channel, including bed and banks, shall always be restabilized immediately after in-channel work is completed.

C. Where a live (wet) watercourse must be crossed by construction vehicles during construction, a Temporary Stream Crossing shall be provided for this purpose.

3.3 PROTECTION OF ADJACENT PROPERITES

A. Properties adjacent to the site of a land disturbance shall be protected from sediment deposition.

B. In addition to the erosion control measures required on the drawings, perimeter controls may be required if damage to adjacent properties is likely, and may include, but is not limited to:
   1. Vegetated buffer strip around the lower perimeter of the land disturbance.
      a. Vegetated buffer strips may be used only where runoff in sheet flow is expected and should be at least twenty (20) feet in width.
   2. Sediment barriers such as straw bales, erosion logs, and silt fences.
   3. Sediment basins and porous landscape detention ponds.
   4. Combination of above measures.

3.4 CONSTRUCTION

A. Stabilization of Disturbed Areas:
   1. Temporary sediment control measures shall be established within five (5) days from time of exposure or disturbance.
   2. Permanent erosion protection measures shall be established within five (5) days after final grading of areas.

B. Stabilization of Sediment and Erosion Control Measures:
   1. Sediment barriers, perimeter dikes, and other measures intended to either trap sediment or prevent runoff from flowing over disturbed areas shall be constructed as a first step in grading and be made functional before land disturbance takes place.
   2. Earthen structures such as dams, dikes, and diversions shall be stabilized within five (5) days of installation.
   3. Stormwater outlets shall also be stabilized prior to any upstream land disturbing activities.

C. Stabilization of Waterways and Outlets:
   1. All onsite stormwater conveyance channels used by Contractor for temporary erosion control purposes shall be designed and constructed with adequate capacity and protection to prevent erosion during storm and runoff events.
   2. Stabilization adequate to prevent erosion shall also be provided at the outlets of all pipes and channels.

D. Storm Sewer Inlet Protection:
   1. All storm sewer inlets which are made operable during construction or which drain stormwater runoff from a construction site shall be protected from sediment deposition by the use of filters.

E. Construction Access Routes:
   1. Wherever construction vehicles enter or leave a construction site, a Stabilized Construction Entrance is required.
   2. Where sediment is transported onto a public road surface, the roads shall be cleaned thoroughly at the end of each day.
   3. Sediment shall be removed from roads by shoveling or sweeping and be transported to a sediment-controlled disposal area.
   4. Street washing shall be allowed only after sediment is removed in the manner described above.

3.5 DISPOSITION OF TEMPORARY MEASURES

A. All temporary erosion and sediment control measures shall be disposed of within thirty (30) days after final site stabilization is achieved or after the temporary measures are no longer needed as determined by the Town

B. Trapped sediment and other disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion.

C. Contractor will be responsible for maintaining temporary erosion control measures until such time as work has been accepted by the Town and as specified in the Grading Permit.

END OF SECTION

SECTION 32 12 00
FLEXIBLE PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Full depth and/or composite hot bituminous pavement (asphalt) over prepared subgrade

B. Overlay, patch and/or pavement rehabilitation applications for streets, parking lots and other miscellaneous asphalt pavement

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. T 230: Standard Method of Test of Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures

B. American Society for Testing and Materials (ASTM)
   1. C29: Unit Weight and Voids in Aggregate
   2. C88: Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
   3. C117: Materials Finer than No. 200 Sieve in Mineral Aggregates by Washing
   4. C128: Specific Gravity Test and Absorption of Fine Aggregate
   5. C131: Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
   6. C136: Sieve or Screen Analysis of Fine and Coarse Aggregates
   7. D70: Specific Gravity of Semi-Solid Bituminous Materials
   8. D2726: Bulk Specific Gravity of Compacted Bituminous Mixtures
   9. D2041: Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures
   10. : Viscosity of Asphalts (Bitumens)
   11. : Quantities Extraction of Bitumens from Bituminous Paving Mixtures
   12. D2419: Sand Equivalent Value of Soils and Fine Aggregate
   13. D290: Bituminous Mixing Plant Inspection
   14. D6373: Performance Graded Asphalt Binder
   15. D692: Course Aggregate for Bituminous Paving
   16. D1073: Fine Aggregate for Bituminous Paving Mixtures
   17. D1241: Materials for Soil-Aggregate Subbase, Base and Surface Courses
   18. D2026: Cutback Asphalt (Slow-Curing Type)
   19. D2027: Cutback Asphalt (Medium-Curing Type)
   20. D2028: Cutback Asphalt (Rapid-Curing Type)
   21. D2950: Density of Bituminous Concrete in Place by Nuclear Methods

C. Surface Preparation Standards (SSPC)
   1. SP-2: Superior Performing Asphalt Pavement System (Superpave) Level 1 Mix Design

D. Colorado Department of Transportation (CDOT)

E. Colorado Asphalt Pavement Association (CAPA)

F. Larimer County Urban Area Street Standards (LCUASS)

G. Town of Berthoud Standards and Specifications

1.3 SUBMITTALS

A. Record of Work: Maintain record of time and date of placement, temperature, and weather conditions. Retain until completion and furnish a copy to Town of Berthoud.

B. Proposed Design Job Mix Formula for each mixture required by the contract. The mixture

design shall be determined using AASHTO T-312 or Colorado Procedure CP-L 5115 for the Superpave Method of Mixture Design.

C. Test Reports: Proposed Design Job Mix testing shall be performed in a materials laboratory under the direct supervision of; and shall be stamped and signed by a Professional Engineer licensed in the State of Colorado practicing in this field. In addition, the General Contractor shall submit as part of the Proposed Design Job Mix, documents to verify the following:
   1. Source of materials
   2. Gradation, specific gravity, source and description of individual aggregates and the final blend
   3. Aggregate physical properties
   4. Source and Grade of the Performance Graded Binder (PG Binder)
   5. Proposed Design Job Mix – aggregate and additive blending, final gradation shown on 0.45 power graph, optimum asphalt content
   6. Required mixing and compaction temperatures
   7. Mixture properties determined at a minimum of four asphalt contents and interpolated at optimum and graphs showing mixture properties versus asphalt content.
   8. Sampling and testing of asphalt concrete mixtures for quality control during paving operations
      a. Uncompacted asphalt concrete mix
         i. Asphalt cement content: ASTM D2172 (AASHTO T164)
         ii. Maximum Specific Gravity: ASTM D2041 (AASHTO T209)
      b. Compacted asphalt concrete mix
         i. Bulk density: ASTM D1188 (AASHTO T166)
   c. Perform at least one test for each day's paving but not less than one test per each 4000 sf of each lift.

1.4 QUALITY ASSURANCE

A. Materials and installation shall conform to applicable portions of CDOT, LCUASS, and Town of Berthoud construction specifications, standards and details as applicable.

1.5 REGULATORY REQUIREMENTS

A. For work on public streets or rights-of-way, conform to the requirements of Town of Berthoud Standards and Specifications and details.

B. Comply with applicable requirements of CABO/ANSI A117.1 for accessibility requirements related to walks, ramps, parking areas, drives, curb ramps, etc.

1.6 DELIVERY, STORAGE AND HANDLING

A. Transport mixture from mix plant in trucks with tight, clean, smooth, non-sticking compartments. Thinly coat hauling compartments with lime-water mixture, paraffin oil or other approved release agent to prevent sticking. Petroleum distillates such as kerosene or fuel oil are not approved release agents. Elevate and drain compartment of excess solution before loading mix.

B. Cover to protect from weather and prevent loss of heat

C. Provide insulated truck beds during temperature below 50 degrees F on long-distance deliveries

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not apply when underlying surface is muddy, frozen or wet

B. Place material only when weather conditions permit pavement to be properly placed and compacted

C. The hot mix asphalt will be placed only when both the air and surface temperatures are equal to or exceed the temperatures specified in LCUASS.

D. Air temperature shall be taken in the shade. Surface is defined as the existing base on which the new pavement is to be placed.

PART 2 PRODUCTS

2.1 MATERIALS

A. General: Pavement shall be asphalt of the plant hot mix type. Materials and construction shall comply with LCUASS Standards and Specifications or CDOT Standards and Specifications when applicable.

B. Weed Control
   1. First application: “Roundup” or accepted substitute
   2. Second application: Casoron “W-50" or “G-10” with colored marker dye, manufactured by Pacific Coast Borax Company or an accepted substitute of non- flammable type.

2.2 ACCESSORIES

A. Traffic Control Devices
   1. Comply with LCUASS standards and specifications for signs, sign posts, and pavement markings within the public right-of-way.

2.3 MIXES/SOURCE QUALITY CONTROL

A. Determine full depth design mix based upon aggregates furnished
   1. Test mix by independent laboratory at Contractor's expense
   2. Submit mix designs for review and acceptance by Town Engineer

B. Submit mix design giving unit weight prior to placement of asphalt.

C. Establish a single percentage passing each sieve size, a single percent of asphalt and a mix temperature. Maintain job mixes within following percentages of design mix as specified in LCUASS.

PART 3 EXECUTION

3.1 EXAMINATION

A. Establish and maintain required lines and elevations. Provide grade and location stakes under this section as required for asphaltic concrete paving work.

B. Operate heavy, rubber-tired front loader over subgrade of paved areas. Where soft spots occur, remove loose materials and replace with road base aggregate compacted to level of subgrade.

3.2 PREPARATION

A. Prepare subgrade under provisions of these Specifications

B. Loose and Foreign Material
   1. Remove loose and foreign material from compacted subgrade surface immediately before application of paving. Clean surface with mechanical sweeper, blowers, or hand brooms, until surfaces are free from dust

C. Weed Control
   1. If weeds or vegetation exist at or on the subgrade, apply “Round-up” at rates following manufacturer’s instructions. Apply “Round-up” three days prior to removal of vegetation,

subgrade preparation and application of Casoron as described below to allow “Round-up” to kill all vegetation. Remove all living and dead weeds, root balls, tree/shrub roots, vegetation, and/or any organic matter from on or in the subgrade per applicable earthwork specifications prior to subgrade preparation and paving at all areas to be paved.

2. After all fine grading, checking, shaping, and compacting of the subgrade has been completed, and just prior to placing asphalt or aggregate base course, all subgrade soil in the area to receive asphalt pavement shall be thoroughly treated with Casoron soil sterilant (in addition to “Round-up” and regardless of presence of existing weeds or vegetation). Casoron shall be thoroughly sprinkled to distribute the chemical through the first two or three inches of the subgrade. For all areas to be paved, apply Casoron weed control at a minimum rate per 100 square yards of 2.4 pounds for G-10 or 4.0 pounds for 50w at rates and methods recommended by manufacturer within one day of paving.
3. The Contractor shall provide all necessary protection to prevent injury to animal, fish, or plant life and property occasioned by the application of the soil sterilant. Apply on a calm, wind-free day. The Contractor will be held responsible for all application of soil sterilant or the storage of same. Protect existing and new trees and shrubs beyond the limit of paving from damage due to weed killer or soil sterilant overspray or root contact. Extra caution is required to prevent over-application of products in areas to be paved under tree canopies. Trees and shrubs damaged or killed by weed killer or sterilant application shall be replaced by the contractor at contractor’s expense.
4. Do not apply within 20 feet of trees or shrubs

3.3 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
   1. Mill to minimum depth of 1 ½-inches, or as indicated on the plans.
   2. Mill to a uniform finished surface free of gouges, grooves, and ridges of more than ¼ inch depth.
   3. Control rate of milling to prevent tearing of existing asphalt course.
   4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
   5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
   6. Transport milled hot-mix asphalt to asphalt recycling facility.
   7. Keep milled pavement surface free of loose material and dust.

3.4 RING/FRAME ADJUSTMENTS

A. Set ring/frames of subsurface structures to final grade as a part of this work.

B. Placing Ring/Frames
   1. Surround ring/frames set to elevation with a ring of compacted asphalt concrete base prior to paving
   2. Place asphalt concrete mixture up to 1-inch below top of ring/frame, slope to grade, and compact by hand tamping

C. Adjust frames to proper position to meet paving

D. If permanent covers are not in place, provide temporary covers over openings until

completion of rolling operations

E. Set ring/frames to grade, flush with surface of adjacent pavement

3.5 PREPARING THE MIXTURE

A. Comply with ASTM D995 for material storage, control, and mixing and for plant equipment and operation

B. Stockpile
   1. Keep each component of the various sized combined aggregates in separate stockpiles
   2. Maintain stockpiles so that separate aggregate sizes will not be intermixed and to prevent segregation.

C. Heating
   1. Heat the asphalt cement at the mixing plant to viscosity at which it can be uniformly distributed throughout mixture
   2. Use lowest possible temperature to suite temperature viscosity characteristics of asphalt
   3. Do not exceed 350 degrees F

D. Aggregate
   1. Heat-dry aggregates to acceptable moisture content
   2. Deliver to mixer at recommended temperature to suite penetration grade and viscosity characteristics of asphalt cement, ambient temperature, and workability of mixture
   3. Accurately weigh or measure dry aggregates and weigh or meter asphalt cement to comply with job-mix formula requirements

E. Mix aggregate and asphalt cement to achieve 90-95 percent coated particles for base mixtures and 85-90 percent coated particles for surface mixture, per ASTM D2489

3.6 EQUIPMENT

A. Bituminous Pavers
   1. Pavers shall be self-propelled, spread material without tearing surfaces, be equipped with an activated screed assembly, be heated if necessary, control pavement edges to true lines without use of stationary forms and capable of spreading and finishing the asphalt plant mix material in widths applicable to the typical sections and thicknesses for the work.
   2. Pavers used for roadway shoulders, recreational paths and similar construction will be capable of spreading and finishing the courses of asphalt plant mix material in width shown in the contract documents.
   3. Pavers will be equipped with automatic screed controls with sensors capable of sensing grade from an outside reference line and maintaining the screed at the specified longitudinal grade and transverse slope. The sensor will be constructed to operate from either or both sides of the paver and will be capable of working with the following devices:
      a. Ski-type device at least 30 feet in length
      b. Short ski or short shoe
      c. At least 5,000 feet of control line and stakes
   4. The controls will be capable of maintaining the screed at the specified transverse slope within plus or minus 0.1 percent.
   5. Manual operation will be permitted:
      a. For constructing irregularly shaped or minor areas
      b. If the automatic controls fail or malfunction the equipment may be operated

manually for the remainder of the normal working day, provided specified results are obtained. However, if specified surface tolerances cannot be achieved, paving operations will be suspended until satisfactory correction, repairs of equipment replacements are made.

6. Placement of hot mix asphalt on a waterproofed bridge deck shall be accomplished with equipment that will not damage the membrane or other protective covering

B. Rolling Equipment
   1. Steel-wheel roller: Self-propelled, contact pressure of 250 to 350 psi per inch of width of roller wheel, equipped with adjustable scrapers and means for keeping wheel wet to prevent mix from sticking
   2. Pneumatic-tired rollers: Self-propelled, contact pressure under each tire of 85 to 110 psi, wheels spaced so that one pass will accomplish one complete coverage equal to rolling width of machine, oscillating wheels. Remove and replace immediately tires picking up fines

C. Hand Tools: Provide rakes, lutes, shovels, tampers, smoothing irons, pavement cutters, portable heaters, and other miscellaneous small tools as required.

3.7 PLACING THE MIX

A. Place asphalt concrete mixture on prepared surface, spread and strike-off using paving machine

B. Complete placement over full width of section on each day's run

C. Spread mixture at minimum temperature specified by CDOT Table 401-5 for the specific binder used in the asphalt mix:
   1. PG 64-22: 320 F minimum mix discharge temperature, 235 F minimum delivered mix temperature
   2. PG 58-28: 275 F minimum mix discharge temperature, 235 F minimum delivered mix temperature
   3. The maximum mix discharge temperature will not exceed the minimum discharge temperature by more than 30 F.
   4. Delivered mix temperature will be measured behind the paver screed
   5. Hot asphalt mixture will be produced at the lowest temperature with the specified temperature range:
      a. A workable mix that provides for uniform coating of aggregates, in accordance with AASHTO T195
      b. Allowing the required compaction to be achieved

D. Inaccessible and small areas may be placed by hand

E. Conform to the grade, cross section, finish thickness, and density indicated.

F. Lift Thickness
   1. Place in multiple lifts. Place asphalt in lifts such that each compacted lift thickness is no less than 2.0” thick and no greater than 3.0” thick. Top lift to be 2” thick.

2. Typical Lift Thickness Sequencing:

Final Asphalt Section Required (inches)	No. of Lifts	Thickness of each Lift (inches) from bottom to top lift
2”	1	2
3”	1	3
4”	2	2-2
5”	2	3-2
6”	3	2-2-2
7”	3	3-2-2
Final Asphalt Section Required (inches)	No. of Lifts	Thickness of each Lift (inches) from bottom to top lift
8”	3	3-3-2
9”	4	3-2-2-2
10”	4	3-3-2-2
>10	Review with Town Engineer	

G. Paver Placing
1. Unless otherwise directed, place pavers along centerline of areas in crowned section and at high side on one-way slope and in direction of traffic flow.
2. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips.
3. Complete base courses before placing surface courses.
4. Place mixture in continuous operation as practicable.

H. Hand Placing
1. Spread, tamp, and finish mixing using hand tools in areas where machine spreading is not possible as acceptable to Town Engineer.
2. Place mixture at a rate that will insure handling and compaction before mixture becomes cooler than acceptable working temperature.

I. Joints
1. Construct transverse joint at right angles to centerline when operations are suspended long enough for mixture to chill.
2. Construct joints to have same texture, density, and smoothness as adjacent sections of asphalt concrete course.
3. Clean contact surfaces free of sand, dirt, or other objectionable material and apply tack coat.
4. Offset transverse joints in succeeding courses not less than 24 inches.
5. Cut back edge of existing pavement or previously placed course to expose an even, vertical surface for full course thickness.
6. Offset longitudinal joints in succeeding courses not less than 6 inches.
7. When the edges of longitudinal joints are irregular, honeycombed or inadequately compacted, cut back unsatisfactory sections to expose an even, vertical surface for full course thickness.
8. Wearing course constructed in even number of strips; place 1 longitudinal joint on centerline of road.
9. Wearing course constructed in odd number of strips; place the centerline of 1 strip on centerline of road.
10. Joints shall not be placed in traffic wheel paths.

D. Gutter: Finish surface high adjacent to concrete gutter so when compacted surface is slightly higher than edge of curb and flashing

3.8 COMPACTING THE MIX

A. All paving will be compacted to the required density as required by LCUASS.

B. Provide pneumatic and steel-wheel type rollers to obtain the required pavement density, surface texture and rideability

C. Begin rolling operations when the mixture will bear weight of roller without excessive displacement and complete as quickly as possible after placement occurs.

D. Compaction operations will be continuous until the required density is achieved, or the density requirements are not met, and the mix temperature falls below 185˚ F or there is obvious surface distress or breakage. Minimum compaction temperatures may be adjusted according to the asphalt binder supplier recommendations. Adjusted minimum compaction temperatures must be shown on the approved mix design or on the asphalt binder supplier documentation kept on file at the jobsite.

E. Do not permit heavy equipment, including rollers to stand on finished surface before it has thoroughly cooled or set

F. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers

G. Start rolling longitudinally at extreme lower side of sections and proceed toward center of pavement. Roll to slightly different lengths on alternate roller runs.

H. Do not roll centers of sections first under any circumstances

I. Breakdown Rolling
   1. Accomplish breakdown or initial rolling immediately following rolling of transverse and longitudinal joints and outside edge.
   2. Operate rollers as close as possible to paver without causing pavement displacement
   3. Check crown, grade, and smoothness after breakdown rolling
   4. Repair displaced areas by loosening at once with lutes or rakes and filling, if required, with hot loose material before continuing rolling.

J. Second Rolling
   1. Follow breakdown rolling as soon as possible, while mixture is hot and in condition for compaction
   2. Continue second rolling until mixture has been thoroughly compacted.

K. Finish Rolling
   1. Perform finish rolling while mixture is still warm enough for removal of roller marks by combination of steel and pneumatic rollers.
   2. Continue rolling until roller marks are eliminated and course has attained specified density and required surface texture and surface tolerances.
   3. After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled and attained its maximum degree of hardness.

L. Patching
   1. Remove and replace defective areas.
   2. Cut-out and fill with fresh, hot asphaltic concrete.
   3. Remove deficient areas for full depth of course.
   4. Saw cut sides perpendicular and parallel to direction of traffic with edges vertical.

5. Apply tack coat to exposed surfaces before placing new asphaltic concrete mixture.
6. Compact by rolling to specified surface density and smoothness.

3.9 JOINING TO EXISTING WORK

A. Saw cut sides vertically and apply tack coat to exposed asphalt surfaces before placing new pavement. Meet existing thickness of surface and base courses, but not less than specified for new work.

B. All joints shall be compacted to meet the density requirements specified in LCUASS.

3.10 FIELD QUALITY CONTROL

A. The Contractor will engage a certified testing agency to perform field testing to determine compliance of in-place asphaltic concrete paving materials and compaction in accordance with LCUASS.

B. It is the Contractor's responsibility to initiate, coordinate and accommodate all required tests and inspections

C. Testing Agency will test in-place pavement for density and thickness.

D. Contractor to verify final surfaces are of uniform texture, conforming to required grades and cross sections.

E. Thickness: Variations from drawings
   1. Base course: 1/4-inch +
   2. Remove and replace paving less than minimum thickness

F. Grade Tolerance
   1. Lawn or Unpaved Areas ±0.25 feet
   2. Walks: ±0.1 feet
   3. Pavements: ±0.04 feet

G. Surface Smoothness
   1. Test using a 10-foot straight edge applied parallel to direction of drainage.
   2. Areas showing high spots greater than 1/4 inch as measured with a 10-foot straight edge, but less than 1/2 inch, may be diamond ground to within the specification of 1/4 inch. High spots more than ½ inch must be approved by the Town Engineer
   3. Do not permit pockets or depressions where water may pool.
   4. Remove and replace areas, deficient in smoothness. Overlay corrections may be permitted only if acceptable to the Engineer.

H. Inspection: The work of this section is subject to the inspection and approval of the Town. The following inspections are required:
   1. Protection of adjacent property
   2. Staking and establishment of elevations
   3. Establishment and compaction of subgrade
   4. Placement and compaction of bituminous base course and wearing surface
   5. Final inspection
   6. Obtain approval of each element of work listed above in sequence of its completion before proceeding with the next item

3.11 CLEANING

A. After completion of paving operations, clean surfaces of excess or spilled asphalt materials to the satisfaction of the Town.

3.12 PROTECTION OF FINISHED WORK

A. After final rolling, do not permit vehicular traffic on asphalt concrete pavement until it has cooled and hardened and in no case sooner than 6 hours.

B. Provide barricades and warning devices as required to protect pavement and the general public.

3.13 WARRANTY

A. Provide installer's 2-year written warranty endorsed by the contractor warranting the pavement from creeping, shoring, cracking, softening, settling, ponding and other defects due to improper placing or defective materials. Replace defective materials upon notification by the Town in accordance with the requirements of the original work.

3.14 SCHEDULE OF MIX PLACEMENT

A. Refer to approved drawings for asphalt thickness and subgrade requirements.

END OF SECTION

SECTION 32 13 00
RIGID PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Forming, jointing, placing and curing of concrete pavements, curbs, gutters, cross pans, islands and sidewalks.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO)
   1. AASHTO M171 – Sheet Materials for Curing Concrete

B. American Concrete Institute (ACI)
   1. 214 – Recommended Practice for Evaluating Compression Test Results of Field Concrete
   2. 301 – Specifications for Structural Concrete for buildings
   3. 304 – Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
   4. 305/305R – Hot Weather Concreting
   5. 306/306R – Cold Weather Concreting
   6. 308 – Standard Practice for Curing Concrete

C. American Society for Testing and Materials (ASTM)
   1. A1064 – Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed for Concrete
   2. A615 – Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
   3. C31 – Making and Curing Concrete Test Specimens in the Field
   4. C33 – Concrete Aggregates
   5. C39 – Test Method for Compressive Strength of Cylindrical Concrete Specimens
   6. C94 – Ready Mix Concrete
   7. C143 – Test Method of Slump of Hydraulic Cement Concrete
   8. C150 – Portland Cement
   9. C260 – Air-Entraining Admixtures for Concrete
   10. C309/AASHTO M148 – Liquid Membrane-Forming Compounds for Curing Concrete
   11. C494 – Chemical Admixtures for Concrete
   12. C618 – Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
   13. C1116 – Fiber Reinforced Concrete
   14. D994 – Preformed Expansion Joint Filler for Concrete (Bituminous Type)
   15. D6690 – Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
   16. C979 – Pigments for Integrally Colored Concrete
   17. D1751 – Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction
   18. D1752 – Preformed Sponge Rubber Cork Expansion and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

D. CABO/ANSI A117.1 for accessibility requirements related to walks, ramps, parking areas, drives, curb ramps, etc.

E. Colorado Department of Transportation (CDOT)

F. Larimer County Urban Area Street Standards (LCUASS)

G. Town of Berthoud Standards and Specifications

1.3 SUBMITTALS

A. Product Data: Provide sufficient information on mix design and products specified to verify compliance with specifications. Provide data on joint filler admixtures and curing compounds.
   1. Existing data on proposed design mixes, certified and complete
   2. Submit reports of field quality control testing

1.4 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301, Conform materials and installation to applicable portions of LCUASS, CDOT, and the Town of Berthoud Standards and Specifications

1.5 REGULATORY REQUIREMENTS

A. For work on public streets or rights-of-way conform to the requirements of Town of Berthoud Standards and Specifications and details for the construction of curbs, gutters, sidewalks, driveways, Street Paving, and other public right-of-way Improvements.

B. Comply with applicable requirements of CABO/ANSI A117.1 for accessibility requirements related to walks, ramps, parking areas, drives, curb ramps, etc.

C. Obtain cementitious materials and aggregate from same source for all work

1.6 DELIVERY, STORAGE, AND HANDLING

A. Reinforcing steel: Store on supports which will keep materials from contact with the ground and cover.

B. Rubber and plastic materials: Store in a cool place. Do not expose to direct sunlight.

C. Prepare a delivery ticket for each load of ready-mixed concrete.

D. Contractor shall submit tickets for all concrete delivered to site which document the following:
   1. Quantity delivered
   2. Actual quantity of each material in batch
   3. Outdoor temp in the shade
   4. Time at which cement was added
   5. Numerical sequence of the delivery
   6. Quantity of water that can be added in the field based on mix design
   7. Free moisture in fine and coarse aggregate in percent by weight
   8. Temperature of batch

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

B. Protect concrete from rapid loss of moisture during hot water placement.

PART 2 PRODUCTS

2.1 MATERIALS

A. Form Materials
   1. Plywood: PS 1, waterproof resin-bonded, exterior type Douglas Fir; face adjacent to concrete Grade B or better
   2. Fiberboard: FS LL-B-810, Type IX, tempered, waterproof, screen back, concrete form hardboard
   3. Capable of supporting loads imposed by construction equipment, straight and free from

warp. Clean and strong enough to resist pressure of concrete when placed and retain horizontal and vertical alignment. Coat forms with a non-staining form release agent that will not discolor or deface the surface of the concrete

4. Joint filler: ASTM D1751 or D1752 type; 3/4-inch thick unless indicated otherwise

B. Reinforcement
   1. Where reinforcement is specified herein or indicated on the plans:
      a. Bars: ASTM A615, Grade 60
      b. Welded Wire Fabric (WWF): ASTM A1064, steel, 16 gage minimum
         i. Furnish in flat sheets
      c. Dowels: ASTM A615; 40 ksi yield, Grade 60, plain steel, unfinished finish
      d. Fibrous reinforcement: Collated, fibrillated, polypropelyne fibers, tensile strength 70,000 psi
         i. ASTM C1116
         ii. 1.5 lbs. Per cubic yard minimum iii) Fibermesh or accepted substitution

C. Weed Control: First application, “Roundup.” Second application, Casoron “W-50" or “G-10” with colored marker dye, manufactured by Pacific Coast Borax Company or an accepted substitute of non-flammable type.

2.2 ACCESSORIES

A. Curing Compound: ASTM C309, AASHTO M-148, white pigmented liquid membrane

B. Joint Sealers: Polyurethane base, elastomeric, self leveling, chemical cure, handling 50% joint movement; Sikaflex-2C-SL or accepted substitutions

C. Sheet Materials: AASHTO M171, 4 mil

2.3 CONCRETE MIX

A. Comply with ASTM C94

B. Maximum Coarse Aggregate Size: 1 1/2-inch

C. Portland Cement: ASTM C150, Type II; 555 pounds minimum per cubic yard of concrete

D. Water/Cementitious Material (Cement and Fly Ash) Ratio: Less than or equal to 0.45

E. Slump: 4-inch maximum
   1. May be increased to 4.5 inches for hand work, acceptable to Town
   2. As low as possible consistent with proper handling and thorough compaction

F. Volumetric Air Content: Air content between 5 and 8% by volume with a maximum course aggregate size for 1-1/2 inches
   1. Vary air content with maximum size aggregate, ASTM C94, Table 3.

G. Strength: Compressive strength as determined by ASTM C39, 4,000 psi minimum at 28 days

H. Consistency: Uniform slump, suitable for the placement conditions with aggregate floating uniformly throughout the concrete mass, flowing sluggishly when vibrated or spaded

I. Adjust mix as required to meet specifications.

J. Approved fly ash may be substituted for ASTM C150 cement up to a maximum of 25 percent Class C or Class F by weight of the cementitious material content. Fly ash for concrete shall conform to the requirements of ASTM C618 with the following exceptions:

1. The loss on ignition shall not exceed 3.0 percent
2. The CaO in Class F fly ash shall not exceed 18 percent

K. K. Admixtures: Content, batching method, and time of introduction in accordance with the manufacturer's recommendations for compliance with this specification.
1. Include a water reducing admixture
2. Calcium chloride content shall not exceed 0.05% of the cement content by weight

2.4 SOURCE QUALITY CONTROL AND TESTS

A. Submit proposed mix design to the Town of Berthoud for review prior to commencement of work.

B. Tests on cement and aggregates will be performed to ensure conformance with specified requirements.

C. Test samples in accordance with ACI 301.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that the compacted subgrade is acceptable and ready to support paving and imposed loads.

B. Verify that the gradients and elevations of base are correct.

C. Check completed formwork for grade and alignment to the following tolerances:
1. Top of forms not more than 1/8-inch in 10 feet
2. Vertical face on longitudinal axis, not more than 1/4-inch in 10 feet

3.2 PREPARATION

A. Subgrade
1. Prepare subgrade in accordance with Section 31 00 00 – Earthwork and the most recent version of LCUASS
2. Moisten subgrade to depth of 6 inches at optimal moisture not more than 12 hours prior to placement to minimize absorption of water from fresh concrete.
3. Check for soft spots by proof-rolling or other means prior to setting forms. Remove soft yielding material and replace. Compact to specifications under provisions of Section 31 00 00 – Earthwork and the most recent version of LCUASS
4. Check crown and/or elevation of subgrade to assure specified thickness. Compact to specification additional material used to bring to correct elevation. Remove excess material where subgrade is too high
5. Clean subgrade of all loose materials before placement of concrete. Do not disturb area inside forms after fine grading is complete.

B. Weed Control
1. If weeds or vegetation exist at or on the subgrade, apply “Round-up” at rates following manufacturer’s instructions. Apply “Round-up” three days prior to removal of vegetation, subgrade preparation and application of Casoron as described below to allow “Round-up” to kill all vegetation. Remove all living and dead weeds, root balls, tree/shrub roots, vegetation, and/or any organic matter from on or in the subgrade per applicable earthwork specifications prior to subgrade preparation and paving at all areas to be paved.
2. After all fine grading, checking, shaping, and compacting of the subgrade has been completed, and just prior to placing pavement, all subgrade soil in the area to receive pavement shall be thoroughly treated with Casoron soil sterilant (in addition to “Round-up” and regardless of presence of existing weeds or vegetation). Casoron shall be

thoroughly sprinkled to distribute the chemical through the first two or three inches of the subgrade. For all areas to be paved, apply Casoron weed control at a minimum rate per 100 square yards of 2.4 pounds for G-10 or 4.0 pounds for 50w at rates and methods recommended by manufacturer within one day of paving.

3. The Contractor shall provide all necessary protection to prevent injury to animal, fish, or plant life and property occasioned by the application of the soil sterilant. Apply on a calm, wind-free day. The Contractor will be held responsible for all application of soil sterilant or the storage of same. Protect existing and new trees and shrubs beyond the limit of paving from damage due to weed killer or soil sterilant overspray or root contact. Extra caution is required to prevent over-application of products in areas to be paved under tree canopies. Trees and shrubs damaged or killed by weed killer or sterilant application shall be replaced by the contractor at contractor's expense.
4. Do not apply within 20 feet of trees or shrubs.

C. Frame Adjustment
1. Coat surfaces of manhole and catch basin frames with oil to prevent bond with concrete pavement for concrete collars.
2. Set frames of structures in full grout bed to provide bearing. Set to final grade.
3. Form construction joints and blockouts as indicated on approved drawings.

3.3 PERFORMANCE AND INSTALLATION

A. Transporting mixed concrete
1. Transporting of mixed concrete shall conform to ACI 305R
2. Do not exceed manufacturer's guaranteed capacity of truck agitators. Maintain the mixed concrete in a thoroughly mixed and uniform mass during handling
3. Do not incorporate additional mixing water into the concrete during hauling or after arrival at the delivery point, unless ordered by the Town If additional water is to be incorporated into the concrete, revolve the drum not less than 30 revolutions at mixing speed after the water is added and before placing concrete.
4. Furnish a water measuring device in good working condition, mounted on each transit mix truck, for measuring the water added to the mix on the site by the Town.
5. Provide delivery ticket and comply with delivery requirements of this Section.

B. Forming
1. Place and secure forms to correct location, dimension, profile, and gradient
2. Install sufficient quantity of forms to allow continuous progress of work so that forms can remain in place at least 24 hours after concrete placement.
3. Join neatly and mechanically tamp to assure firm placement. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
4. Oil forms prior to concrete placement.
5. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.
6. Set dowels, expansion joints, preformed construction joints and header boards as specified or indicated on the drawings.
7. Low roll or mountable curbs may be formed without the use of face form by using a straight edge and template to form curb face.
8. Backfill behind forms as required to prevent water from entering subgrade.

C. Reinforcement
1. Add fiber reinforcement to mix at plant prior to delivery to jobsite.
2. Place bar or WWF reinforcement at mid-height of slabs-on-grade or as shown on the approved drawings.
    a. Install in as long lengths as possible. Lap adjoining pieces at least one full mesh and lace with wire.
        i. Support with metal chairs, brick or stone is unacceptable.
3. Hold all tie and marginal dowels in proper position by sufficient supports or pins.
4. Mechanically install dowels or place on supports if center longitudinal joint is sawed in lieu of placing plastic strip.

5. Interrupt reinforcement at expansion joints.
6. Place dowels to achieve pavement and curb alignment as detailed.
7. Provide doweled joints inch at interruptions of concrete with one end of dowel set in capped sleeve to allow longitudinal movement.
8. Grease dowels on one side of joints with caps on greased end.

D. Placing concrete
   1. Place concrete in accordance with ACI 301.
   2. Lightly moisten subgrade or base course immediately before placing concrete.
   3. Ensure reinforcement, inserts, embedded parts, and formed joints are not disturbed during concrete placement.
   4. Deposit concrete near final position. Minimize segregation and damage to subgrade.
   5. Place concrete continuously over the full width of the panel and between predetermined construction joints. Spread mechanically to prevent segregation and separation of materials.
   6. Consolidate concrete with vibrators and spade next to forms to remove air spaces or honeycombs.
   7. Do not place concrete in forms that has begun to set.
   8. Do not place more concrete in one day than can be finished before dark the same day.
   9. Curbs and Gutters: Automatic machine may be used for curb and gutter placement at Contractor's option. If machine placement is to be used, submit revised mix design and laboratory test results which meet or exceed minimums specified. Machine placement must produce curbs and gutters to required cross-section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified
   10. Walks: Construct sidewalks with a minimum thickness of 6 inches.Tool edges to rounded profile and finish as specified or as shown on the approved drawings. Pitch walks 1/4-inch per foot for cross drainage unless otherwise indicated

E. Cold weather concreting
   1. Refer to the most recent version of LCUASS for cold weather concreting

F. Hot weather concreting
   1. Conform to ACI 305/305R, except as modified herein.
   2. At air temp of 90 degrees F and above keep concrete as cool as possible during placement and curing. Fog sprayers or special wetting agents may be required for protection
   3. Do not allow concrete temperature to exceed 70 deg F at placement.
   4. Prevent plastic shrinkage cracking due to rapid evaporation of moisture.
   5. Do not place concrete when the actual or anticipated evaporation rate equals or exceeds 0.2 lbs per sq ft per hr as determined from ACI 305, Fig 2.1.4.

G. Joints
   1. Provide concrete joints per LCUASS or CDOT Standard Details, as required
   2. Sidewalk and pavement
      a. Contraction joints: At intervals not to exceed 10 feet and 1 1/2 inches deep, tooled or sawcut
      b. Expansion joints: 1/2-inch premolded joints where sidewalks end at curb returns, against fixed objects, at points of sharp radius, and between sidewalk and driveway slabs. Place expansion joint at minimum of every 100 feet.
      c. Construction joints: At all separate pours, and around all appurtenances such as manholes, utility poles, and other penetrations extending into and through sidewalks. Place backer rod and polyurethane sealant for entire joint length.
   3. Curb and Gutter
      a. Contraction joints: At intervals not to exceed 10 feet made by insertion of 1/8-inch template at right angles to curb and 1 1/2-inch deep.
      b. Expansion joints: At curb returns, against fixed objects, at points of sharp radius, between adjacent sidewalk and curb at all curb returns, between sidewalk and all

driveway slabs, and along straight lengths every 200 linear feet. Install expansion joint filler between concrete sidewalks and any fixed structure. Extend expansion joint material for full depth of concrete, except stop 1/2-inch below finish surface.

c. Construction joints: At all separate pours, place backer rod and polyurethane sealant for entire joint length.

4. Place expansion joint filler between paving components and buildings or other appurtenances at temperatures above 50 deg F. Clean all dust, debris and water from joint. Recess top of filler 1/2-inch for sealant placement.
5. Provide keyed joints as indicated in approved drawings

H. Finishing
1. Run straight-edge over forms with sawing motion to fill all holes and depressions.
2. After striking-off and consolidating concrete, smooth surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust floating to compact surface and produce uniform texture.
3. After floating, test surface for trueness with a 10' straightedge. Distribute concrete as required to remove surface irregularities, and re-float repaired areas to provide a continuous smooth finish
4. Finish surfaces with a wooden or magnesium float. Plastering of surfaces is not permitted
5. Immediately after float finishing, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route. Use fine hair fiber-bristle broom unless otherwise directed. Coordinate the required final finish with the Town before application.
6. On inclined slab surfaces and steps, provide a coarse, non-slip finish by scoring surface with a stiff-bristled broom, perpendicular to line of traffic
7. Edge all outside edges of the slab and all joints with a 0.25-inch radius edging tool.
8. Work edges of gutters, back top edge of curb, and formed joints with an edging tool, and round to 0.5-inch radius, unless otherwise indicated. Eliminate tool marks on concrete surface
9. Brush with soft bristle brush to remove trowel marks and leave a uniform appearance just before concrete takes initial set.
10. Direction of Texturing
    a. Curb and Gutter: At right angles to the curb line
    b. Sidewalk: At right angles to centerline of sidewalk.
11. Place curing compound on exposed concrete surfaces immediately after finishing. Apply under pressure at the rate of one gallon to not more than 135 square feet by mechanical sprayers in accordance with manufacturer's instructions acceptable to Town.

I. Joint sealing
1. Seal joints and clean concrete prior to opening to traffic.
2. Seal all expansion joints.
3. Separate concrete from other structures with 3/4-inch thick joint filler.
4. Place joint filler in concrete pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
5. Extend joint filler from bottom of pavement to within 1/4-inch of finished surface.

J. Curing and protection
1. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.
2. Have plastic sheeting, straw, burlap and/or canvas materials available at all times to protect fresh uncured surfaces from adverse weather conditions.
3. Do not permit pedestrian traffic over sidewalks for 7 days minimum after finishing. Do not permit vehicular traffic over pavement for 14 days minimum after finishing or until 75 percent design strength of concrete has been achieved.

K. Acceptance
1. Any visible cracks, including hairline cracks, in new concrete sidewalks are considered defects. Concrete sidewalks must be finished to a smooth, true line and grade as

specified in the approved plans.
2. If, after stripping of forms, any concrete is found to be not formed as shown on the drawings, out of alignment or level, or shows a defective surface, it shall be considered as not conforming to these Standards.
3. The defective concrete must be removed and replaced at the developer's expense to meet the specified standards.
4. The developer is responsible for ensuring all concrete work is free from defects before acceptance and occupancy is granted.

3.4 FIELD QUALITY CONTROL

A. Comply with Division One Specifications - Quality Assurance: Field inspections and testing

B. It is the Contractor's responsibility to initiate, coordinate and accommodate all required tests and inspections including conformance with requirements of all applicable public agencies and authorities. Contractor will be responsible for coordinating the testing requirement with testing agency and provide testing agency sufficient advance notification to schedule tests

C. Tolerances
1. Maximum Variation of Surface Grade: 1/4- inch in 10 ft
2. Maximum Variation from True Alignment: 3/8-inch in 10 ft

D. Take cylinders and perform slump and air entrainment tests as required by Division One Specifications in accordance with ACI 301. Unit weight and mix temperature will also be taken

E. The first three loads will be tested for slump and air content. If any one test fails to meet requirements, that load will be rejected and tests will continue on each load until three consecutive loads meet requirements. Thereafter, five concrete test cylinders will be taken for every 75 cu yds or less cu yds of concrete placed each day.

F. One additional test cylinder will be taken during cold weather and cured on site under same conditions as concrete it represents.

G. One slump and air entrainment test will be taken for each set of test cylinders taken.

H. Cylinders will be tested as follows: 1 at 7 days, 2 at 28 days and one at a later date should the test at 28 days fail. All tests shall be in accordance with the most recent version of the LCUASS.

I. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

J. Thickness of fresh concrete may be checked by Owner at random. Coring will be conducted in accordance with Town of Berthoud requirements. Where average thickness of concrete is deficient in thickness by more than 0.20-inch, but not more than 1.0-inch, payment to Contractor will be adjusted based on amount indicated in schedule of values for Portland cement concrete paving as specified in the contract documents and/or the documented material costs of the concrete in question.

K. Failure of Test Cylinders or Coring Results: Engineer may order removal and replacement of concrete as required upon failure of 28-day tests or if thickness of pavement is less than 95% of specified thickness.

3.5 SCHEDULE OF CONCRETE

A. See plans for concrete thicknesses and subgrade preparation. Concrete thicknesses and subgrade preparation shall be per approved drawings and applicable LCUASS standard drawings

3.6 SCHEDULE OF CONCRETE REINFORCEMENT

A. Fiber reinforcement required for all concrete flatwork, including curb and gutter, sidewalk and pavement.

B. Rebar reinforcement shall be in accordance with the most recent version of

END OF SECTION

Section 33 10 00
WATER DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Buried pipe, fittings, hydrants, valves, appurtenances, and associated accessories for water distribution and transmission lines

B. Precast vaults

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)
1. A36 – Standard Specification for Carbon Structural Steel
2. A48 – Standard Specification for Gray Iron Castings
3. A53 – Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
4. A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
5. A185 – Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement
6. A242 – Standard Specification for High-Strength Low-Allow Structural Steel
7. A276 – Standard Specification for Stainless Steel Bars and Shapes
8. A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
9. A449 – Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
10. A536 – Standard Specification for Ductile Iron Castings
11. A674 – Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids
12. A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars forConcrete Reinforcement
13. A1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
14. B62 – Standard Specification for Composition Bronze or Ounce Metal Castings
15. B88 – Standard Specification for Seamless Copper Water Tube
16. B96 – Standard Specification for Copper-Silicon Alloy Plate, Sheet, Strip, and Rolled Bar for General Purposes and Pressure Vessels
17. B763 – Standard Specification for Copper Alloy Sand Castings for Valve Applications
18. B843 – Magnesium Alloy Anodes for Cathodic Protection
19. C33 – Standard Specification for Concrete Aggregates
20. C136 – Standard Test Method for Sieve Analysyis of Fine and Coarse Aggregates
21. C150 – Standard Specification for Portland Cement
22. C913 – Standard Specification for Precast Concrete Water and Wastewater Structures
23. C1227 – Standard Specification for Precast Concrete Septic Tanks
24. D429 – Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates
25. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kn-m/m3))
26. D1241 – Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses
27. D1248 – Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
28. D1330 – Standard Specification for Rubber Sheet Gaskets
29. D1351 – Standard Specification for Thermoplastic Polyethylene Insulation for Electrical Wire and Cable
30. D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
31. D1785 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules

40, 80, and 120
32. D2000 – Standard Classification System for Rubber Products in Automotive Applications
33. D2239 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
34. D2241 – Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
35. D2467 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
36. D2454 – Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
37. D2737 – Standard Specification for Polyethylene (PE) Plastic Tubing
38. D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping
39. D2837 – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
40. D3035 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
41. D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
42. D3212 – Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
43. D3261 – Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
44. D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
45. D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
46. D3950 – Standard Specification for Strapping, Nonmetallic (and Joining Methods)
47. D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
48. D4254 – Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
49. D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
50. E8 – Standard Test Methods for Tension Testing of Metallic Materials
51. F412 – Standard Terminology Relating to Plastic Piping Systems
52. F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
53. F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
54. G97 – Standard Test Method for Laboratory Evaluation of Magnesium Sacrificial Anode Test Specimens for Underground Applications

B. American Water Works Association (AWWA)
1. B300 – Standard for Hypochlorites
2. B301 – Standard for Liquid Chlorine
3. B302 – Standard for Ammonium Sulfate
4. B303 – Standard for Sodium Chlorite
5. C104 – Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
6. C105 – Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
7. C110 – Standard for Ductile-Iron and Gray-Iron Fittings
8. C111 – Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
9. C115 – Flanged Ductile-Iron Pipe with Ductile-Iron or Grey-Iron Threaded Flanges
10. C116 – Standard for Protective Fusion-Bonded Epoxy Coatings for Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
11. C150 – Standard for Thickness Design of Ductile-Iron Pipe
12. C151 – Standard for Ductile-Iron Pipe, Centrifugally Cast
13. C153 – Standard for Ductile-Iron Compact Fittings
14. C200 – Standard for Steel Water Pipe 6 In. (150 mm) and Larger
15. C203 – Standard for Coal-Tar Protective Coatings & Linings for Steel Water Pipes

16. C206 – Standard for Field Welding of Steel Water Pipe
17. C207 – Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)
18. C213 – Standard for Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings
19. C214 – Standard for Tape Coatings for Steel Water Pipelines
20. C219 – Standard for Bolted, Sleeve-Type Couplings for Plain-End Pipe
21. C500 – Standard for Metal-Seated Gate Valves for Water Supply Service
22. C502 – Standard for Dry-Barrel Fire Hydrants
23. C504 – Standard for Rubber-Seated Butterfly Valves
24. C509 – Standard for Resilient-Seated Gate Valves for Water Supply Service
25. C515 – Standard for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
26. C550 – Standard for Protective Epoxy Interior Coatings for Valves and Hydrants
27. C600 – Standard for Installation of Ductile Iron Mains and Their Appurtenances
28. C604 – Standard for Installation of Buried Steel Water Pipe – 4 In. (100 mm) and Larger
29. C605 – Standard for Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
30. C651 – Disinfecting Water Mains
31. C700 – Standard for Cold-Water Meters – Displacement Type, Metal Alloy Main Case
32. C800 – Standard for Underground Service Line Valves and Fittings
33. C900 – Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm) for Water Transmission and Distribution
34. C901 – Standard for Polyethylene (PE) Pressure Pipe and Tubing 1/2 In. (13 mm) Through 3 In. (76 mm) for Water Service
35. C905 – Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm) for Water Transmission and Distribution
36. C906 – Polyethylene (PE) Pressure Pipe and Fittings 4 in. (100 mm) Through 63 In. (1,600 mm) for Water Distribution and Transmission
37. M11 – Steel Pipe: A Guide for Design and Installation
38. M17 – Standard for Installation, Field Testing, and Maintenance of Fire Hydrants
39. M23 – Standard for PVC Pipe Design and Installation
40. M41 – Standard for Ductile-Iron Pipe and Fittings

C. Berthoud Fire Protection District (BFPD)

D. Colorado Department of Transportation (CDOT)

E. National Fire Protection Agency (NFPA)

F. Occupational Safety and Health Administration (OSHA)

G. NSF International
   1. Standard 60 – Drinking Water Treatment Chemicals – Health Effects
   2. Standard 61 – Drinking Water System Components – Health Effects

H. Surface Preparation Standards (SSPC)

I. National Association of Corrosion Engineers (NACE)
   1. SP0169 – Control of External Corrosion on Underground or Submerged Metallic Piping Systems
   2. SP0286 – Electrical Isolation of Cathodically Protected Pipelines

J. Uni-Bell PVC Pipe Association
   1. Uni-Pub-8: Tapping Guide for PVC Pressure Pipe

K. Plastics Pipe Institute (PPI)
   1. TR-4 – HDB / HDS / SDB / PDB / MRS Ratings for Thermoplastic Piping Materials or Pipe
   2. TR-33 – Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe
   3. Handbook of Polyethylene Pipe
   4. Material Handling Guide

L. Ductile Iron Pipe Research Association (DIPRA)
   1. Thrust Restraint Design for Ductile Iron Pipe

1.3 SUBMITTALS

A. Shop Accepted drawings: Provide piping layout and assembly accepted drawings with fitting dimensions. Provide sufficient information to verify compliance with specifications. Provide sufficient data to verify compliance with the specifications and to illustrate construction and assembly of precast vault

B. Product Data: Provide manufacturer's catalog information with dimensions, material and assembled weight. Indicate pressure ratings for pipe, fittings, valves
   1. Pipe materials
   2. Special, fitting, and coupling details
   3. Joint restraint system
   4. Valves
   5. Laying and installation schedule
   6. Specifications and data sheets
   7. Affidavits of compliance for protective shop coatings and linings
   8. Provide manufacturer catalog information on castings, grating, and accessories to indicate compliance with specifications of recast vault

C. Design Data: Include calculations prepared by precast manufacturer indicating design loads and material requirements for reinforcement

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements and applicable standards. Provide prior to shipment.

E. Test Reports: Submit reports of field pressure and disinfection tests under provisions of Section 01340

F. Test Reports: Indicate disinfection results comparative to specified requirements

1.4 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of piping mains, valves, connections, top of pipe elevations, and any mapped or unmapped utilities

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities

1.5 QUALITY ASSURANCE

A. Manufacturers shall be experienced in the design and manufacturing of materials specified herein for a minimum period of 5 years

B. All [PVC, ductile iron, etc.] pipe, regardless of diameter, shall be supplied by a single manufacturer

C. Perform Work in accordance with AWWA C651, and the Colorado Department of Public Health and Environment (CDPHE), Larimer County and/or Weld County, and the Town of the

Berthoud.

D. Contractor shall conduct visual inspection before installation

E. Provide manufacturer's name and pressure rating marked on piping and valves

F. Provide piping complete with all fittings, jointing materials, supports, joint restraint system, and necessary appurtenances for watertight, fully operational water lines

1.6 REGULATORY REQUIREMENTS

A. Conform to all municipal codes and ordinances, laws and regulations of Larimer County and/or Weld County, the Town of Berthoud, CDPHE, the notes and details on the accepted drawings and as specified herein, and CDPHE Stormwater Management and/or Construction Dewatering Permit

B. Conform to AWWA C651, as appropriate, and CDPHE Design Criteria for Potable Water Systems for performing the work of this Section

C. In case of apparent conflict, CDPHE requirements govern over these specifications

D. In absence of State and local regulations, International Plumbing Code applies

E. NFPA Compliance: Install fire water systems in accordance with NFPA 24 “Standard for the Installation of Private Fire Service Mains and Their Appurtenances”

F. UL Compliance: Provide fire hydrants that comply with UL 246 “Hydrants for Fire- Protection Service,” and are listed by UL.

G. Contractor, not the Town, shall prepare, submit, pay, and otherwise obtain all necessary permits from all appropriate entities

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery
   1. 1. Ship rubber gaskets in cartons and store in a clean area away from grease, oil, ozone producing electric motors, heat and the direct sunlight

B. Storage
   1. Store pipe, fittings and gaskets in clean locations protected from environmental conditions such as: direct sunlight, mud, etc.
   2. Do not use pipe and fittings stored in direct sunlight for periods in excess of 18 months
   3. Store pipe on a flat surface which provides even support for the barrel with bell ends overhanging
      a. Do not stack pipe higher than 5 feet

C. Storage: Use the following precautions for valves, during storage:
   1. Do not remove end protectors unless necessary for inspection; then reinstall for storage
      a. Protect valves from weather by storing indoors or support valves off ground or pavement in watertight enclosures when outdoor storage is necessary

D. Handling
   1. Handle so as to insure installation in sound undamaged condition
   2. Use equipment, tools and methods for unloading, reloading, hauling and laying that do not damage pipe or cause an impact. Damaged pipe will be cause for rejection.
   3. Use hooks or straps with broad, well-padded contact surfaces for lifting sections of pipe

E. Preparation for Transport: Prepare valves, for shipping as follows: Ensure that valves are dry

and internally protected against rust and corrosion. Protect valves against damage to threaded ends, flange faces, and weld ends. Set valves in best position for handling. Set valves closed to prevent rattling

F. Deliver and store valves and accessories in shipping containers with labeling in place in accordance with AWWA C500

G. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation

H. Seal valve ends to prevent entry of foreign materials into valve body

I. During loading, transporting and unloading, exercise care to prevent damage to material
   1. Use nylon slings only
   2. Do not drop pipe or fittings
   3. Do not roll or skid against pipe already on ground
   4. Repair any damage done to coating or lining
   5. Handle per manufacturer's recommendations
   6. Store rubber gaskets in cool dark location
   7. Store all material on wood pallets or timbers

J. Adequately tag or otherwise mark all piping, fittings, and valves as to size per AWWA C509 and C900

K. Shop coated materials shall be handled, transported, stored and shipped in a manner that will prevent damage to the coating and lining. Coating or lining damaged in handling or other operations shall be repaired to the approval of and at no additional cost to the Town.

L. Any damage to the pipe or the protective coating from any cause during the installation of the pipeline and before final acceptance by the Town Engineer shall be repaired in accordance with these Specifications and at no additional cost to the Town.

M. Precast Concrete Structures
   1. Transport and handle precast concrete units with equipment to protect from dirt and damage
   2. Do not place precast concrete units in position which will cause damage
   3. Handle precast concrete structures by means of lifting inserts. Do not move from manufacturer’s yard until curing is complete.

1.8 JOB CONDITIONS

A. All work which requires the interruption of active water service lines must be completed as quickly as possible in order to minimize inconvenience to customers and risk to the Town.

B. Underground Obstructions
   1. Locations shown may prove inaccurate and other obstructions not known may be encountered
   2. Contractor shall field locate and verify all obstructions where or not shown on the Accepted drawings
   3. Notify each utility owner and request utility be field located by surface reference at least 48 hours prior to trenching or excavation
   4. Expose and verify size, location and elevation of underground utilities and other obstructions where conflicts might exist sufficiently in advance to permit changes in the event of a conflict
      a. Notify the Engineer in case of a conflict
      b. In case of a conflict, the proposed work may be changed by Engineer
   5. Maintain, protect, and support by shoring, bracing or other means existing utilities and

appurtenances

C. Verify existing system operation, pressures, and valve settings (open or closed) prior to construction

PART 2 PRODUCTS

2.1 PIPE, FITTINGS, AND ACCESSORIES

A. Comply with Town of Berthoud Standards and Standard Details.

2.2 PVC PIPE – 4" TO 12" DIAMETER

A. Manufacturers:
   1. JM Eagle
   2. Georg Fischer Piping Systems
   3. North American Pipe Corporation
   4. Diamond Plastics Corporation
   5. Vinyltech Corporation
   6. Or accepted substitution

B. Pipe: AWWA C900, DR 18 with nominal laying length of 20-ft except as otherwise specified or indicated on the Accepted drawings

C. Marking: Identification markings on pipe shall conform to AWWA C900

D. Fittings: Ductile iron compact fittings: ANSI A 21.53/AWWA C153
   1. Working pressure rating: 350 psi rating
   2. Joint: Mechanical joints with restraints
   3. Coating:
      a. Exterior: AWWA C111, Asphalt coated
      b. Interior: AWWA C104 and C111, lined with double thickness cement seal coated
      c. Or interior and exterior: AWWA C116, fusion bonded epoxy coating

E. Joints: ASTM D3139, integral bell with restraint or mechanical joint
   1. Integral Bell with Restraint:
      a. Integral bell type with elastomeric gaskets, ASTM F477 factory installed
      b. Suitable for buried service
      c. Gaskets:
         i. Material: Virgin SBR rubber suitable for potable water conforming to AWWA C111
         ii. Lubricant shall be suitable for potable water contact
   2. Restraint device for PVC integral bell joint
      a. Restraint material: ASTM A536, ductile iron
      b. A split ring shall be used behind the pipe bell. A serrated ring shall be used to grip the pipe, and a sufficient number of bolts shall be used to connect the bell ring and the gripping ring
      c. Nuts and bolts torqued to requirements of manufacturer
      d. Pressure rating consistent with pipe pressure rating
      e. Restraint coatings shall be consistent with manufacturer's standard
      f. Manufacturers:
         i. Iron Inc. "Series 1600"
         ii. Romac Industries "Series 611"
         iii. Or accepted substitution
   3. Mechanical joint restraint
      a. Provide mechanical joint restraint for all fittings
      b. Restraint devices for shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA A21.10/C110

c. Pressure rating consistent with pipe pressure rating
d. Restraint coatings shall be consistent with manufacturer's standard
e. Manufacturer:
    i. EBAA Iron "MEGALUG 2000 PV"
    ii. Romac Industries "Roma-Grip"
    iii. Or accepted substitution

F. Couplings
1. Mechanical couplings:
    a. Style 38
    b. Rockwell 411
    c. accepted substitution
2. Insulated Mechanical Couplings:
    a. Dresser Style 39
    b. Or accepted substitution
3. Transition Couplings:
    a. Rockwell 415
    b. Dresser Style 39
    c. Or accepted substitution
4. Glands color coded: Black

G. Couplings
1. Provide for connection between dissimilar water distribution pipe
2. Material: Ductile Iron, ASTM A536 Grade 65-45-12
3. End Rings: Ductile Iron, ASTM A536
4. Gaskets: Virgin SBR rubber suitable for potable conforming to AWWA C111
5. Bolts and Heavy Hex Nuts: UNC 5/8" rolled threads with black finish.
6. Manufacturer:
    a. JCM
    b. EJ Prescott
    c. Or accepted substitution

2.3 PVC SADDLE TAP

A. Provide saddle tap for connection to air release/vacuum breaker combination valves as shown on the Accepted drawings

B. Use tapping saddle manufactured specifically for C900 PVC pipe with stainless steel wide band straps, nuts and washers

C. Manufacturer:
1. Mueller
2. Or accepted substitution

2.4 DUCTILE IRON PIPE

A. Manufacturers
1. U.S. Pipe
2. American Cast Iron Pipe Company
3. Griffin Pipe Products Company
4. Or accepted substitution

B. Pipe: ANSI A21.51/AWWA C151:
1. Class 51, pressure rating 350 psi
2. Nominal Laying Length of 18 or 20 feet
3. For mechanical joints, or restrained joints: Class 50 for 6-inch or larger; Class 51 for 3-inch and 4-inch, single gasket
4. Lining: cement mortar, AWWA C104
5. External coating for buried pipe: asphaltic coating, 1 mil

C. Fittings: Ductile iron compact fittings: ANSI A 21.53/AWWA C153
   1. Working pressure rating: 350 psi rating
   2. Joint: Mechanical joints with restraints
   3. Coating:
      a. Exterior: AWWA C111, Asphalt coated
      b. Interior: AWWA C104 and C111, lined with double thickness cement seal coated
      c. interior and exterior: AWWA C116, fusion bonded epoxy coating
   4. Tapping Sleeve and Tapping Valve: Complete assembly, including tapping sleeve, tapping valve, and bolts and nuts. Use sleeve and valve compatible with tapping machine.
      a. Tapping Sleeve: Cast-iron or ductile-iron 2-piece bolted sleeve with flanged outlet for new branch connection. Sleeve may have mechanical joint ends with rubber gaskets or sealing rings in sleeve body. Use sleeves that mate with size and type of pipe material being tapped. Outlet flange shall be of a size required for branch connection.

D. Joints
   1. Mechanical joints: ANSI A21.11/AWWA C111
      a. Bolts and nuts: High strength, low alloy steel, "Cor-Ten" or approved substitution.
   2. Restrained joints: ANSI A21.11/AWWA C111
      a. Pressure rated 350 psi
      b. Lubricant: Heavy vegetable soap solution suitable for potable water contact
   3. Gaskets: Butyl rubber gaskets in conformance with ANSI A21.11/AWWA C111. Natural rubber is not acceptable.
      a. Pressure rated 350 psi
   4. Restraint device for joint
      a. Restraint material: ASTM A536 , ductile iron
      b. b. A split ring shall be used behind the pipe bell. A serrated ring shall be used to grip the pipe, and a sufficient number of bolts shall be used to connect the bell ring and the gripping ring
      c. Nuts and bolts torqued to requirements of manufacturer
      d. d. Pressure rating consistent with pipe pressure rating
      e. e. Restraint coatings shall be consistent with manufacturer's standard
      f. Manufacturers:
         i. EBAA Iron Inc. "Series 1600"
         ii. Romac Industries "Series 611"
         iii. Or accepted substitution
   5. Threaded connections: ANSI B1.20.3 NPT: provide boss or tapping saddle at all tapped connections
   6. Mechanical couplings:
      a. Dresser, Style 38
      b. Rockwell, 411
      c. Romac, 501
      d. accepted substitution
   7. Insulated Mechanical Couplings:
      a. Dresser, Style 39
      b. Rockwell, Style 416 ‘
      c. Romac, IC501
      d. Or accepted substitution
   8. Mechanical joints with restraint device
      a. Provided for all ductile iron fittings
      b. 360° serration lock engagement type
      c. Nuts and bolts torqued to requirements of manufacturer
      d. Working pressure rated at 350 psi minimum
      e. Glands color coded: Black
      f. Manufacturers:

i. EBBA Iron Inc., Meg-a-Lug Series 1100
ii. Uni-Flange Corporation, 1400 Series
iii. Romac Industries Inc., RomaGrip™
iv. Or accepted substitution

2.5 COPPER TUBING – 3 INCHES OR LESS

A. Manufacturers:
1. Mueller
2. Or accepted substitution

B. Copper Tube: ASTM B88; Type K, soft-annealed temper with flared connections.
1. Fittings: Wrought-copper solder-joint fittings, ANSI B16.22; soldered joints, pressure type. Compression fitting will not be accepted.

2.6 POLYETHYLENE TUBING

A. Manufacturers:
1. Centennial Plastics, Inc.
2. Or accepted substitution

B. Service lines shall be Polyethylene (PE) Copper Tube Size (CTS) potable water tubing
1. Service line pipe sizes are indicated on Accepted drawings.
2. Resin formulation: PE 3608
3. Cell Classification of 4345464C per ASTM D2239 and ASTM D2737
4. Hydrostatic Design Basis (HDB)
    a. HDB: 1600 psi @ 73.4 °F
    b. HDB: 800 psi @ 140 °F

C. Joining:
1. Shall be by butt-fusion
2. All personnel conducting butt-fusion should be experienced and follow guidelines published by the pipe manufacturer or by PPI in TR-33

D. Installing:
1. To be direct buried
2. Buried pipe must be supported by proper embedment material as shown on Accepted drawings
3. Refer to PPI's "Handbook of Polyethylene Pipe" and follow all local, state, and/or federal guidelines

E. Safe Handling:
1. To safely handle and store PE pipe, refer to PPI's "Material Handling Guide"

F. Disinfection:
1. Disinfection of service line should follow specifications herein

G. Testing:
1. All pipe shall be hydrostatically tested after installation as specified herein.

2.7 SERVICE LINE ACCESSORIES

A. Corporation Stops: Corporation stops shall have inlet threaded CC type, and outlet shall be copper compression or flare. No soldering will be allowed

B. Curb Stops: Curb stop style shall be compression or flared with copper on both ends.

Minneapolis pattern valve threads are required to allow for Minneapolis style curb box.

C. Curb box: Curb Box shall have Minneapolis base extension type curb boxes, cast iron lid and base with brass pentagon head plug using a 1.5-inch upper section. Include cover with lettering “WATER.”

D. Service Clamps for ¾-inch to 2-inch Copper: Complete assembly, including double band service clamp (bolted or hinge pin), corporation stop, and bolts and nuts. Use service clamp and stop compatible with drilling machine.
   1. O-ring gasket
   2. Counterclockwise thread
   3. Manufacturers:
      a. Mueller Co.
      b. Romac Industries, Inc.
      c. Or accepted substitution

E. Meter box:
   1. 18-inch diameter meter box with minimum 0.30-inch thick PVC shell for 3/4" or 1" meter
   2. Lid: cast-iron with closed cell insulating pad
   3. Provide with shell extensions as required to satisfy 9 foot bury depth requirements
   4. Manufacturers:
      a. Mueller Co.
      b. Hunt
      c. Ford
      d. Or accepted substitution

2.8 PIPE ACCESSORIES

A. Identification Marker Tape: Provide metallic core tape, blue with black letters “CAUTION – WATER LINE BELOW” continuously printed plastic tape with metallic core, intended for direct-burial service; not less than 6-inch wide x 4 mils thick. Provide identification markers of one of the following:
   1. Allen Systems, Inc.
   2. Emed Co., Inc.
   3. Seton Name Plate Corp.
   4. Or accepted substitution

B. Tracer Wire
   1. Provide tracer wire for all PVC pipe
   2. All tracer wire shall be 12 AWG solid copper wire coated with 45 mil Type HMW - PE blue insulation compliant with ASTM D1351 specifically designed for direct burial in corrosive soil or water
   3. UL listed

C. Tracer Wire Test Stations
   1. 4-inch with locking lid
   2. Manufacturers:
      a. CP Test Services
      b. Glenn Series "Glenn-4"
      c. Or accepted substitution

D. Corrosion Control
   1. Rust inhibitive primer:
      a. Tnemec "Series 77H Chem-Prime"
      b. Or accepted substitution
   2. Rust preventative compound:
      a. Houghton "Rust Veto 344"

b. Rust-Oleum "R-9"
c. Or accepted substitution

2.9 GATE VALVES – 3" TO 12" AND ACCESSORIES

A. Manufacturers:
1. Mueller
2. American AVK
3. American Flow Control
4. Clow
5. Kennedy
6. Or accepted substitution

B. AWWA C509, Iron body, bronze trim, two O-ring stem seals, non-rising stem with square nut, single wedge, resilient seat, mechanical joint ends, extension stem, and extension valve box, pressure rating of 250 psi. For installation in horizontal or near horizontal pipe lines
1. Non-adjustable elastomeric stem seals
    a. Adjustable packing glands are not permitted
2. Direct operation of stem from above via 2-inch square nut a. No gear box provided
3. Rotation: Counterclockwise to open with the word "OPEN" and an arrow indicating the direction to open cast on valve body or operating nut

C. Rotation: Contractor to verify the operating direction with the jurisdictional water district or
1. Provide the word "OPEN" and an arrow indicating the direction to open cast on valve body or operating nut.
2. Contractor to confirm nut size with the jurisdictional water district or department

D. Valve stem material: ASTM B763, UNS alloy C99500 minimum yield strength of 40,000 psi
1. Valve stem extensions: Provide valve stem extensions as necessary for proper valve operation with a 7-foot key with tee handle
2. Provide one (1) key to the Town prior to project closeout

E. Extension stems
1. Provide for buried valves with operating nuts more than 5 feet below grade
2. Non-rising stems
    a. Solid steel shafting with O.D. not less than O.D. of valve stem or galvanized steel pipe with I.D. not less than O.D. of valve stem
    b. Connected to the valve by a flexible socket coupling
    c. All other connections pinned
    d. Extend stem to within 6-inch of grade
    e. Provide spacers to center stem in valve box
    f. Provide wrench nut

F. Coating
1. AWWA C550 and NSF 61 certified
2. Minimum 8 mils dry film thickness
3. Fusion bonded epoxy applied to all ferrous metal surfaces after cleaning surfaces of grease, dirt and moisture, and performing near-white blast cleaning following SSPC-SP10
4. Do not coat fasteners or machined surfaces subject to contact and relative movement against other surfaces during operation of valve or other surfaces where such coating would compromise proper installation or functionality of valve

G. Valve boxes, depth as required for valve
1. Three piece cast iron (complying with ASTM A48, Class 20A) adjustable screw type, 5.25-inch diameter, minimum thickness of 3/16 inch

2. Box, cover, and base coated by dipping in asphalt varnish.
3. Cover marked with word, “WATER.”
4. Provide extension piece to permit 6-inch adjustment above finish grade
5. Manufacturers:
    a. Tyler Pipe Company "Series 6860 with #160 oval base"
    b. East Jordan Iron Works "8560 Series"
    c. Tyler Union "6860 Series"
    d. Or accepted substitution

2.10 BUTTERFLY VALVES – 16" TO 20" (DIRECT BURY) AND ACCESSORIES

A. Manufacturers:
1. Pratt
2. Milliken
3. Or accepted substitution.

B. AWWA C504 Class 150B for direct bury service
1. Valve body shall be constructed of cast iron ASTM A126 Class B and conform to AWWA C504 in terms of laying lengths and minimum body shell thickness
2. Mechanical joint ends following AWWA C111
3. Valve disc shall be cast iron or ductile iron furnished with Type 316 stainless steel seating edge to mate with rubber seat on body
    a. Valve disc shall seat in position at 90 degrees to pipe axis and shall rotate 90 degrees between full-open and tight-closed position. Install valves with valve shafts horizontal and convex side of disc facing anticipated direction of flow
    b. Disc shall not creep or flutter under service conditions
4. Seat: Buna-N-Rubber
    a. 16-inch to 18-inch: Bonded seats that meet ASTM D429 Method B
    b. 24-inch and larger: Seats retained in the valve body by mechanical means without metal retainers or other devices located in the flow stream
    c. Retaining hardware for seats: type 304 or 316 stainless steel. Nuts and screws used with clamps and discs for rubber seats shall be held securely with locktight, or other approved method, to prevent loosening by vibration or cavitation effects
5. Valve Shaft: type 304 SS, ASTM A276
    a. Shaft bearings: stainless steel in accordance with AWWA C504. Design valve shaft to withstand 3 times amount of torque necessary to open valve
    b. Packing: Standard self-adjusting and wear compensating, split-V type, and replaceable without removing actuator assembly
6. Actuators:
    a. Provide manual actuators for single project, from same manufacturer
    b. Shaft connecting actuator to valve body must be fully enclosed. Bonnet and extension to be fully enclosed and water tight
    c. Provide bonnet extensions, as required, between valve body and actuator. Space between actuator housing and valve body shall be completely enclosed so that no moving parts are exposed to soil or elements
    d. Provide actuators for valves with size based on line velocity of 12 feet per second and unidirectional service.
        i. Equip with gear manual actuator
        ii. Fully enclosed, traveling-nut type. Traveling nut shall engage alignment grooves in the housing
        iii. Traveling nut actuator shall be self-locking and designed to transmit twice the required actuator torque without damages to faces of gear teeth or contact faces of nut
    e. Oil-tight and watertight actuator housing for valves, specifically designed for buried service and factory packed with suitable grease
    f. Equipped with 2-inch actuator nut
    g. Rotation: Counterclockwise to open with the word "OPEN" and an arrow indicating the direction to open cast on valve body or operating nut
    h. Valve operating key: Provide one (1) for project, 7-foot length with tee handle

7. Coating
    a. Follow AWWA C550 and NSF 61
    b. Coat interior and exterior ferrous surfaces of valve with epoxy suitable for potable water conditions: in accordance with AWWA C550 and coating manufacturer's recommendations
    c. Provide three coats of two component, high-build epoxy with minimum dry film thickness of 12 mils

C. Extension stems
1. Provide as specified for buried valves with operating nuts more than 5 feet below grade
2. Non-rising stems
    a. Solid steel shafting with O.D. not less than O.D. of valve stem or galvanized steel pipe with I.D. not less than O.D. of valve stem
    b. Connected to the valve by a flexible socket coupling
    c. All other connections pinned
    d. Extend stem to within 6-inch of grade
    e. Provide spacers to center stem in valve box
    f. Provide wrench nut

D. Valve boxes, depth as required for valve
1. Three-piece cast iron (complying with ASTM A48, Class 20A) adjustable screw type, 5.25-inch diameter, minimum thickness of 3/16 inch
2. Box, cover, and base coated by dipping in asphalt varnish.
3. Cover marked with word, “WATER.”
4. Provide extension piece to permit 6-inch adjustment above finish grade
5. Manufacturers:
    a. Tyler Pipe Company "Series 6860 with #160 oval base"
    b. East Jordan Iron Works "8560 Series"
    c. Tyler Union "6860 Series"
    d. Or accepted substitution

2.11 TAPPING VALVE – 4” TO 12” MECHANICAL JOINT TYPE

A. Manufacturers:
1. American AVK
2. American Flow Control/American Cast Iron
3. Pipe Company, Series 2500 RW
4. Clow
5. Kennedy
6. Mueller Company
7. U. S. Pipe and Foundry Company
8. Or accepted substitution

B. Tapping valves shall be designed and manufactured in accordance with AWWA C509 or AWWA C515, as applicable, with the following additional requirements or exceptions.
1. Valves shall be suitable for frequent operation and for long periods of inactivity.
2. Valves shall operate with flows in either direction; the operating pressure for all sizes shall be 200 psi.

C. Valves:
1. Valves shall be 150-pound class tapping valves – mechanical joint type
2. Valves shall be iron body, resilient seated gate valves with non-rising stems.
3. If the resilient seats are bonded to the gates, the gates shall be completely encapsulated with the material except for guide tabs or slots

D. Valve Stems
1. Valve stems shall be made of bronze in accordance with ASTM B 763, Copper Alloy No. C99500; stainless steel in accordance with ASTM A 276, Type 304, Type 316, or AISI

420; or copper alloy in accordance with ASTM B 98, Copper Alloy No. C66100/H02
2. Valves shall be furnished with 2-inch square wrench nuts. The stem seal shall consist of two O-rings.

E. Bolting Material
1. The bonnet, gland bolts, and nuts shall be in accordance with ASTM F 593, Type 304 stainless steel or electro-plated with zinc or cadmium. The hot-dip galvanized process is not acceptable.

F. End Connections
1. A. Flanges shall be sized and drilled in accordance with ANSI B16.1, Class 125. Flanges shall be machined to a flat surface with a serrated finish in accordance with AWWA C207.
2. Mechanical joint components shall be in accordance with AWWA C111 with tee- head bolts and hexagon nuts fabricated from a high-strength, low alloy steel known in the industry as Cor-Ten, Usalloy, or Durabolt.
3. Accessories for the mechanical joint shall consist of the gasket, gland, and fasteners and shall be furnished and packaged separately from valves. Each package shall be labeled in a manner that provides for proper identification, and the number of units listed per package or bundle.

G. Seat Ring Sizes
1. The body of the valve and the seat opening shall be sized large enough to accommodate the following sizes of shell cutters:

H. Coatings
1. Ferrous surfaces, except machined or bearing surfaces, shall be prepared in accordance with SSPC SP10.
2. These surfaces shall then be coated with liquid epoxy in two or more uniform coats or with fusion-bonded epoxy to a minimum DFT of 10-mils in accordance with AWWA C550.
3. Machined flange faces shall be shop-coated with a rust-preventive compound; they shall not be painted or coated with the same coating as the body.

2.12 PRESSURE REGULATING VALVE - 4” TO 20” AND ACCESSORIES

A. Manufacturers:
1. Cla-Val
2. Singer
3. Or accepted substitution

B. Pressure regulating valves shall be designed and manufactured in accordance with AWWA C530
1. Working pressure shall be 150 psi
2. The function of the pressure regulating valve is to reduce an upstream high pressure to a preadjusted lower downstream pressure to vary the rates of flow without causing shock or water hammer on the system.

C. Valves
1. Valves shall be 150-pound class pressure regulating valves
2. Pressure regulating valves shall be hydraulically operated and pilot controlled with a activated globe or angle valve.
3. A stainless-steel indicator rod shall be furnished as an integral part of the valve to show the valve position.
4. The valve shall be designed to provide an access opening in the body for the removal of internal parts without the removal of the main valve body from the service line.

D. Body Material
   1. Valve body, flanges, and covers shall be CI in accordance with ASTM A 126, Class B, or ASTM A 48, Class 35B
   2. DI in accordance with ASTM A 536, grade 65-45-12

E. Internal Trim Materials
   1. Stem, nut, and spring shall be stainless steel.
   2. Bronze or brass alloys used for the internal trim or bushings shall comply with ANSI/NSF 61.

F. Diaphragm
   1. Flat or rolling diaphragm shall be nylon reinforced and bonded EPDM or Buna-N synthetic rubber.

G. Disc and Seats
   1. Resilient disc materials shall be Buna-N or EPDM to provide a drip-tight seal with a stainless-steel seat.

H. Valve Ends
   1. Valves shall be furnished with flanged ends sized and drilled in accordance with ANSI B16.1, Class 125.
   2. Flanges shall be machined to a flat surface with a serrated finish in accordance with AWWA C207 and coated with a rust-preventive compound.

I. PILOT SYSTEM
   1. The pilot valve for controlling the operation of the main valve shall be a single seated stainless-steel construction, EPDM diaphragm operated, and spring-loaded type.
   2. The pilot valve shall be attached to the main valve with stainless steel piping and isolation ball valves and threaded nipple extending inside the valve body covering all port threads at all port connections.
   3. Provide stainless steel strainer with minimum 40 mesh screen and blow down port upstream of the pilot valve.
   4. Provide 2 1/2-inch stainless steel, bourbon tube pressure gauge integral to the pilot system to show system pressure downstream of the pilot valve.
   5. Pilot piping shall be arranged for easy access for adjustments and with isolation valves for removal from the main valve while it is under pressure.

J. Needle Valve
   1. The needle valve shall be stainless steel and included with the main valve to control the speed of valve travel.

K. Coatings
   2. Ferrous surfaces, except machined or bearing surfaces, shall be prepared in accordance with SSPC SP10.
   3. These surfaces shall then be coated with liquid epoxy in two or more uniform coats or with fusion-bonded epoxy to a minimum DFT of 10-mils in accordance with AWWA C550.
   4. Machined flange faces shall be shop-coated with a rust-preventive compound; they shall not be painted or coated with the same coating as the body.

2.13 VALVE INSERTION

A. Manufacturers:
   1. Romac
   2. Or accepted substitution

B. Resilient wedge designed for use in potable water systems

C. The design shall allow the valve to be installed into an existing pressurized pipeline while maintaining constant pressure and service as usual. The valve shall be equipped with a standard handwheel operator.

D. Valve Construction:
   1. The ductile iron body, bonnet, and wedge shall provide a strength and pressure rating that meets or exceeds the requirements of AWWA C515
   2. Valve shall be ductile iron construction and meet ASTM A536 Grade 65-45-12
   3. Chemical and modularity tests shall be performed as recommended by the Ductile Iron Society, on a per ladle basis. Testing for tensile, yield and elongation shall be done in accordance with ASTM E8
   4. Sizes 12" and smaller must be capable of working on Cast/Grey Iron or Ductile Iron Class A, B, C and D without changing either top or bottom portion of split valve body
   5. 250 psi maximum working pressure. The pressure rating markings must be cast into the body of the insert valve.
   6. After the installation of the insert valve body on to the existing pipe, a pressure test of 1.1 times that of the contents shall be sustained for 15 minutes. Once the pressure test is affectively achieved, the insert valve body must not be moved in accordance with AWWA Standards. If the insert valve is moved the pressure test must be completed again. The insert valve must not be moved or re-positioned once the pressure test is achieved.

E. Resilient Wedge Gate Assembly:
   1. The construction of the resilient wedge shall comply with AWWA C509 requirements
   2. The ductile iron wedge shall be fully encapsulated with EPDM rubber by a high pressure and high temperature compression or injection mold process
   3. The resilient wedge shall seat on the valve body and not the pipe to obtain the optimum seating and flow control results. The resilient wedge shall be totally independent of the carrier pipe.
   4. The resilient wedge shall not come into contact with the carrier pipe or depend on the carrier pipe to create a seal
   5. Pressure equalization on the down or upstream side of the closed wedge shall not be necessary to open the valve
   6. The wedge shall be symmetrical and seal equally well with flow in either direction
   7. The resilient wedge must ride inside the body channels to maintain wedge alignment throughout its travel to achieve maximum fluid control regardless of high or low flow pressure or velocity
   8. The resilient wedge must have more support than the operating stem as the resilient wedge enters and exits the water (fluid) way

F. Fusion-Bonded Epoxy:
   1. The insert valve is fully epoxy coated on the interior and the exterior. The fusion- bonded coating is applied prior to assembly so that even the bolt holes and body-to- bonnet flange surfaces are fully epoxy coated
   2. Valve shall be coated with a minimum of 8 mils epoxy in compliance with AWWA C550 and certified to ANSI/NSF-61

G. Gaskets and Triple O-Ring Stem Seals:
   1. This insert valve features triple O-Ring stem seals. One O-Ring is located above, and two O-Rings are located below the thrust collar.

2. The lower two O-Rings provide a permanently sealed lubrication chamber that will make the valve easier to operate over a longer period of time. The upper O-Ring ensures that sand, dirt or grit cannot enter the valve to cause damage to the lower O- Rings. This is especially important for buried and sewage service applications.
3. Side flange seals shall be of the O-Ring type of either round, oval, or rectangular cross-sectional shape

H. Valve Stem & Thrust Washers:
1. The gate valve stem and wedge nut shall be copper alloy in accordance with AWWA C515
2. The NRS stem must have an integral thrust collar in accordance with AWWA C515. Two-piece stem collars are not acceptable. The wedge nut shall be independent of the wedge and held in place on three sides by the wedge to prevent possible misalignment.
3. Two thrust washers are used. One is located above, and one is located below the stem thrust collar. Two thrust washers ensure easy operation at all times.
4. NRS with AWWA standard turns.
5. Operated by 2” square wrench nut according to ASTM A126 CL.B – open counter-clockwise.

I. Hardware:
1. Bolting materials shall develop the physical strength requirements of ASTM A307 with dimensions conforming to ANSI B18.2.1.

J. Extended Life Value:
1. The stuffing box, operating stem and resilient wedge (complete bonnet and all moving parts) shall be removable, repairable and or replaceable under pressure. In other words, even while the valve is fully pressurized in the system all moving components can be removed under pressure. In the event the valve stem is broken or damaged the bonnet can be removed under pressure.
2. Internal pressure equalization system assures the safe entry and removal of the valve bonnet during initial installation as well as future maintenance

K. Split Restraint Devices:
1. Shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10
2. The devices shall have a working pressure rating of 350 psi for 4-12 inch. Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes
3. Chemical and modularity tests shall be performed as recommended by the Ductile iron Society, on a per ladle basis. Three test bars shall be incrementally poured per production shift as per U.L. specifications and ASTM A536. Testing for tensile, yield and elongation shall be done in accordance with ASTM E8.
4. Gland body wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536
5. Mechanical joint restraint shall require conventional tools and installation procedures per AWWA C600, while retaining full mechanical joint deflection during assembly as well as allowing joint deflection after assembly.
6. Proper actuation of the gripping wedges shall be ensured with torque limiting twist off nuts. Set screw pressure point type hardware shall not be used.
7. Restraint devices shall be listed by Underwriters Laboratories and Approved by Factory Mutual (3” through 12” inch size)

2.14 RELEASE AND VACUUM BREAKER COMBINATION VALVES

A. Manufacturers:
1. Vent-o-mat "RBX"
2. GA "Figure CAV"
3. Val-Matic "200C Series"

4. APCO "140C Series"
5. Or accepted substitution

B. Provide combination air release and vacuum breaker valves as indicated on Accepted drawings
   1. Provide integral type that functions as both an air release and a vacuum breaker valve
   2. Provide a shutoff valve
      a. 2" and smaller valve size: ball valve b. Larger than 2" valve size: gate valve

2.15 RESTRAINED COUPLING ADAPTER

A. Manufacturers:
   1. JCM Industries
   2. Romac
   3. Or accepted substitution

B. General:
   1. Must meet or exceed AWWA C219
   2. Used to transition between dissimilar pipe materials in 3” to 12”as indicated on Accepted drawings
   3. Rated for 250 psi working pressure
   4. Contractor to verify pipe material and diameter of all existing distribution pipelines

C. Sleeve and Flanges:
   1. Ductile iron per ASTM A536

D. Gasket:
   1. Nitrile Butadiene Rubber (NBR, Buna-N) per ASTM D2000
   2. Gasket temperature range -40oF to 212oF (-40oC to 100oC)
   3. Gasket suitable for water, salt solutions, mild acids, bases, and sewage

E. Bolts:
   1. 5/8” corrosion resistant, high strength low alloy oval neck track head bolts per ASTM A242 / ANSI 21.11 / AWWA C111 and heavy hex nuts per A563 or equal.
   2. Optional hardware: Stainless Steel 18-8 Type 304 or 316, Epoxy Coated Alloy Hardware, Powercron 590-534 black cationic electrocoat

F. Finish:
   1. Corrosion resistant shop coat paint primer
   2. Optional fusion applied epoxy coating per ANSI/AWWA C213

2.16 BLOW-OFF DRAIN

A. Provide blow-off drains where indicated on the Accepted drawings as shown on Details

2.17 FIRE HYDRANT

A. Fire hydrants to be provided for installation where indicated on the Accepted drawings

B. Manufacturers:
   1. Mueller
   2. Or accepted substitution

C. General
   1. Fire hydrants shall meet or exceed AWWA C502; latest revision
   2. Hydrants shall be manufactured and tested in ISO 9001 certified facility
   3. Fire hydrants shall be rated for a working pressure of 250 psi

4. A Higbee cut (blunt start) will be provided on the lead thread of the outlet nozzles, nozzle caps, seat ring, drain ring, and thrust nut.
5. Fire hydrants shall be of the compression type, opening against system pressure and closing with system pressure

D. Main Valves and Drain
1. The main valve and drain shall be of one-piece construction and completely encapsulated with EPDM.
2. Fire hydrants shall have a minimum 5-1/4 main valve opening.
3. Fire hydrants shall open right and be clearly marked.
4. The EPDM shall be permanently vulcanized to the main valve.
5. The main valve shall provide complete closing of the drains after 4 to 5 turns.
6. During initial stages of opening, the drains shall momentarily flush outward to remove any debris in the drain ports, in order to provide complete draining upon closing of the hydrant main valve.
7. The drain ring assembly shall be replaceable without removing the hydrant from the connecting pipe or having to dig.
8. Valve facings shall be of nontoxic materials suitable for potable water service.

E. Stems
1. Upper hydrant stems shall be made of stainless steel
2. Hydrant shall have one breakaway flange and stem coupling located 3-inches above finished grade.

F. Operating Nut
1. Operating nuts shall be one-piece bronze design with upper and lower anti-friction washers for ease of operation.
2. A protective weather shield shall be installed over the operating nut.
3. Operating nut shall be 1-1/2 inch and pentagon shape

G. Nozzles
1. Pumper nozzles shall be 4-1/2 inch NH / NST threaded having 6 threads per inch.
2. Fire hydrants shall have two 2-1/2 inch hose connection outlets NH/NST threaded.
3. Nozzles shall be of the 1/4 turn bayonet lug style, secured with a stainless steel locking screw.
4. Caps shall have 1-1/2 inch pentagon shape nuts.
5. Nozzle caps shall be chained to hydrant.

H. Lubrication
1. A lubrication port shall be provided for application of lubricant without disassembly of the bonnet section.
2. The reservoir shall be filled with NSF/FDA approved food grade grease or oil at the manufacture’s facility.
3. Valve stem seals shall be an o-ring type with not less than two o-rings below the thrust nut and two o-rings above the thrust nut.
4. O-ring and gaskets shall be made of an NBR rubber to help prevent the effects of permeation.

I. Protective Coatings
1. All ferrous parts except the lower barrel and those parts made of stainless steel shall be fusion bonded epoxy coated yellow
2. All epoxy coatings shall meet the requirements of ANSI/AWWA C550 (latest edition).
3. The lower barrel shall be bitumen coated both internally and externally.
4. A bury line shall be marked on the lower barrel below the break flange to indicate proper installation depth. Bury depth will be clearly stenciled on the standpipe section.
5. Shop paint exterior of hydrants yellow

J. Shoe
   1. End connections shall be 6 inch mechanical joint unless specified
   2. Mechanical joints shall comply with AWWA C111

K. Break Flange and Couplings
   1. All fire hydrants shall be of the traffic Breakaway type and allow 360-degree rotation of the fire hydrant to position the pumper nozzle in the desired direction
   2. The break flange segments shall be located under the upper barrel flange to prevent the segments from falling into the lower barrel when the hydrant is struck

L. Warranty
   1. All fire hydrants shall be covered by a manufactured warranty for a minimum of 10 years for defects

M. Hydrant Gravel: Hydrant gravel shall be well graded crushed stone or gravel, conforming to AASHTO #67 gradation as listed below:

Sieve Size	Percent Passing
1”	100
3/4”	90-100
3/8”	20-55
No. 4	0-10
No. 8	0-5

2.18 CORROSION CONTROL

A. Shop paint all ferrous metal surfaces of valves and accessories, both interior and exterior for corrosion protection, epoxy interior coating for potable water contact.

B. Manufacturer's standard paint will be acceptable if it is functionally equivalent and compatible with specified field coatings

C. Exterior bituminous coating or asphalt varnish: Manufacturer's Standard epoxy coal tar

D. Ductile-iron Pipe and Fittings Shop lining: Cement-lined, AWWA C104/C205

E. Rust inhibitive primer: Tnemec "Series 77H Chem-Prime" or accepted substitution

F. Rust preventative compound: Houghton "Rust Veto 344", Rust-Oleum "R-9", or accepted substitution

2.19 ACCESSORIES – MISCELLANEOUS

A. Extension stems
   1. For valve installations with operating nuts over 5 five below grade, extend stem to 5 feet of final grade. Provide spacers to center stem in valve box.

B. Valve boxes for all buried valves, depth as required for valve.
   1. Valve boxes shall be the 3-piece adjustable screw type with a 16-inch top section, 18-inch extension, 24-inch stem, and 30-inch bottom and base.
   2. Valve box parts shall be made of grey CI in accordance with ASTM A 48, Class 35B. The use of an aluminum alloy as a casting material is not acceptable.
   3. Box, cover, and base coated by dipping in asphalt varnish.
   4. Cover marked with word, “WATER.”
   5. Provide threaded top section to permit 6-inch adjustment above finish grade.
   6. Series 6860 with #160 oval base as manufactured by Tyler Pipe Company or accepted substitution.

C. Concrete for Thrust Blocks: constructed of “Class B” Concrete as defined by CDOT Construction Specifications with maximum water to cement ratio of 0.63 by weight and 28-day compressive strength of 3,000 psi

D. Anchorages: Provide anchorages for tees, wyes, crosses, plugs, caps, bends, valves and hydrants. After installation, apply full coat of asphalt or other acceptable corrosion- retarding material to surfaces of ferrous anchorages.
   1. Clamps, straps and washers: Steel, ASTM A506
   2. Rods: Steel, ASTM A575
   3. Rod Couplings: Malleable-iron, ASTM A197
   4. Bolts: Steel, ASTM A307
   5. Cast-Iron Washers: Gray-iron, ASTM A126

2.20 DISINFECTION CHEMICALS

A. Calcium and sodium hypochlorite shall conform to AWWA B300 and B301

B. Store hypochlorite in a cool, dark place away from flammable materials

2.21 PRECAST CONCRETE VAULT

A. Manufacturers:
   1. Oldcastle Precast
   2. Front Range Precast Concrete
   3. Or accepted substitution

B. Materials
   1. Reinforcement
      a. Reinforcing Steel: ASTM A615 Grade 60 b. Welded Wire Fabric: ASTM A185
   2. Concrete:
      a. Cement: ASTM C150, Portland Cement, Type II
      b. Aggregates: ASTM C33, free of deleterious substances
      c. Minimum compressive strength: ASTM C39, 4500 psi minimum at 28 days
   3. Precast Sections
      a. Specification: ASTM C1227
      b. Minimum wall thickness: 6 inch c. Grade rings as required
   4. Gaskets: ASTM C923
      a. Mastic: FS SS-S-210A, "RAM-NEK" or accepted substitution
      b. Rubber: Neoprene, 40+ 5 hardness when measured by ASTM D2240, Type A durometer
   5. Castings: ASTM A48 with asphalt varnish coating hot dip applied at foundry, 6 mils thick
   6. Manhole Steps: Steel bar, 1/2-inch Grade 60, drop-front type, with copolymer polypropylene plastic coating applied by manufacturer, Type MA Industries, Inc. "PS2-PF" or accepted substitution
   7. Inlet Gratings and Manhole Ring and Cover
      a. Cast iron, heavy duty traffic type, ASTM A48, Class 30B. Grind bearing surfaces to ensure flat, true surfaces
      b. Manhole lids to be manufactured by East Jordan Iron Works, Deeter Foundry, or accepted substitution.
      c. Covers to seat at all points on ring
   8. Pipe Penetrations:
      a. Cast-a-Seal gasket
      b. Link-Seal
      c. Or accepted substitution
   9. Manhole Height Adjustment: Use precast concrete grade rings
   10. Rock Subbase: 1-1/2 inch minus, well-graded gravel over compacted subgrade
   11. Water: Clean and free of deleterious substances

C. Fabrication
   1. Vault Section
      a. Precast concrete dimensions as shown on plans
      b. Precast lid: Same or greater reinforcement and wall thickness with capability for H20 loading
      c. Joints: Shiplap or tongue and groove with double mastic gaskets, each joint to set equally and tightly
      d. Access opening: Minimum 24 clear
      e. Pipe connection: As indicated on Accepted drawings
      f. Pipe knockout: As indicated on Accepted drawings
   2. Grating and Metal Frame: As specified on Accepted drawings

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify locations and inverts of tops of pipe for connections to existing system as well as crossings with other utilities as indicated on the accepted drawings. Report any discrepancies to the Town Engineer.

B. Carefully examine pipe and fittings for cracks, damage to linings, and other defects prior to installation

C. Remove all defective piping from site and replace

D. Examine areas for weak or structural defects or deviations beyond allowable tolerances for piping clearances that adversely affect excavation and quality of Work

E. Start installation only when conditions are satisfactory

3.2 PERFORMANCE - GENERAL

A. Perform work in a safe and proper manner with appropriate precautions against hazard

B. Provide adequate working space and clearances for work performed within excavations and for installation and removal of utilities

C. Contain all construction activity on the designated site and within the limits of work. Cost of restoration of site will be the responsibility of the Contractor

D. Contractor to verify quantities to perform all earthwork required according to Accepted drawings, including but not limited to, additional import or export required to handle compaction, pavement subgrade preparation, and pipe bedding

E. Contractor shall take precautions to limit the removal of or damage to existing pavements, multi-use paths sidewalks, curbs, lawns, shrubbery, trees, hedges, walls, fences, buildings, or other existing improvements to the least practicable amounts and shall replace or restore such improvements to their original location and condition after the excavation has been backfilled and compacted

3.3 PROTECTION OF EXISTING UTILITIES AND STRUCTURES

A. Excavation and backfill operations shall be performed in such a manner to prevent cave- ins of excavations or the undermining, damage or disturbing of existing utilities and structures or of new work

B. Backfill shall be placed and compacted so as to prevent future settlement or damage to existing utilities and structures and new work

C. Any excavations improperly backfilled or where settlement occurs shall be reopened to the

depth required then refilled with approved materials and compacted, and the surface restored to the required grade and condition, at no additional costs to the Town.

D. Any damage due to excavation, backfilling, or settlement of the backfill, or injury to persons or damage to property occurring as a result of such damage shall be the responsibility of the Contractor. All costs to repair such damage, in a manner satisfactory to the Town Engineer, shall be borne by the Contractor at no additional expense to the Town.

3.4 SITE PREPARATION

A. Clear all site areas within the limits of work of grasses, roots, brush, and other objectionable material and debris

B. Remove all waste materials from site and dispose. Stockpile all acceptable grubbings for reuse in revegetation areas.

C. Remove debris including all demolished trees, underbrush, stumps, roots and other combustible materials from site and dispose of off-site; on-site burning is not permitted

3.5 DEWATERING

A. Comply with CDPHE Dewatering Requirements

B. Dewatering discharge to surface waterways requires CDPHE dewatering permit. Contractor must obtain dewatering permit and comply with discharge requirements therein, if necessary

3.6 PIPE PREPARATION

A. Ream pipe and tube ends and remove burrs

B. Remove scale and dirt, on inside and outside, before assembly

C. Cut ends of metallic pipe, recoat with coating approved for potable water service and compatible with manufacturer's coatings.

3.7 PRECAST CONCRETE VAULT [OR MANHOLE] PREPARATION

A. Verify items provided by other section of Work are properly sized and located

B. Verify that built-in items are in proper location, ready for roughing into Work

C. Verify excavation for manholes is correct

D. Excavation, Backfill, Subgrade Compaction: Refer to Specification Section 33 00 00 - Earthwork for requirements

E. Rock Subbase
   1. Remove water and place 6-inch minimum depth
   2. Vibrate for compaction
   3. Level top to accept precast sections with uniform bearing all around
   4. If material below vault is unsuitable, excavate as directed by the Town Engineer and backfill to grade with 1-1/2 inch minus rock and compact

3.8 PLACING PRECAST SECTIONS

A. Thoroughly clean joints of sections to place gasket material

B. Place gasket material on base or lower section to ensure watertight fit between lower precast section and upper precast section

C. Fill inside and outside of joint completely with non-shrink grout and trowel smooth

D. Cure non-shrink grout using approved methods as recommended by manufacturer

3.9 PREFORMED GASKETS

A. Remove and replace vault sections which have chipped or cracked joints

B. Thoroughly clean section joints

C. Install gasket in conformance with manufacturer's recommendations

D. Only use primer furnished by gasket manufacturer

3.10 PIPE INSTALLATION

A. Install PVC Pipe in accordance with AWWA M23 and AWWA C605

B. Install Ductile Iron Pipe in accordance with AWWA C600

C. Install Ductile Iron Fittings in accordance with AWWA M41

D. Route pipe as indicated on the Accepted drawings

E. The inside of all pipe, valves, and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand, and dirt when connected

F. Install as specified or in accordance with the manufacturer's recommendations

G. Cutting Pipe
   1. Cut pipe to measurement taken at the site, not from the accepted drawings
   2. Cut pipe neatly without damage to pipe
   3. Cut smooth, straight, and at right angles to pipe axis
   4. Dress and bevel end of cut pipe to remove roughness and sharp corners
   5. Cut pipe with saw or abrasive wheel
   6. Follow state and federal safety regulations pertaining to cutting asbestos concrete pipe as necessary

H. Provide an isolation or shutoff valve and union at the water connections to each fixture and unit of equipment, whether shown on the accepted drawings or not

I. Install pipe to indicated elevations. Maintain minimum 5.0 feet depth of ground cover and maintain minimum grade for drainage. Establish elevations of buried piping to ensure minimum cover is achieved. Add additional soil in areas of future fill to provide minimal cover at all times. Report any variations from plan to the Town.
   1. Provide air release valve at all high points and blow-offs or hydrant at all low points. Coordinate locations and details with the Town Engineer.
   2. Where minimum depth cannot be maintained, provide a minimum of 2 inch of specified insulation board per 1 foot of cover not provided. Contractor must have approval of the Town Engineer prior to installation. Insulation board to be a minimum of 40 PSI or greater depending on backfill material.
      a. Place insulation board over bedding material for the width of the trench

J. Install pipe to allow for expansion and contraction without stressing pipe or joints

K. Protect from lateral displacement by placing embedment evenly on both sides of pipe

L. Do not lay pipe in water. Maintain groundwater level a minimum of 12 inches below pipe to be

installed. Do not lay pipe under unsuitable weather or trench conditions

M. Make changes in horizontal, vertical, and curved alignment shown on accepted drawings by using joint deflections in the amount permissible by manufacturer and shown on accepted drawings

N. Do not bend pipe

O. Deflect pipe at joints

P. Do not deflect PVC pipe at connection to ductile iron fittings

Q. Form and place concrete for thrust blocks at hydrants, plugs, caps, tees and 90-degree bends. Thrust blocks are not required on bends 45 degrees or less when joint restraints are installed for the full alignment.

R. Utility crossings
   1. Whenever possible, lay water mains over sanitary and storm sewers to provide vertical separation of at least 18-inch between invert of water main and crown of sewer
   2. If standard crossing detail is not available and above separation cannot be met, provide one continuous length of watertight sewer pipe 20' long centered on water main with joints between different pipes encased in 6-inch minimum of concrete and extending 6-inch either side of joint or encase sewer pipe in 6-inch of concrete completely around pipe, for not less than 10' either side of water main
   3. Water Mains Passing Under Sanitary Sewers: If vertical separation is less than 18- inch, provide structural support for sewer. Provide concrete encasement where water lines pass under sanitary sewer line. Reference detail shown on Accepted drawings

S. Maintain a minimum 10 feet of horizontal separation and 18 inches of vertical separation between water main and storm or sanitary sewer lines in accordance with the CDPHE
   1. Provide concrete encasement if these clearances cannot be achieved and when water line is below sanitary sewer line

T. Tracer wire and marker tape
   1. Install tracer wire continuous over top of pipe
   2. Install tracer wire test stations at maximum 500 LF of water line per Town requirements. Locate test station at fire hydrants, gate valves, or special test station locations in a valve box
   3. Terminate tracer wire following drawing details
   4. Tape tracer wire to top of pipe using PVC tape every 4 feet along the pipe, and on each side of fitting
      a. Tape: minimum 2 inches wide and wrapping full circumference of pipe
   5. Install identification /warning marker tape in fill area of trench above all water lines

U. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system

V. Install access fittings to permit disinfection of water system, subject to approval by the Town Engineer

W. Backfill trench in accordance to specifications herein

X. Protect pipe from floatation or movement until completely backfilled and put into service

3.11 WATER MAIN CONNECTIONS

A. Comply with the Town of Berthoud Standards and Specifications. Coordinate with the Town and fire department representatives for any impacts to the existing water system and provide advanced notice to impacted properties if applicable.

B. Connect to water main per plans and referenced standards or details.

3.12 JOINTS

A. Make pipe joints carefully and neatly

B. Connect piping in accordance with manufacturer's recommendations

C. Push-on joints
   1. Lay pipe with bell ends facing the direction of laying except when the Town Engineer authorizes reverse laying
   2. Assembly of PVC plain end into bell: follow PVC pipe manufacturer's recommendation
   3. For PVC pipe, Contractor to ensure that pipe is not inserted into the bell ends beyond the push line
      a. Utilize EBAA Mega-Stop bell protection, or approved substitution, if necessary, to ensure previously laid pipe joints are not impacted by ongoing installation
   4. Lubricate joint surfaces immediately before completing the joint
   5. Bevel spigot ends of field cut piping
   6. Groove spigot ends of field cut restrained joint piping if required by joint system
   7. Install restrained joints following manufacturer's recommendations

D. Mechanical joints
   1. Before assembling joint, clean both bell and plain end of rust and foreign matter
   2. Assemble joint following AWWA C111, C600, C605 and as specified
   3. Lubricate gasket and install in accordance with manufacturer's instructions
   4. If an effective seal is not obtained, disassemble joint, clean thoroughly, and reassemble
   5. Do not over tighten bolts to compensate for poor installation
   6. Carefully align holes in mechanical joints with restraint device to permit installation of the harness bolts
   7. Install mechanical joint pieces so the mechanical joint holes straddle the top centerline for horizontal piping, or the side centerline for vertical piping

3.13 PROTECTIVE COATING

A. Provide polyethylene tube encasement on all buried ductile iron fittings, valves, and fire hydrant extensions
   1. Encase ductile iron fittings and valves in polyethylene per AWWA C105, Method A, secured with polyethylene compatible adhesive tape. Overlap polyethylene onto PVC pipe a minimum of 6 inches
   2. Before backfilling, inspect polyethylene for rips, punctures and other damage and repair following AWWA C105

B. Coat exposed ferrous metal surfaces of joints, couplings, and uncoated steel with primer and tape coating system after installation. Do not coat stainless steel or high strength low alloy steel nuts and bolts
   1. Surface Preparation: Clean surfaces of rust, scale, soil, mud, oil, grease, and other contaminants by hand or power tool following SSPC-SP2 or SP3 and other appropriate means as recommended by coating manufacturer Remove excess moisture and provide surface dryness as recommended by coating manufacturer
   2. Application: Apply primer in uniform manner to clean and dry surfaces following coating manufacturer's recommendations
      a. Fill complex and irregular surfaces with appropriate mastic or filler tape to

eliminate bridging; then apply tape/wrap to primed and filled surfaces following coating manufacturer's recommendations.
   b. When coating restraining rods or strapping, apply tape wrap longitudinally
   c. Where metal being coated enters concrete, overlap coating onto concrete by minimum of 2 inches after placement of concrete
3. Inspection: After field coating of specified items, conduct visual inspection to verify complete coverage has been accomplished.
   a. Repair damaged or incompletely coated surfaces following coating manufacturer's recommendations

C. Metal Surfaces not Protected by Poly Wrap
1. Coat all steel clamp rods, bolts, and other metal accessories used in tapping saddles, anchorages, cut ends of pipe, follower rings and bolts or joint harnesses subject to submergence or contract with the earth and not concrete encased, but including pipe fittings and bolts in polyethylene tube protection
2. Apply 2 coats of coal tar paint to clean, dry metal surfaces, allow first coat to dry before applying second coat

D. Metal Harness Rods
1. Provide field applied primer and Polyken tape wrap

3.14 VALVES AND HYDRANTS INSTALLATION

A. Carefully inspect valve before installation. Clean interior. Operate valve to determine parts in proper working order, with valves seating and drain valve operating properly. Set plumb and center stem in valve box and securely brace into place. Comply with AWWA C600 and referenced standards

B. Center and plumb valve box over valve. Set box cover flush with finished grade.
1. Backfill and compact under and around valve boxes to ensure no vertical loads are transmitted to valve operators or bonnets

C. Comply with AWWA M17 for fire hydrant installation. Install with gate valve and provisions for drainage

D. Install valves, hydrants, and accessories in accordance with the manufacturer's recommendations and in accordance with referenced standards and specifications.

E. Hydrants and valves to be set plumb on solid bearing surface

F. Locate hydrant flange a minimum of 3” and maximum 6” above adjacent finished grade or flush with the adjacent top of curb. Contractor to verify final grade or adjust flange height upon the completion of final grading

G. Drainage shall be provided at the base of the hydrant by placing rock from the bottom of the trench to at least 12 inches above the barrel flange of the hydrant and to a distance of 12 inches around the elbow. The minimum distance from the bottom of the trench to the bottom of the hydrant elbow shall be 6 inches. The minimum amount of rock placed shall be 1/3 cubic yard

3.15 VALVE INSTALLATION

A. Carefully inspect valve before installation. Clean interior. Operate valve to determine parts in proper working order, with valves seating and drain valve operating properly. Set plumb and center stem in valve box and securely brace into place. Comply with AWWA C600 and referenced standards.

B. Provide concrete collar for installations within landscaped areas

C. Protect valve box and cover during paving operations and clean any excess concrete, or asphalt, or road base from valve box and cover to ensure visibility and proper operation

D. Pressure regulating valves shall be installed in a horizontal position in an underground concrete manhole or concrete vault as applicable.

E. Tapping valves shall be installed with the stem positioned vertically in buried horizontal water lines without gearing, bypasses, rollers, or tracks. The valve bonnet shall be installed below frost line.

3.16 INSERTION VALVE INSTALLATION

A. Install according to Manufacturer's suggested procedures
   1. Clean the area of the pipeline that is to receive the insert valve
   2. Prepare the insert valve for assembly onto the pipeline per Manufacturer's recommendations
   3. Install the two insert valve body halves on the pipeline
   4. Bolt two body halves of insert valve together. Tighten bolts per Manufacturer's recommendations.
   5. After body bolts have been tightened, confirm that the insert valve is level
   6. Install mechanical joint gaskets to insert valve and complete assembly using split mechanical joint restraints
   7. Attach temporary insertion valve. A test port shall be attached, and the assembly should be pressure tested.
   8. Prepare tapping machine for mounting to temporary valve.
   9. Tapping machine shall be mounted to the temporary isolation valve with chip flushing valve attached.
   10. After completing the tap, close temporary isolation valve.
   11. Remove tapping machine and cut out pipeline section.
   12. Prepare insertion valve bonnet for live line insertion and attach to valve insertion tool per Manufacturer's recommendations
   13. Position and attach valve insertion tool to temporary insertion valve. Confirm proper orientation of valve bonnet.
   14. Open temporary isolation valve and advance travel of the bonnet to the body of the insert valve
   15. Install six set pins to secure bonnet to insert valve body
   16. Once set pins are in place, release the bonnet from the insertion tool
   17. Use insertion tool blow off valve to release water with insertion tool housing and remove insertion tool from temporary insolation valve
   18. Remove temporary isolation valve
   19. Install O-Ring between valve body and bonnet to seal connection

3.17 TAPPING

A. Tapping shall be performed using standard tapping saddles designed for use on PVC piping in accordance with AWWA C605. Tapping shall be performed only with use of tap saddles or sleeves. NO DIRECT TAPPING WILL BE PERMITTED. Tapping shall be performed in accordance with the applicable sections for saddle tapping as per "Uni- Pub-8: Tapping Guide for PVC Pressure Pipe by Uni-Bell PVC Pipe Association"

B. All connections requiring a larger diameter than that recommended by the pipe supplier, should be made with a pipe connection as specified and indicated on the accepted drawings.

C. Equipment used for tapping shall be made specifically for tapping PVC pipe:
   1. Tapping bits shall be slotted "shell" style cutters, specifically made for PVC pipe. 'Hole saws' made for cutting wood, steel, ductile iron, or other materials are strictly prohibited

3.18 WATER SERVICES

A. Water services are to be connected to the new water main per the Contract Accepted

drawings and the Town Standards

B. Water services are to be tapped per the Contract Accepted drawings. Direct taps are not permitted.

3.19 THRUST BLOCKS

A. Installation:
   1. Thrust blocks shall be constructed at hydrants, 90 bends, tees, plugs, and caps that require support due to unbalanced line thrust. Care shall be taken to ensure that outlets, cover bolts, nuts, clamps, and other fittings are accessible. A bond breaker shall be placed between the pipe and the thrust block to aid in future removal. If a large thrust block is to be placed, it shall be separated into sections by a suitable material. Bearing surface areas are minimum areas to bear against the undisturbed trench wall. If the soil bearing capacity is insufficient to provide adequate support based on minimum bearing areas established by Drawing Details, then the minimum bearing area shall be increased to a size that shall ensure support restraint. In every instance, the thrust block shall bear against undisturbed earth
   2. Before placing concrete, equipment used in the mixing and transport shall be cleaned. Debris, water, or ice shall be removed from the area to be occupied by concrete. Concrete shall not be placed on frozen subgrade.

B. Formwork for Thrust blocks:
   1. Forming for concrete thrust blocks and anchors shall be done by bulkheading around the shape of the thrust block or anchor with wood, burlap sacks, or reinforced paper sacks that are filled with sand or earth. Sacks shall be constructed of a size easily handled when full and left in place in the trench. Wood forms shall be removed before backfilling.
   2. Horizontal struts or braces required for trench shoring shall not remain in concrete thrust blocks. Prior to placing concrete, the forms and ditch bank will be inspected and approved by the Town Engineer.
   3. When concrete is deposited against the ground without the use of forms, the ground shall be thoroughly moistened, or other provisions made to prevent the ground from drawing water in from the concrete

C. Thrust block Curing Time:
   1. Newly placed concrete shall be allowed to set undisturbed for a minimum of 24 hours

D. Compaction of Fill Over Thrust blocks
   1. Backfill may be placed over thrust blocks once the surface has set sufficiently and they are able to resist the weight of the backfill. However, tamping or compacting shall not be allowed above the thrust block for a minimum of 24 hours after placement

E. Hydrostatic testing shall not be conducted until thrust blocks have fully cured, a minimum of 7 days

3.20 ABANDONMENT

A. Cap ends of main as shown. Place required concrete blocking as shown on drawing details

B. Where mains are to be abandoned and removed to a fitting or valve, cut and plug main at fitting or valve
   1. When shown on accepted drawings, remove fire hydrants and valves, including lead joint tees when encountered; salvage and deliver removed fire hydrants and valves to the Town.
   2. Pipe, fittings, and other appurtenances that are removed, but are not required to be salvaged become property of Contractor
      a. Remove and dispose of offsite

3.21 FIELD QUALITY CONTROL

A. Comply with the Town of Berthoud Standards and Specifications. Test each line at the Contractor's expense in the presence and to the satisfaction of the Town inspectors.

B. Field inspection and testing will be performed under provisions set forth by the referenced standards

C. Test each line at the Contractor's expense in the presence and to the satisfaction of the Town at a maximum of 1,000-foot intervals

D. Water Line Disinfection
   1. Comply with AWWA C651 and provide the Town with results.
   2. Flush water lines prior to disinfection, except when tablet method is used. Acceptable chlorine disinfectants are calcium hypochlorite granules, sodium hypochlorite solutions, and calcium hypochlorite solutions, and calcium hypochlorite tablets.
   3. After the pipe is filled with water and chlorine, the chlorinated water shall be held in contact with the pipe for 24 hours. At the end of the 24-hour period, the water in the pipeline shall be tested by the local health authority having jurisdiction, or their designated representative, to ensure a residual chlorine content in compliance with the Town requirements. The pipeline shall then be thoroughly flushed to remove the heavily chlorinated water. This activity requires a permit from the CDPHE WQCD prior to flushing. Comply with all provisions of the permit. Care shall be taken in flushing the pipeline to prevent property damage and danger to the public. Discharges of water from blowoff assemblies or other appurtenances shall be contained or discharged in a manner approved by the Town and the CDPHE.
   4. For fire lines, flush piping complying with NFPA 24
   5. If water in pipe does not meet the governing agency requirements, repeat disinfection procedure until acceptable. Furnish copies of acceptance forms from governing agency to the Town.

E. Valve Testing
   1. Conduct pressure and leakage tests on all newly installed valves
   2. Furnish all necessary equipment and material and make all connections to the pipe, as required. The Town shall monitor the tests.
   3. Each valve, after shop assembly, shall be operated and hydrostatic tested in accordance with AWWA C509 or AWWA C515. The body of a PRV shall be hydrostatic tested to 150% of the working pressure specified herein. A seat leakage test shall be made at the working pressure.
   4. The Manufacturer shall submit a written statement that the inspection and all specified tests have been completed and that results comply with the requirements of these Standards.
   5. Components in contact with potable water shall be certified to comply with NSF/ANSI 61, and a copy of the NSF/ANSI 61 certification shall be provided to the Town, if requested.

F. Hydrostatic Pressure Testing
   1. Provide all necessary pumping equipment, piping connections, pressure gauges with maximum of 5 psi increments, and other required equipment, facilities, and materials.
   2. Test only using potable water in conformance with the Town Standards.
   3. If tests indicate work does not meet specified requirements, remove work, replace and retest at no cost to the Town.
   4. Hydrostatic Test Conditions: At lowest point in the line or section under test, pressurize to 150 psi minimum. The pipeline shall be filled at a rate that does not create surges and does not exceed the rate at which air can be released.
   5. While the test pressure is maintained, an examination shall be made of the pipeline and any leaks located and repaired. Pipe or fittings found to be faulty shall be removed and replaced. Leakage is not allowed through the bonnet of the line valve. A valve leaking through the bonnet may be repaired in place or removed and replaced. Cutting and

replacement of pavement as well as excavation and backfilling may be necessary when locating and repairing leaks discovered during pressure testing.

6. After visible leaks are stopped, the full test pressure shall be maintained for 1 continuous hour. Allowable leakage for each section between line valves shall not exceed the Town requirements.

G. PVC Water Pipe Continuity Testing
   1. Notify the Town five working days in advance to schedule testing
   2. Continuity test to consist of locating the PVC water pipe with an electronic-type pipe locator
   3. If test is negative for continuity, repair or replace as necessary to achieve continuity

H. Bac-T Testing
   1. After completion of water line disinfection, Contractor shall take Bac-T samples to ensure pipe has been properly disinfected and submit results to the Town.
   2. If water line fails Bac-T sampling, any repeat disinfection and Bac-T testing will be at the Contractor's expense
   3. The Contractor shall receive Town approval before placing a water line in service

3.22 CLEANING

A. Verify that piping has been cleaned and inspected

B. Verify that piping has been successfully pressure tested and flushed

C. Perform scheduling and disinfection activity with start-up, testing, adjusting, demonstration procedures, including coordination with related systems

3.23 DISINFECTION

A. Provide and attach required equipment to perform the work of this Section

B. Tablet, continuous, or slug disinfection may be followed in accordance with AWWA C651

C. The preferred method is continuous disinfection, summarized as follows:
   1. Inject treatment disinfectant, free chlorine in liquid form into piping system to obtain 50 to 80 ppm residual
   2. Bleed water from outlets to ensure distribution and test for disinfectant residual
   3. Maintain disinfectant in system for 24 hours
   4. If final disinfectant residual tests less than 25 ppm, repeat treatment
   5. Flush, circulate and clean until residual equal to that of incoming potable water or 1.0 mg/L is achieved

D. Replace permanent system devices removed for disinfection

3.24 FINAL FLUSHING

A. Maintain a flushing velocity of 2.5 feet per second in piping

B. Collect chlorinated water for proper disposal and/or dechlorinate to less than 0.1 ppm free chlorine prior to discharge in accordance with State, County, and local regulations

3.25 DISINFECTION FIELD QUALITY CONTROL

A. After final flush, and before main or equipment is placed in service, collect water samples from representative points along the main and field test for chlorine residual

B. Chlorine residual shall be within 50 percent of the chlorine residual prevailing in the source

C. If initial disinfection fails to provide satisfactory samples, repeat disinfection until satisfactory samples have been obtained

3.26 DISINFECTION TESTING AND ACCEPTANCE

A. The Contractor will perform Bacteriological (Bac-T) sampling and testing after pipes have been disinfected and flushed as specified herein

B. If any portion of the piping or equipment or tanks fails Bac-T testing, the Contractor is responsible for repeating disinfection procedures until passing Bac-T test is obtained

3.27 FINAL ACCEPTANCE

A. The inside of all pipe, valves, and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand, and dirt when connected.
   1. Wire brush, if necessary, wipe clean and keep joint contact surfaces clean until connection is complete

B. Drain all test water from the new pipe system prior to placing in service

C. Provide water tap locations (x, y, z) on the Accepted drawings

D. Provide operation and maintenance manuals for air and line valves and fire hydrants

E. Provide final reports to the Town for:
   1. Bac-T results
   2. Residual chlorine tests
   3. Hydrostatic tests for each section or pipe
   4. Cathodic protection system test (if applicable)
   5. Tracer wire continuity test

END OF SECTION

SECTION 33 33 00
SANITARY SEWER SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Polyvinyl chloride (PVC) non-pressure pipe for gravity sanitary sewer with all jointing materials, fittings, and other appurtenances required for a complete installation

B. [Polyvinyl chloride (PVC) pressure pipe [OR HDPE pressure pipe] for sanitary sewer force main with all jointing materials, fittings, and other appurtenances required for a complete installation]

C. All precast manholes complete with steps, ring and cover as required

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. A48 – Standard Specification for Gray Iron Castings
2. A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
3. A185 – Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement
4. A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
5. A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
6. C33 – Standard Specification for Concrete Aggregates
7. C150 – Standard Specification for Portland Cement
8. C443 – Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
9. C478 – Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
10. C497 – Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile
11. C913 – Standard Specification for Precast Concrete Water and Wastewater Structures
12. C923 – Standard Specification for Resilient Connectors Between Reinforced Concrete manhole Structures, Pipes, and Laterals
13. C1227 – Standard Specification for Precast Concrete Septic Tanks
14. C1619 – Standard Specification for Elastomeric Seals for Joining Concrete
15. C1821 – Standard Practice for Installation of Underground Circular Precast Manhole Structures
16. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
17. D1248 – Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
18. D1330 – Standard Specification for Rubber Sheet Gaskets
19. D1351 – Standard Specification for Thermoplastic Polyethylene Insulation for Electrical Wire and Cable
20. D1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC)
21. D1785 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
22. D2122 – Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
23. D2240 – Standard Test Method for Rubber Property – Durometer Hardness
24. D2321 – Standard Specification for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
25. D2466 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings,

Schedule 40
26. D2774 – Standard Specification for Underground Installation of Thermoplastic Pressure Piping
27. D2837 – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
28. D3034 – Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
29. D3035 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
30. D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
31. D3212 – Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
32. D3261 – Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
33. D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
34. F412 – Standard Terminology Relating to Plastic Piping Systems
35. F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
36. F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
37. F679 – Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
38. F1055 – Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing
39. F2164 – Standard Specification for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure

B. American Water Works Association (AWWA):
1. C104 – Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
2. C105 – Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
3. C111 – Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
4. C115 – Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Grey-Iron Threaded Flanges
5. C150 – Standard for Thickness Design of Ductile-Iron Pipe
6. C151 – Standard for Ductile-Iron Pipe, Centrifugally Cast
7. C504 – Standard for Rubber-Seated Butterfly Valves
8. C512 – Standard for Air Release, Air/Vacuum, and Combination Air Valves for Water and Wastewater Service
9. C600 – Standard for Installation of Ductile Iron Mains and Their Appurtenances
10. C900 – Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution
11. C905 – Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm), for Water Transmission and Distribution
12. M23 – PVC Pipe: Design and Installation

C. Colorado Department of Transportation (CDOT)

D. Occupational Safety and Health Administration (OSHA)

E. National Association of Corrosion Engineers (NACE):
1. SP0169 – Control of External Corrosion on Underground or Submerged Metallic Piping Systems
2. SP0286 – Electrical Isolation of Cathodically Protected Pipelines

F. Plastics Pipe Institute (PPI):
1. TR-4 – HDB / HDS / SDB / PDB / MRS Ratings for Thermoplastic Piping Materials or Pipe

2. TR-33 – Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe
3. Handbook of Polyethylene Pipe
4. Polyethylene Piping Systems Field Manual for Municipal Water Applications
5. Material Handling Guide

1.3 SUBMITTALS

A. Shop Drawings: Provide piping layout and assembly drawings with fitting dimensions. Provide sufficient information to verify compliance with specifications

B. Product Data: Provide manufacturer's catalog information with dimensions, material and assembled weight.
   1. Pipe materials
   2. Special, fitting, and coupling details
   3. Gasket materials
   4. Valves
   5. Laying and installation schedule
   6. Specifications and data sheets
   7. Affidavits of compliance for protective shop coatings and linings

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements and applicable standards. Provide prior to shipment.

D. Test Reports: Submit reports of field exfiltration/infiltration, mandrel and lamp tests

E. TV Inspection Files:
   1. Submit videos and reports
   2. For rehabilitation work, show cured liner, connections to mains, and reestablished service connections after relining work is complete

1.4 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of piping mains, valves, connections, invert elevations, and any mapped or unmapped utilities

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities

C. Sewer Rehabilitation Work: Accurately record actual locations of piping mains, laterals, and services that include CIPP liner. Indicate pipe inverts and top of pipe elevations

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with Town of Berthoud and CDPHE Stormwater and/or Groundwater Discharge Permit, notes on the drawings and as specified herein.

B. Manufacturers shall be experienced in the design and manufacturing of materials specified herein for a minimum period of 5 years

C. All PVC pipe, regardless of diameter, shall be supplied by a single manufacturer

D. Perform Work in accordance with the Colorado Department of Public Health and Environment (CDPHE), Larimer County and or Weld County, and the Town of Berthoud.
E. Contractor shall conduct visual inspection before installation
F. Provide manufacturer's name and pressure rating marked on piping and valves
G. Provide piping complete with all fittings, jointing materials, supports, joint restraint system, and necessary appurtenances for watertight, fully operational sewer lines

1.6 REGULATORY REQUIREMENTS

A. Conform to all municipal codes and ordinances, laws and regulations of Larimer County and/or Weld County, Town of Berthoud, CDPHE, the notes and details on the drawings, and as specified herein, and CDPHE Stormwater Management and/or Construction Dewatering Permit

B. In case of apparent conflict, CDPHE requirements govern over these specifications

C. Contractor, not Owner, shall prepare, submit, pay, and otherwise obtain all necessary permits from all appropriate entities

1.7 DELIVERY, STORAGE AND HANDLING

A. During loading, transporting and unloading, exercise care to prevent damage to material
   1. Use nylon slings only
   2. Do not drop pipe or fittings
   3. Do not roll or skid against pipe already on ground
   4. Repair any damage done to coating or lining
   5. Handle per manufacturer's recommendations
   6. Store rubber gaskets in cool dark location
   7. Store all material on wood pallets or timbers

B. Shop coated materials shall be handled, transported, stored and shipped in a manner that will prevent damage to the coating and lining. Coating or lining damaged in handling or other operations shall be repaired to the approval of and at no additional cost to the Owner

C. Any damage to the pipe or the protective coating from any cause during the installation of the pipeline and before final acceptance by the Engineer shall be repaired in accordance with these Specifications and at no additional cost to the Owner

D. Pipe
   1. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation
   2. PVC pipe has reduced flexibility and impact resistance as temperatures approach and drop below freezing. Extra care should be used in handling PVC pipe during cold weather
   3. Do not store PVC pipe uncovered in direct UV light
   4. Pipe stored along the trench side shall be suitably supported off the ground to avoid damage to the coating

E. Valves
   1. Prepare valves for shipping as follows:
      a. Ensure that valves are dry and internally protected against rust and corrosion
      b. Protect vales against damage to threaded ends, flange faces, and weld ends
      c. Seal valve ends to prevent entry of foreign materials into valve body
      d. Set valves in best position for handling
      e. Set valves closed to prevent damage
   2. Deliver and store valves and accessories in shipping containers with labeling in place
   3. Storage: Use the following precautions for valves during storage:
      a. Do not remove end protectors unless necessary for inspection; then reinstall for storage
      b. Protect valves from weather by storing indoors or support valves off ground or pavement in watertight enclosures when outdoor storage is necessary

F. Precast Concrete Structures
   1. Transport and handle precast concrete units with equipment to protect from dirt and damage
   2. Do not place precast concrete units in position which will cause damage

3. Handle precast concrete structures by means of lifting inserts. Do not move from manufacturer's yard until curing is complete.

1.8 JOB CONDITIONS

A. All work which requires the interruption of active sanitary sewer service lines must be completed as quickly as possible in order to minimize inconvenience to customers and risk to the Town of Berthoud and coordinated with the Town

B. Underground Obstructions
   1. Underground Obstructions known to Engineer are shown on Drawings
      a. Locations shown may prove inaccurate and other obstructions not known to Engineer may be encountered
      b. Contractor shall field locate and verify all obstructions where or not shown on the Drawings
   2. Notify each utility owner and request utility be field located by surface reference at least 48 hours prior to trenching or excavation
   3. Expose and verify size, location and elevation of underground utilities and other obstructions where conflicts might exist sufficiently in advance to permit changes in the event of a conflict
      a. Notify Engineer and Owner in case of a conflict
      b. In case of a conflict, the proposed work may be changed by Engineer
   4. Maintain, protect, and support by shoring, bracing or other means existing utilities and appurtenances

PART 2 PRODUCTS

2.1 PIPE, MANHOLES, AND ACCESSORIES

A. Comply with Town of Berthoud Standards and Standard Details.

2.2 PVC GRAVITY SANITARY SEWER PIPE (NON-PRESSURE)

A. The PVC piping shall be non-pressure PVC pipe for gravity sanitary sewer application of sizes indicated in the approved drawings

B. Pipe and fittings:
   1. ASTM D3034, T-1 wall, SDR 35, non-pressure pipe
   2. Cell classification: ASTM D1784
   3. Pipe length: 12-20 feet standard manufactured length for construction

C. Joints: ASTM D3212 and F477 - Rubber gasket with one compression gasket ring, integral bell and spigot type
   1. Designed to hold pipe in alignment, provide flexibility, separate the ends of pipe lengths, resist applied earth pressures, and provide fluid tightness
   2. Rubber rings: ASTM F477

2.3 SOURCE QUALITY CONTROL

A. Identification Marks: Clearly and permanently marked at not greater than 5 foot intervals with pipe diameter, PVC cell classification (if applicable), manufacturer, plant, shift, ASTM, date designations and service designation

B. Testing per ASTM D3034
   1. Test products not manufactured in the U.S. at an acceptable laboratory in the U.S.

2.4 PIPE ACCESSORIES

A. Underground Type Plastic Line Marker
   1. Manufacturer's standard permanent, continuous-printed plastic tape with metallic core, intended for direct-burial service; not less than 6-inch wide x 4 mils thick. Provide green tape with black printing reading "CAUTION SANITARY SEWAGE LINE BURIED

BELOW." Provide identification markers of one of the following:
a. Allen Systems, Inc.
b. Emed Co., Inc.
c. Seton Name Plate Corp.
d. Or accepted substitution

B. Tracer Wire for Buried Pipe
1. Provide tracer wire for all HDPE pipe and PVC pipe
2. All tracer wire shall be 12 AWG solid copper wire coated with 45 mil Type HMW - PE blue insulation compliant with ASTM D1351 specifically designed for direct burial in corrosive soil or water
3. UL listed

C. Tracer Wire for Horizontal Directional Drilling
1. Non-UL listed tracer wire specifically developed for Horizontal Directional Drilling application
2. 1/4-inch 304 Stainless Steel tracer wire
    a. Performance Wire & Cable Inc.: "Tracer wire, Stranded SS /45 mil HMW-HDPE, 30 Volt, HDD direct bury use only"
3. #12 AWG Solid Carbon Clad Steel Extra High Strength tracer wire
    a. Copperhead Industries, LLC: "Direct Burial #12 AWG Solid (.0808" diameter), 21% conductivity copper-clad hard drawn high carbon steel extra high strength horizontal directional drill tracer wire, 1150# average tensile break load, 45 mil. high molecular weight-high density polyethylene jacket complying with ASTM D1248, 30 volt rating"
    b. Pro-Line Safety Products Co.: "Pro-Trace HDD-CCS PE45"

D. Tracer Wire Test Stations
1. 4-inch with locking lid
2. Manufacturers:
    a. CP Test Services
    b. Glenn Series "Glenn-4"
    c. Or accepted substitution

E. Corrosion Control
1. Rust inhibitive primer:
    a. Tnemec "Series 77H Chem-Prime"
    b. Or accepted substitution
2. Rust preventative compound:
    a. Houghton "Rust Veto 344"
    b. Rust-Oleum "R-9"
    c. Or accepted substitution

2.5 AIR RELEASE AND VACUUM BREAKER COMBINATION VALVES

A. Manufacturers:
1. Val-Matic "Model 801A"
2. Dezurik/APCO "Series 440 SCAV"
3. Or accepted substitution

B. Provide combination air release and vacuum breaker valves as indicated on accepted drawings
1. Provide single body type that functions as both an air release and a vacuum breaker valve
2. Valves shall be manufactured and tested in accordance with AWWA C512
3. Provide a shutoff valve and transition piece from HDPE to NPT threaded connection on valve
    a. Ball valve: compatible with butt fusion, HDPE fitting

C. General
1. Usage: Recommended for service up to a pressure rating indicated by approved drawings
2. Bodies and covers:
    a. Gray iron meeting requirements of ASTM A126 Class B
    b. Globe style of 1-inch valves to increase float clearance and reduce clogging
3. Exterior coating: universal alkyd primer
4. Valve cleanout: 2" NPT
5. Valve drain connection: 1" NPT
6. Inlet and Outlet:
    a. Inlet: NPT, 2-inch on 1-inch valves
    b. Outlet: NPT equal to valve size, 1-inch
7. Internals:
    a. Metal internal parts only
    b. Float sensitive skirt provided
    c. Float, plug, guide shafts, and bushings: Type 316 stainless steel
    d. Resilient seats: Buna-N

2.6 ECCENTRIC PLUG VALVES

A. Manufacturers:
1. DeZurik
2. Henry Pratt Company
3. Milliken
4. Val-Matic Valve and Manufacturing Corporation
5. Or accepted substitution

B. Provide plug valves as indicated on Drawings

C. General
1. Quarter-turn non-lubricated eccentric plug valves
2. Resilient faced plug
3. Valves with vane type seat rings are not acceptable
4. Valve ends to match connecting piping
    a. Buried: Mechanical joint, ANSI A21.11/AWWA C111
    b. Flanged: 125 lb, ANSI B16.1
    c. Screwed valve ends shall be to the NPT standard
5. Minimum Working Pressure Rating:
    a. 175 psi
6. Opening motion eccentric, lifting plug away from body seat
7. Valve alignment
    a. Valve shall be installed so that the plug is horizontal and rotates upward as the valve opens
    b. Valve shall be installed with seat on low pressure side of valve
8. Provided with fully adjustable plug position stops
9. Plugs shall be eccentric type with no backing ring or frame
10. Valve body cavity shall be smooth without protrusions or baffles
11. Valve body plainly marked to indicate seat end
12. Valve packing adjustment accessible without removing actuator from valve

D. Valve Materials
1. Plug and body: Cast iron, ASTM A126, Class B
2. Resilient plug facing or replaceable style body seats shall be synthetic rubber, neoprene, or Buna N compound suitable for use with water and wastewater applications
3. Seat rings shall be threaded, or welded of corrosion-resistant stainless steel (18-8), nickel, or Monel conforming to AWWA C504
4. Sprayed or plated mating seat surfaces are not acceptable
5. Bearings shall be replaceable. Sleeve type and thrust bearings in the upper and lower

journals shall be corrosion-resistant stainless steel or bronze
6. Shaft seals shall be multiple O-ring, self-adjusting U-cup or chevron type packing conforming to AWWA C504
7. Pull-down packing is not acceptable
8. Shaft seals shall be field adjustable or replaceable without valve disassembly
9. Plug seat: Chloroprene (Neoprene)
10. Packing: Acrylonitrile Butadiene V-Type Cup a. Dual U-cup
11. Upper thrust bearing: TFE
12. Body seat: Welded-in overlay seat of no less than 90% nickel
13. Upper and lower trunnion bearings: Sleeve type, 18-8 stainless steel
14. Valves complete with epoxy coating on the interior and exterior, manufacturer's standard corrosion resistant coating shall be acceptable

E. Testing
1. Valves shall be capable of drip-tight shut-off up to the full leak test rating a. Test and certify pressure capacity in the reverse direction

2.7 MANHOLES

A. Precast Concrete Units:
1. Manufacturers:
   a. Rinker Materials
   b. Old Castle Precast
   c. Or accepted substitution
2. Specification: ASTM C478
3. Minimum wall thickness: greater of 6 inch or 1/12 of internal diameter
4. Reinforced
5. Grade rings as required

B. Precast Units or Cast-in-place: Use concrete that will attain a 28-day compressive strength of not less than 4000 psi with a cement content of not less than 6 sacks per cu. yd. Openings to be precast per plan. Sawcut in field only if no other option.

2.8 FABRICATION

A. Vault/Manhole Sections
1. Precast concrete dimensions as shown on plans
2. Minimum manhole inside diameter: 48 inch
3. Precast lid and Cones: Same or greater reinforcement and wall thickness as vault or manhole section with capability for H20 loading
4. Vault Joints: Shiplap or tongue and groove with double mastic gaskets, each joint to set equally and tightly
5. Manhole Joints: Keylock type with double mastic gaskets, each joint to set equally and tightly
6. Access opening: Minimum 24 clear or as indicated
7. Pipe connection: As indicated on Drawings
8. Pipe knockout: As indicated on Drawings
9. Precast or Cast-in-place base: As indicated on Drawings
10. Manhole steps: 12-inch (up to 16-inch maximum) on center, vertical alignment above largest bench or open area

B. Grating and Metal Frame: As specified on drawings

2.9 ACCESSORIES

A. Plugs and Caps: Use pipe plugs or caps provided by the pipe manufacturer and approved by the Engineer for pipe stubouts

B. Cleanouts: Provide as indicated, pipe extension to grade with ferrule and countersink cleanout plug. Provide round cast-iron access frame over cleanout, with heavy duty secured

scoriated cover with lifting device cast with the word “SANITARY”

C. Reinforcement:
   1. Reinforcing Steel: ASTM A615 Grade 60
   2. Welded Wire Fabric: ASTM A185

D. Concrete: Refer to Division 3 Specifications if applicable
   1. Minimum compressive strength: ASTM C39, 4500 psi at 28 days
   2. Cement: ASTM C150, Portland Cement, Type II
   3. Aggregates: ASTM C33, free of deleterious substances

E. Gaskets and Plastic Sealing Compound
   1. Mastic: FS SS-S-210A, "RAM-NEK" or approved substitution
   2. Rubber: Neoprene, 40+5 hardness when measured by ASTM D2240, Type A durometer
   3. Compression Gaskets: ASTM C443
   4. Boot Connectors: ASTM C923
      a. Flexible rubber boots shall provide a watertight seal between the pipe and concrete structure.
      b. Z-LOK connector by A-LOK Products, Inc.
      c. Or approved substitution

F. Frames and Castings: ASTM A48 with asphalt varnish coating hot dip applied at foundry, 6 mils thick Class 30b

G. Manhole Rings and Covers
   1. Cast iron, heavy duty traffic type, ASTM A48, Class 35B. Grind bearing surfaces to ensure flat, true surfaces
   2. Covers to seat at all points on ring
   3. Lids
      a. All sanitary sewer lids shall be forged with the following: "Sanitary Sewer".
      b. Sewer manhole lids must be Denver Pick slot style model #1156
      c. Manufacturers
         i. Deeter Foundry
         ii. A-1480 by D&L Foundry,
         iii. East Jordan Iron Works
         iv. Or accepted substitution unless a bolted lid is required.
      d. Rings and covers shall be cast-iron. Manhole rings and covers shall be twenty-four (24) inch diameter manholes.
   4. Provide type as indicated on the drawings

H. Manhole Height Adjustment: Use precast concrete grade rings

I. Rock Subbase: 1-1/2 inch minus, well-graded gravel over compacted subgrade

J. Water: Clean and free of deleterious substances

K. Grout: Provide under provisions of Division 3 Specifications

2.10 GROUT MANUFACTURERS

A. Non-Shrink, Non-Metallic Grout
   1. Master Builders: Masterflow 928
   2. Burke: Non-Ferrous Non-Shrink
   3. M.R. Meadows: Sealtight 588
   4. Sonneborn: Sonogrout G.P.
   5. Tamms: Tammsgrout 621
   6. Sika: SikaGrout 212
   7. Or accepted substitution

B. Epoxy Grout
   1. Burke: BurkEpoxy Anchoring Grout
   2. L&M Inc.: Epogrout
   3. Sika: Sikadur 42, Grout Pack
   4. Or accepted substitution

2.11 SOIL MATERIALS

A. Furnish pipe bedding and cover as specified in Section 31 00 00 – Earthwork

PART 3 EXECUTION

3.1 INSPECTION

A. Examine pipe and fittings and do not use individual sections containing cracks, dents, abrasions, and other defects

3.2 INSTALLATION OF PVC GRAVITY SANITARY SEWER PIPE (NON-PRESSURE)

A. Trenching, Pipe Embedment, Backfill, and Compaction: See Section 31 00 00 - Earthwork
B. Install pipe in accordance with ASTM D2321 as modified herein or on the drawings
C. Cutting
   1. Cut and bevel ends in accordance with manufacturer's standard recommendations
   2. Machine cut ends smooth and square to proper dimensions
   3. Do not cut with a cold chisel, iron pipe cutter, flame or any other method that may fracture the pipe or leave ragged, uneven edges
   4. Remove burrs and wipe off all dust and dirt from jointing surfaces

D. Pipe Laying
   1. Inspect pipe and accessories for cracks and other defects before lowering into trench
   2. Repair or replace any defective, damaged or unsound pipe
   3. Remove all dirt and foreign material from the inside of pipe before laying
   4. Check bedding for firmness and uniformity of surface immediately before laying each section of pipe
   5. Carefully lower pipe, fittings, valves, and accessories into the trench with derricks, ropes, and other suitable equipment to prevent damage
   6. Do not dump or drop pipe or accessories into trench
   7. Lay to lines and grades indicated on drawings or as specified
      a. Lay piping beginning at a low point of system, true to line and grade with unbroken continuity of invert.
      b. Closely joint to form a smooth flow line
      c. Place bell end or groove ends of piping facing upstream
      d. Maximum length of pipe that can be used without exceeding the allowable deflection at a coupling shall be determined
   8. Utilize implements, tools, and facilities as recommended by the manufacturer
   9. Keep pipe clean during and after laying
   10. Close all open ends with watertight expandable type sewer plugs or test plugs
   11. Remove and relay any pipe which has floated
   12. Do not lay pipe when
      a. There is water in the trench
      b. Trench conditions are unsuitable
      c. Weather conditions are unsuitable
   13. Use acceptable adaptors at manhole and structure connections to provide a watertight seal
   14. Protect from lateral displacement by placing and compacting bedding material under provisions of Section 31 00 00 - Earthwork

E. Jointing
   1. Assemble in accordance with the manufacturer's instructions
   2. Wipe clean pipe ends, gasket and gasket groove before inserting gasket

3. Apply lubricant furnished by the pipe manufacturer to the gasket and the outside of the spigot end
4. Insert the spigot end to the reference mark

F. Fittings
1. Install utilizing standard methods
2. Lower into trench with rope or other means to prevent damage
3. Attach rope around the exterior
4. Do not attach rope through the interior
5. Carefully connect to pipe or other facility
6. Check joint to insure a sound and proper joint

G. Water Line and Sanitary Sewer Crossings
1. Whenever possible lay water mains over sanitary sewers to provide vertical separation of at least 18-inches between invert of water main and crown of sewer.
2. If above separation cannot be met, provide one continuous length of watertight sewer pipe 20 feet long centered on water main with concrete encasement. See Town standard detail D4.07 for pipe encasement.
3. Water Mains Passing Under Sewers: If vertical separation less than 18-inches provide structural support for sewer

3.3 MANHOLE PREPARATION

A. Verify items provided by other section of Work are properly sized and located

B. Verify that built-in items are in proper location, ready for roughing into Work

C. Verify excavation for manholes is correct

D. Excavation, Backfill, Subgrade Compaction: Refer to Section 31 00 00 - Earthwork for requirements

E. Rock Subbase
1. Remove water and place 6-inch minimum depth
2. Vibrate for compaction
3. Level top to accept precast sections with uniform bearing all around
4. If material below vault is unsuitable, excavate as directed by the Engineer and backfill to grade with 1-1/2 inch minus rock and compact

3.4 PLACING MANHOLE

A. Place manhole sections plumb and level. If not level, remove and re-level the grade.

B. Clean ends of sections and place double mastic gasket

C. Set cover rings and covers level without tipping, to correct elevations or set cover rings and covers with slight tip to match cross slope of finished surface where directed by Engineer

D. Completed manholes shall be rigid and watertight

E. Coordinate with other sections of work to provide correct size, shape, and location

F. For case-in-place:
1. Place base pad, trowel top surface level to accept manhole section with uniform bearing all around
2. Place sufficient non-shrink grout on base to ensure watertight fit between first manhole section and base of place first manhole section directly in wet concrete

3.5 PREFORMED GASKETS

A. Remove and replace manhole sections which have chipped or cracked joints

B. Thoroughly clean section joints

C. Install gasket in conformance with manufacturer's recommendations

D. Only use primer furnished by gasket manufacturer

3.6 MANHOLE INVERT

A. Place concrete in bottom of manhole and form smooth transition. Trowel smooth and brush for non-skid finish. Slope bench 1/2 inch per foot for drainage to invert.

B. Invert shape to conform to radius of pipe it connects

C. Remove all rough sections or sharp edges which tend to obstruct flow or cause material to snag. Remove all grout droplets from invert

D. Construct in conformance with standard drawings

3.7 MANHOLE RINGS AND COVERS

A. Place rings in bed of non-shrink grout on top of manholes

B. Ensure no infiltration will enter manhole at this location

C. Carry non-shrink grout over flange of ring

D. Manhole Lid Elevation
   1. If manholes are in cultivated fields, they should be left twenty (20) inches below grade unless directed otherwise by Town Engineer. Manholes in parks or detention basins must be above the flood plain. All other manholes in these types of areas should be no more than six (6) inches above grade. In these circumstances, bolt down ring and cover are to be used and properly marked carbonite composite utility marker located by a property line or other suitable site as close to the manhole as possible, with the off-set marked in feet to the centerline of the manhole cover.
   2. In paved roads, the manhole ring and cover shall be designed to final grade. In unpaved roads, the manhole ring and cover shall be designed to be six (6) inches below final grade.

E. Use precast grade rings for height adjustment of manhole ring and cover

3.8 CONNECTION TO EXISTING MANHOLES

A. Maintain flow at all times

B. Prior approval of proposed method for maintaining flow must be obtained from the Town

C. Cover area around new pipe with non-shrink grout and or waterstop gasket to ensure a watertight structure

D. Make connection during low flow periods

E. The contractor shall core drill the existing manhole as necessary to insert a “Kor-N-Seal or approved gasket and new sewer pipe.

F. The existing concrete foundation bench shall be ground to the cross-section of the new pipe in order to form a smooth, continuous invert similar to what would be formed in a new concrete base. Portland cement grout shall be used as necessary to smoothly finish the new

invert.

3.9 NEW MANHOLE CONNECTIONS TO ACTIVE SEWER LINES

A. When connecting to an active line, the connecting manhole shall be poured in place, Class "B" 4,500 psi concrete with a minimum thickness of eight inches (8) below the flow line of the pipe and four inches (4) above the crown is required.

B. Manhole inverts shall be formed to the full diameter of the pipe to insure full and unobstructed flow. Each pipe must extend no more than four (4) inches into the manhole wall to a formed concrete invert.

C. Pre-cast bases may be used when specifically authorized by the Town. Pipes extended through manholes and cut to form an invert are not acceptable without prior written permission from the Town.

3.10 FIELD QUALITY CONTROL – GENERAL TESTING REQUIREMENTS

A. Testing shall be accomplished through a combination of visual inspections, deflection tests, low-pressure air tests, and leakage test methods.

B. Sanitary sewer pipe and appurtenances shall be cleaned and tested after backfill operations have been completed and acceptable compaction test results have been submitted to the Town Engineer. All testing shall be completed and approved by the Town prior to placement of permanent resurfacing.

C. All testing shall be witnessed by the Town Engineer. The Contractor shall provide a minimum of 48 hours' notice to Town Engineer prior to testing. Tests performed in the absence of the Town's representative shall be considered invalid and shall be repeated at the Contractor's expense.

D. The Contractor shall provide the Town a final report of all testing completed.

E. New sanitary sewer installations shall be televised and as-built shots taken to verify design slope requirements by the Contractor after backfill operations have been completed. The results of the inspection and video shall be submitted to the Town Engineer for approval. Digital video files to be provided with reach noted, footage, inverts, and manhole number at each end, and pipe size and type. Water line installation may not begin until acceptable televised testing video and as-built shots have been submitted and reviewed by the Town

F. The Contractor shall have sewers jet washed on new installation prior to the initial television inspection. Debris resulting from the cleaning shall be removed before entering the Town's existing sewer, by either some type of plug or elbow to catch debris. Material shall be removed from the site and disposed of by the Contractor. If, on the initial television inspection, the cleaning is unsatisfactory and prevents the television inspection from being completed, the Contractor shall reclean the sewer and shall be responsible for costs incurred by a second television inspection.

G. Any damages to the pipe caused by cleaning or testing operations shall be repaired or replaced by the Contractor at their own expense. Should the pipe fail to meet the requirements of the low-pressure air test or infiltration of ground water is noted, the Contractor shall determine the source or sources of the leakage and shall replace defective materials or workmanship. Replacement of defective materials or workmanship as above noted shall be the financial responsibility of the Contractor. Pipe which fails to meet these requirements shall be repaired or replaced and retested in accordance with these requirements.

H. New sanitary sewer installations may also be televised by the Town for initial acceptance after the installation, cleaning, testing, and final lift of asphalt are complete. Inspection reports

and videos shall be available for review by the Responsible Party. The Responsible Party shall be responsible for any repairs or replacement of any portions of the pipeline that are determined defective by the television inspections.

I. Prior to the final acceptance there may be another television inspection performed by the Town. If there are any discrepancies, a punch list shall be formulated and sent to the Responsible Party. Any discrepancies must be repaired prior to final acceptance being granted.

3.11 PIPE TESTING

A. Low Pressure Air Test

1. The Contractor shall perform a low-pressure air test on each reach of sanitary sewer pipe between manholes. The low-pressure air test shall be required on the entire length of pipe installations. The test shall conform to the recommended practice and calculations established by the ASTM C-828.
2. Pipe outlets shall be plugged with suitable test plugs. Pipe may be tested without pre-wetting. If the pipeline to be tested is submerged in groundwater, the Responsible Party shall determine the groundwater elevation at the test location and provide it to the Town Engineer. The backpressure on the pipe due to groundwater shall be determined and the internal pipeline test pressure shall be established at 4.0 psi (gauge) in excess thereof. Add air slowly to the portions of the pipe being tested. After the pipe has been filled to the required pressure, allow at least two (2) minutes for the air-temperature to stabilize, adding only the amount of air necessary to maintain the test pressure. After the two (2) minute period, disconnect the air supply and allow the initial pressure to drop to 3.5 psi (gauge) in excess of the groundwater back pressure.
3. The time interval required for the sewer internal pressure to drop from 3.5 psi (gauge) to 2.5 psi (gauge) above the excess of ground water backpressure shall be measured and recorded.
4. The basis for acceptance of the air test shall be the minimum time required for the internal pressure to drop 1.0 psi (gauge). The calculations generated by ASTM C- 828 shall then be used to check the adequacy of the pipe installation. The minimum allowable time in seconds shall be in accordance with the following tables. The minimum allowable pressure drop time is computed based upon an allowable leakage rate not to exceed 0.003 cfm per square foot of internal pipe surface. Sewers 15 inches in diameter and smaller shall be tested from manhole to manhole. Sewers 18 inches in diameter and larger shall be tested in lengths such that the total loss is no less than two (2) cfm when computed using an allowable rate of 0.003 cfm per square foot of internal surface.
5. Minimum allowable pressure drop times for pipe 15 inches in diameter and smaller (in seconds) per table below

Pipe Diameter (Inches)	Length of Pipe Being Tested (Feet)			
	100	**200**	**300**	**400**
8	38	76	114	152
10	47	94	141	188
12	56	113	170	226
15	71	141	212	283

6. Minimum allowable pressure drop times for pipe 18 inches in diameter and larger (in seconds) per table below:

Pipe Diameter (Inches)	Length of Pipe Being Tested (Feet)					Maximum Testing Length (Feet)
	25	**50**	**75**	**100**	**126**	
18	21	42	64	85	106	**140**
21	25	50	74	99		**120**
24	28	56	85	113		**106**
27	32	64	95			**94**
30	35	71	106			**84**
36	42	85				**70**

The minimum allowable pressure drop time when using the maximum testing length is 120 seconds.

7. Sewers 36 inches in diameter shall be tested one (1) joint at a time.

8. The Responsible Party shall follow precautions necessary to perform a safe and successful test. Plugs used to isolate the line for the air test must be securely braced to avoid the unintentional release of the plug. Gauges, air piping manifolds, and control valves shall be located above ground. No one shall be permitted to enter a manhole when a plugged pipe is under pressure. Air testing apparatus shall be equipped with a pressure relief device designed to relieve the pressure when in excess of six (6) psi (gauge)

B. Exfiltration/Infiltration Test
   1. Contractor shall perform an exfiltration test on each reach of sanitary service and sanitary sewer pipe between manholes or discharge.
      a. Test the first reach prior to backfilling and before installing any of the remaining pipe
   2. Procedure
      a. Block off all manhole openings except those connecting with the reach under test
      b. Fill the line
         i. Average depth: 10 feet above invert except as required by manhole depth
         ii. Maximum depth at lower end: 25 feet above crown
         iii. Minimum depth at upper end: 5 feet above crown
      c. Add and measure water as required to maintain a constant level
         i. Air pocket entrapment shall be avoided when filling the line with water. Once filled with water, the system shall be allowed to stabilize for a period of one or two hours before starting the test.
         ii. Maximum exfiltration/infiltration: 0.039 gallons per inch of nominal diameter per hour per 100 feet of pipe.
         iii. For the purposes of exfiltration leakage, manholes shall be considered to be concrete pipe of the same diameter as the manhole i.e. 48, 60 or 72 – inch diameter
         iv. Maintain test for a minimum of 2 hours or as long as necessary, in the inspector's opinion, to locate all leaks
   3. Repair and retest any reach which exceeds the allowable exfiltration/infiltration
      a. If excessive ground water is encountered during construction of a sanitary sewer section or as requested by the Town Engineer, the infiltration test for leakage shall be used
      b. Maximum infiltration: 0.039 gallons per inch of nominal dimeter per hour per 100 feet of pipe
   4. Repair and retest any reach which exceeds the allowable infiltration
C. Infiltration

1. If excessive ground water is encountered during construction of a sanitary sewer section or as requested by the Town Engineer, the infiltration test for leakage shall be used.

2. Maximum infiltration: 0.039 gallons per inch of nominal diameter per hour per 100 feet of pipe.

3. Repair and retest any reach which exceeds the allowable infiltration

D. Pipe Deflection Test
   1. Pipe deflection test shall be completed if video inspection shows defects or as required by the Town Engineer.
   2. No sooner than 30 days after placement and compaction of backfill, but prior to placement of permanent surface materials, clean and mandrel each line to detect obstructions (deflections, joint offsets, lateral pipe intrusions, etc.)
   3. Use a rigid mandrel with diameter of at least 95 percent of the pipes specified average inside diameter and a length of the mandrel circular portion at least equal to the nominal pipe diameter
   4. Maximum allowable deflection is 5 percent of the base internal diameter. Mandrel outside diameters in inches are as follows:

Pipe Size (Inches)	Base I.D.	Mandrel O.D.
6	5.792	5.50
8	7.764	7.38
10	9.711	9.23
12	11.558	10.98

   5. Pull the mandrel through the pipe by hand
   6. Relay or replace all pipe exceeding the 5 percent deflection
   7. Retest repaired sections
   8. Maximum allowable deflection at end of one-year correction period, 7-1/2 percent of the base internal diameter tested in the same manner. Uncover and repair sections exceeding the allowable deflection

E. TV Inspection shall be provided as requested by the Town. Digital video files to be provided with reach noted, footage, inverts, and manhole number at each end, and pipe size and type

F. All sewer lines shall be inspected visually to verify accuracy of alignment and freedom from debris and obstructions. The full diameter of the pipe should be visible when viewed between consecutive manholes. The method of test can be photography, closed circuit television or visually lamping with mirrors and lights.

G. Lamp Test
   1. Each section between manholes will be lamped by Contractor in the presence the Town Engineer if requested
   2. A true circle will be required in the lamp tests to indicate a properly constructed sewer line
   3. Repair any sections not passing the lamp test at Contractor's expense.

3.12 MANHOLE TESTING

A. Test all manholes:
   1. Vacuum test:
      a. Plug all inlets and outlets in such a manner as to prevent displacement of plugs
      b. Install and operate vacuum tester head assembly in accordance with equipment specifications and manufacturer instructions
      c. Attach the vacuum pump assembly to the proper connection on the test head assembly. Ensure that vacuum inlet/outlet valve is closed

d. Inflate sealing element to twice the pressure test to be used. Do not over inflate
e. Start vacuum pump assembly engine and allow preset RPM to stabilize
f. Open vacuum inlet/outlet valve and evacuate manhole to 5-inches Hg (mercury)
g. Close vacuum inlet/outlet valve, disconnect vacuum pump and monitor vacuum. Record time for vacuum to drop from initial 5 inches Hg to 4 inches Hg.
h. Acceptance for 4-foot diameter manhole is when the time to drop from 5 inches Hg to 4 inches Hg meets or exceeds requirements as defined below:

Maximum Allowable Vacuum Drop		
Manhole Depth Rim to Invert	**Manhole Diameter (feet)**	**Time for Vacuum to Drop 1 Inch Hg**
10 feet or less	4	120 seconds
10 feet to 15 feet	4	150 seconds
15 feet to 25 feet	4	180 seconds

i. Adjust time to drop from 5 inches Hg to 4 inches Hg for other manhole diameters as follows:
    i. 5-foot diameter manhole: Add 30 seconds from time shown above ii) 6-foot diameter manhole: Add 60 seconds to time shown above
j. Repair all manholes that fail leakage test and retest until manhole passes test
k. If joint mastic or gasket is displaced during vacuum test, disassemble manhole and replace seal
l. If the manhole fails the initial test, necessary repairs should be made with a non-shrink grout. Repairs and retesting shall proceed until a satisfactory test is obtained.

2. All testing shall be witnessed by the Town Engineer or Town Inspector. Contractor shall provide a minimum 48-hour notice prior to testing.

3.13 TRACER WIRE TESTING

A. The Contractor shall provide test report for tracer wire continuity.

3.14 CLEANUP AND RESTORATION

A. Restore pavements, curbs and gutters, utilities, and other improvements to condition equal to or better than before work began and to satisfaction of the Town.

B. Deposit waste material in designated waste areas and disposal site graded and shaped.

3.15 FINAL ACCEPTANCE

A. The inside of all pipe, valves, and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand, and dirt when connected.
    1. Wire brush, if necessary, wipe clean and keep joint contact surfaces clean until connection is complete

B. Provide record drawings with manhole number, inverts, and location (x, y, z) for each service connection

C. Provide test report for tracer wire continuity

D. Provide pipe and manhole tests and results

E. Provide video files of TV inspection on a DVD

END OF SECTION

SECTION 33 40 00
STORM DRAINAGE SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping and concrete structures for storm sewer system, roof drainage, and culverts

B. Riprap for channel lining, outlet protection and rock check dams

1.2 REFERENCES

A. ACPA - American Concrete Pipe Association

B. ASTM – American Society for Testing and Materials
1. ASTM C76 - Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
2. ASTM C150 - Portland Cement
3. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
4. ASTM C478 – Precast Concrete Structures
5. ASTM C497 - Testing Concrete Pipe, Manhole Sections, or Tile
6. ASTM A48 - Gray Iron Castings
7. ASTM A185 - Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
8. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
9. ASTM C33 - Concrete Aggregates
10. ASTM C478 - Precast Reinforced Concrete Manhole Sections

C. Urban Storm Drainage Criteria Manual, Mile High Flood District (MHFD)

D. Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction

1.3 SUBMITTALS

A. Shop Drawings: Provide drawings with pipe and structure details, design standards, reinforcement, dimensions, etc. Provide additional detailed information (including elevations, fittings, specialty materials or fabrications, etc.) for special or custom features, structures, junctions and/or pipes. Provide pipe-laying schedule.

B. Product Data: Provide sufficient data on features, pipe, joints, gasket material, lubricant and accessories to verify compliance with specifications.

C. Manufacturers Certificate: Certify that pipe, meets or exceeds specified requirements. Confirm all materials comply with applicable standards.

D. Provide sufficient data to verify compliance with these specifications.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery
1. Ship rubber gaskets in cartons and store in a clean area away from grease, oil, ozone producing electric motors, heat and the direct rays of the sun

B. Storage
1. Store pipe, fittings and gaskets in clean locations protected from environmental conditions such as: (direct sunlight, mud, etc.)
2. Do not use pipe and fittings stored in direct sunlight for periods in excess of 18 months
3. Store pipe on a flat surface which provides even support for the barrel with bell ends overhanging

a. Do not stack pipe higher than 5 feet

C. Handling
1. Handle so as to insure installation in sound undamaged condition.
2. Use equipment, tools and methods for unloading, reloading, hauling and laying that do not damage pipe or cause an impact. Damaged pipe will be cause for rejection
3. Use hooks or straps with broad, well-padded contact surfaces for lifting sections of pipe

1.5 ENVIRONMENTAL REQUIREMENTS

A. Weather limitations: Do not install piping over frozen surfaces or in standing water.

PART 2 PRODUCTS

2.1 PIPE MATERIALS

A. General: Provide pipes of one of the following materials, of weight/class indicated. Provide pipe fittings and accessories of same material and weight/class as pipes, with joining method as indicated

B. Fittings: Furnish bends, ells, tees, wyes, couplings and other fittings of the same type and class of material having equal or superior physical and chemical properties as acceptable to the Engineer

C. Reinforced Concrete Pipe: ASTM C76
1. 12-inch RCP Class V, with modified tongue-and-groove compression gasket joints complying with ASTM C443.
2. 15-inch RCP Class IV (Class V when specified on plans), with modified tongue-and-groove compression gasket joints complying with ASTM C443.
3. 18-inch thru 24-inch RCP Class III (Class IV or V when specified on plans), with modified tongue-and-groove compression gasket joints complying with ASTM C443.
4. 24-inch thru 36-inch RCP Class II (Class III, IV or V when specified on plans), with modified tongue-and-groove compression gasket joints complying with ASTM C443.

D. PVC Sewer Pipe: ASTM D3034, Type PSM, SDR 35 with PVC, elastomeric joints complying with ASTM D3212 using elastomeric seals complying with ASTM F477.

E. HDPE Sewer Pipe: smooth interior, corrugated exterior piping conforming to ASTM D 2412, ASTM D 3212, AASHTO specifications M252 and M 294, joints to conform to ASTM F 477.

F. Corrugated Metal Pipe (CMP): AASHTO M218 or ASTM A444, helically or circumferentially corrugated, mill galvanized steel.
1. Furnish galvanized sheet metal, 16 gauge, 0.064-inch galvanized thickness, 0.0598- inch base metal thickness and size of conduit as indicated. Sizes indicated are minimal inside diameters.
2. Furnish width and lap depths and corrugations conforming to AASHTO M36.

G. Corrugated Aluminum Pipe (CAP): ASTM M197 helically or circumferentially corrugated.
1. Aluminum alloy, 16-gauge, Size shown on approved drawings
2. Furnish width and lap depths and corrugations conforming to AASHTO M196.

H. Perforated PVC Sewer Pipe: ASTM D3034, Type PSM, SDR 35 with PVC, elastomeric joints complying with ASTM D3212 using elastomeric seals complying with ASTM F477.

2.2 MATERIALS

A. Plugs and Caps: Use pipe plugs or caps provided by the pipe manufacturer and approved by the Engineer for pipe stubouts.

B. Cleanouts: Provide as indicated, pipe extension to grade with ferrule and countersink cleanout plug. Provide round cast-iron access frame over cleanout, with heavy duty secured

scoriated cover with lifting device cast with the word “STORM”.

C. Reinforcement
   1. Reinforcing Steel: ASTM A615 Grade 60
   2. Welded Wire Fabric: ASTM A185

D. Concrete:
   1. Minimum compressive strength: ASTM C39, 4500 psi at 28 days
   2. Cement: ASTM C150, Portland Cement, Type II
   3. Aggregates: ASTM C33, free of deleterious substances

E. Gaskets: ASTM C923
   1. Mastic: FS SS-S-210A, "RAM-NEK" or accepted substitution
   2. Rubber: Neoprene, 40+ 5 hardness when measured by ASTM D2240, Type A durometer

F. Inlet Gratings and Manhole Rings and Covers
   1. Cast iron, heavy duty traffic type, ASTM A48, Class 35B. Grind bearing surfaces to ensure flat, true surfaces
   2. Provide bike/pedestrian-safe grates where such traffic is anticipated
   3. Set grate on frame such that openings maximize inlet intake
   4. Covers to seat at all points on ring
   5. Rings and covers shall be cast-iron. Manhole rings and covers shall be twenty-four (24) inch diameter manholes.
   6. Covers to be cast with "STORM SEWER" in 1 1/2" tall flush letters in addition to the symbol of a fish with the phrase “DUMP NO WASTE, DRAINS TO WATERWAYS”.
   7. Manhole lids to be manufactured by East Jordan Iron Works, or accepted substitution.
   8. Manhole covers to receive asphalt varnish coating hot dip applied at foundry, 6 mils thick

G. Manhole Height Adjustment: Use precast concrete grade rings

H. Rock Subbase: 1-1/2 inch minus, well-graded gravel over compacted subgrade

I. Water: Clean and free of deleterious substances

J. Grout:
   1. Non-Shrink, Non-Metallic Grout: Factory premixed compound consisting of non- metallic aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 4000 psi in one day and 8000 psi in 7 days
   2. Epoxy Grout: Three Component Epoxy Resin System
      a. Two liquid epoxy components
      b. One inert aggregate filtered component
      c. Each component furnished in separate package for mixing at job site

2.3 CONCRETE CATCH BASINS AND MANHOLES

A. Comply with Town of Berthoud Standard Details and CDOT standards and specifications for public storm sewer products.

B. Precast Concrete Units:
   1. Manufacturers:
      a. Carder Concrete Products
      b. Amcor Precast
      c. or accepted equal
   2. Specification: ASTM C478 and C789, wall “B
      a. Minimum wall thickness: greater of 6 inch 1/12 of internal diameter
      b. Reinforced

c. Grade rings as required
d. Cast steps into units

C. Precast Units or Cast-in-place as shown. Use concrete that will attain a 28-day compressive strength of not less than 4500 psi with a cement content of not less than 6 sacks per cu. yd. Openings to be precast per plan or sawcut in field.

D. Cast-in-place Concrete Units: As shown on the drawings complying with the Town of Berthoud, LCUASS, and Colorado Department of Transportation drainage and design standards.

2.4 PVC PLASTIC INLINE DRAINS AND DRAIN BASINS

A. Manufacturer:
1. Nyloplast America Inc.
2. or accepted substitution.

B. Inline drains and drain basins shall be manufactured from PVC pipe stock, utilizing a thermo molding process to reform the pipe stock to the furnished configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. The joint tightness shall conform to ASTM D3212.

C. Surface drainage products shall meet the mechanical property requirements for fabricated fittings as described in ASTM F794, F949 and F1336.

D. Inline drain and drain basin adapters and accessories
1. Adaptable to SDR-35 PVC piping.
2. Watertight adaptors.

E. Cast iron or ductile iron frames and grates:
1. Light-traffic rated
2. Pedestrian rated
3. Hinged and locking
4. Made specifically for use with the specified inline drains and drain basins
5. Painted black
6. ASTM A-48-83 Class 30B or A536 grade 70-50-05 grade iron
7. Size indicated on the approved drawings

2.5 CONCRETE FABRICATION

A. Vault/Manhole Sections
1. Precast concrete dimensions as shown on plans
2. Minimum manhole inside diameter: 48 inch
3. Precast lid and Cones: Same or greater reinforcement and wall thickness as vault or manhole section with capability for H20 loading
4. Vault Joints: Shiplap or tongue and groove with double mastic gaskets, each joint to set equally and tightly
5. Manhole Joints: Keylock type with double mastic gaskets, each joint to set equally and tightly
6. Access opening: Minimum 24 clear or as indicated
7. Pipe connection: As indicated on Drawings
8. Pipe knockout: As indicated on Drawings
9. Precast concrete, monolithic base or cast-in-place base
10. Manhole steps: 12 inch on center, vertical alignment above largest bench or open area

B. Grating and Metal Frame: As specified on approved drawings

2.6 SOIL MATERIALS

A. Furnish pipe bedding and cover as specified in Section 31 00 00 – Earthwork

B. Riprap Materials:
   1. Hard, dense, durable stone, angular in shape and resistant to weathering
   2. Minimum specific gravity of 2.5
   3. Material may be approved by Engineer, if by visual inspection, the rock is determined to be sound and durable
   4. Town Engineer may require Contractor to furnish laboratory test results if the material appears to be marginal or unacceptable
   5. Tested material shall meet the following requirements for abrasion resistance or compressive strength:

Test	Test Method	Requirement
Abrasion Resistance by Los Angeles Machine	ASTM C 535	50% loss, max
Unconfined Compressive Strength of Drilled Core Specimen	AASHTO T 24	2500, min

   6. Gradation:

Riprap Designation	% Smaller Than Given Size By Weight	Intermediate Rock Dimension (Inches)	Mean Particle Size,d50 (Inches)
Type L	70-100 50-70 35-50 2-10	15 12 9 3	9
Type M	70-100 50-70 35-50 2-10	21 18 12 4	12
Type H	70-100 50-70 35-50 2-10	30 24 18 18 6	18

7. Granular Riprap Bedding:
   a. 3/4" – 1" Crushed rock – AASHTO 57/67

Sieve Size	Percent Passing by Weight
1"	100
3/4"	90-100
1/2"	25-60
3/8"	20-55
NO. 4	0-10
NO. 8	0-5
NO. 200	0-2

C. Pipe Bedding:
   1. Refer to Section 31 00 00 – Earthwork
   2. Minimum 6 inch deep, unless specified otherwise

D. Drainage Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
   1. Grab Tensile Strength: 110 lbf (490 N); ASTM D 4632.
   2. Tear Strength: 40 lbf (178 N); ASTM D 4533.
   3. Puncture Resistance: 50 lbf (222 N); ASTM D 4833.
   4. Water Flow Rate: 150 gpm per sq. ft. (100 L/s per sq. m); ASTM D 4491.
   5. Apparent Opening Size: No. 50 (0.3 mm); ASTM D 4751.

PART 3 EXECUTION

3.1 PIPE PREPARATION

A. Shape trench and place bedding as specified in Section 31 00 00 and as shown on the drawings.
   1. Dig bell or coupling holes
   2. Do not support pipe on blocks or mounds of earth.
   3. Provide uniform and continuous bearing and support for full length of pipe between bell holes
   4. Minor disturbance over a maximum length of 18 inches near the middle of each length of pipe will be permissible by the withdrawal of pipe slings or other lifting tackle

B. Alignment and Grade
   1. Except as indicated on the Drawings, lay all pipe straight and at a uniform grade.
   2. Use batter boards to determine and check pipe subgrades.Other methods of maintaining alignment and grade may be acceptable if approved by the Town Engineer.

3.2 PIPE INSTALLATION

A. Inspect pipe and accessories for defects before lowering into trench. B. Replace any defective, damaged or unsound pipe.

B. Carefully lower pipe, fittings, and accessories into the trench with derricks, ropes, and other suitable equipment to prevent damage. Do not dump or drop pipe or accessories into trench.

C. Pipe embedment shall be as specified in Section 31 00 00 for pipe.

D. Protect from lateral displacement by placing the specified pipe embedment material.

E. Do not lay pipe in water, under unsuitable weather conditions or under unsuitable trench conditions

F. Joint to form true and smooth line.

G. Remove any pipe not making a good fit.

H. Begin pipe laying at the lowest point unless reverse laying is accepted by Engineer.

I. Utilize implements, tools and facilities as recommended by the manufacturer and/or catch basins if required to remove debris.

J. Keep pipe clean during and after laying.

K. During construction, close all open ends with watertight expandable type plugs.
   1. At the end of each day's operations.
   2. Whenever pipe ends are left unattended.
   3. Deposit adequate backfill on pipe to prevent flotation.
   4. 4Do not use wood, burlap or other similar temporary plugs.

L. Remove and re-lay any pipe which has floated.

3.3 PRECAST STRUCTURE PREPARATION

A. Verify items provided by other section of Work are properly sized and located

B. Verify that built-in items are in proper location, ready for roughing into Work

C. Verify excavation for manholes is correct

D. Excavation and Backfill: Refer to Section 31 00 00 - Earthwork for requirementsCoordinate placement of inlet and outlet pipe or duct sleeves required by other sections

E. Rock Subbase: Remove water, excavate, and place 1-1/2 inch washed rock 6-inch minimum depth, vibrate for compaction

3.4 CATCH BASINS

A. Construct catch basins to the sizes and shapes indicated, and to conform to requirements of authorities having jurisdiction.
   1. Rock Subbase: Remove water, excavate, and place 1-1/2 inch washed rock 6-inch minimum depth, vibrate for compaction
   2. For precast units, set in place to accurate elevations on firm, solid bed, plumb and level.
   3. Pipe openings, elevations and alignment per plans
   4. Seal and grout all pipe penetrations
   5. Set cast iron frames and gratings to the elevations indicated.

3.5 PLACING MANHOLE SECTION OR CAST-IN PLACE BASE

A. Rock Subbase: Remove water, excavate, and place 1-1/2 inch washed rock 6-inch minimum depth, vibrate for compaction

B. Place base pad, trowel top surface level to accept manhole section with uniform bearing all around

C. Place sufficient non-shrink grout on base to ensure watertight fit between first manhole section and base or place first manhole section directly in wet concrete

D. Place manhole sections plumb and level, trim to correct elevations

E. Clean ends of sections and place double mastic gasket

F. Fill inside and outside of joint completely with non-shrink grout and trowel smooth

G. Cure non-shrink grout using approved methods

H. Set cover rings and covers level without tipping, to correct elevations or set cover rings and covers with slight tip to match cross slope of finished surface where directed by Town

Engineer

I. Completed manholes shall be rigid and watertight

J. Coordinate with other sections of work to provide correct size, shape, and location

3.6 PREFORMED GASKETS

A. Remove and replace manhole sections which have chipped or cracked joints

B. Thoroughly clean section joints

C. Install gasket in conformance with manufacturer's recommendations

D. Only use primer furnished by gasket manufacturer

3.7 MANHOLE INVERT

A. Place concrete in bottom of manhole and form smooth transition. Trowel smooth and brush for non-skid finish. Slope bench 1/2 inch per foot for drainage to invert.

B. Invert shape to conform to radius of pipe it connects

C. Remove all rough sections or sharp edges which tend to obstruct flow or cause material to snag. Remove all grout droplets from invert

D. Construct in conformance with standard drawings

3.8 MANHOLE RINGS AND COVERS

A. Place rings in bed of non-shrink grout on top of manholes

B. Ensure no infiltration will enter manhole at this location

C. Carry non-shrink grout over flange of ring

D. Set top of ring flush with all surfaces subject to foot and vehicular traffic

E. Set top of ring 6 inches above surfaces in open, unraveled, non-pedestrian areas

F. Use precast grade rings for height adjustment

3.9 CONNECTION TO EXISTING MANHOLES

A. Maintain flow at all times

B. Prior approval of proposed method for maintaining flow must be obtained from Engineer

C. Cover area around new pipe with non-shrink grout and or waterstop gasket to ensure a watertight structure

D. Make connection during low flow periods

3.10 GROUT

A. PREPARATION

1. Non-Shrink, Non-Metallic Grout, General Use
    a. Clean concrete surface to receive grout
    b. Saturate concrete with water for 24 hrs prior to grouting and remove excess water just prior to placing grout
    c. Cold weather conditions
        i. Warm concrete, substrate and base plate to 40 deg F, or above; store grout in warm area

ii. Follow manufacturer's recommendations for cold weather application d. Hot weather conditions

d. Hot weather conditions
   i. Use cold mixing water and cool base plate if possible; store grout in cool area
   ii. Follow manufacturer's recommendations for hot weather application
e. Apply to clean, sound surface
f. Apply latex bonding agent to hardened concrete, mix-in-grout, or as directed by Engineer

2. Epoxy Grout:
   a. Apply only to clean, dry, sound surface
   b. Patching cavities in concrete including, but not limited to, tie holes, and structural and equipment support

B. APPLICATION
1. Non-Shrink, Non-Metallic Grout
   a. Mix in a mechanical mixer
   b. Use no more water than necessary to produce flowable grout
   c. Provide air vents where necessary to eliminate air pockets
   d. Place in accordance with manufacturer's instructions
   e. Where exposed to view finish grout edges smooth
   f. Protect against rapid moisture loss by immediately covering with wet rags and polyethylene sheets or curing compound
   g. Wet cure grout for 7 days, minimum
   h. Maintain the temperature at a minimum of 40 deg F until grout reaches 3000 psi
      i. After placement of grout, eliminate excessive external vibration
2. Epoxy Grout
   a. Mix and place in accordance with manufacturer's instructions
   b. Completely fill all cavities and spaces around dowels and anchors without voids
   c. Obtain manufacturer's technical assistance as required to insure proper placement

3.11 RIPRAP

A. Do not place riprap over frozen or spongy subgrade surfaces.

B. Place riprap at pipe outlets and in channels as indicated on plans. Top of riprap to match invert of outlet pie and channels.

C. Excavate and prepare subgrade.

D. Place geotextile fabric per plans under all bedding. Place bedding and place riprap on bedding per plans.

E. Material may be machine placed and then arranged as necessary by use of a Gradall with multi-prong grapple device or by hand to minimize voids. Dumping alone is not sufficient to achieve properly placed riprap.

3.12 FIELD QUALITY CONTROL

A. Field inspection and testing including a lamp test will be performed for every section of pipe after backfill has occurred
   1. Contractor shall furnish suitable assistance to the Engineer
   2. A minimum of 75% of a true circle will be required to indicate a properly constructed line
   3. Contractor will repair any section not passing the lamp test.

B. Request inspection immediately after placing cover over pipe.

C. Backfilling and testing as required per Section 31 00 00 - Earthwork.

END OF SECTION

TOWN OF BERTHOUD

APPENDIX B
STANDARD DETAILS

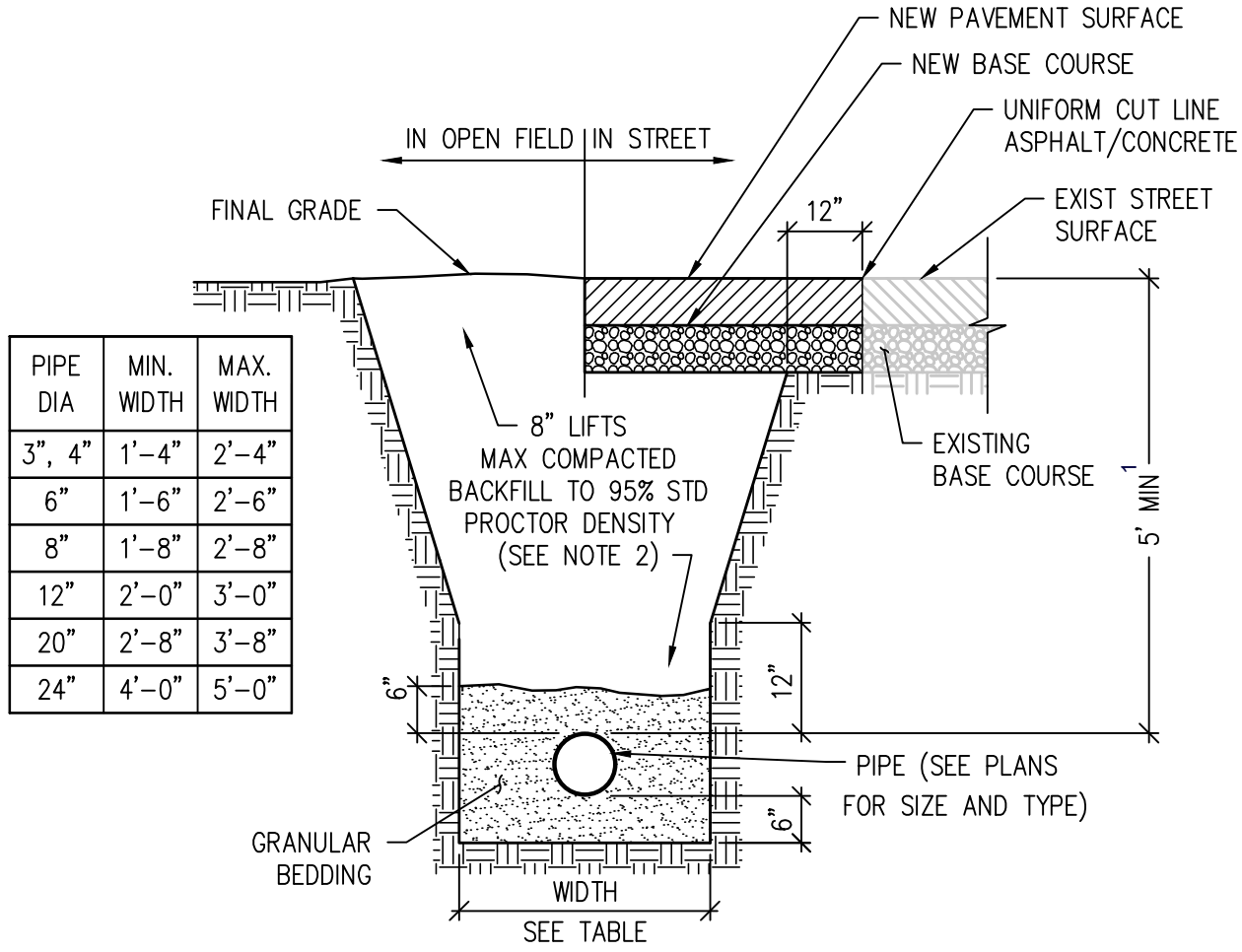
STANDARD DETAILS

D0.01 Typical Trench Detail
D0.02 Trench (Dipping Bedrock & Expansive Soils)
D0.03 Standard Manhole
D0.04 Manhole Ring and Cover – Non-Bolted
D0.05 Manhole Ring and Cover - Bolted
D0.06 Plastic Manhole Step
D0.07 Manhole Base
D0.08 Manhole Base and Deflector
D0.09 Utility Marker Post
D0.10 Trench Stop
D0.11 Town of Berthoud Approval Block

D4.01 Sanitary Drop Manhole
D4.02 Monitoring Sanitary Manhole
D4.03 Monitoring Sanitary Manhole Diagrams
D4.04 Sanitary Cleanout
D4.05 Typical Service Connection
D4.06 Tapping Saddle
D4.07 Pipe Encasement
D4.08 Concrete Collar Underdrain
D4.09 Two-Way Cleanout

D5.01 Fireline Connection with Main Extension
D5.02 Fire Hydrant Profile
D5.03 Fireline Tracer Wire
D5.04 PRV Rectangular Vault Plan View
D5.05 PRV Rectangular Vault Cross Section
D5.06 PRV Manhole Plan View
D5.07 PRV Manhole Cross Section
D5.08 2-inch Air and Vacuum Valve Installation
D5.09 Blow-Off Installation – 12-inch And Smaller Pipe
D5.10 Blow-Off Detail
D5.11 Crossing Over or Under Conflicting Utility
D5.12 Meter Vault Assembly
D5.13 Service Line, Stop Box, Outside Meter Installation
D5.14 Outside Setting for 0.75-inch and 1-inch Meter
D5.15 Outside Setting for 1.5-inch and 2-inch Meter
D5.16 Direct Bury Butterfly Valve Installation
D5.17 Gate Valve
D5.18 Floor Pipe Support
D5.19 Residential Vent Assembly
D5.20 Wall Penetration with Core Hole
D5.21 Pressure Gauge
D5.22 Mechanical Joint Restraint
D5.23 Concrete Thrust Blocks 1 of 2
D5.24 Concrete Thrust Blocks 2 of 2
D5.25 Tapping Tee and Valve
D5.26 Insulated Joint, Rod, and Coupling
D5.27 Polyethylene Wrap

D6.01 Storm Cleanout
D6.02 Storm Sewer Bedding Detail
D6.03 CMP Type 1 Flared End Section
D6.04 Riprap Apron Sizing & Placement at Flared End Section
D6.05 Type C Inlet
D6.06a Combination Inlet (1 of 2)
D6.06b Combination Inlet (2 of 2)
D6.07 Direct Connection RCP To PVC Connection
D6.08a Valley Inlet (CDOT Type 13) (1 of 2)
D6.08b Valley Inlet (CDOT Type 13) (2 of 2)
D6.09a Type R Curb Inlet (1 of 3)
D6.09b Type R Curb Inlet (2 of 3)
D6.09c Type R Curb Inlet (3 of 3)
D6.10 Small Pipe Headwall
D6.11 Headwall with Circular Pipe
D6.12 Low Flow Channel
D6.13 Emergency Overflow



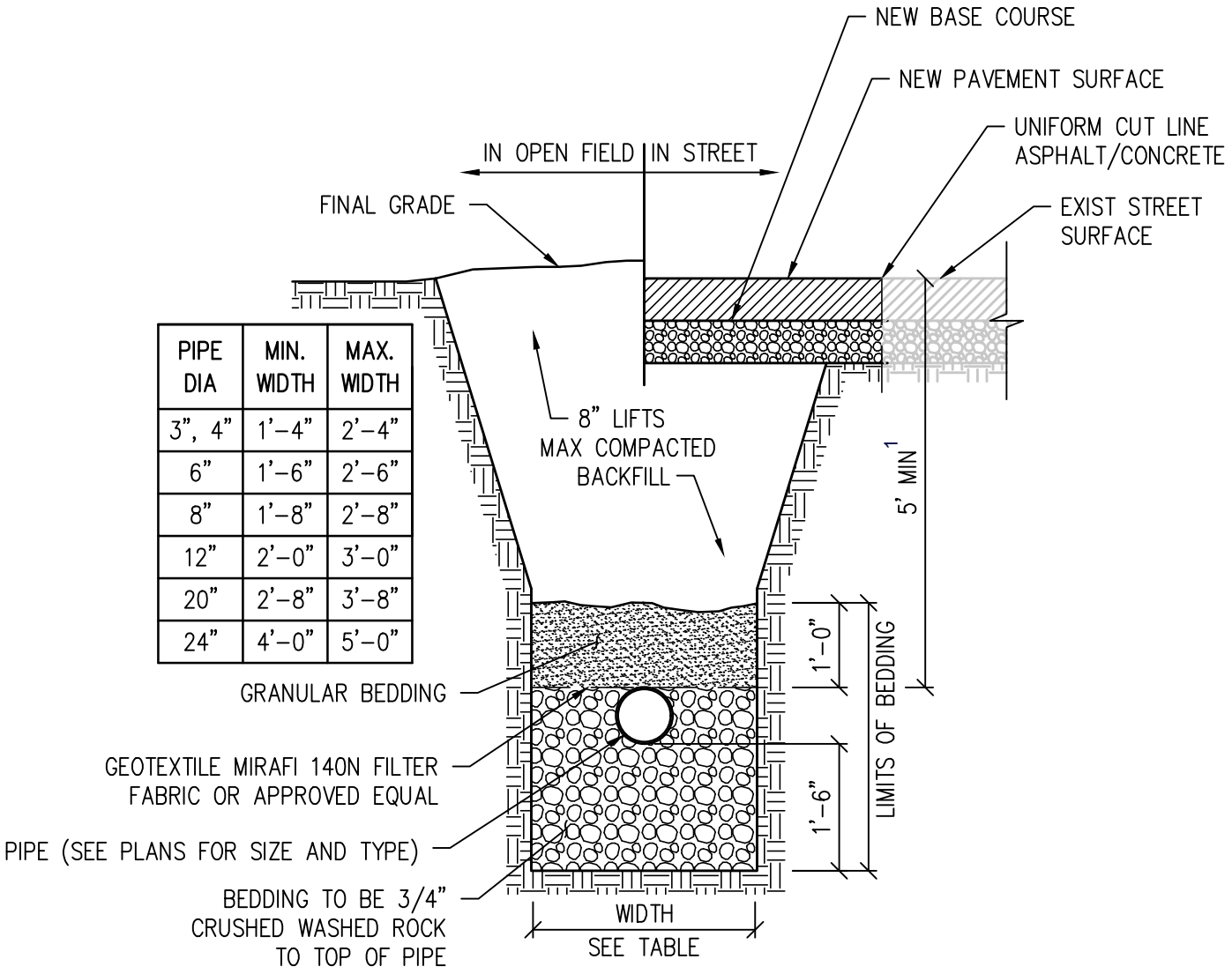
PIPE DIA	MIN. WIDTH	MAX. WIDTH
3", 4"	1'-4"	2'-4"
6"	1'-6"	2'-6"
8"	1'-8"	2'-8"
12"	2'-0"	3'-0"
20"	2'-8"	3'-8"
24"	4'-0"	5'-0"

NOTES:

1. MINIMUM COVER 5' FOR WATER AND SANITARY SEWER
2. COMPACTED BACKFILL TO 90% STD PROCTOR DENSITY IN NON-DRIVING SURFACES AND 95% UNDER PAVEMENT
3. SHOULD THE TRENCH BE EXCAVATED WIDER THAN ALLOWED, A CONCRETE CRADLE SHALL BE PLACED WITH 2500PSI CONCRETE FROM TRENCH BOTTOM TO PIPE SPRINGLINE
4. TRENCH TO BE BRACED OR SHEETED AS NECESSARY FOR THE SAFETY OF THE WORKERS AND THE PROTECTION OF OTHER UTILITIES IN ACCORDANCE WITH LOCAL, STATE, FEDERAL, & OSHA SAFETY REGULATIONS
5. PAVING SHALL COMPLY WITH LOCAL AUTHORITY JURISDICTION

SCALE: NTS

TOWN OF BERTHOUD	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA GENERAL DETAILS	D0.01
	TYPICAL TRENCH DETAIL	DATE: 12/2020



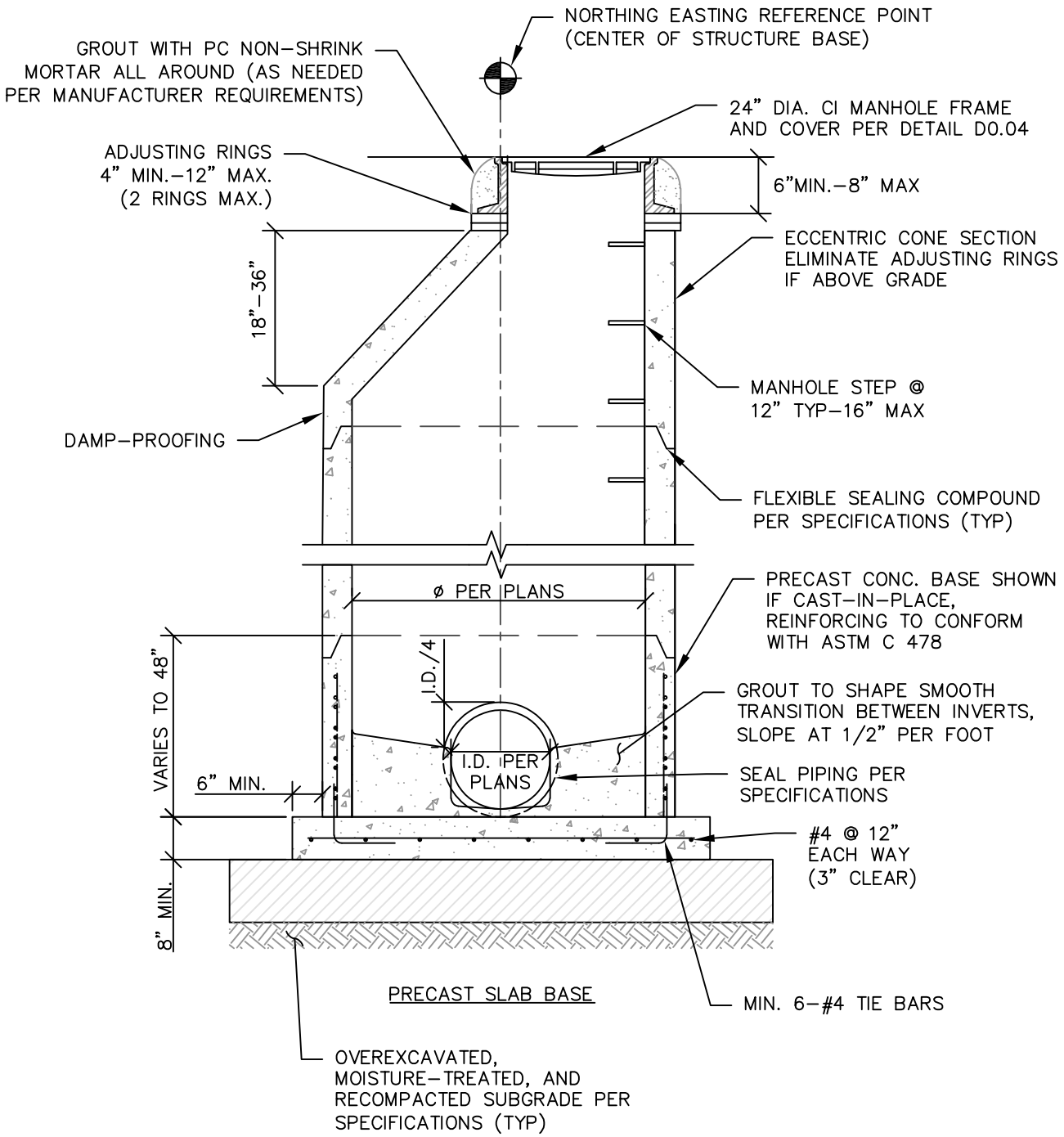
PIPE DIA	MIN. WIDTH	MAX. WIDTH
3", 4"	1'-4"	2'-4"
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NOTES:

1. MINIMUM COVER 5' FOR WATER AND SANITARY SEWER
2. SHOULD THE TRENCH BE EXCAVATED WIDER THAN ALLOWED, A CONCRETE CRADLE SHALL BE PLACED WITH 2500PSI CONCRETE FROM TRENCH BOTTOM TO PIPE SPRINGLINE
3. TRENCH TO BE BRACED OR SHEETED AS NECESSARY FOR THE SAFETY OF THE WORKERS AND THE PROTECTION OF OTHER UTILITIES IN ACCORDANCE WITH LOCAL, STATE, FEDERAL, & OSHA SAFETY REGULATIONS
4. COMPACTION SHALL BE AS FOLLOWS: PIPE ZONE BEDDING 18" UNDER AND 12" OVER PIPE WILL REQUIRE 90% SPD TRENCH ZONE ABOVE BEDDING MATERIALS, OUTSIDE OF STREET ROW WILL REQUIRE 90% SPD, INSIDE OF STREET ROW WILL REQUIRE 95% SPD

SCALE: NTS

TOWN OF BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA GENERAL DETAILS	D0.02
	TRENCH (DIPPING BEDROCK & EXPANSIVE SOILS)	DATE: 12/2020

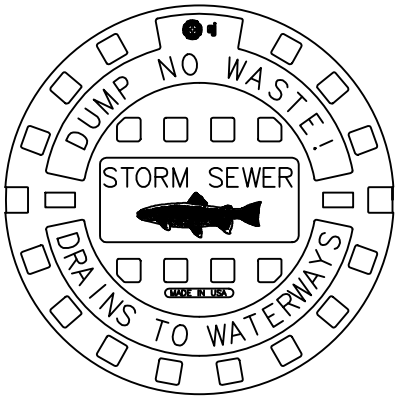


NOTES:

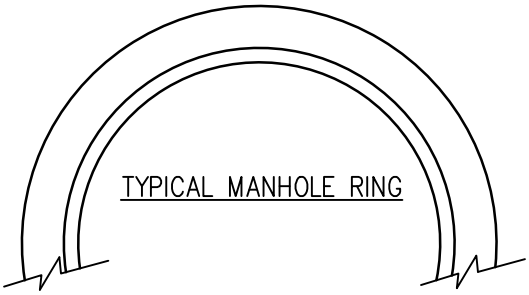
1. SHAPING FOR SMOOTH MANHOLE INVERTS MUST BE DONE BY FORMING OR SHAPING BASE CONCRETE.
2. BLOCK-OUTS WHEN APPROVED SHALL EXTEND A MAX OF 6" PAST MANHOLE OD AND BE SATISFACTORILY PLUGGED AND SEALED.
3. CONCRETE MANHOLE BASES MAY BE POURED IN PLACE WITH PRIOR APPROVAL.
4. ALL MORTAR SHALL BE MIXED WITH A TYPE II CEMENT.
5. BENCH MUST HAVE A BRUSHED, NON-SKID SURFACE.

SCALE: NTS

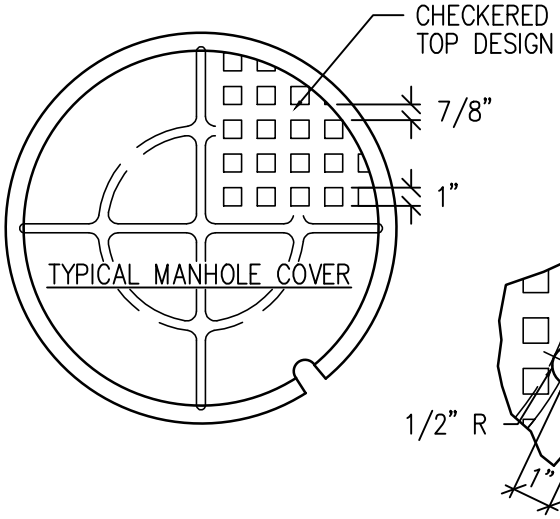
TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA GENERAL DETAILS	D0.03
	STANDARD MANHOLE	DATE: 10/2025

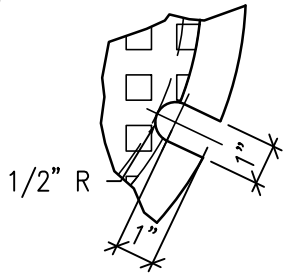


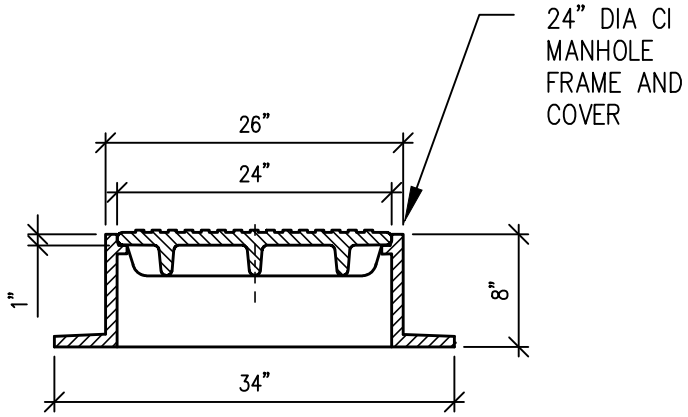
TYPICAL STORM COVER



TYPICAL MANHOLE RING





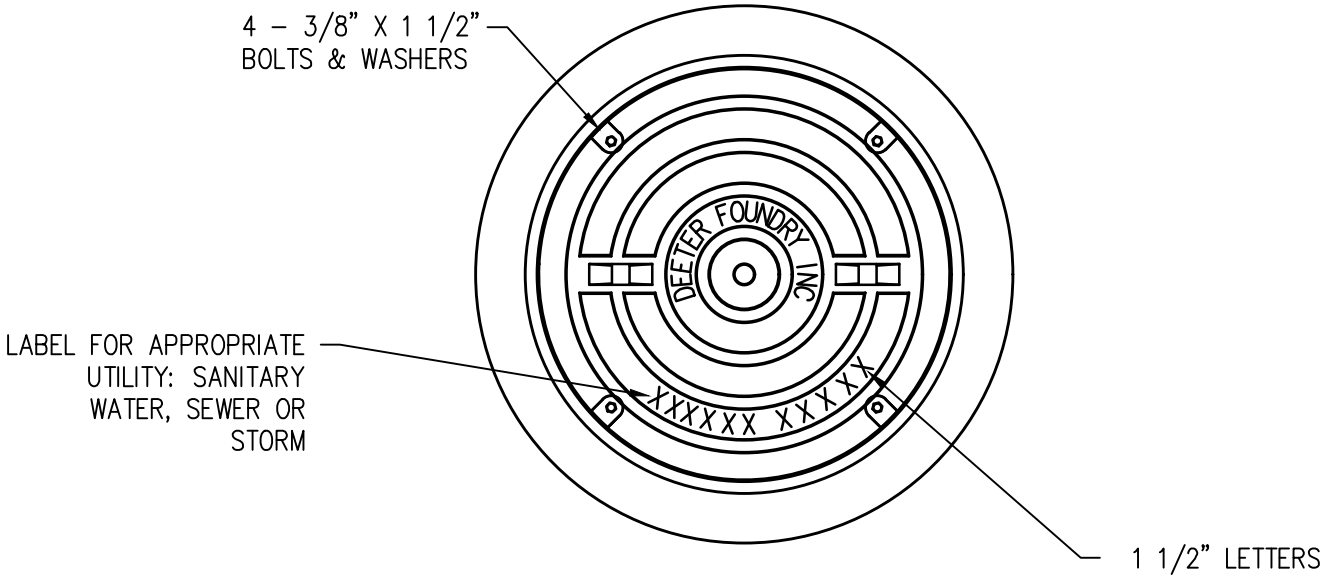


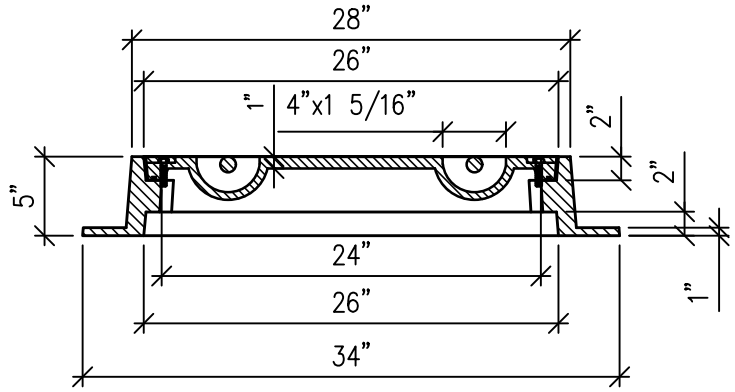
NOTES:

1. ASTM DESIGNATION A-48 CLASS 35B (UNPAINTED) W/ MIN TENSILE STRENGTH KSI (CLASS 25)
2. 1-1/2" LETTERING ON COVER AS REQUIRED (WATER, SEWER, OR STORM). SEE STORM COVER DETAIL ABOVE FOR ADDITIONAL REQUIREMENTS
3. ALL BEARING SURFACES TO BE MATCHED
4. TOTAL MINIMUM WEIGHT APPROXIMATELY 400 LBS CAST IRON ONLY
5. LIFTING NOTCH SHALL NOT EXTEND PAST INSIDE FACE OF RING SEAT
6. MIN FRAME WEIGHT 235 LBS, MIN LID WEIGHT 165 LBS

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA GENERAL DETAILS	D0.04
	MANHOLE RING AND COVER – NON-BOLTED	DATE: 12/2020



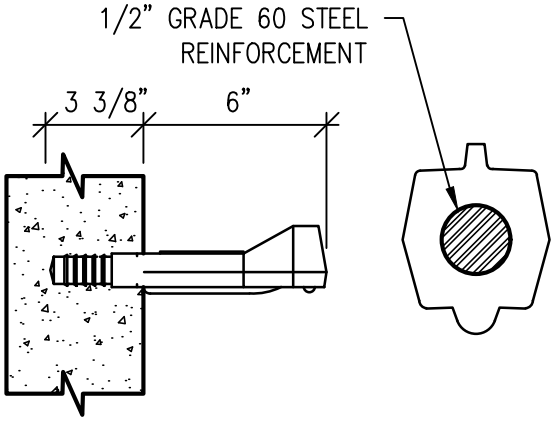


NOTES:

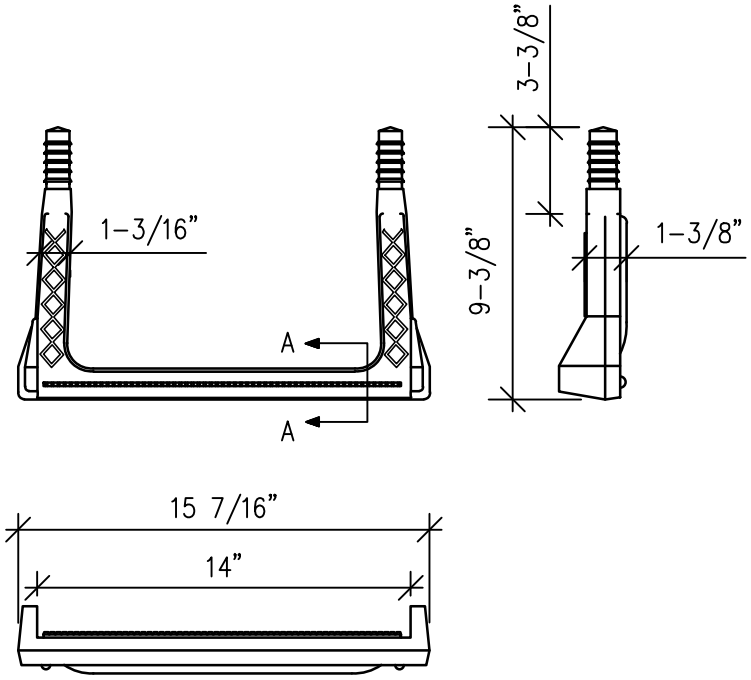
1. RING AND COVER SHALL BE IRON (AS MANUFACTURED FOR CURRENT AWWA STANDARD).
2. 1–1/2" LETTERING ON COVER AS REQUIRED (WATER, SEWER OR STORM).
3. COVER SHALL BE BOLTED, WATER RESISTANT IF LOCATED IN 100 YEAR FLOOD PLAIN, BACK YARDS, OPEN SPACE AND/OR DITCHES BELOW GROUND OR AS SPECIFIED BY THE TOWN.
4. MANHOLE LID AND RING SHALL BE FURNISHED WITH MACHINED HORIZONTAL BEARING SURFACES.
5. COVER IS BOLTED TO FRAME.
6. MANHOLE LID AND RING SHALL BE FURNISHED WITH GASKET.

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA GENERAL DETAILS	D0.05
	MANHOLE RING AND COVER – BOLTED	DATE: 12/2020



SECTION–A



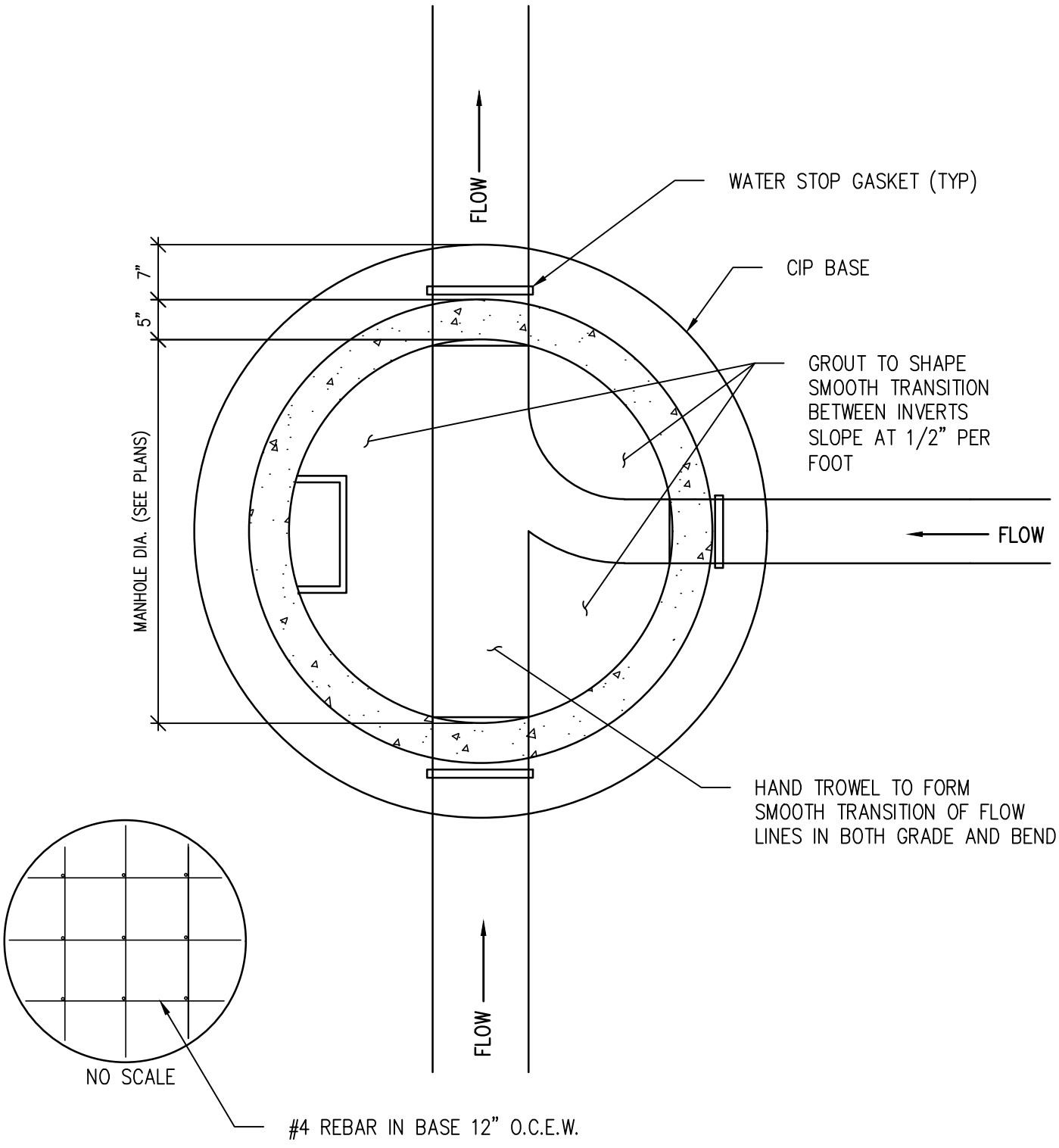
COPOLYMER POLYPROPYLENE PLASTIC

NOTES:

1. AS MANUFACTURED BY M.A. INDUSTRIES (MODEL NO. PS2–PF) OR APPROVED SUBSTITUTION SPACED AT 12" NOT GREATER THAN 16"

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA GENERAL DETAILS	D0.06
	PLASTIC MANHOLE STEP	DATE: 12/2020

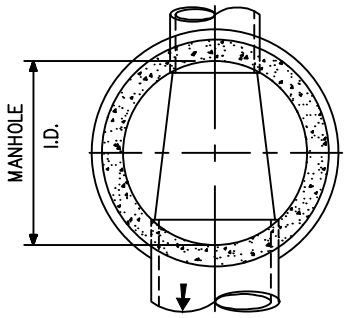


NOTES:

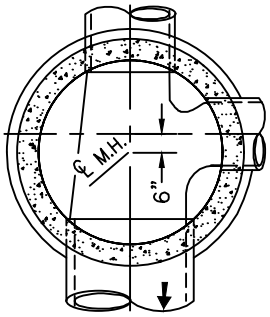
1. FLOW DIRECTION CHANGE 90 DEGREES, MINIMUM

SCALE: NTS

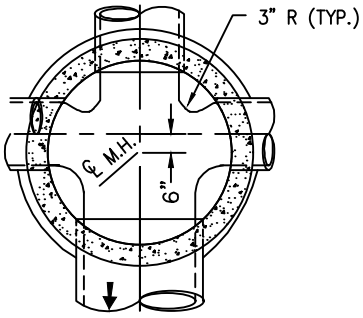
TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA GENERAL DETAILS	D0.07
	MANHOLE BASE	DATE: 12/2020



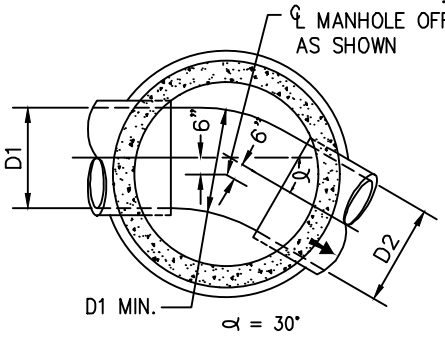
THROUGH MANHOLE



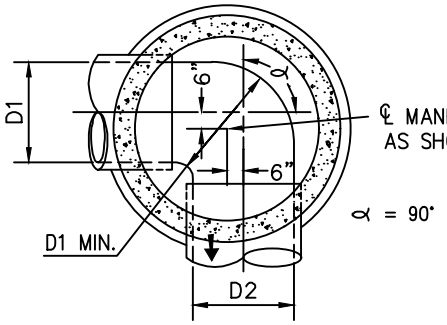
THROUGH MANHOLE
ONE COLLECTION LINE



THROUGH MANHOLE
TWO COLLECTION LINES

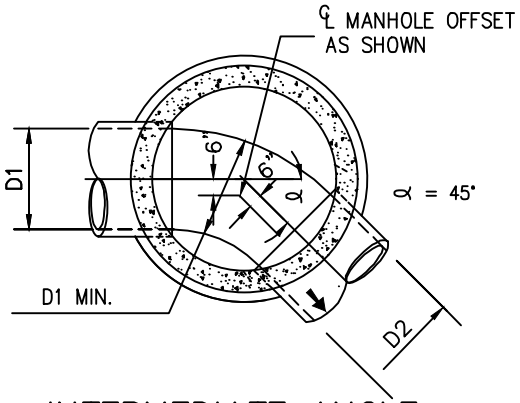


INTERMEDIATE ANGLE

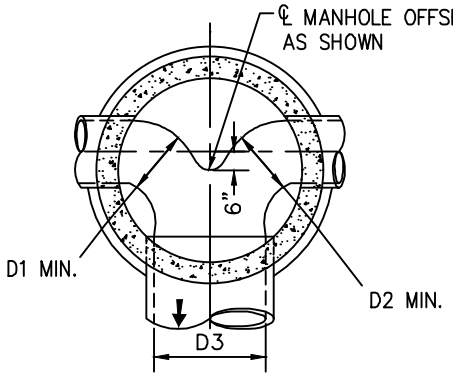


SHARP ANGLE

CURVED DEFLECTOR "POINTS" SHALL EXTEND COMPLETELY ACROSS THE OPPOSED LATERALS AS SHOWN.



INTERMEDIATE ANGLE



OPPOSED LATERALS

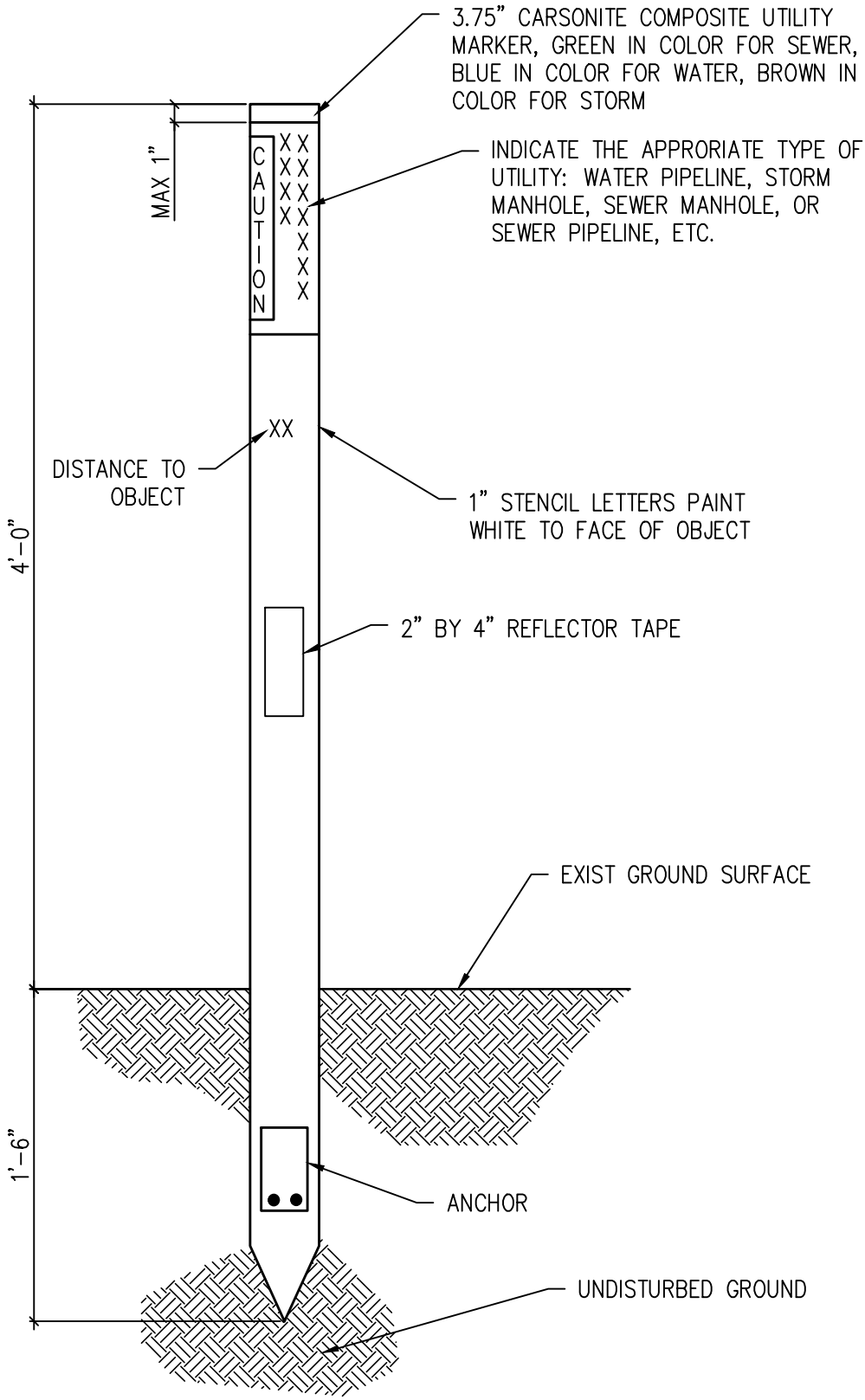
CURVED DEFLECTOR "POINTS" SHALL EXTEND ACROSS THE CENTERLINE OF THE OPPOSING PIPES AS SHOWN.

NOTES:

1. PIPE INVERT ELEVATION AND DROP THROUGH MANHOLES SHALL BE IN CONFORMANCE WITH THE REVIEW AND SIGNED CONSTRUCTION PLANS. THE INTENTION IS TO PROMOTE SMOOTH, NON-TURBULANT FLOW THROUGH THE MANHOLES BY KEEPING THE LARGER LINES LOWER IN THE MANHOLE AND BRINGING THE SMALLER LINES IN SLIGHTLY HIGHER.
2. MAX INSIDE DROP THROUGH ANY MANHOLE SHALL BE 18 INCHES
3. MIN DROP THROUGH ANY MANHOLE SHALL BE 0.2 FEET FOR STRAIGHT RUNS AND 0.2 FEET FOR CHANGES IN DIRECTION
4. ALL INVERT DEFLECTORS SHALL BE CURVED IN SHAPE TO PROVIDE SMOOTH FLOW TRANSITIONS AS SHOWN IN THIS DETAIL
5. MINIMUM ANGLE BETWEEN THE CENTERLINE OF ANY INCOMING PIPE AND THE CENTER OF THE OUTGOING PIPE SHALL BE 90 DEGREES
6. GROUT TO SHAPE SMOOTH TRANSITION BETWEEN INVERTS. SLOPE AT 1/2" PER FOOT.

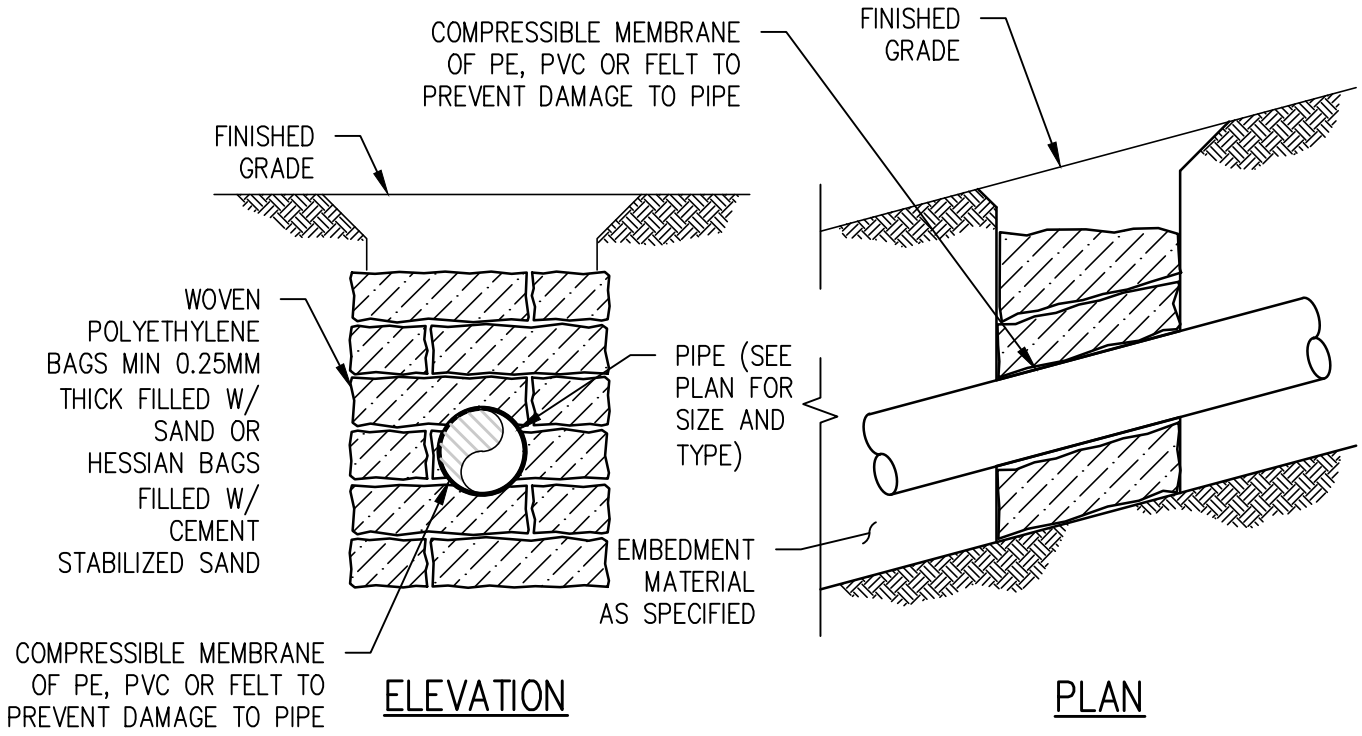
SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA GENERAL DETAILS	D0.08
	MANHOLE BASE AND DEFLECTOR	DATE: 12/2020



SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA GENERAL DETAILS	D0.09
	UTILITY MARKER POST	DATE: 12/2020



REQUIREMENT TRENCHSTOPS		
GRADE (%)	REQUIREMENT	SPACING(S) IN FEET
5–14	TRENCHSTOP	S=500/GRADE%

NOTES:

1. FLOWFILL MAY BE USED WITH APPROVAL OF TOWN ENGINEER

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA GENERAL DETAILS	D0.10
	TRENCH STOP	DATE: 12/2020

TOWN OF BERTHOUD APPROVAL

ALL WORK SHALL BE CONSTRUCTED TO THE TOWN STANDARDS AND SPECIFICATIONS. THESE PLANS HAVE BEEN REVIEWED BY THE TOWN OF BERTHOUD FOR CONCEPT ONLY AND GENERAL CONFORMANCE WITH THE TOWN'S STANDARDS AND SPECIFICATIONS. THE REVIEW BY THE TOWN OF BERTHOUD DOES NOT IMPLY RESPONSIBILITY BY THE TOWN OF BERTHOUD OR THE TOWN ENGINEER FOR ACCURACY AND CORRECTNESS OF THE PLANS OR CALCULATIONS.

THESE PLANS ARE HEREBY APPROVED FOR ONE YEAR FROM DATE OF THE TOWN ENGINEER'S APPROVAL.

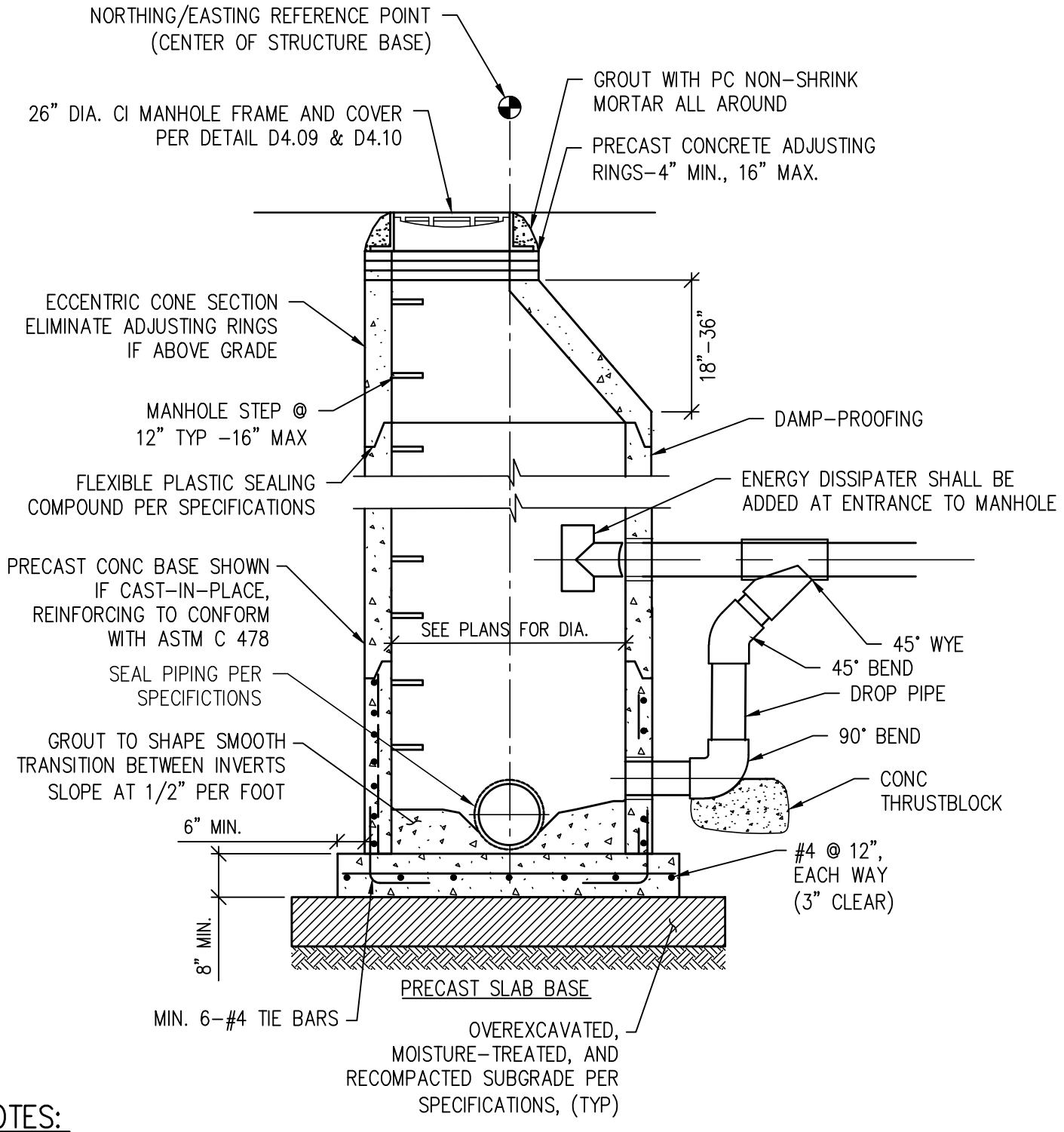
APPROVED BY:

_____

TOWN ENGINEER DATE

SCALE: NTS

	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA GENERAL DETAILS	D0.11
	TOWN OF BERTHOUD APPROVAL BLOCK	DATE: 12/2020

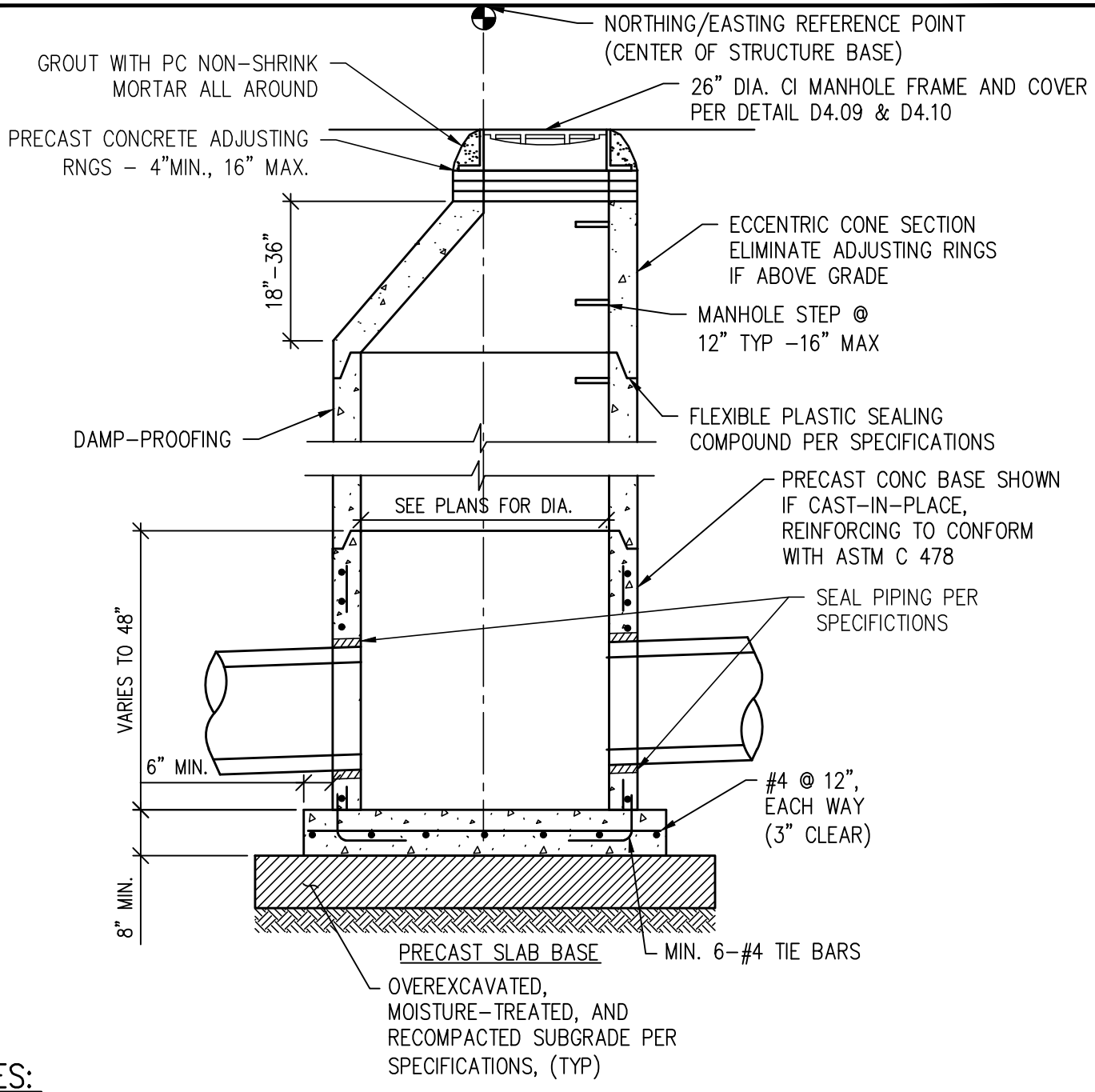


NOTES:

1. SHAPING FOR SMOOTH MANHOLE INVERTS MUST BE DONE BY FORMING OR SHAPING BASE CONCRETE.
2. BLOCK-OUTS WHEN APPROVED SHALL EXTEND A MAX OF 6" PAST MANHOLE OD AND BE SATISFACTORILY PLUGGED AND SEALED.
3. CONCRETE MANHOLES BASES MAY BE POURED IN PLACE ONLY WITH PRIOR APPROVAL.
4. ALL MORTAR SHALL BE MIXED WITH A TYPE II CEMENT.
5. BENCH MUST HAVE A BRUSHED, NON-SKID SURFACE.

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA SANITARY SEWER DETAILS	D4.01
	SANITARY DROP MANHOLE	DATE: 12/2020

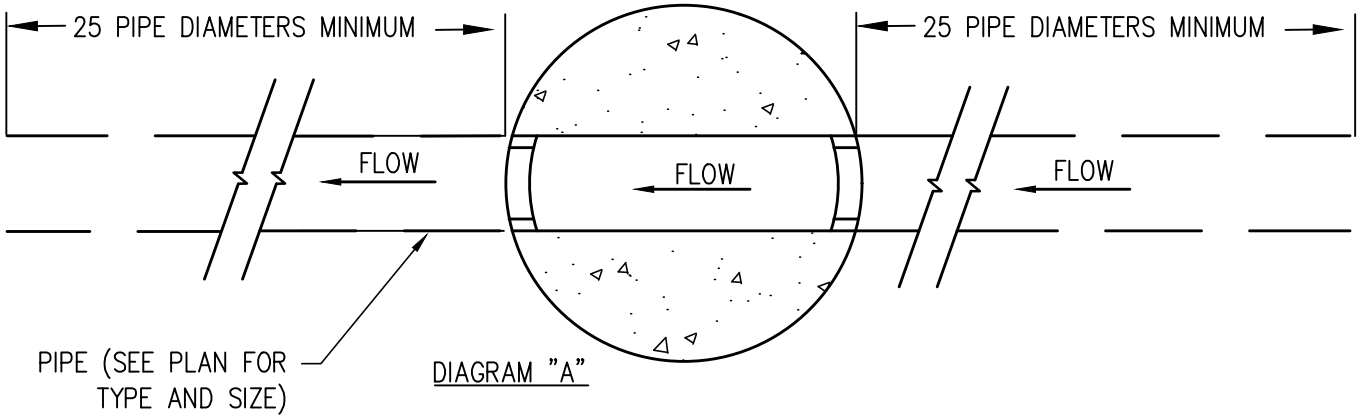


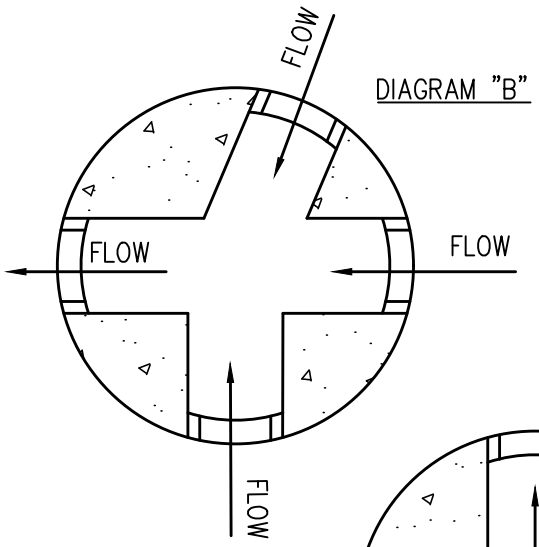
NOTES:

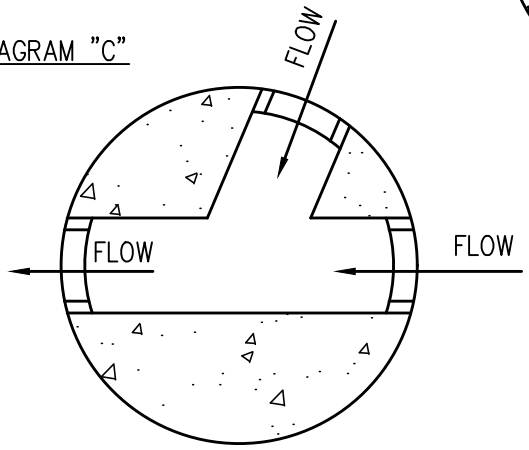
1. MANHOLES SHALL BE SEALED WATERTIGHT. NO GROUT ALLOWED. MANHOLE EXTERIORS SHALL BE DAMP-PROOFED.
2. DROP THROUGH MANHOLE TO BE EQUAL TO SLOPE OF SURROUNDING PIPE. FOR FLUME INSTALLATIONS, FLUME MUST BE SET LEVEL.
3. MONITORING MANHOLE TO BE LOCATED OUTSIDE OF PUBLIC RIGHT-OF-WAY, ON DISCHARGER'S PROPERTY. THE MANHOLE MUST BE SAFELY AND INDEPENDENTLY ACCESSIBLE FOR TOWN USE AT ALL TIMES.
4. FOR MANHOLE DEPTHS LESS THAN FOUR FEET FROM RIM TO TOP OF BENCH, VERTICAL MANHOLE BARRELS OR MINIMUM 30-INCH BY 30-INCH PRECAST BOX WITH PRECAST FLAT TOP SECTONS ARE REQUIRED.
5. DESIGN AND LOCATION OF MONITORING MANHOLE SUBJECT TO DISTRICT APPROVAL.
6. THERE SHALL NOT BE ANY BENDS, DROP MANHOLES FLOW JUNCTIONS, CHANGES IN PIPE DIAMETER, ETC., WITHIN 25 PIPE DIAMETERS UPSTREAM OR DOWNSTREAM OF THE MANHOLE.

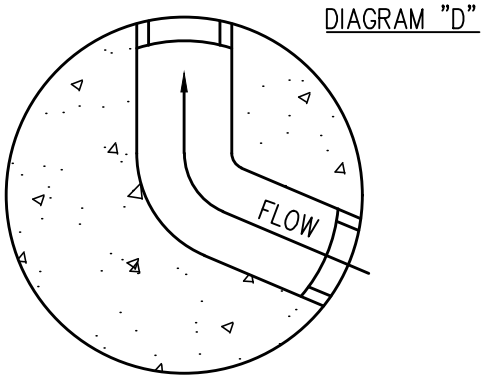
SCALE: NTS

TOWN OF BERTHOUD	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA SANITARY SEWER DETAILS	D4.02
	MONITORING SANITARY MANHOLE	DATE: 12/2020







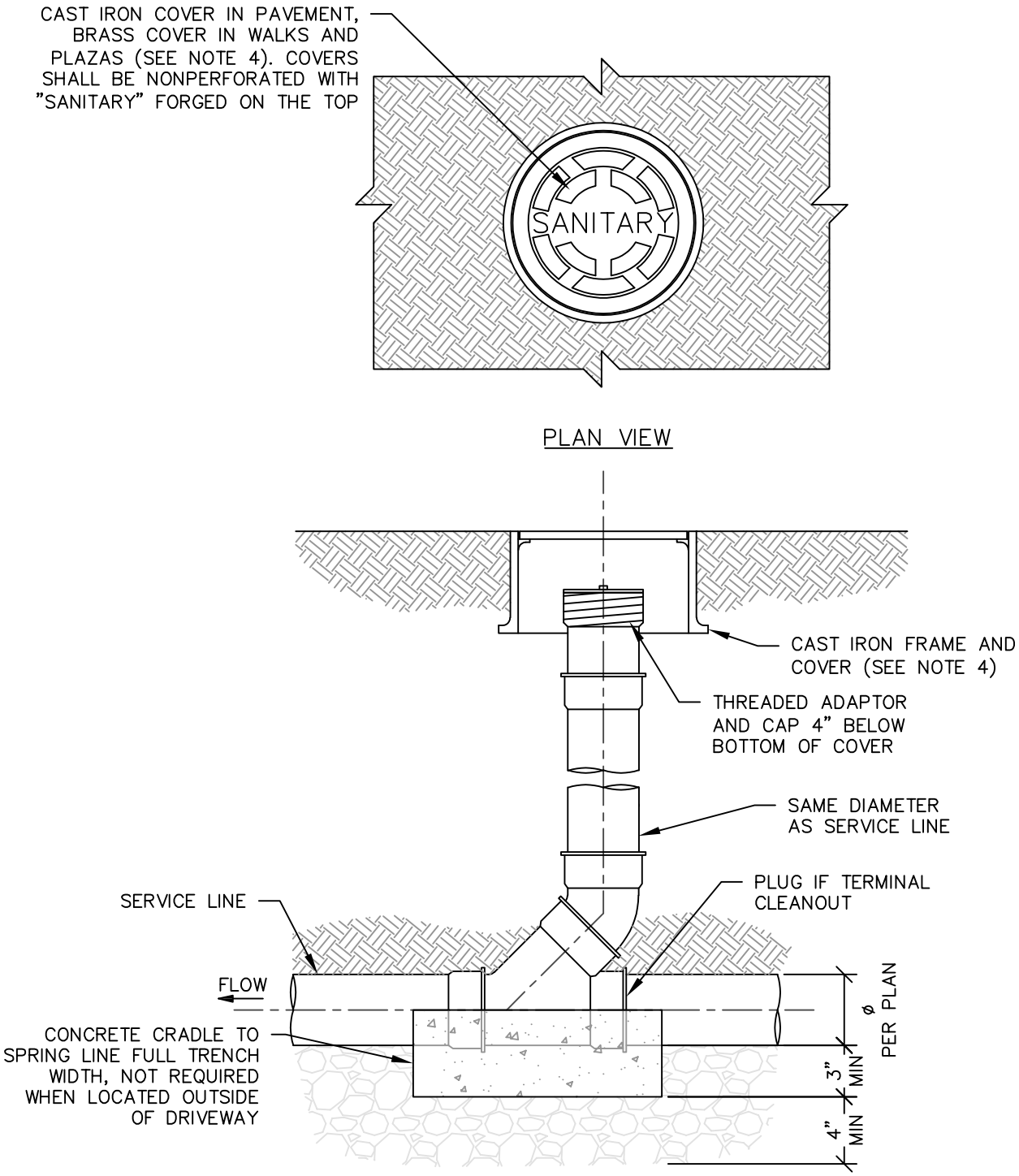


NOTES:

1. DIAGRAM "A" IS COMPATIBLE FOR THE INSTALLATION OF A FLOWMETER OR FLUME IN THE INVERT.
2. DIAGRAMS "B", "C", "D" ARE NOT SUITABLE FOR THE INSTALLATION OF A FLOW MEASURING DEVICE DUE TO THE LOCATION OF THE SIDE SEWERS OR A BEND IN THE INVERT CHANNEL.

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA SANITARY SEWER DETAILS	D4.03
	MONITORING SANITARY MANHOLE DIAGRAMS	DATE: 12/2020

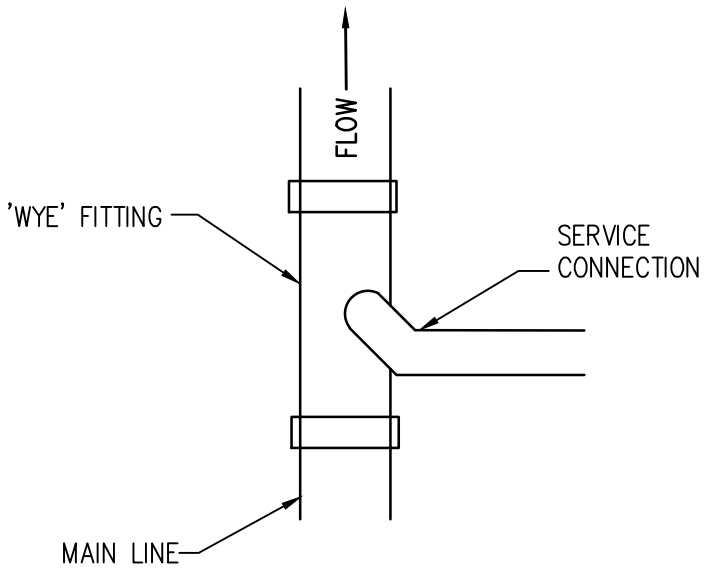


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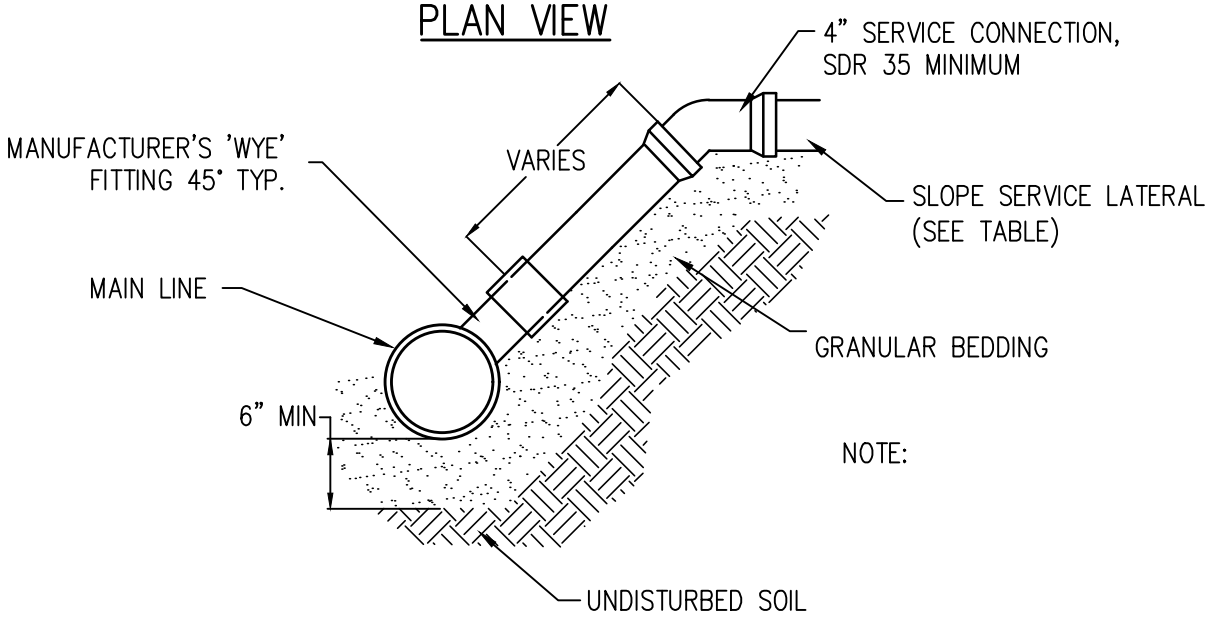
1. CLEANOUT SHALL BE CONSTRUCTED SO THAT SURFACE LOAD WILL NOT BE TRANSFERRED TO MAIN.
2. SERVICE LINE CLEANOUT MAY BE INSTALLED APPROXIMATELY 5 FEET OUTSIDE THE BUILDING FOUNDATION.
3. A CLEANOUT IS REQUIRED ON ALL SERVICE LINES EVERY 100 FEET, AT EVERY "Y" OR AFTER A COMBINED 135 DEGREES OF BEND.
4. CAST IRON FRAME AND COVER ONLY REQUIRED IN ROADWAY OR DRIVEWAY.

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA SANITARY SEWER DETAILS	D4.04
	SANITARY CLEANOUT	DATE: 11/2025



PLAN VIEW



PIPE SIZE (INCHES)	MINIMUM SLOPE (INCH PER FOOT)
2 1/2 OR LESS	1/4
3 TO 6	1/8
8 OR LARGER	1/16

NOTES:

1. SANITARY SEWER SERVICE TAPS SHALL BE LOCATED ON THE MAIN AT 2'OCLOCK OR 10 O'CLOCK POSITION
2. THE MINIMUM DISTANCE BETWEEN ANY TWO CONSECUTIVE FITTINGS SHALL BE 3 FEET, MEASURED BETWEEN FITTING CENTERLINES
3. SANITARY SEWER SERVICE TAPS SHALL NOT BE MADE WITHIN 3 FEET OF A PIPE JOINT, OR 5 FEET FROM EDGE OF MANHOLE BASE.
4. A MAXIMUM OF FOUR SERVICE TAPS ARE ALLOWED PER 20–FOOT LENGTH OF PIPE
5. USE SDR 35 'WYE'. 'TEE'S NOT ALLOWED.

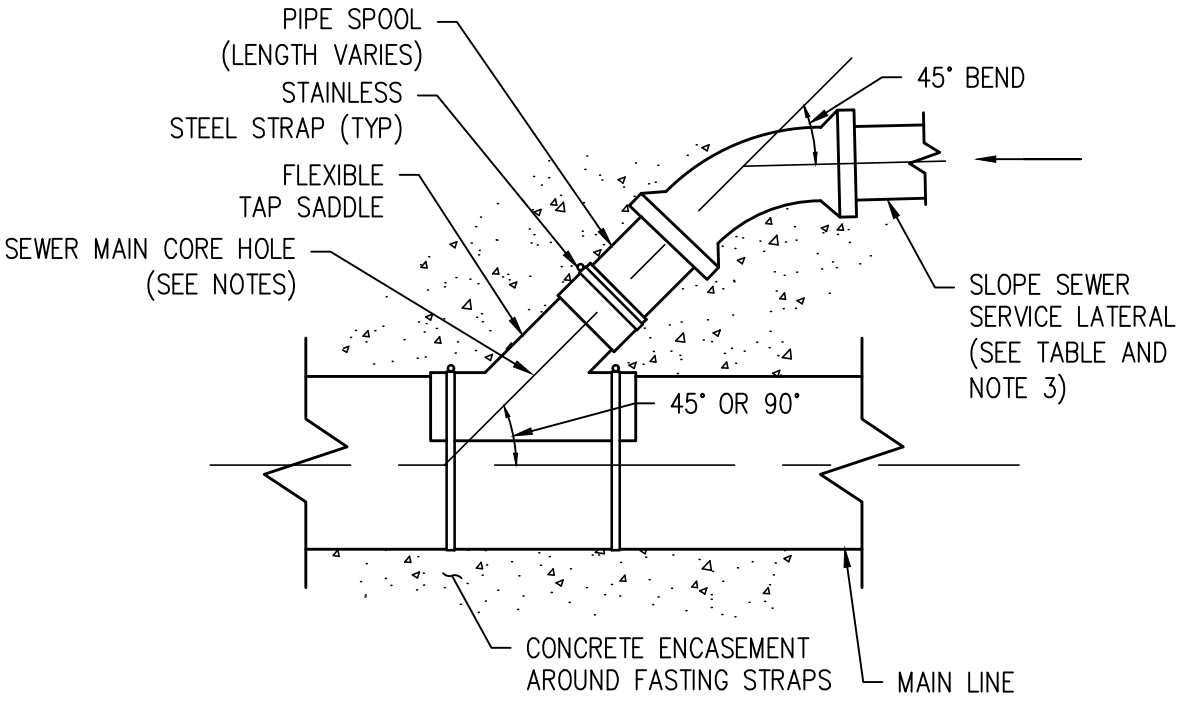
SCALE: NTS

TOWN OF BERTHOUD STANDARD DESIGN CRITERIA
SANITARY SEWER DETAILS

D4.05

TYPICAL SERVICE CONNECTION

DATE: 12/2020



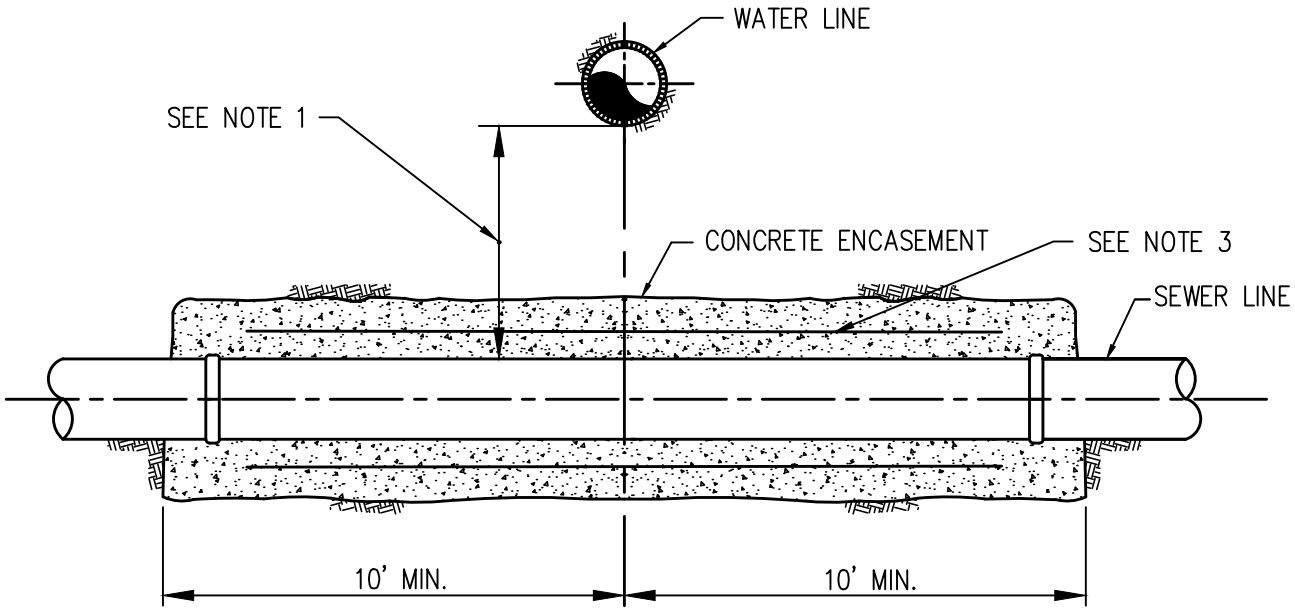
PIPE SIZE (INCHES)	MINIMUM SLOP (INCH PER FOOT)
2 1/2 OR LESS	1/4
3 TO 6	1/8
8 OR LARGER	1/16

NOTES:

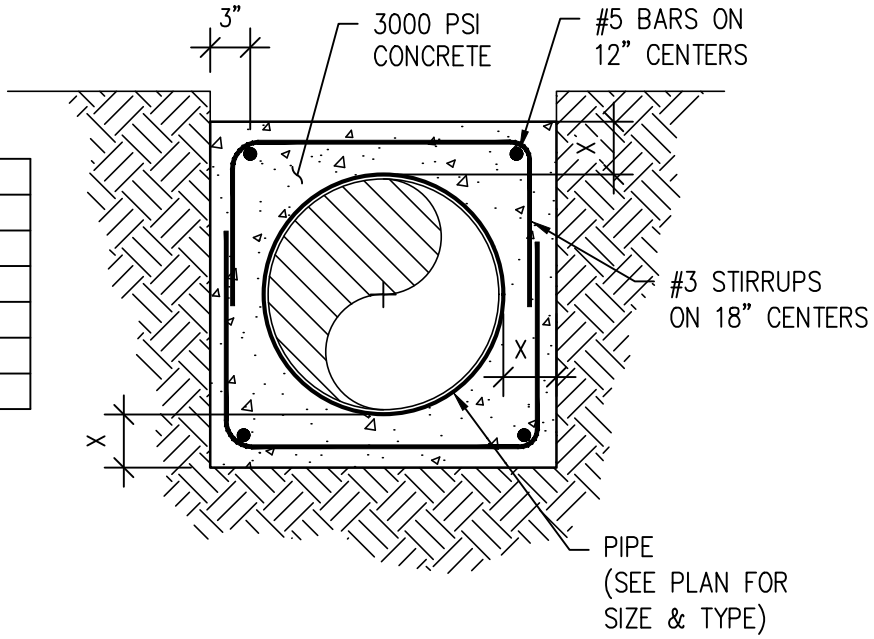
1. INSTALL TAPPING SADDLE PER MANUFACTURES RECOMMENDATIONS.
2. MAKE SURE CORED PIPE WASTE IS RETRIEVED.
3. AN INSERT A TEE MAY BE AN ACCEPTABLE SUBSTITUTION AS APPROVED BY THE TOWN ENGINEER.

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA SANITARY SEWER DETAILS	D4.06
	TAPPING SADDLE	DATE: 12/2020



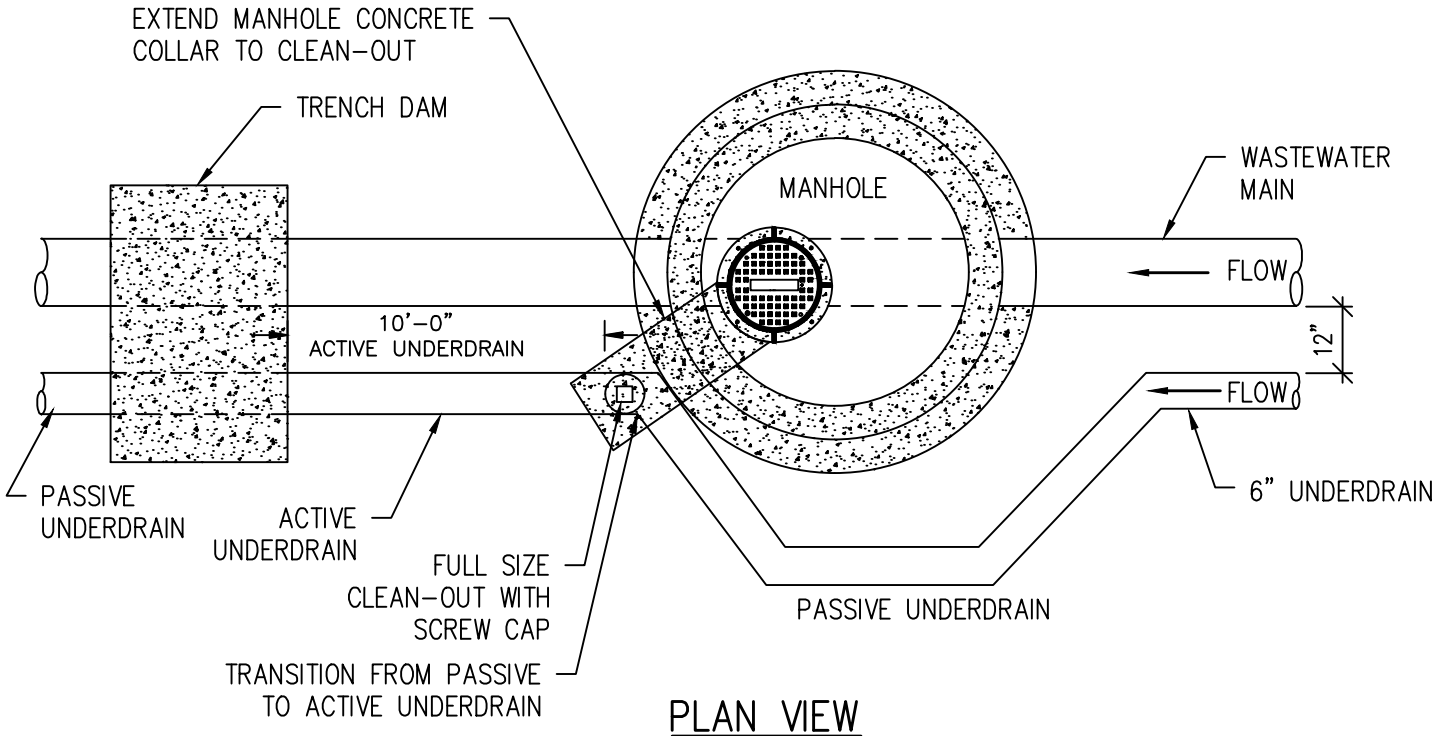
PIPE SIZE	X
6"	4"
8"	4"
12"	4"
18"	5"
24"	6"
36"	6"



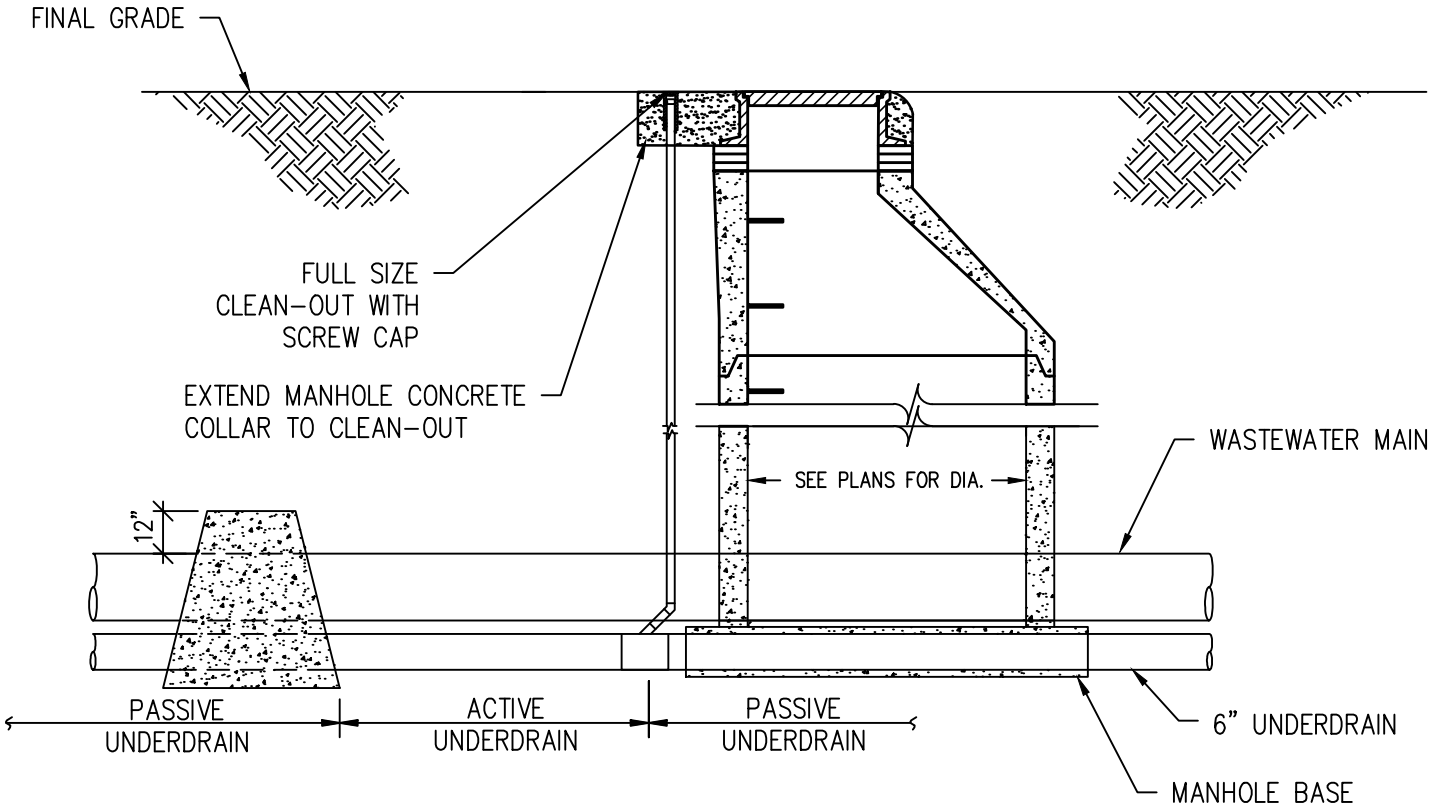
NOTES:

1. CONCRETE ENCASEMENT WILL BE REQUIRED WHEN CLEAR VERTICAL DISTANCE IS LESS THAN 1'6" OR HORIZONTAL DISTANCE IS LESS THAN 10' BETWEEN PARALLEL LINES
2. CONCRETE ENCASEMENT REQUIRED IN ALL CASES WHERE SEWER LINE IS ABOVE WATER LINE.
3. MINIMUM WIDTH AND DEPTH ARE 12" + PIPE O.D.
4. PROVIDE FLOWABLE FILL MATERIAL, NO REINFORCEMENT, AT ROAD AND DITCH CROSSINGS, 10' BEYOND EACH SIDE

SCALE: NTS



PLAN VIEW

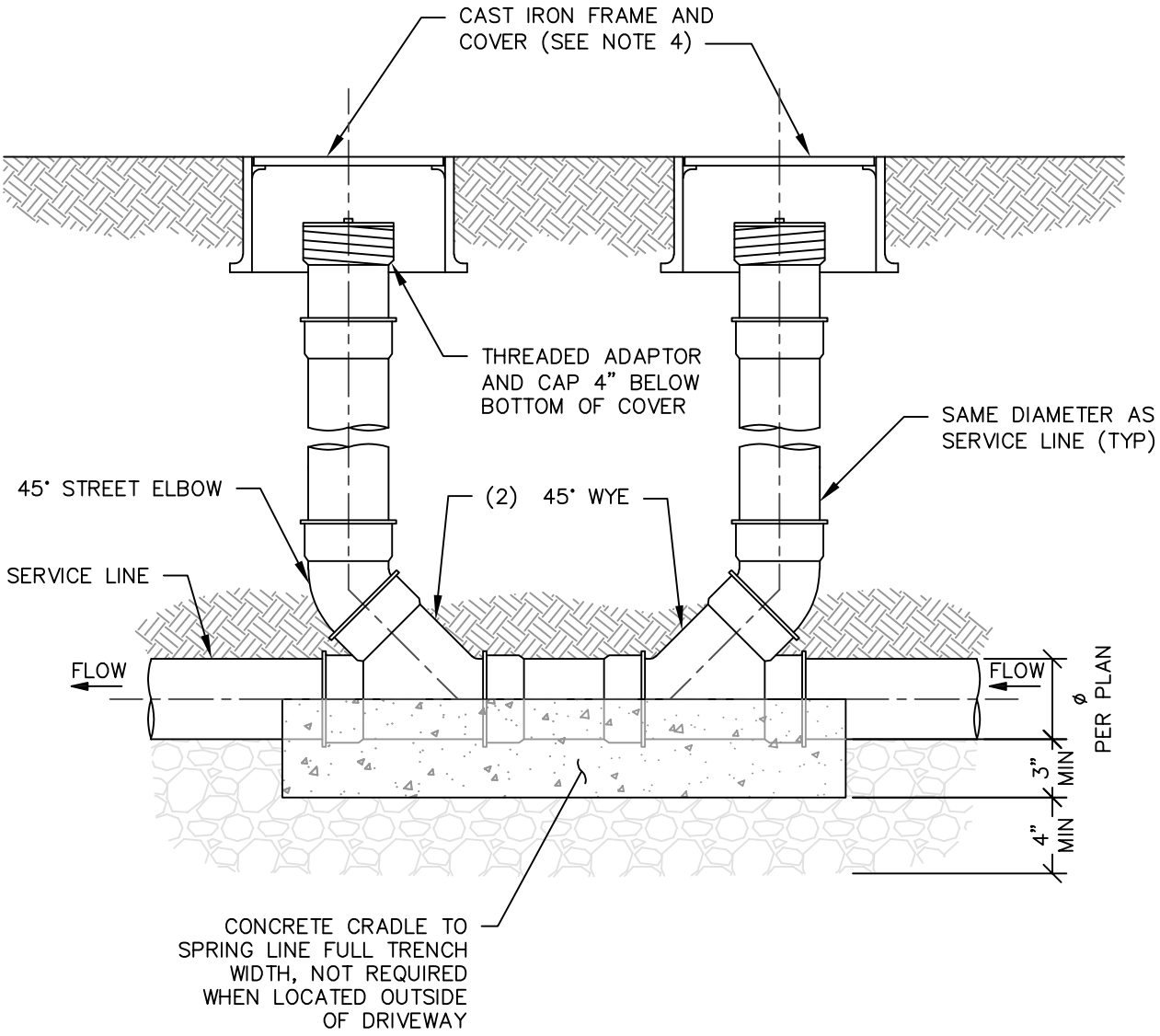


NOTES:

1. USE OF AN UNDERDRAIN SYSTEM IS ONLY ALLOWED WITH TOWN APPROVAL

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA SANITARY SEWER DETAILS	D4.08
	CONCRETE COLLAR UNDERDRAIN	DATE: 12/2020

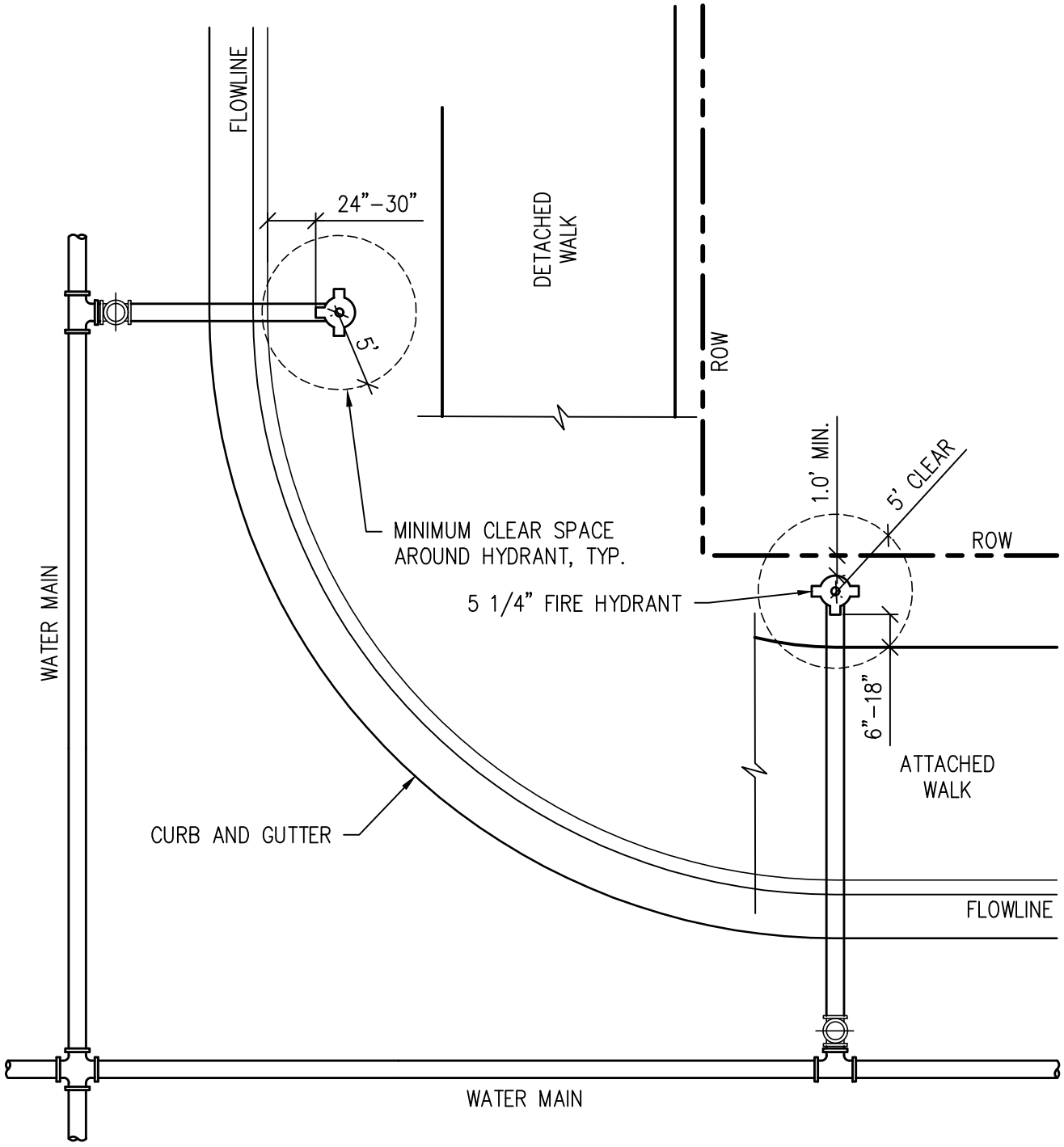


NOTES:

1. CLEANOUT SHALL BE CONSTRUCTED SO THAT SURFACE LOAD WILL NOT BE TRANSFERRED TO MAIN.
2. SERVICE LINE CLEANOUT MAY BE INSTALLED APPROXIMATELY 5 FEET OUTSIDE THE BUILDING FOUNDATION.
3. A CLEANOUT IS REQUIRED ON ALL SERVICE LINES EVERY 100 FEET, AT EVERY "Y" OR AFTER A COMBINED 135 DEGREES OF BEND.
4. CAST IRON FRAME AND COVER ONLY REQUIRED IN ROADWAY OR DRIVEWAY.

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA SANITARY SEWER DETAILS	D4.09
	TWO-WAY SANITARY CLEANOUT	DATE: 11/2025

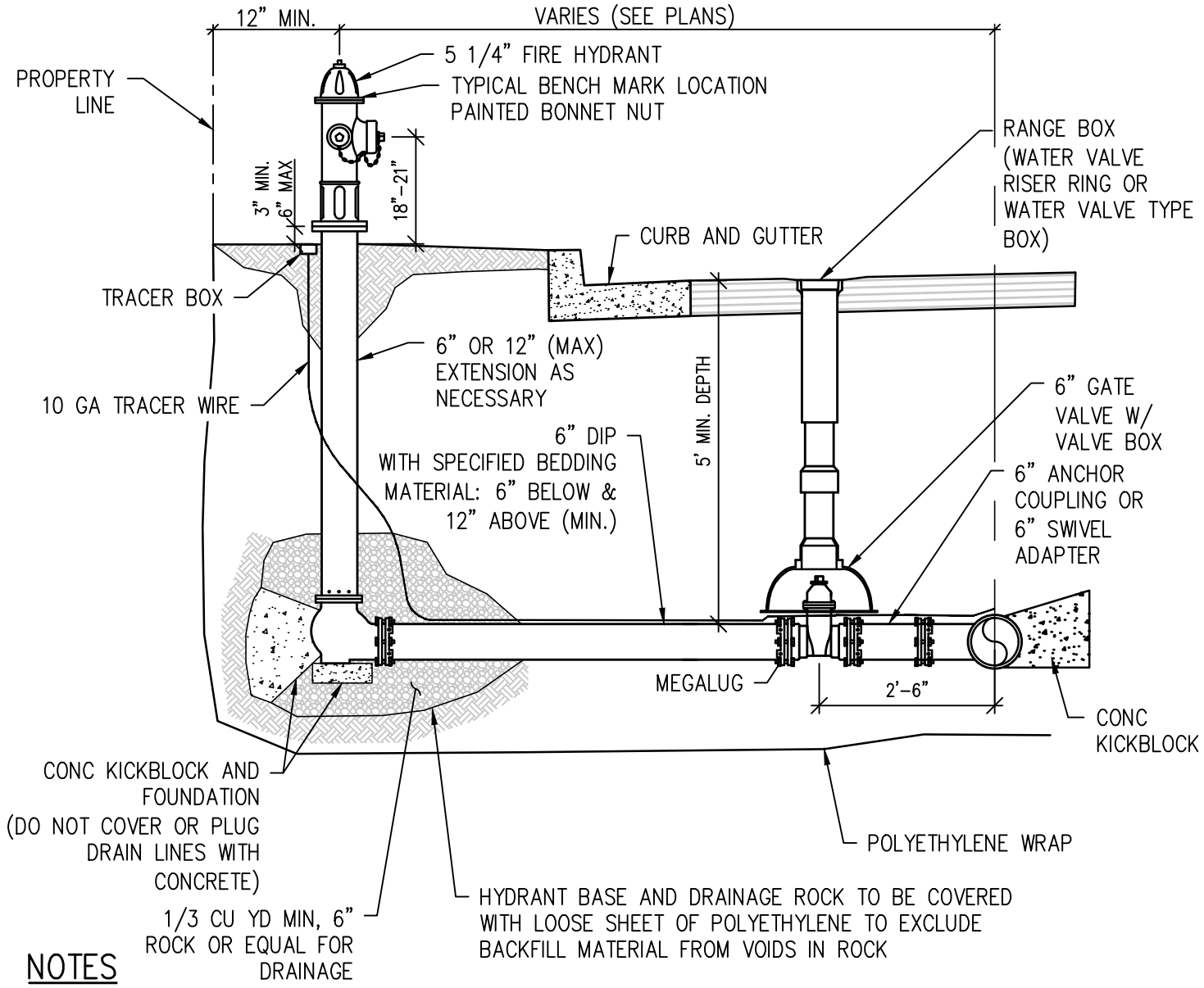


NOTES:

1. HYDRANT TO BE SET AT CURB RETURN
2. VALVES SHALL NOT BE LOCATED UNDER CURB AND GUTTER, OR CONCRETE PAN
3. A 5.0' CLEAR DISTANCE MUST BE MAINTAINED AROUND HYDRANT
4. ALL MEASUREMENTS ARE TO THE OUTSIDE OF THE PIPE

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.01
	FIRELINE CONNECTION WITH MAIN EXTENSION	DATE: 12/2020

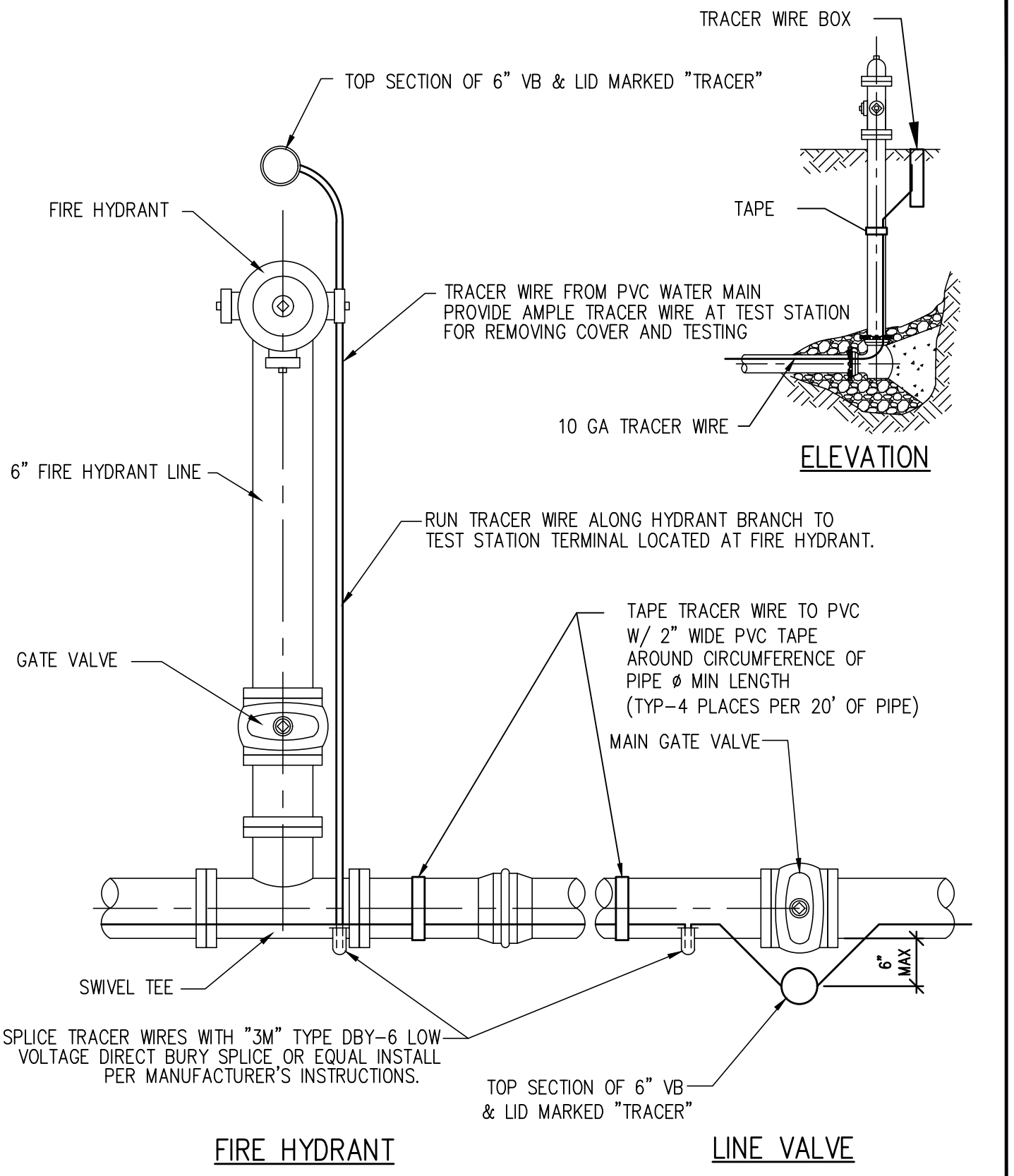


NOTES

1. SHOE AND BARREL SHALL BE CONNECTED WITH HIGH STRENGTH STAINLESS BOLTS AND NUTS
2. HYDRANT SHALL HAVE A FIVE (5') FOOT CLEAR ZONE ON EACH SIDE OF HYDRANT (TEN (10') FOOT EASEMENT AROUND).
3. PUMPER NOZZLE SHALL FACE THE PUBLIC RIGHT-OF-WAY OR REQUIRED FIRE ACCESS ROADWAY.
4. MINIMUM DISTANCE FROM DRIVEWAYS SHALL BE SIX (6) FEET.
5. HYDRANTS SHALL CONFORM TO AND BE TESTED IN ACCORDANCE WITH AWWA SPECIFICATIONS.
6. HYDRANTS SHALL BE MADE OF CAST IRON WITH FULL BRONZE MOUNTINGS.
7. INLET SHALL FIT SIX (6) INCH PIPE WITH BARREL LENGTH SUFFICIENT FOR A FIVE (5) FOOT TRENCH.
8. ONLY TWO (2) HEIGHT EXTENSIONS MAY BE USED PER HYDRANT.
9. HYDRANT BASES SHOULD NOT BE ANY DEEPER THAN SIX (6) FEET FROM THE TOP OF FINISHED GRADE.
10. MAIN VALVE OPENING IN THE HYDRANT SHALL BE NO LESS THAN FIVE (5) INCHES IN DIAMETER.
11. HYDRANTS SHALL BE PLUMBED VERTICALLY WITH PUMPER NOZZLE FACING STREET.
12. NO WATER SERVICE MAIN TAPS SHALL BE MADE TO A DISTRIBUTION MAIN WITHIN FIVE (5) FEET OF A FIRE HYDRANT BRANCH MAIN.
13. NO HORIZONTAL BENDS OR OFFSETS SHALL BE USED IN INSTALLING FIRE HYDRANT BRANCH MAINS.

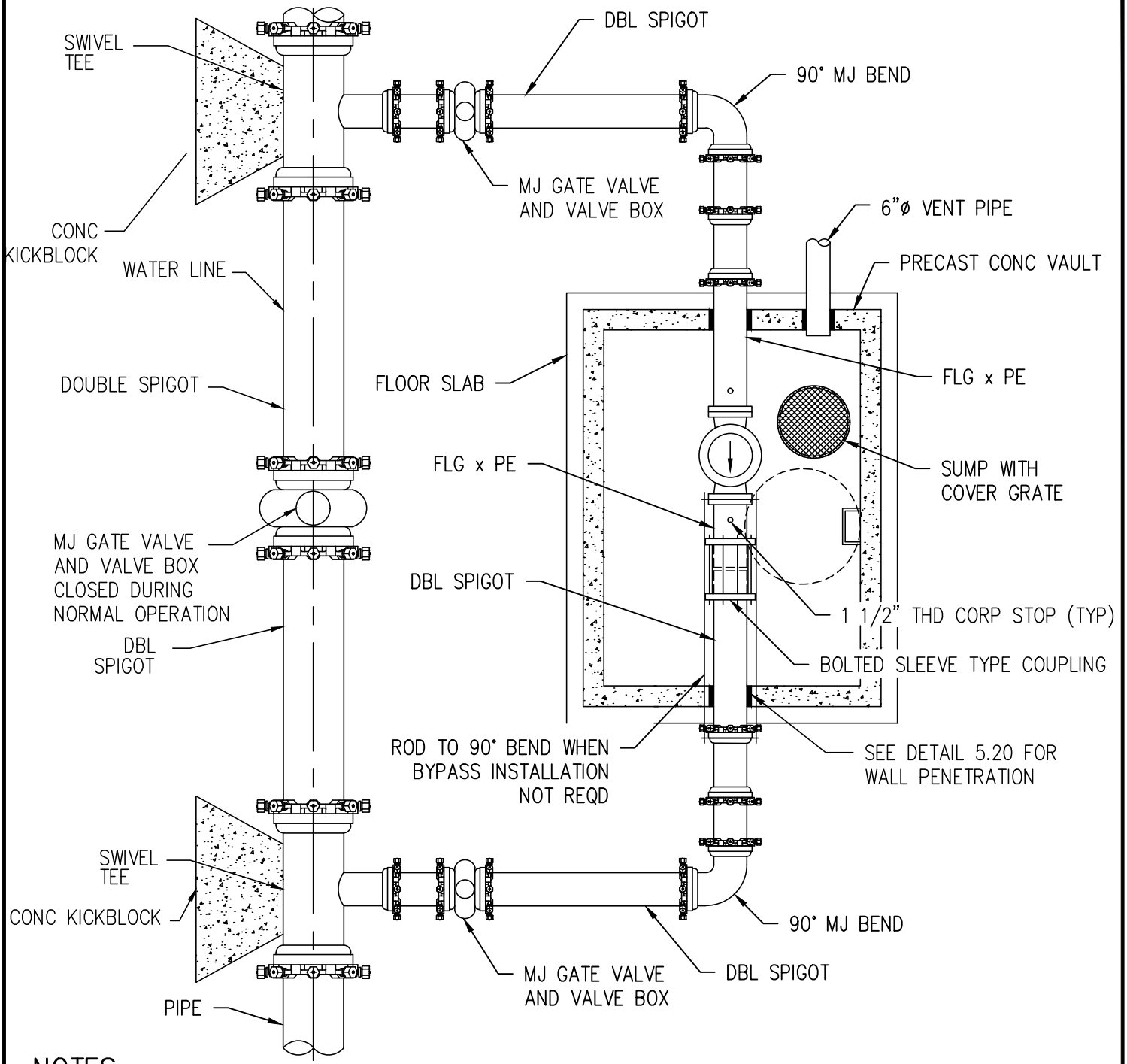
SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.02
	FIRE HYDRANT PROFILE	DATE: 12/2020



SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.03
	FIRELINE TRACER WIRE	DATE: 12/2020

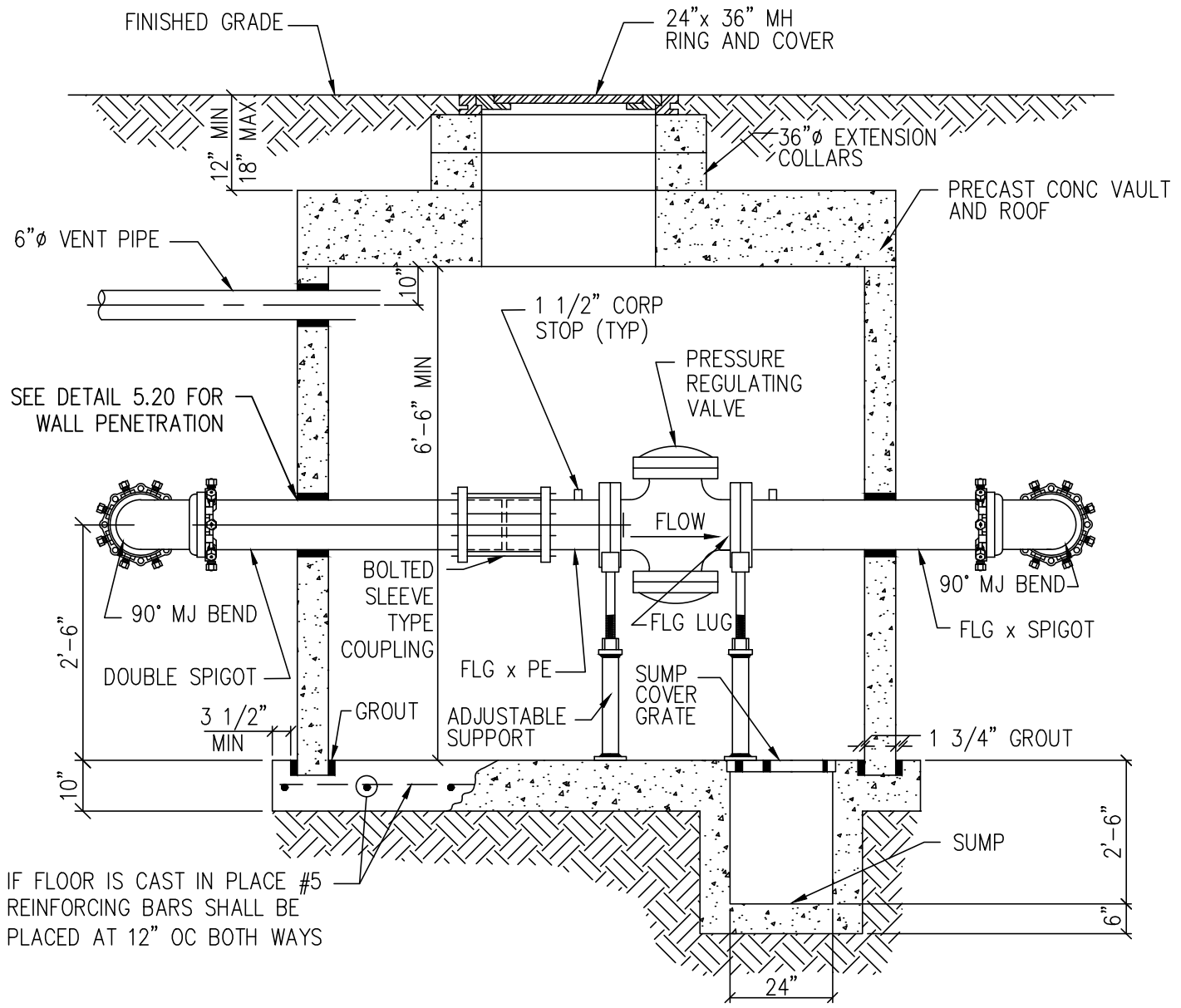


NOTES:

1. A RECTANGULAR VAULT IS REQD WHERE TELEMETRY OR ELECTRICAL EQUIPMENT IS ANTICIPATED INSIDE THE VAULT
2. ACCESS STAIRS WITH DOOR OUTSIDE OF PAVEMENT MAY BE REQD ON STREETS WITH HEAVY TRAFFIC
3. FOR CROSS SECTION VIEW SEE DETAIL D5.05
4. DO NOT PLACE SUMP DIRECTLY UNDER MH
5. PIPING FOR PRV AND CHECK VALVE INSTALLATIONS SHALL BE DI
6. PRV SHALL BE CLA-VAL MODEL 90-01, EPOXY COATED. TRIM (I.E. DISC GUID, SEAT, & COVER BEARING) SHALL BE STAINLESS STEEL TYPE 303. INCLUDE OPTIONAL FEATURES B, C, D, S, AND Y FOR REQUIRED CLA-VAL PRV.

SCALE: NTS

TOWN OF BERTHOUD	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.04
	PRV RECTANGULAR VAULT PLAN VIEW	DATE: 12/2020

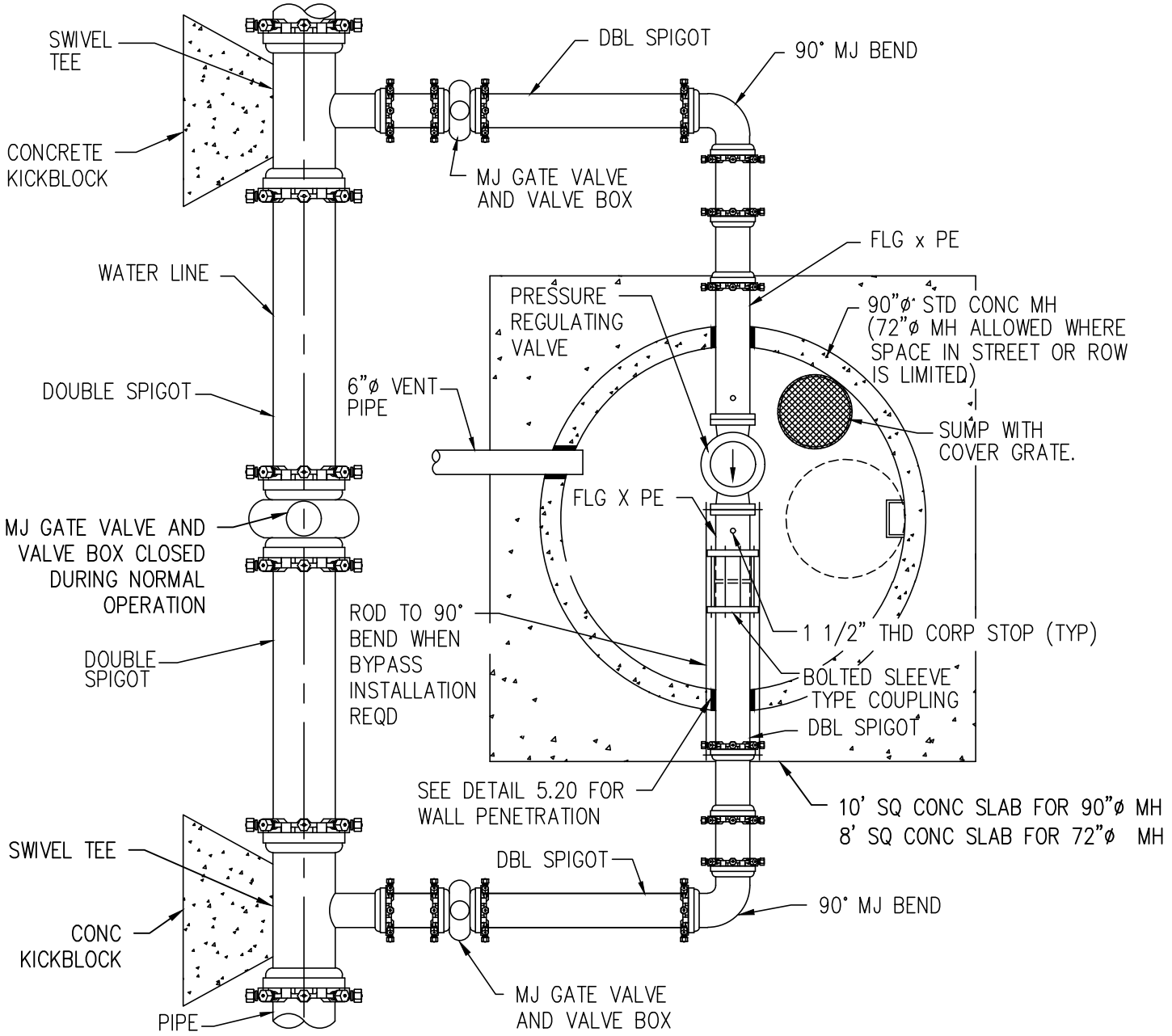


NOTES:

1. APPROVED PRECAST CONC VAULTS
2. SEE DETAIL D5.04 FOR PLAN VIEW OF VAULT AND D5.07 FOR PLAN VIEW OF MANHOLE AND ADDITIONAL NOTES
3. SEE DETAIL D5.18 THROUGH D5.21 FOR FLOOR PIPE SUPPORT, VENTILATION, CORE HOLE,A ND PRESSURE GAUGE DETAILS

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.05
	PRV RECTANGULAR VAULT CROSS SECTION	DATE: 12/2020

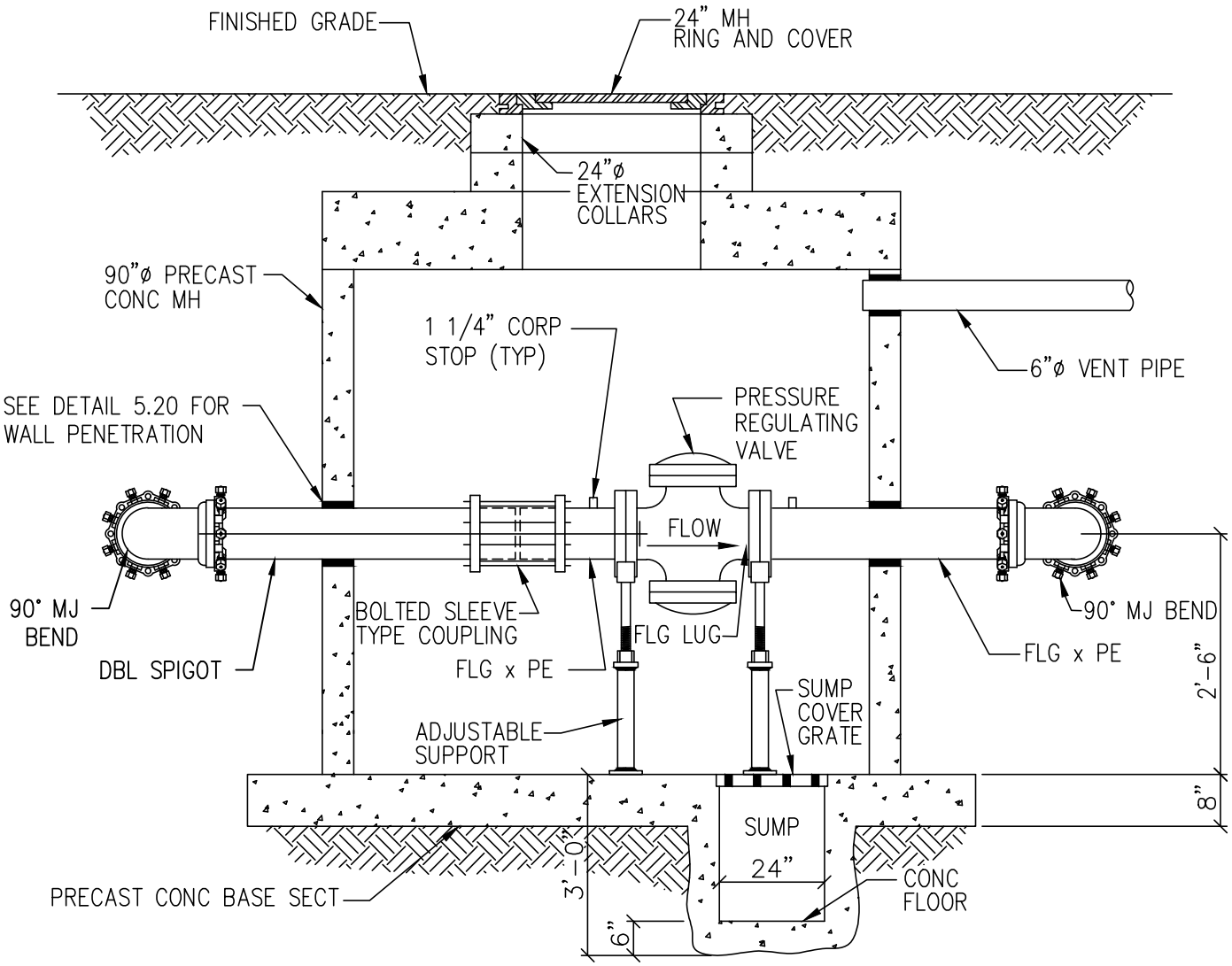


NOTES:

1. A RECTANGULAR VAULT IS REQD WHERE TELEMETRY OR ELECTRICAL EQUIPMENT IS ANTICIPATED INSIDE THE VAULT
2. ACCESS STAIRS WITH DOOR OUTSIDE OF PAVEMENT MAY BE REQD ON STREETS WITH HEAVY TRAFFIC
3. FOR CROSS SECTION VIEW SEE DETAIL D5.07
4. DO NOT POLACE DUMP DIRECTLY UNDER MH
5. THIS MH IS SUITABLE FOR CHECK VALVE INSTALLATIONS
6. PIPING FOR PRV AND CHECK VALVE INSTALLATIONS SHALL BE DI
7. MANHOLE STEPS ARE REQD IN PRE-CAST MANHOLE. SEE DETAIL D0.07 FOR MANHOLE STEP REQUIREMENTS
8. PRVE SHALL BE CLA-VAL MODEL 90-01, EPOXY COATED. TRIM (I.E. DISC GUIDE, SEAT, &COVER BEARING) SHALL BE STAINLESS STEEL TYPE 303. INCLUDE OPTIONAL FEATURES B, C, D, S, AND Y FOR REQUIRED CLA-VAL PRV.

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.06
	PRV MANHOLE PLAN VIEW	DATE: 12/2020

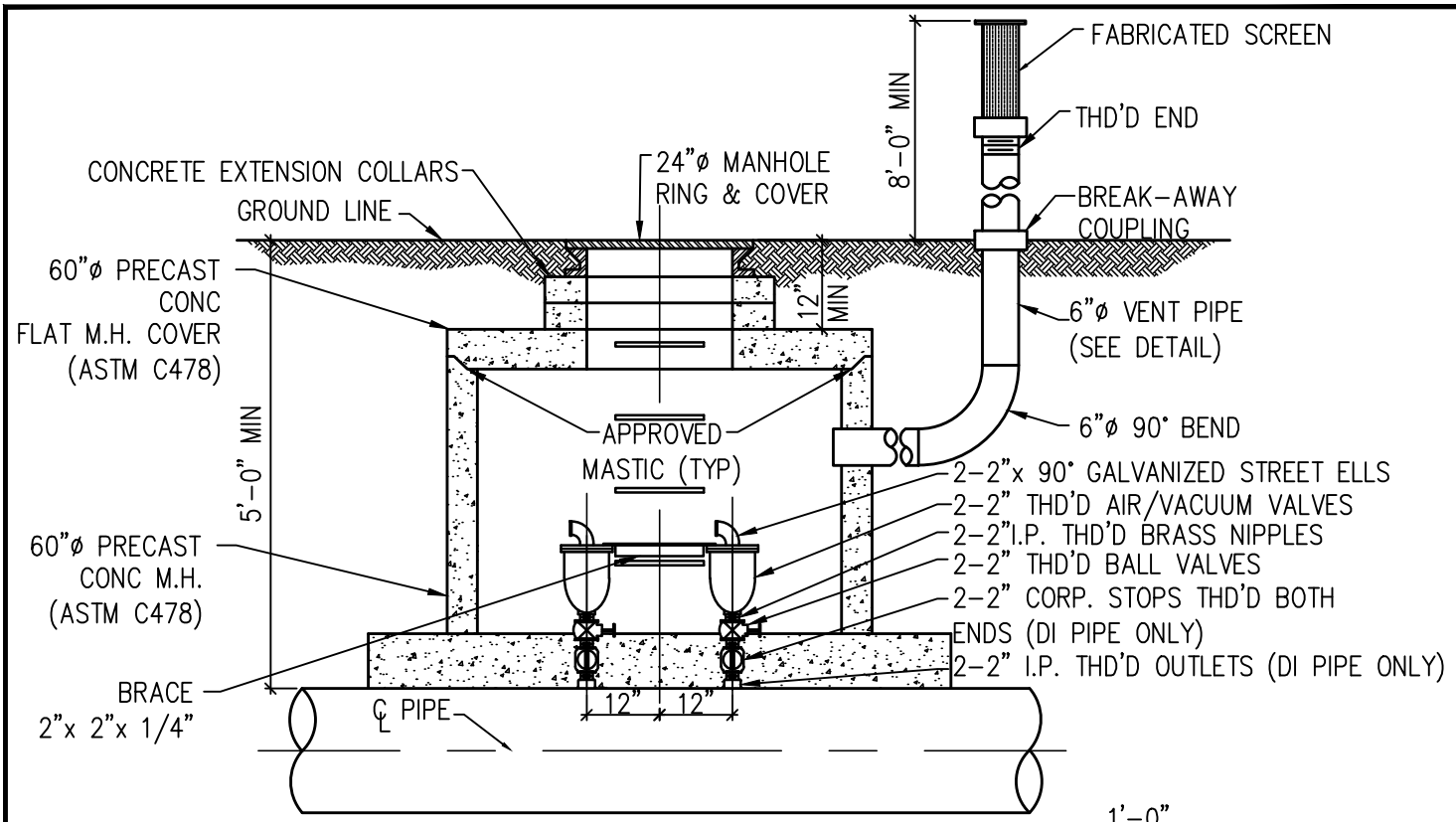


NOTES:

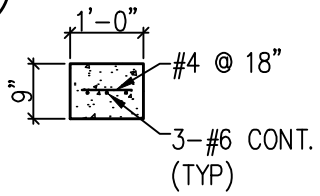
1. SEE DETAIL D5.06 FOR PLAN VIEW AND ADDITIONAL NOTES
2. SEE DETAIL D5.18 THROUGH D5.21 FOR FLOOR PIPE SUPPORT, VENTILATION, CORE HOLE, AND PRESSURE GAUGE DETAIL

SCALE: NTS

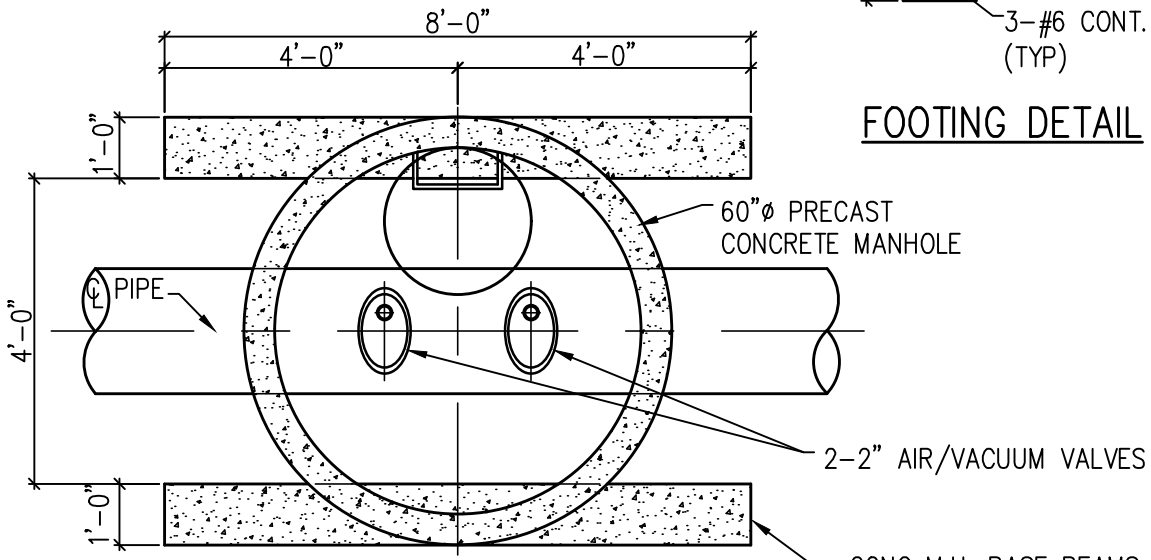
TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.07
	PRV MANHOLE CROSS SECTION	DATE: 12/2020



ELEVATION



FOOTING DETAIL

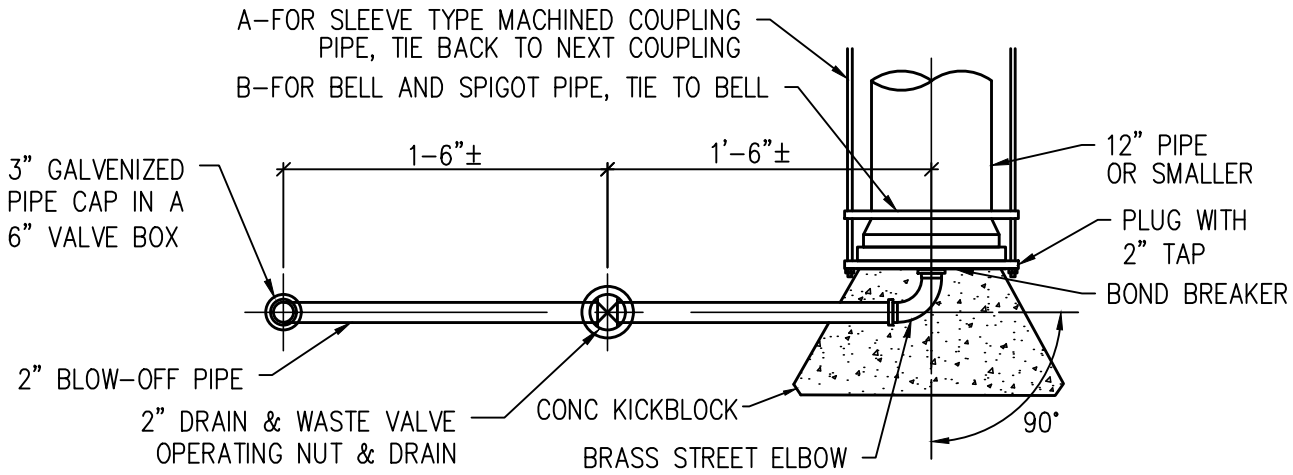


PLAN

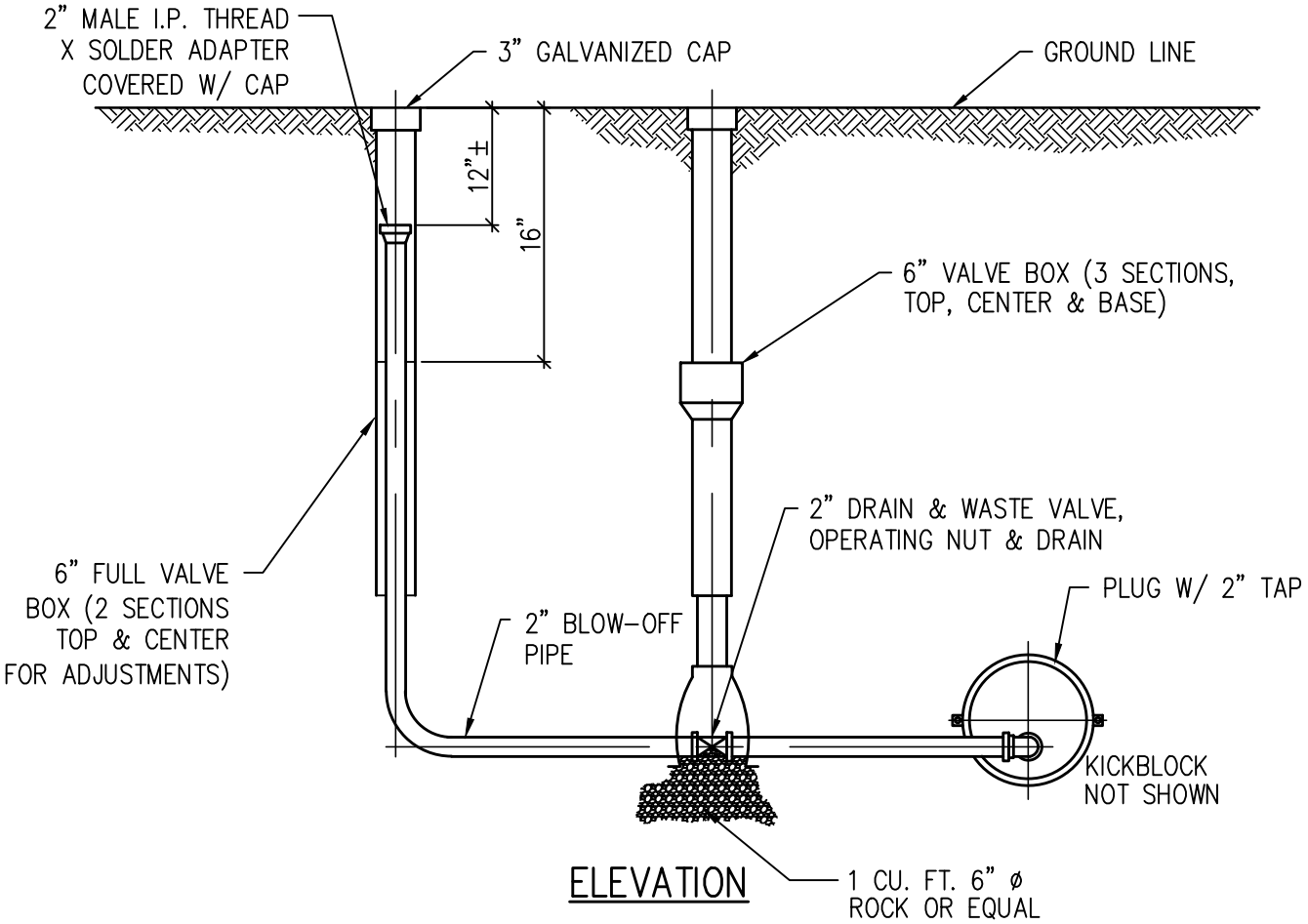
NOTES:

1. ONLY ONE AIR VACUUM VALVE REQUIRED ON 12-INCH PIPE AND SMALLER
2. USE 2" AIR VALVE ASSEMBLY ON 30" OR SMALLER PIPE.
3. THE DISTANCE BETWEEN RUNGS, CLEATS, AND STEPS SHALL NOT EXCEED 12 INCHES AND SHALL BE UNIFORM THROUGHOUT THE LENGTH OF THE LADDER.
4. MANHOLE STEPS ARE REQUIRED IN PRECAST CONCRETE MANHOLES. SEE DETAIL D0.07 FOR REQUIREMENTS

SCALE: NTS



PLAN



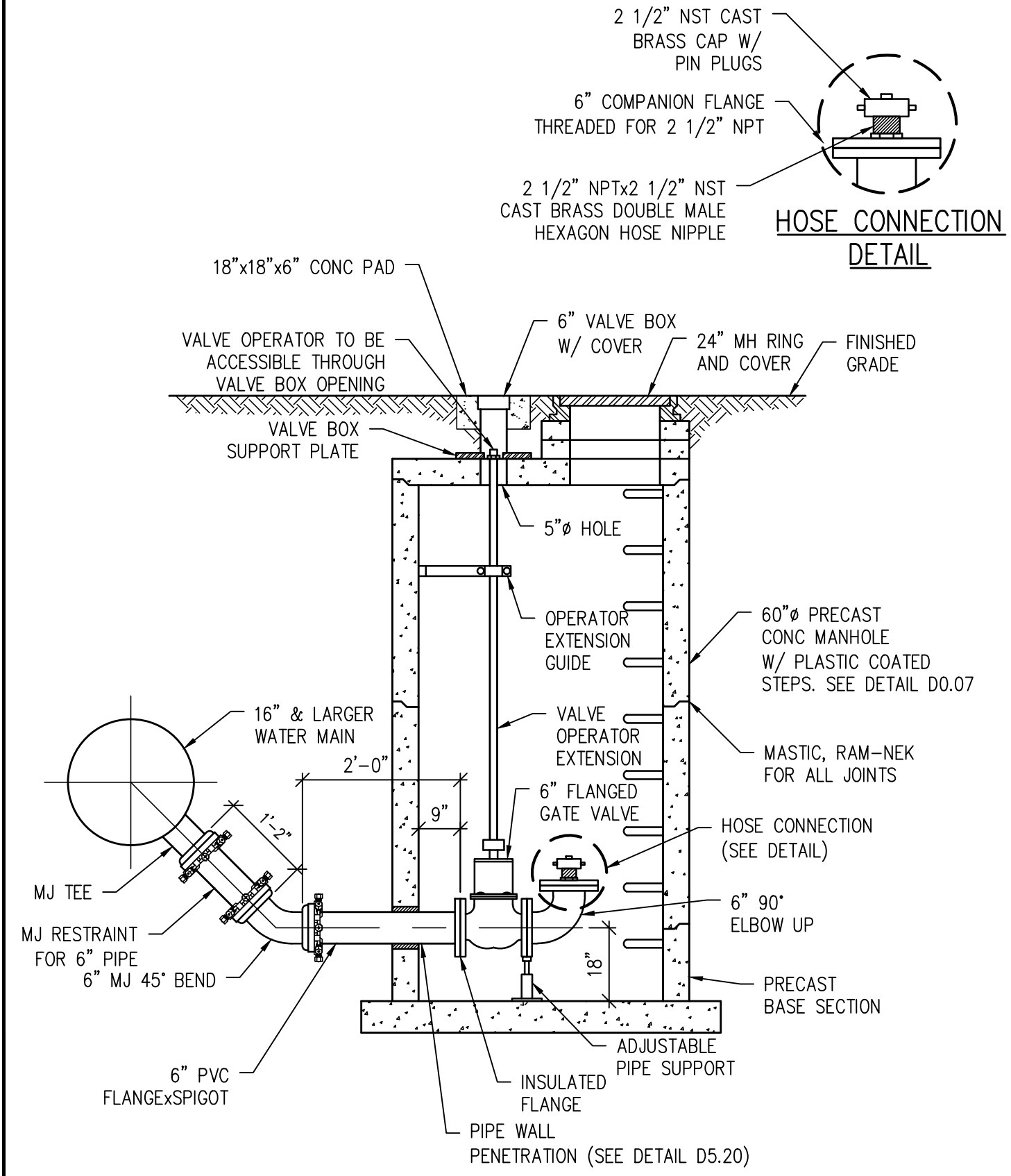
ELEVATION

NOTES:

1. BLOW–OFF PIPE TO BE TYPE K SOFT COPPER OR BRASS
2. ALLOWED IN MASTER METER AND READ AND BILL DISTRICTS ONLY
3. PLUG SHALL BE MECHANICALLY RESTRAINED.

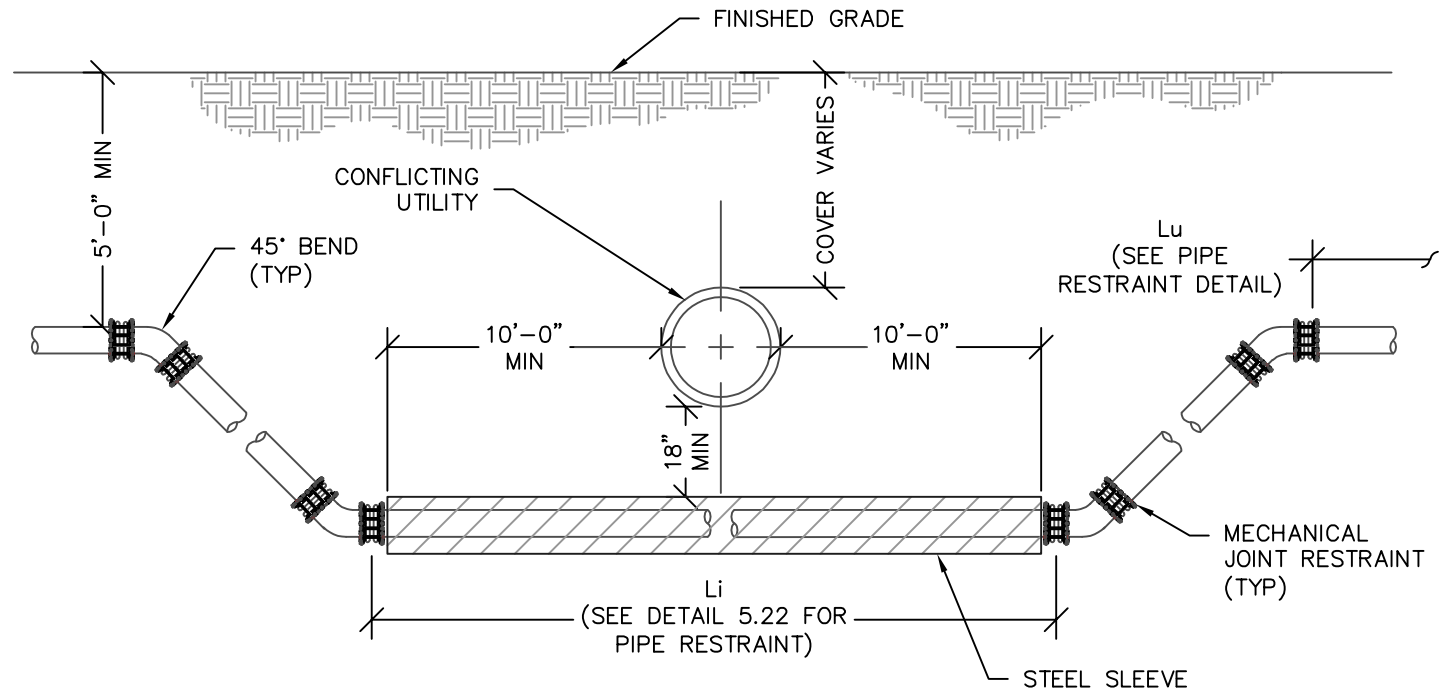
SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.09
	BLOW–OFF INSTALLATION – 12–INCH AND SMALLER PIPE	DATE: 12/2020

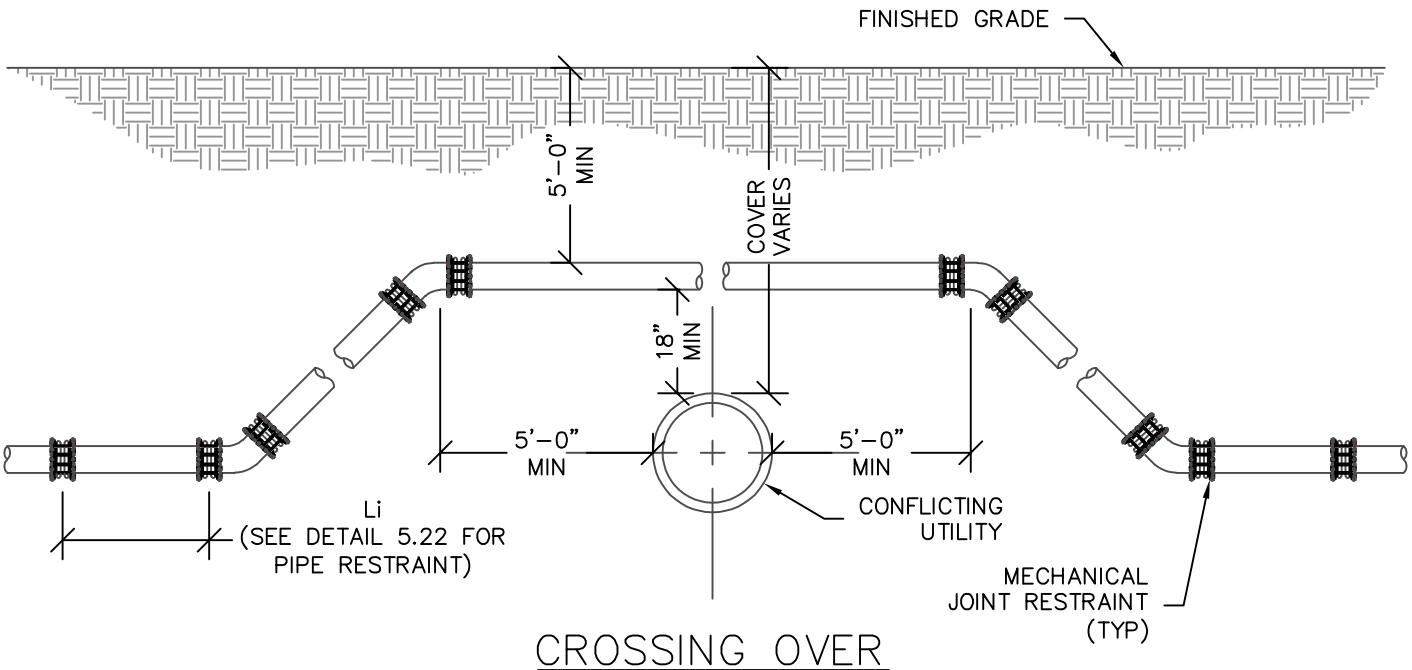


SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.10
	BLOW-OFF DETAIL	DATE: 12/2020



CROSSING UNDER



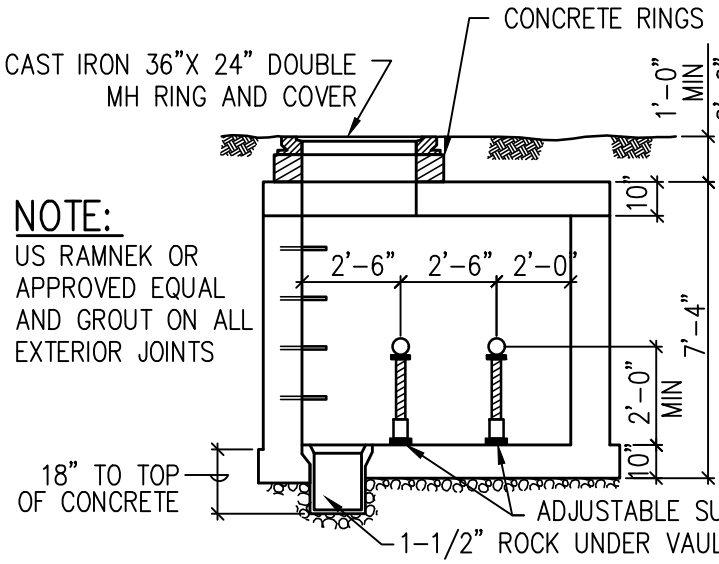
CROSSING OVER

NOTES:

1. CENTER WATER MAIN AT CROSSING TO POSITION JOINTS AS FAR FROM CROSSING AS POSSIBLE.

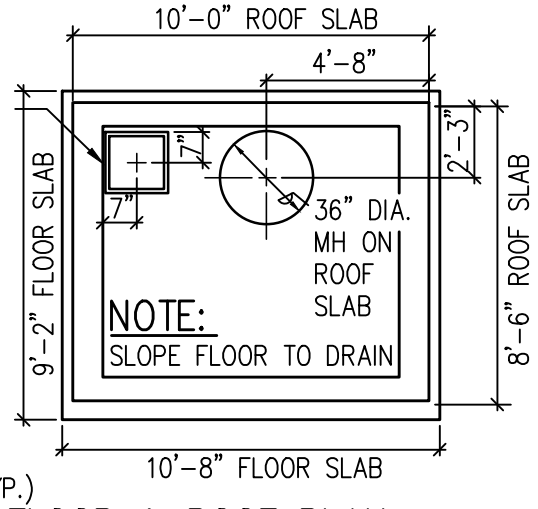
SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.11
	CROSSING OVER OR UNDER CONFLICTING UTILITY	DATE: 10/2025

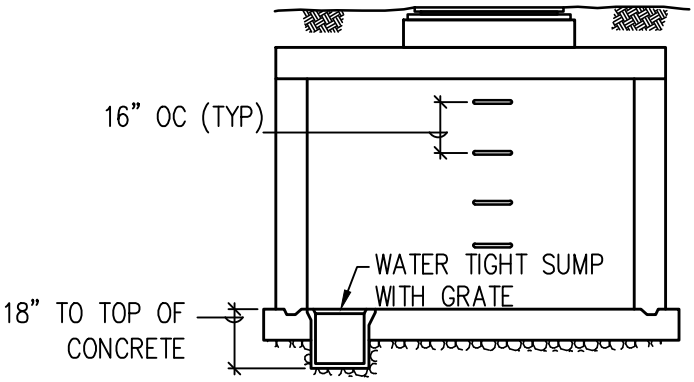


NOTE:
US RAMNEK OR APPROVED EQUAL AND GROUT ON ALL EXTERIOR JOINTS

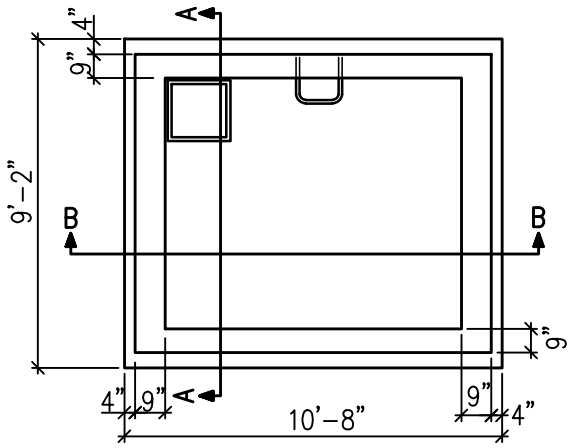
SECTION A



FLOOR & ROOF PLAN



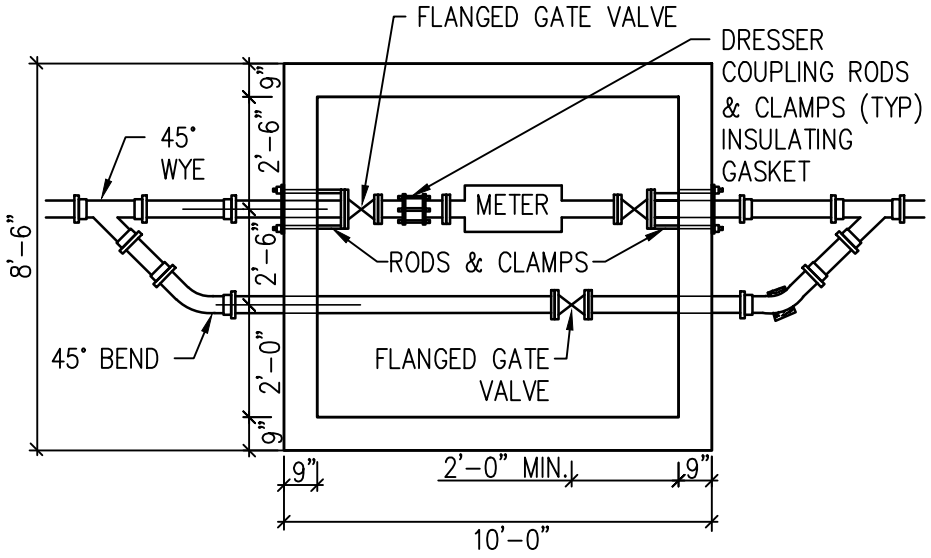
SECTION B



VAULT PLAN

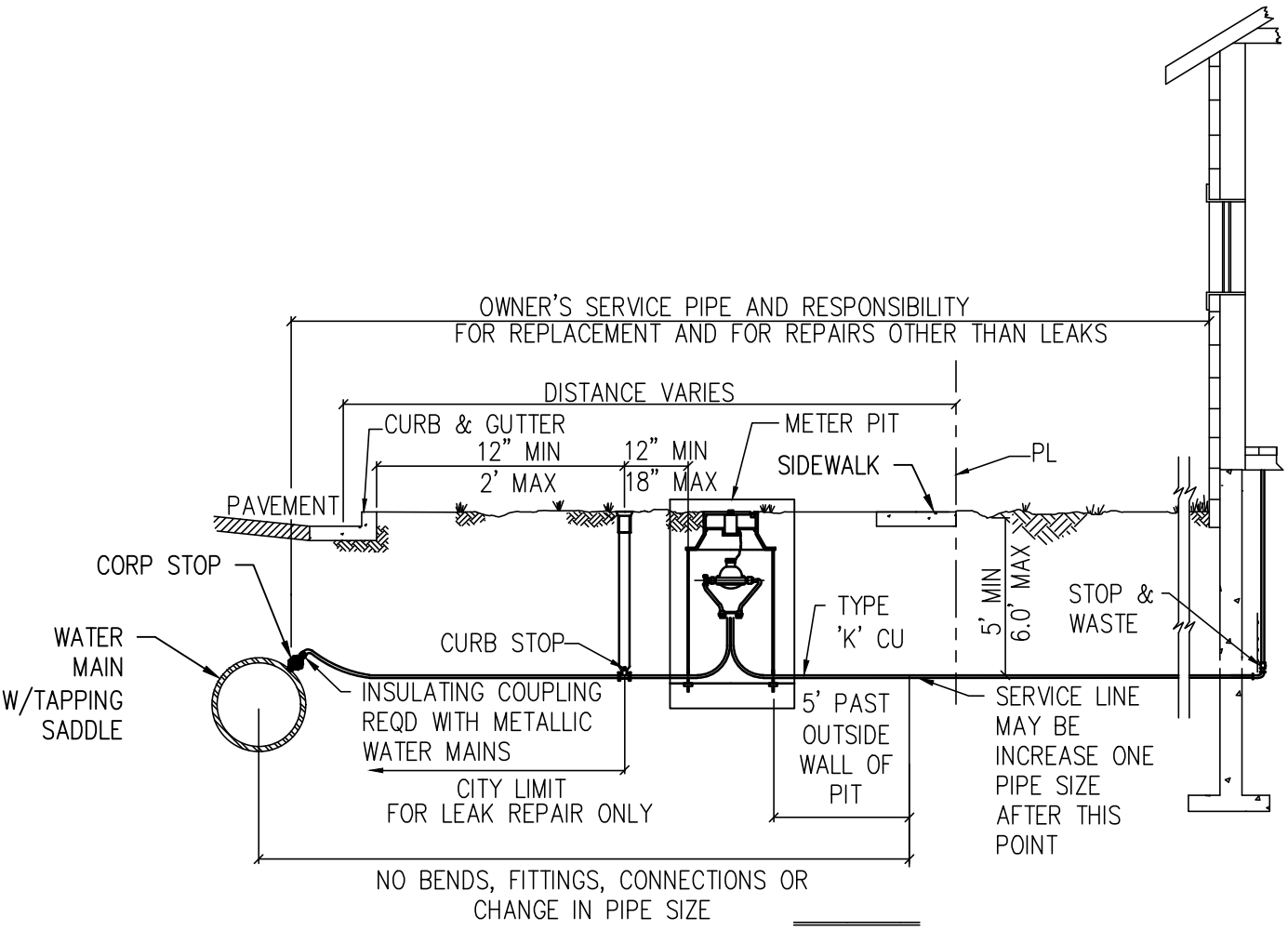
NOTES:

1. ALL MATERIALS, INSTALLATION AND CONSTRUCTION OF METER VAULT ASSEMBLY SHALL BE IN ACCORDANCE WITH CITY OR DISTRICT STANDARDS AND SPECIFICATIONS, TO INCLUDE METER, PIPING, FITTINGS, VALVES, VAULT AND APPARATUS ITEMS.
2. DOMESTIC SERVICE MUST BE INSTALLED BY LICENSED PLUMBER OR WATER SERVICE CONTRACTOR.
3. REFER TO REMOTE READOUT DETAIL IF REQUIRED.
4. BYPASS LINE REQUIRED FOR 1-1/2 INCH AND LARGER METERS EXCEPT THOSE USED FOR IRRIGATION ONLY.
5. PROVIDE ADJUSTABLE SUPPORTS FOR METER AND BY-PASS

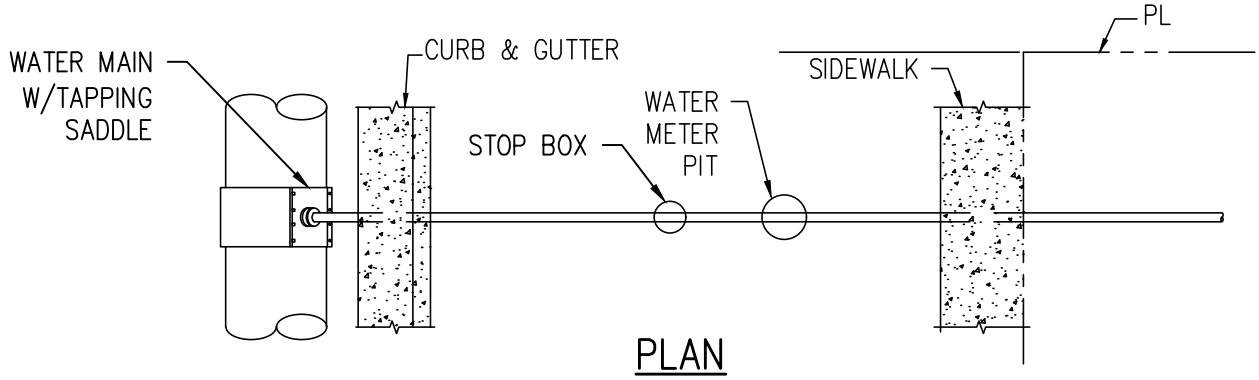


SCALE: NTS

TOWN OF BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.12
	METER VAULT ASSEMBLY	DATE: 12/2020



ELEVATION



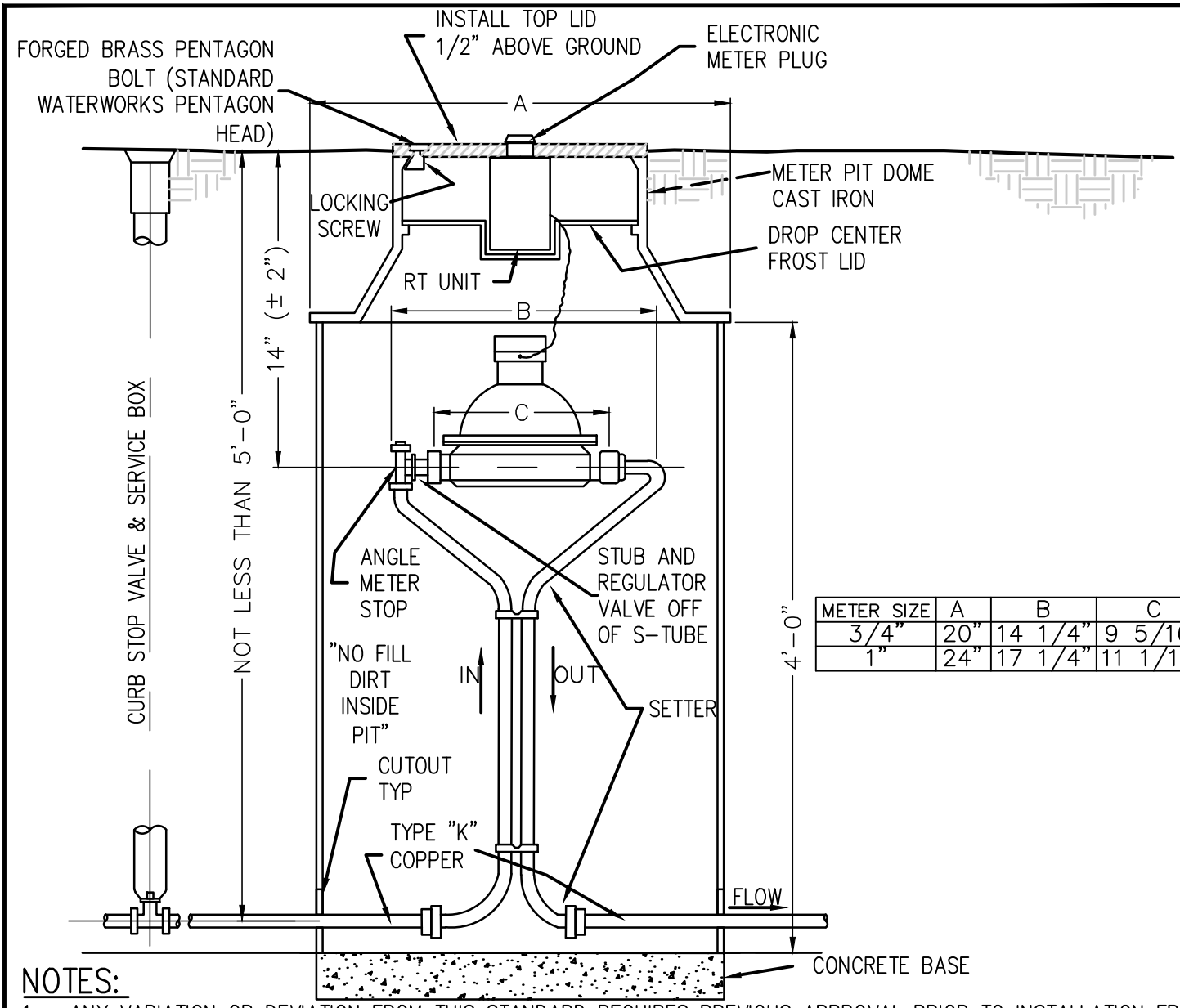
PLAN

NOTES:

1. IF THERE IS A TREE LAWN, BOTH CURB STOP AND METER PIT MUST BE LOCATED BETWEEN CURB AND SIDEWALK
2. STOP BOX SHALL BE LOCATED IN A PUBLIC RIGHT-OF-WAY AS CLOSE TO CURB AS POSSIBLE, IN A LANDSCAPED AREA 24" FROM THE INLET SIDE OF THE METER PIT UNLESS PRIOR APPROVAL IS OBTAINED FROM THE TOWN. FOR A CURB STOP LOCATED BENEATH PAVEMENT, USE A ROADWAY BOX OVER STANDARD STOP BOX WITH A BOND BREAKER. THE CURB STOP CANNOT BE LOCATED BENEATH PARKING AREAS.
3. 2 FT CLEAR FROM THE WATER METER PIT AND STOP BOX LID FOR PLANTINGS, SHRUBS, AND BUSHES
4. 7 FT CLEAR FROM WATER METER PIT AND STOP BOX LID TO PROPERTY LINE

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.13
	SERVICE LINE, STOP BOX, OUTSIDE METER INSTALLATION	DATE: 12/2020



METER SIZE	A	B	C
3/4"	20"	14 1/4"	9 5/16"
1"	24"	17 1/4"	11 1/16"

NOTES:

1. ANY VARIATION OR DEVIATION FROM THIS STANDARD REQUIRES PREVIOUS APPROVAL PRIOR TO INSTALLATION FROM METER INSPECTOR
2. METER PIT MUST BE INSTALLED IN LANDSCAPED AREA. PRIOR APPROVAL REQD FOR INSTALLATIONS IN ROADWAYS, DRIVEWAYS, OR SIDEWALKS, ROAD LIDS, OR OTHER SPECIAL MODIFICATIONS MAY BE REQD.
3. NO SHRUBS, BUSHES, OR PLANTS WITHIN 2 FT OF PIT LID AND STOP BOX. NO FENCES, WALLS, TREES, WITHIN 5 FT OF PIT WALL AND STOP BOX. STOP BOX AND METER MUST NOT BE BEHIND WALL OR FENCE.
4. ALL METER PITS SHALL BE FURNISHED WITH PLASTIC FROST LID WITH 3 INCH DEEP PAN, FIVE DRAIN HOLES, LIFTING HANDL, AND SLOT FOR AMR WIRE RUNNING FULL DEPTH OF LIP.
5. METER PIT SHALL BE CONSTRICTED IN ACCORDANCE WITH STANDARDS. TOTAL DEPTH OF PIT MUST BE AT LEAST 48" WITH ADJUSTMENT RINGS USED BETWEEN PIT TOP RING AND DOME SO PIT LID IS 1/2" TO 1" ABOVE FINISHED GRAD. TOP OF PIT RING SHALL NOT EXCEED 12" HEIGHT.
6. IN MOST CASES AMR DEVICE WILL MOUNT THROUGH CAST IRON LID OR UNDER COMPOSITE LID. IN SOME CASES REMOTE AMR DEVICE WILL BE NEEDED.
7. BENDING COPPER RISERS FOR GRAD ADJUSTMENT OF THE METER YOKE WILL NOT BE PERMITTED.
8. COPPER PIPE SHALL SHOW NO VISIBLE CRIMPING.
9. NO CONNECTIONS, BENDS, OR PIPE SIZE CHANGE.

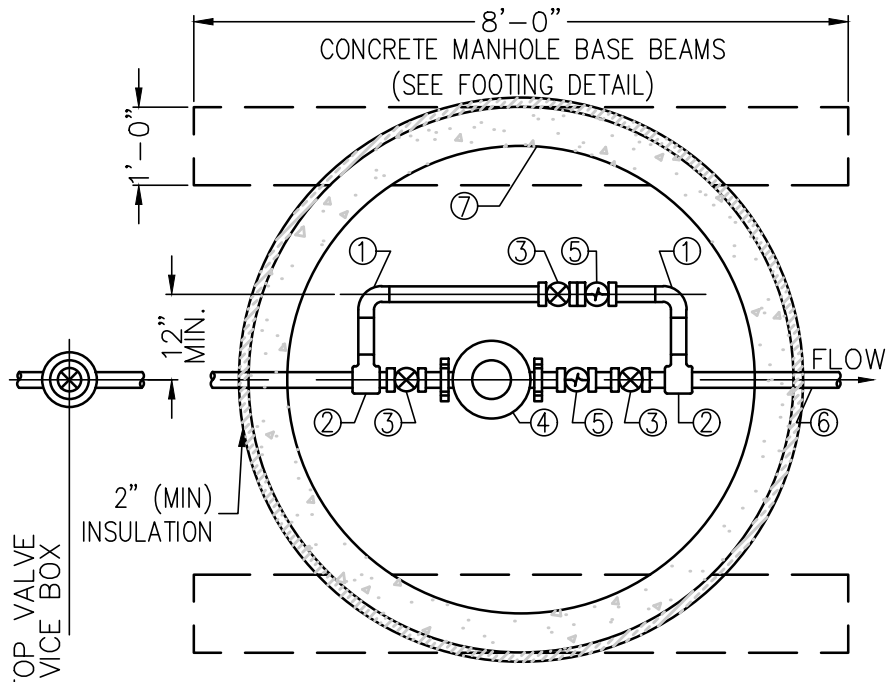
SCALE: NTS

TOWN OF BERTHOUD STANDARD DESIGN CRITERIA
WATER DETAILS

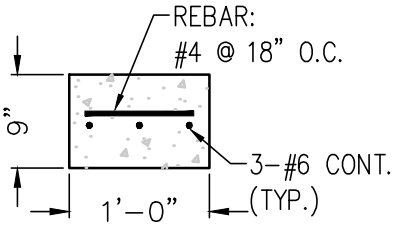
D5.14

OUTSIDE SETTING FOR 0.75-INCH AND 1-INCH METER

DATE: 12/2020



PLAN

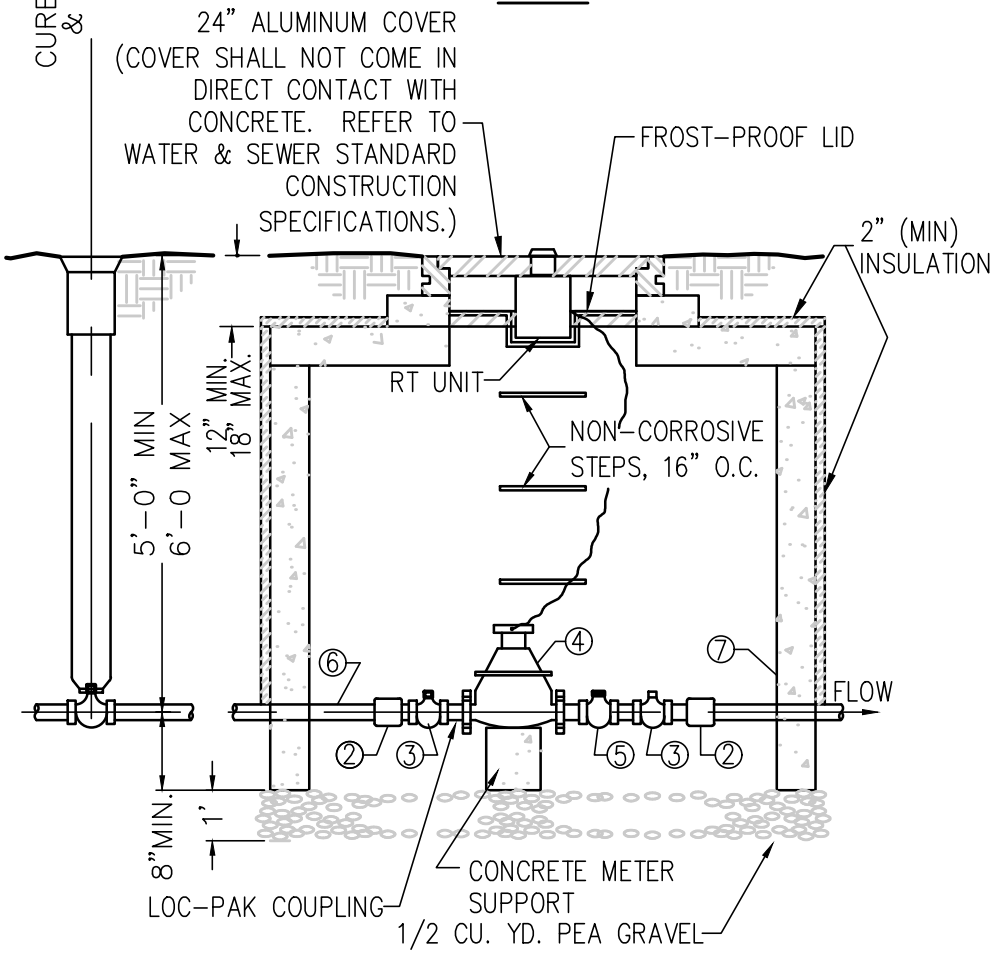


FOOTING DETAIL

① – 90° ELL
② – TEE
③ – CURB STOP W/LOCK WING
④ – METER UNIT
⑤ – APPROVED SINGLE CHECK VALVE
⑥ – TYPE K COPPER TUBING
⑦ – 48" CONCRETE MANHOLE

NOTES:

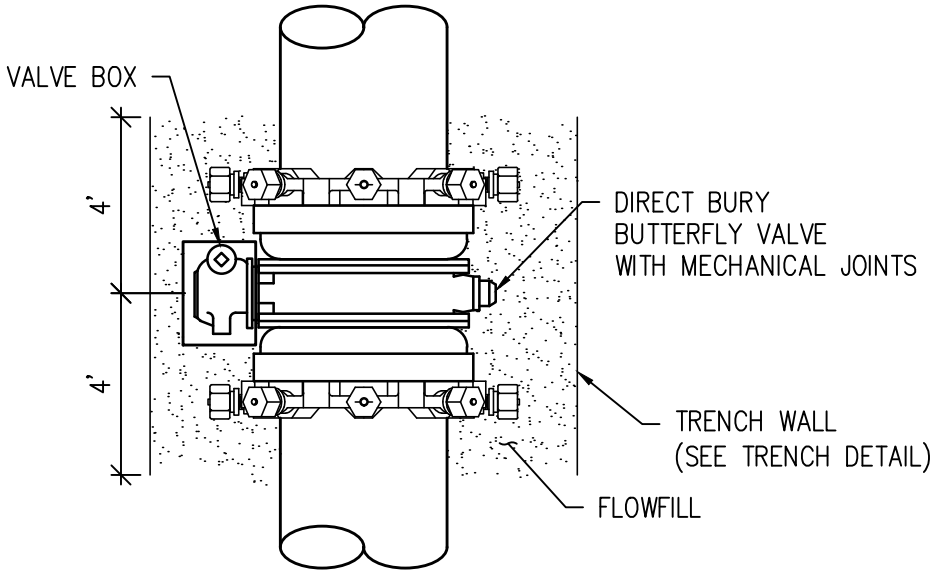
1. MANHOLE BASE BEAMS SHALL BE REQUIRED FOR ALL INSTALLATIONS.
2. A 48" DIA. MANHOLE PIT WILL ACCOMMODATE 1 1/2" & 2" SPLIT CASE METERS (LARGER PIT MAY BE REQUIRED DEPENDING ON CONDITIONS.)
3. JOINTS INSIDE METER VAULT SHALL BE EITHER THREADED OR SOLDERED W/SOLDER APPROVED FOR LEAD-FREE POTABLE WATER SYSTEMS.
4. INSULATION SHALL BE EITHER BLANKET/WRAP OR BOARD TYPE.
5. METER VAULTS LOCATED WITHIN TRAFFIC AREAS SHALL BE HS-25 LOAD RATED.
6. A SINGLE CHECK VALVE MY BE LOCATED BETWEEN BY-PASS AND EDGE OF PIT IF ROOM PERMITS INSTEAD OF TWO DOUBLE CHECK VALVES.
7. ALTERNATE BACKFLOW PREVENTION MY BE REQUIRED, DEPENDING ON HAZARD, & MAY BE LOCATED IN STRUCTURES BEING SERVED.



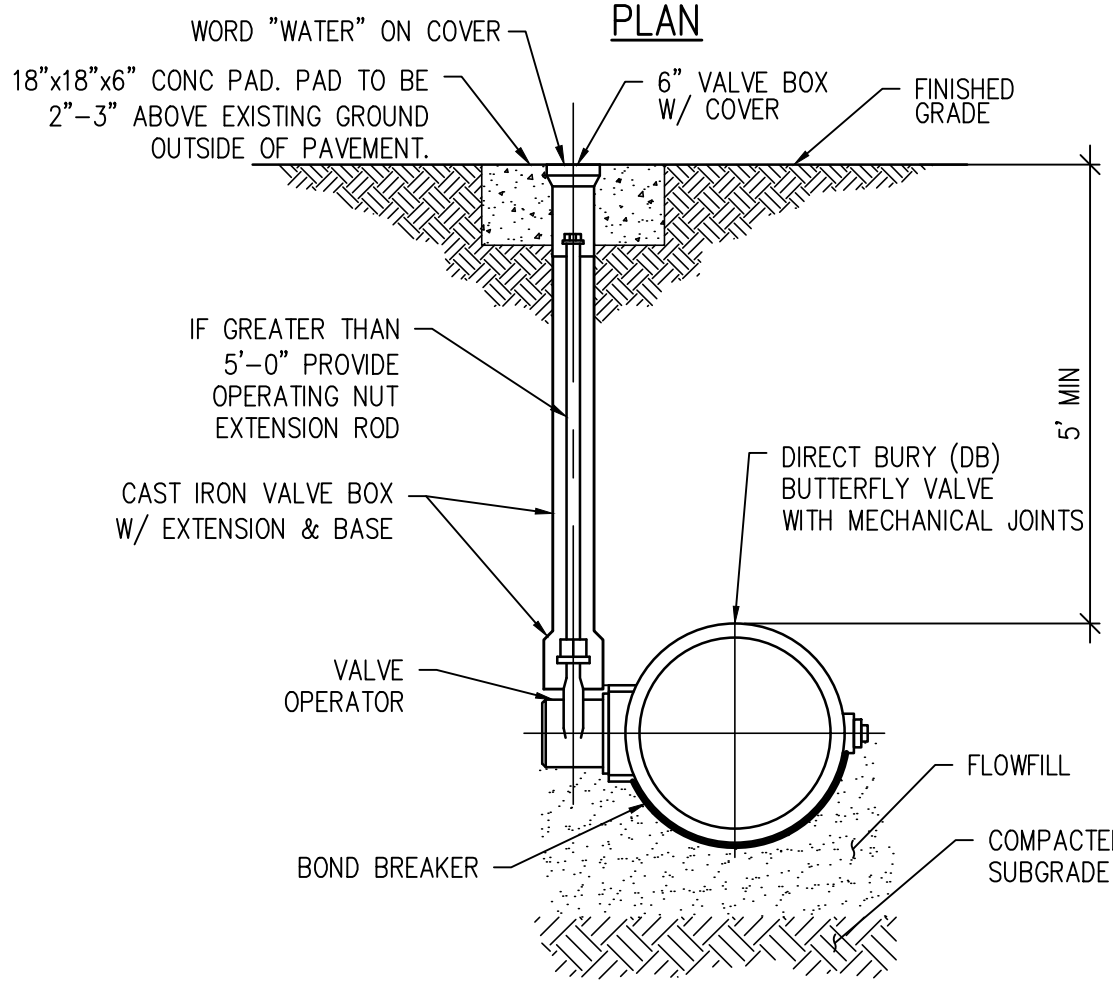
ELEVATION

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.15
	OUTSIDE SETTING FOR 1.5-INCH AND 2-INCH METER	DATE: 12/2020



PLAN



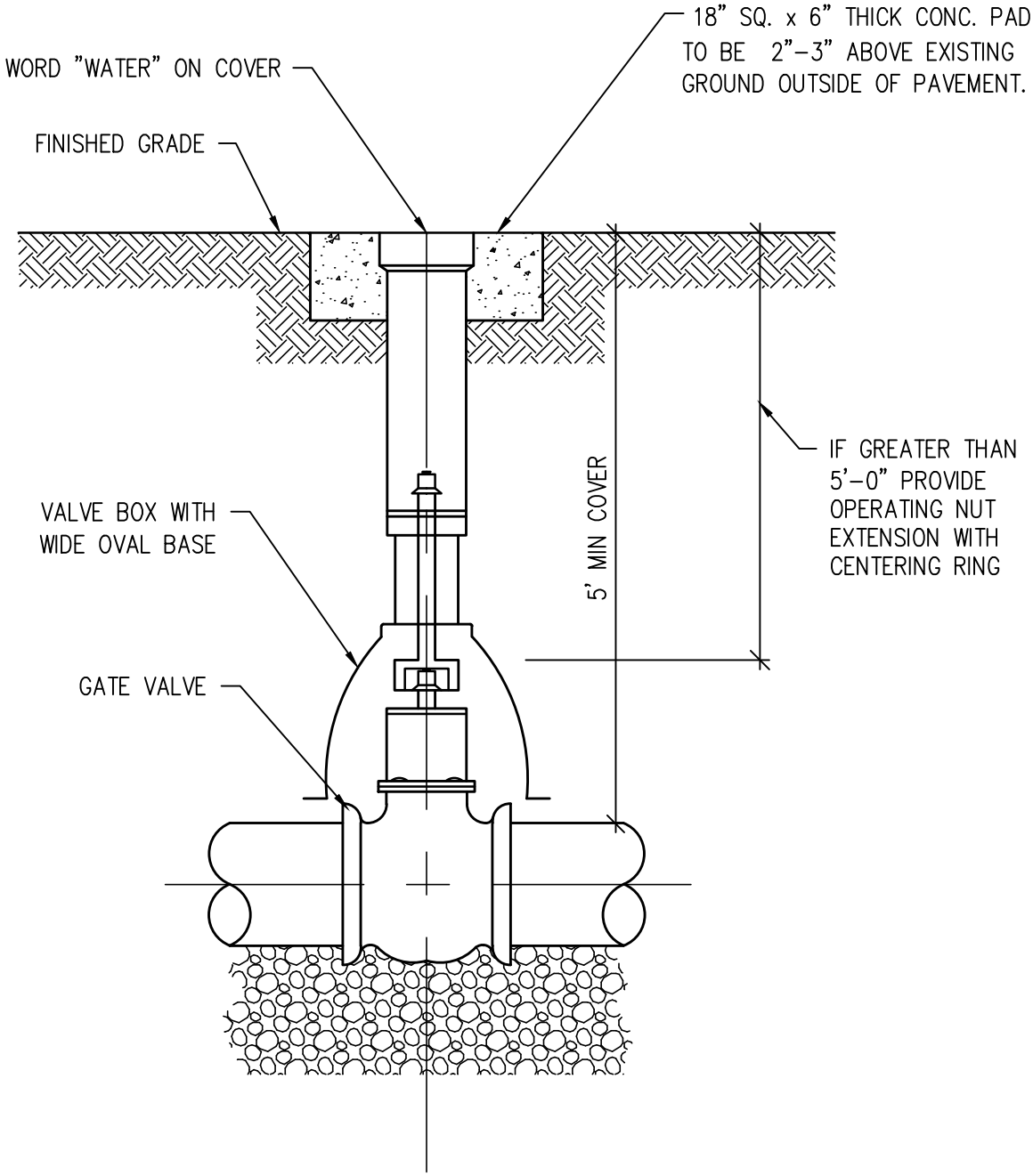
ELEVATION

NOTES:

1. ELEVATION FOR TOP OF COVER, PLACED IN PAVEMENT, SHALL BE SET IN ACCORDANCE WITH PAVING REQUIREMENTS OF LOCAL JURISDICTION.

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.16
	DIRECT BURY BUTTERFLY VALVE INSTALLATION	DATE: 12/2020

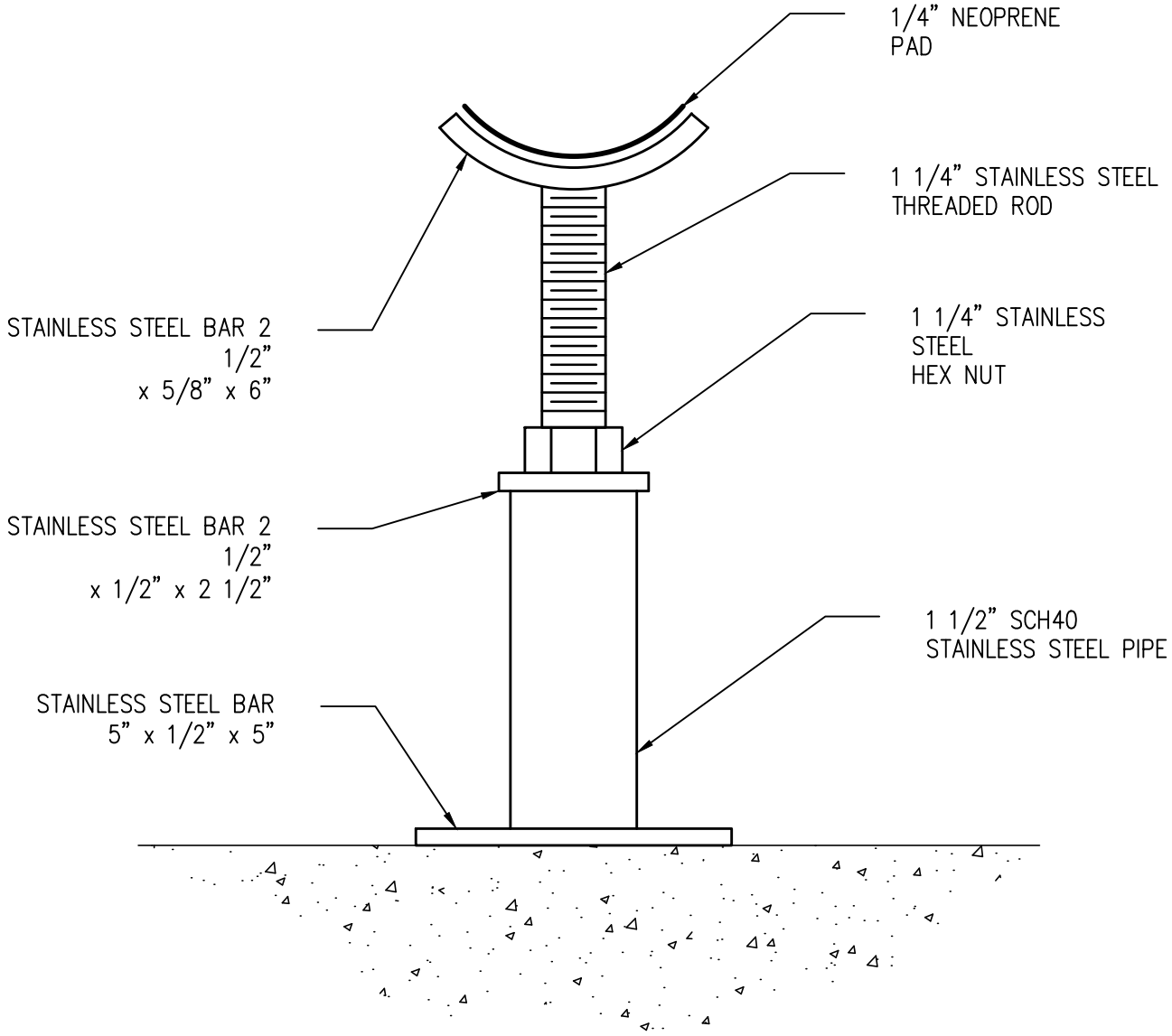


NOTES:

1. CARE SHALL BE TAKEN WHEN INSTALLING VALVES ON' LINES TO ASSURE PROPER SUPPORT OF THE VALVES.
2. WOOD BLOCKS OR 3/4" WASHED ROCK TO BE INSTALLED UNDER THE VALVE TO PROVIDE PROPER SUPPORT WHERE REQUIRED.
3. VALVES SHALL NOT BE PLACED IN CONCRETE CROSS PANS.
4. ELEVATION FOR TOP OF COVER, PLACED IN PAVEMENT, SHALL BE SET IN ACCORDANCE WITH PAVING REQUIREMENTS OF LOCAL JURISDICTION.

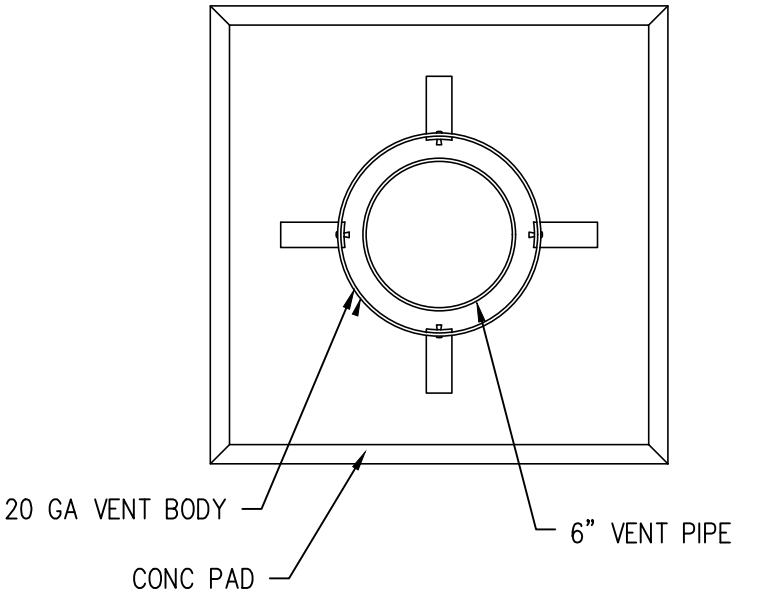
SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.17
	GATE VALVE	DATE: 12/2020

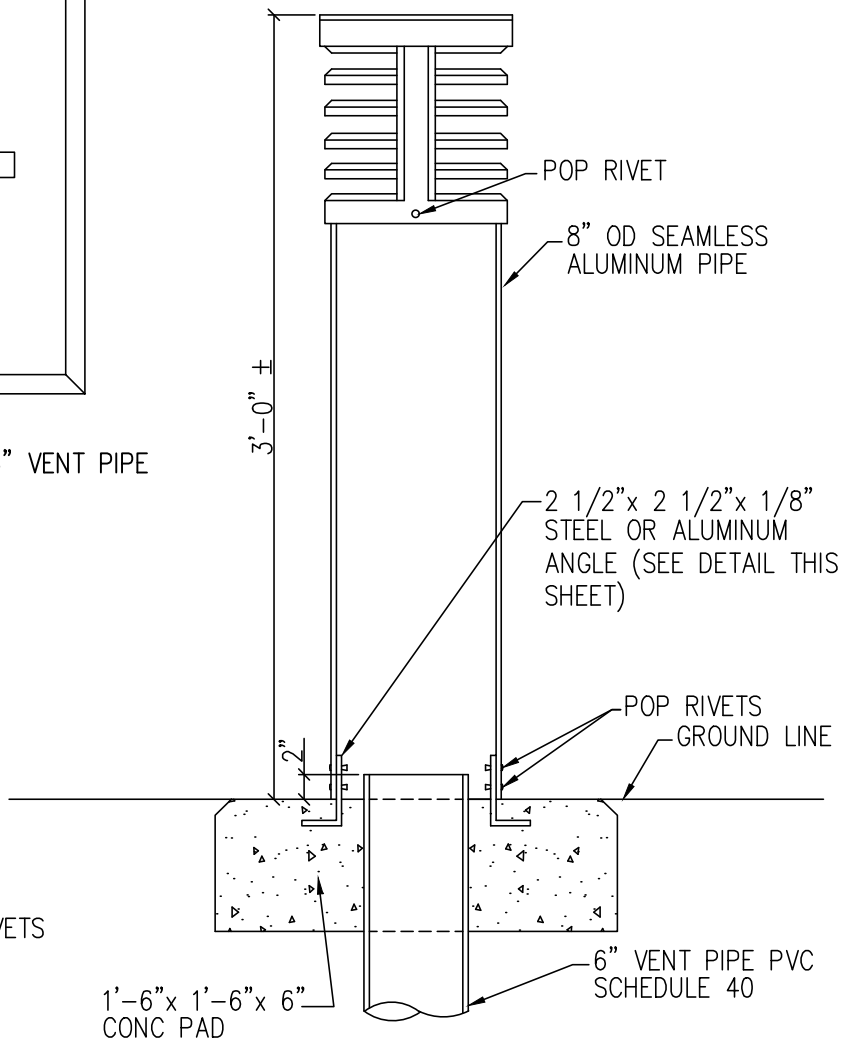


SCALE: NTS

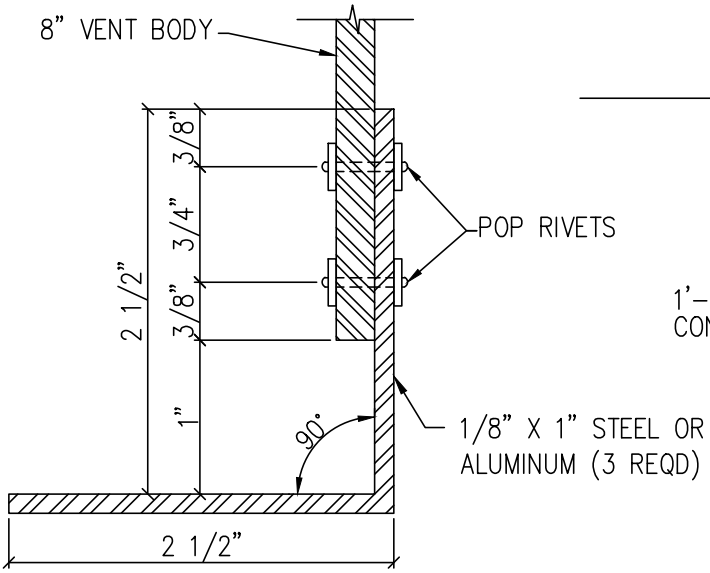
TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.18
	FLOOR PIPE SUPPORT	DATE: 12/2020



BASE DETAIL



ROUND VENT SCREEN



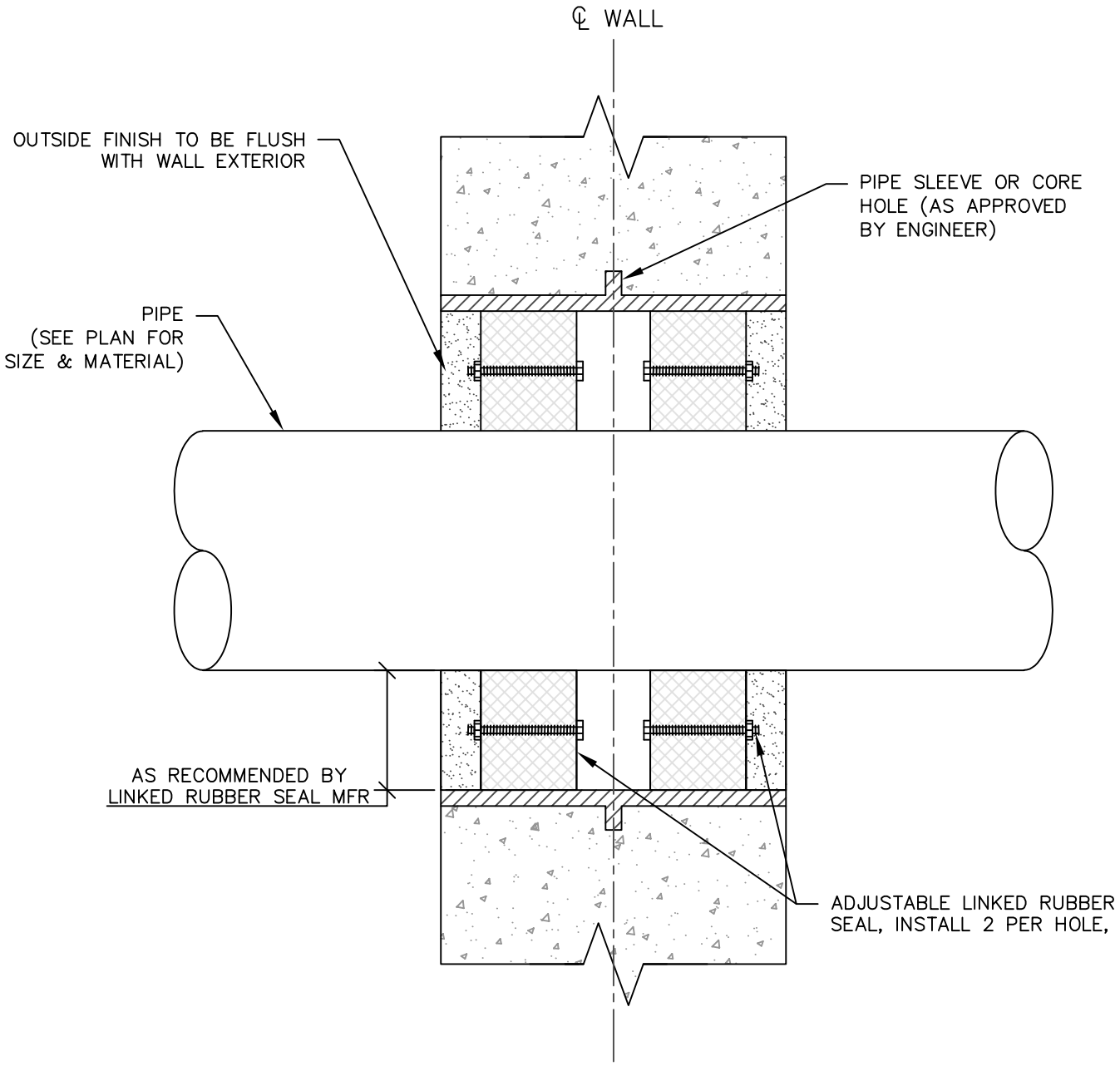
STEEL OR ALUMINUM ANGLE DETAIL

NOTES:

1. COLOR SHALL BE OLIVE GREEN OR FLAT BLACK TO MATCH SURROUNDINGS

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.19
	RESIDENTIAL VENT ASSEMBLY	DATE: 12/2020

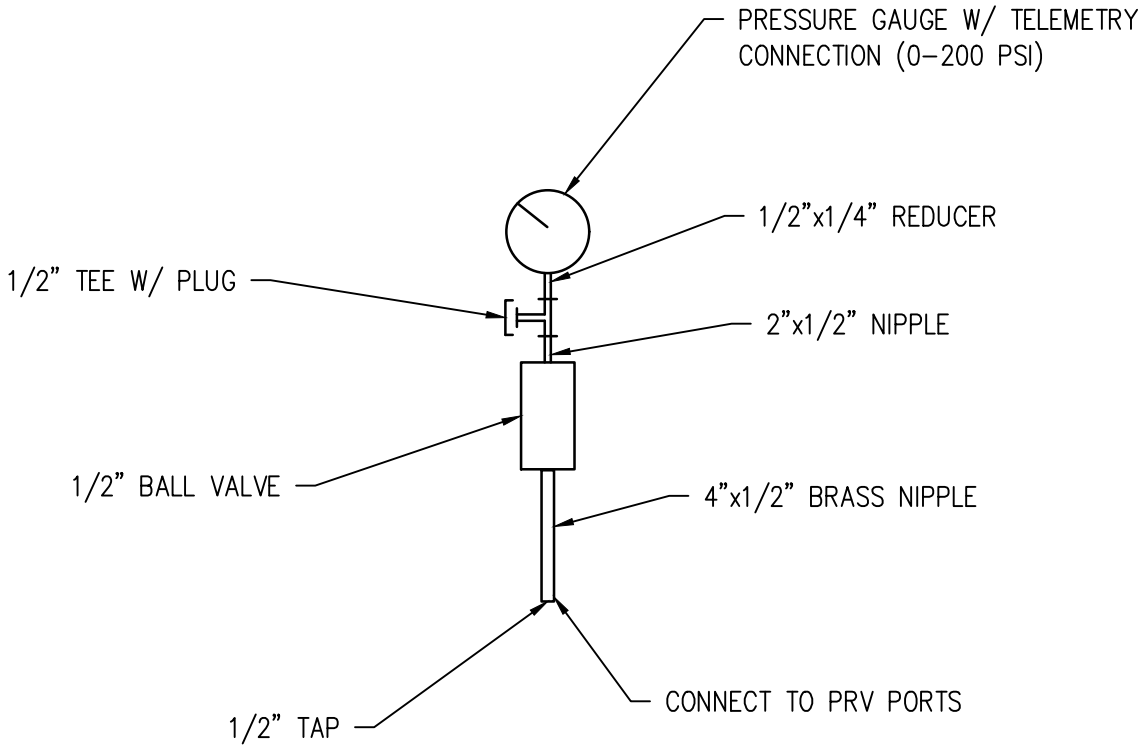


NOTES:

1. WHERE INSTALLED, YIELD STRENGTH OF PIPE MUST BE GREATER THAN SPECIFIED GROUT.
2. ALL PENETRATIONS MUST BE SLEEVED UNLESS APPROVED BY THE ENGINEER.
3. ALL PENETRATIONS TO CONFORM WITH CURRENT IBC AND IMC REQUIREMENTS.

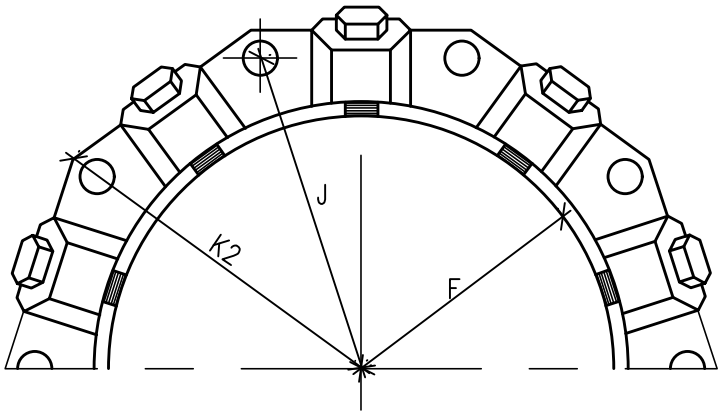
SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.20
	WALL PENETRATION WITH CORE HOLE	DATE: 10/2025

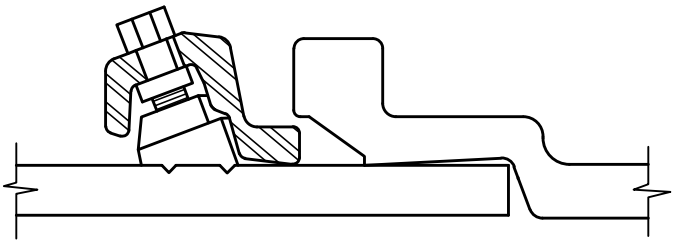


SCALE: NTS

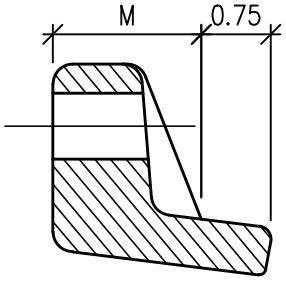
TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.21
	PRESSURE GAUGE	DATE: 12/2020



MECHANICAL JOINT RESTRAINT



WEDGE DETAIL



BOLT HOLE DETAIL

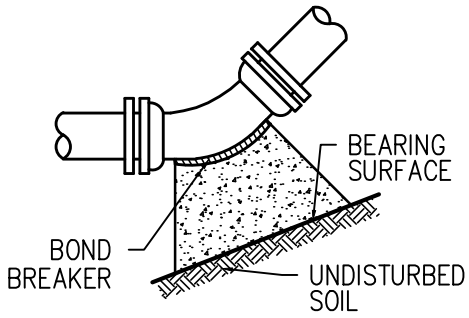
	NOMINAL PIPE SIZE	NO. OF BOLTS	NO. OF WEDGES	K2 INCHES	J INCHES	F INCHES	M INCHES	
PVC	4"	2	2					PVC
	6"	6	3	11.12	9.50	7.00	0.88	
	8"	6	4	13.37	11.75	9.15	1.00	
	10"	8	6	15.62	14.00	11.20	1.00	
	12"	8	8	17.88	16.25	13.30	1.25	
DI	4"	4	2					DI
	6"	6	3	11.12	9.50	7.00	0.88	
	8"	6	4	13.37	11.75	9.15	1.00	
	10"	8	6	15.62	14.00	11.20	1.00	
	12"	8	8	17.88	16.25	13.30	1.25	
	16"	12	12	22.50	21.00	17.54	1.56	
	20"	14	14	27.00	25.50	21.74	1.69	

DIMENSIONS

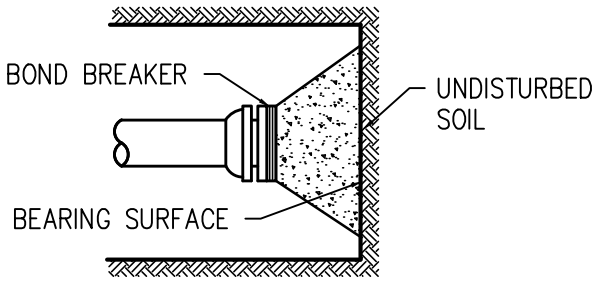
NOTE:

1. BASED ON "MEGA LUG" PIPE RESTRAINT SYSTEM BY EBAA IRON
2. OTHER MECHANICAL JOINT RESTRAINT DEVICES MUST BE APPROVED BY TOWN ENGINEER BEFORE INSTALLATION.

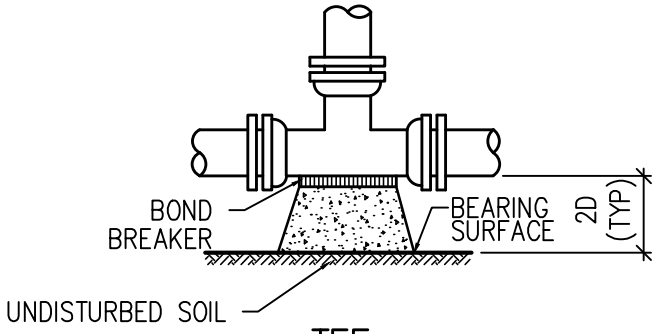
SCALE: NTS



90° BENDS ONLY



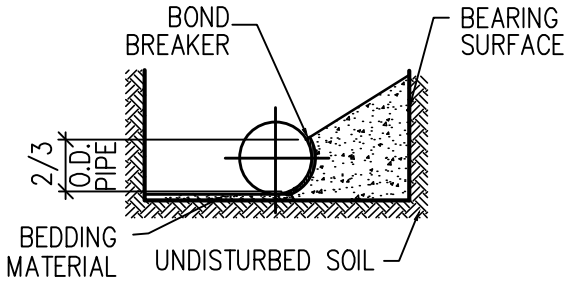
DEAD END



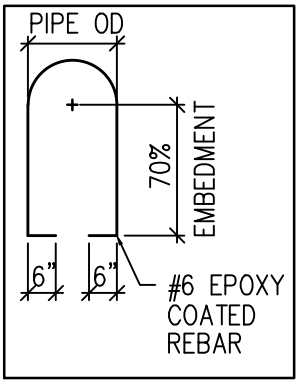
TEE

SIZE OF PIPE	SURFACE AREA (SQ FT)	
	TEE OR DEAD END	90° BENDS
4"	1.50	2.0
6"	3.00	4.5
8"	5.25	8.0
12"	11.25	17.0
16"	19.00	27.00
20"	25.00	35.50
24"	36.00	51.00

MINIMUM BEARING SURFACE AREA
(IN SQUARE FEET)



TYPICAL CROSS SECTION



NOTES:

1. BEARING SURFACES SHOWN IN CHART ARE MINIMUM
2. BASED ON 150 PSI INTERNAL PIPE PRESSURE PLUS WATER HAMMER
3. 6", 8", &12" WATER HAMMER = 110 PSI
4. 16", 20" AND 24" WATER HAMMER = 70 PSI
5. BASED ON 3000 PSI SOIL BEARING CAPACITY
6. THRUST BLOCK SHALL NOT INTERFERE W/MECHANICAL JOINT BOLT OPERATOIN

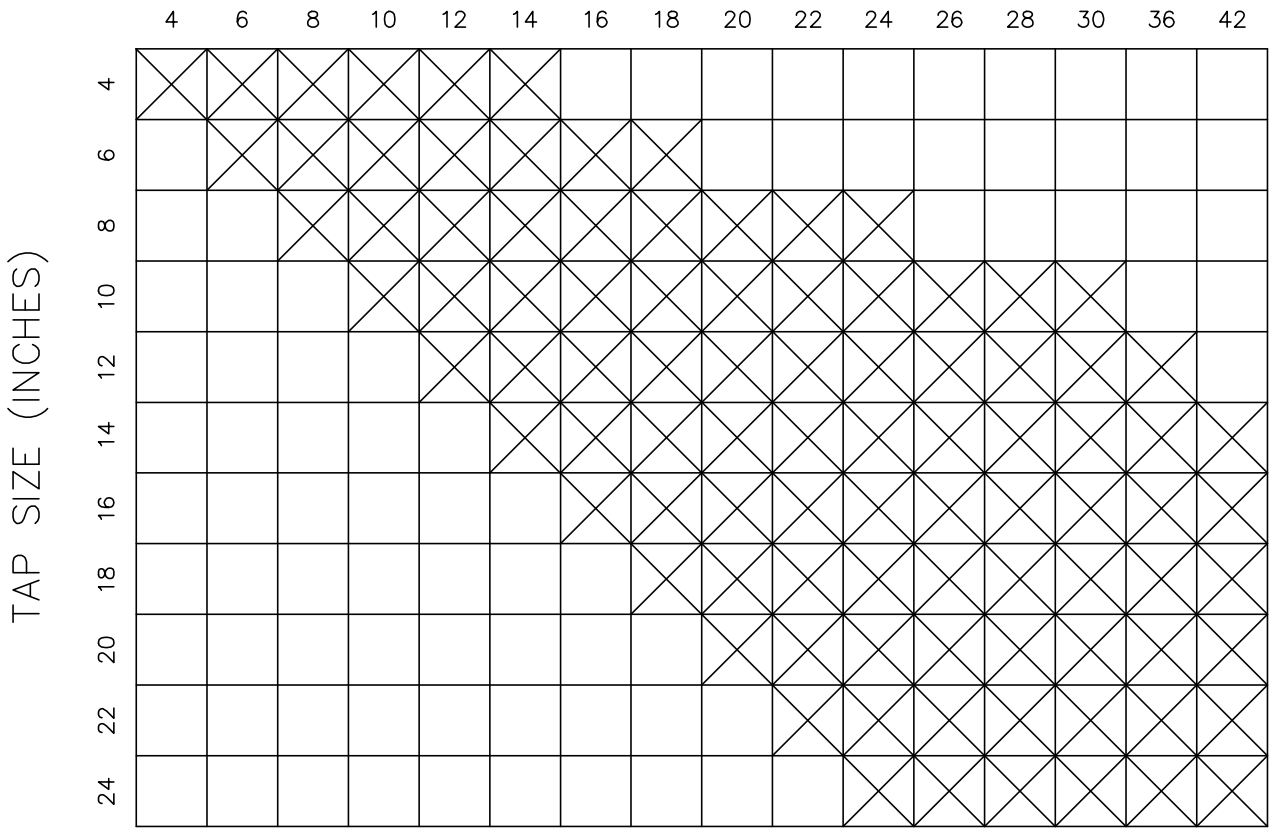
SCALE: NTS

CONCRETE THRUST BLOCKS

WATER MAIN AND TAP SIZE COMBINATIONS WHICH REQUIRE A CONC THRUST BLOCK BEHIND THE MAIN AT THE TAPPING SLEEVE OR SADDLE

ALL WATER MAINS

☒ INDICATED CONC THRUST BLOCK REQD

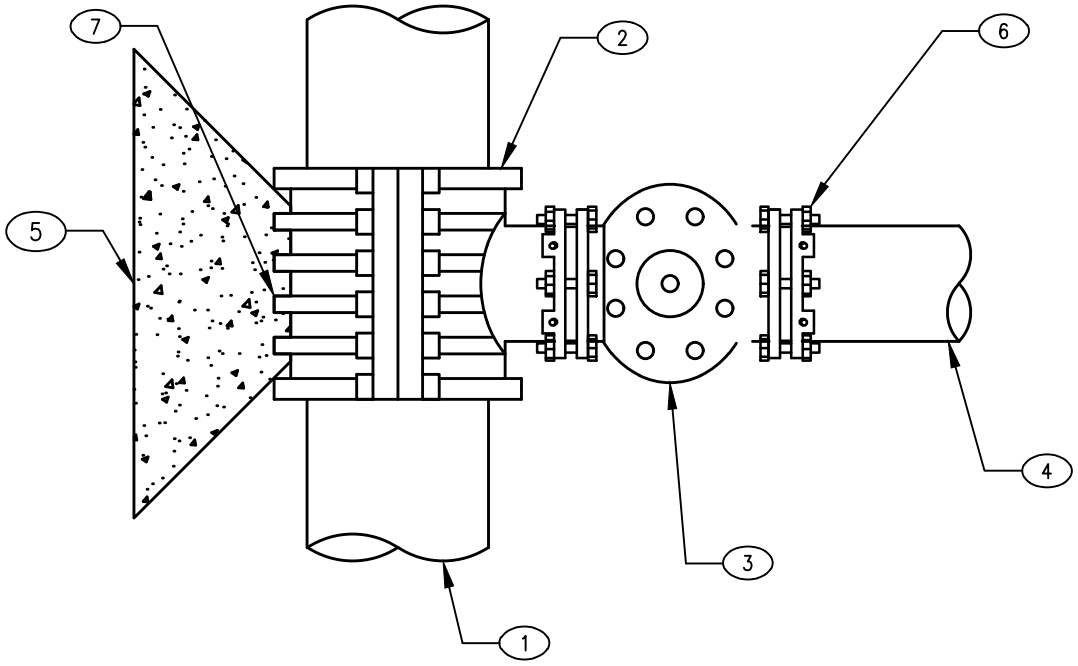


NOTES:

1. ANY THRUST BLOCK REQUIREMENTS FOR WATER MAIN AND TAP SIZED COMBINATIONS OTHER THAN THOSE SHOWN ABOVE WILL REQUIRE SPECIAL DESIGN APPROVAL BY THE TOWN ENGINEER

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.24
	CONCRETE THRUST BLOCKS 2 OF 2	DATE: 12/2020



DETAILS:

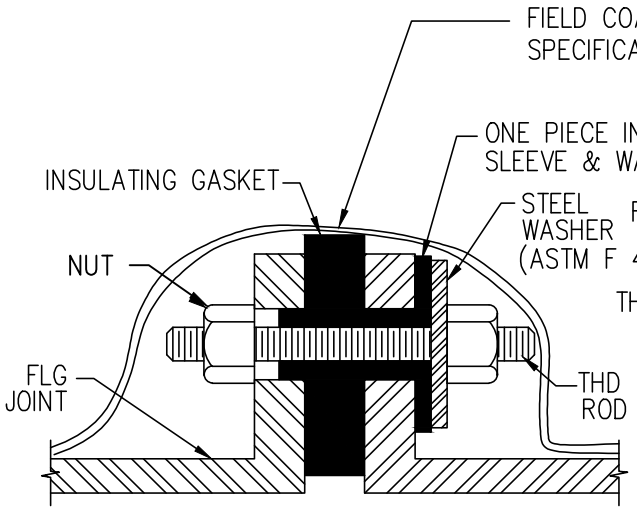
1. EXISTING MAIN
2. FABRICATED STEEL TAPPING SLEEVE WITH EPOXY SHOP COATING, STAINLESS STEEL BOLTS AND NUTS
3. TAPPING VALVE
4. DOUBLE SPIGOT PIPE
5. CONCRETE KICKBLOCK (SEE KICKBLOCK DETAIL)
6. MECHANICAL JOINT RESTRAINT (IF REQUIRED)
7. BOND BREAKER BETWEEN CONCRETE AND WET TAP SADDLE–8 MIL POLYETHYLENE

NOTES:

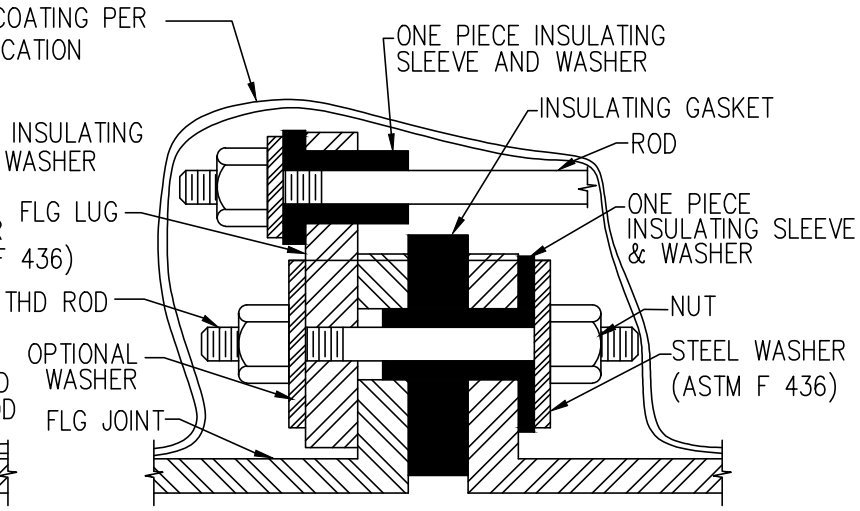
1. DISTRICT MUST BE NOTIFIED AT LEAST 24 HOURS BEFORE TAPPING
2. A TOWN REPRESENTATIVE MUST BE ONSITE DURING TAPPING.

SCALE: NTS

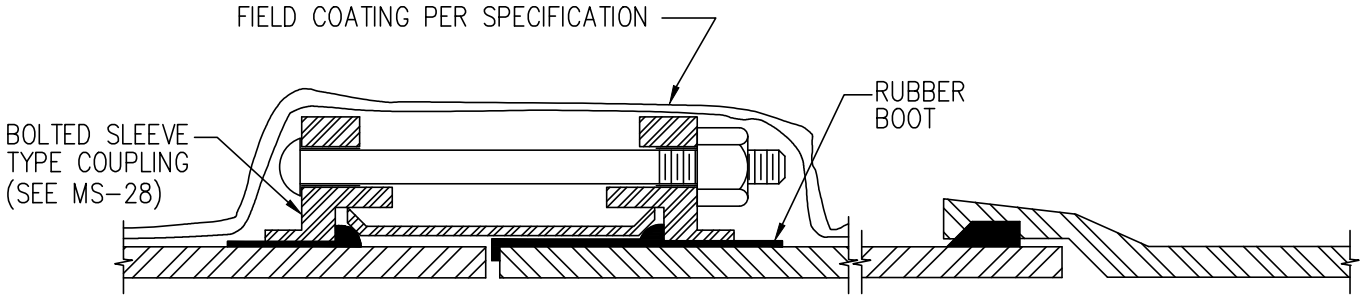
TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.25
	TAPPING TEE AND VALVE	DATE: 12/2020



INSULATED JOINT



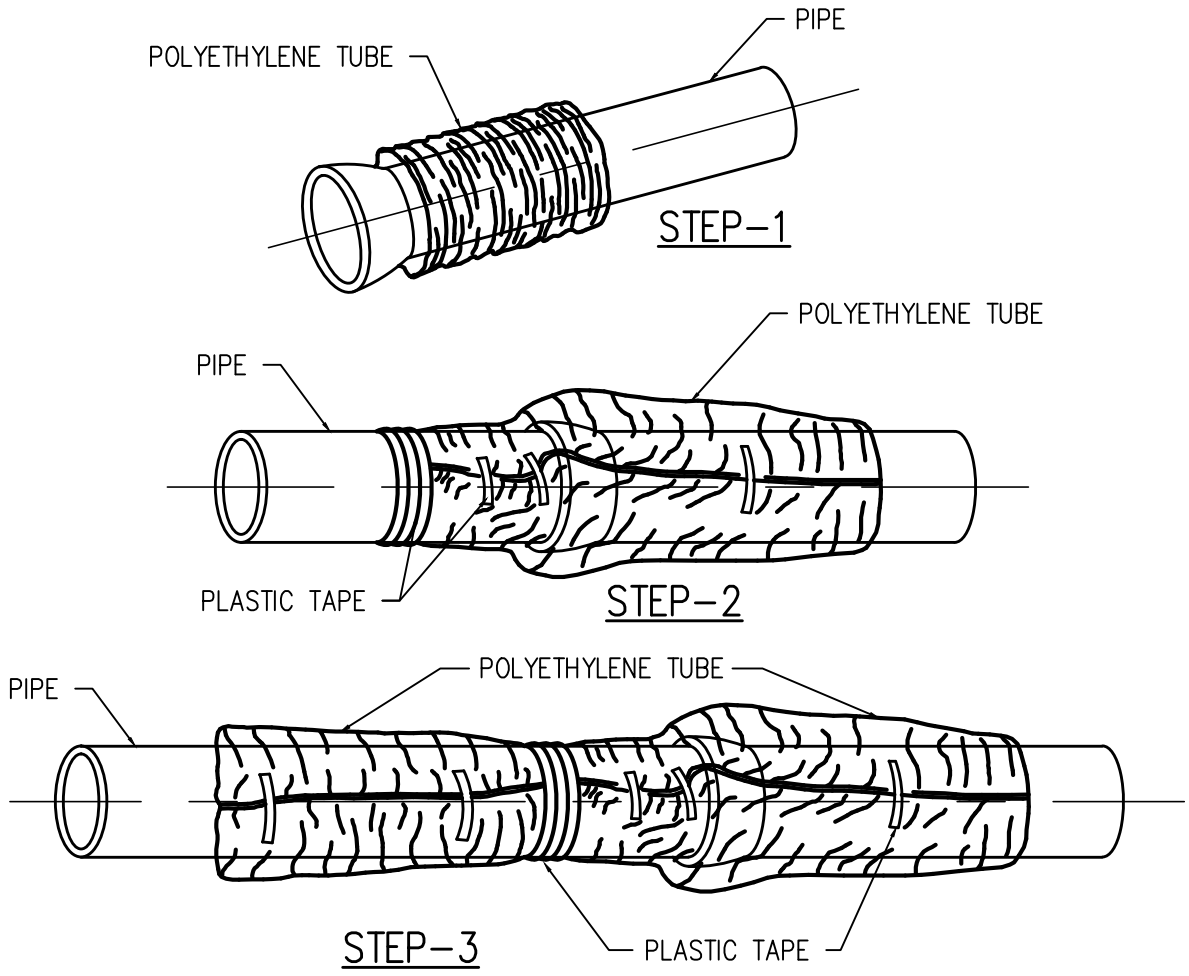
INSULATED ROD



INSULATED BOLTED SLEEVE TYPE COUPLING

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.26
	INSULATED JOINT, ROD, AND COUPLING	DATE: 12/2020



FIELD INSTALLATION–POLYETHYLENE WRAP

STEP–1 PLACE TUBE OF POLYETHYLENE MATERIAL AROUND PIPE PRIOR TO LOWERING PIPE INTO TRENCH

STEP–2 PULL THE TUBE OVER THE LENGTH OF THE PIPE. TAPE TUBE TO PIPE AT JOINT FOLD MATERIAL AROUND THE ADJACENT SPIGOT END AND WRAP WITH THREE CIRCUMFERENTIAL TURNS OF TWO–INCH WIDE PLASTIC TAPE TO HOLD PLASTIC TUBE AROUND SPIGOT END

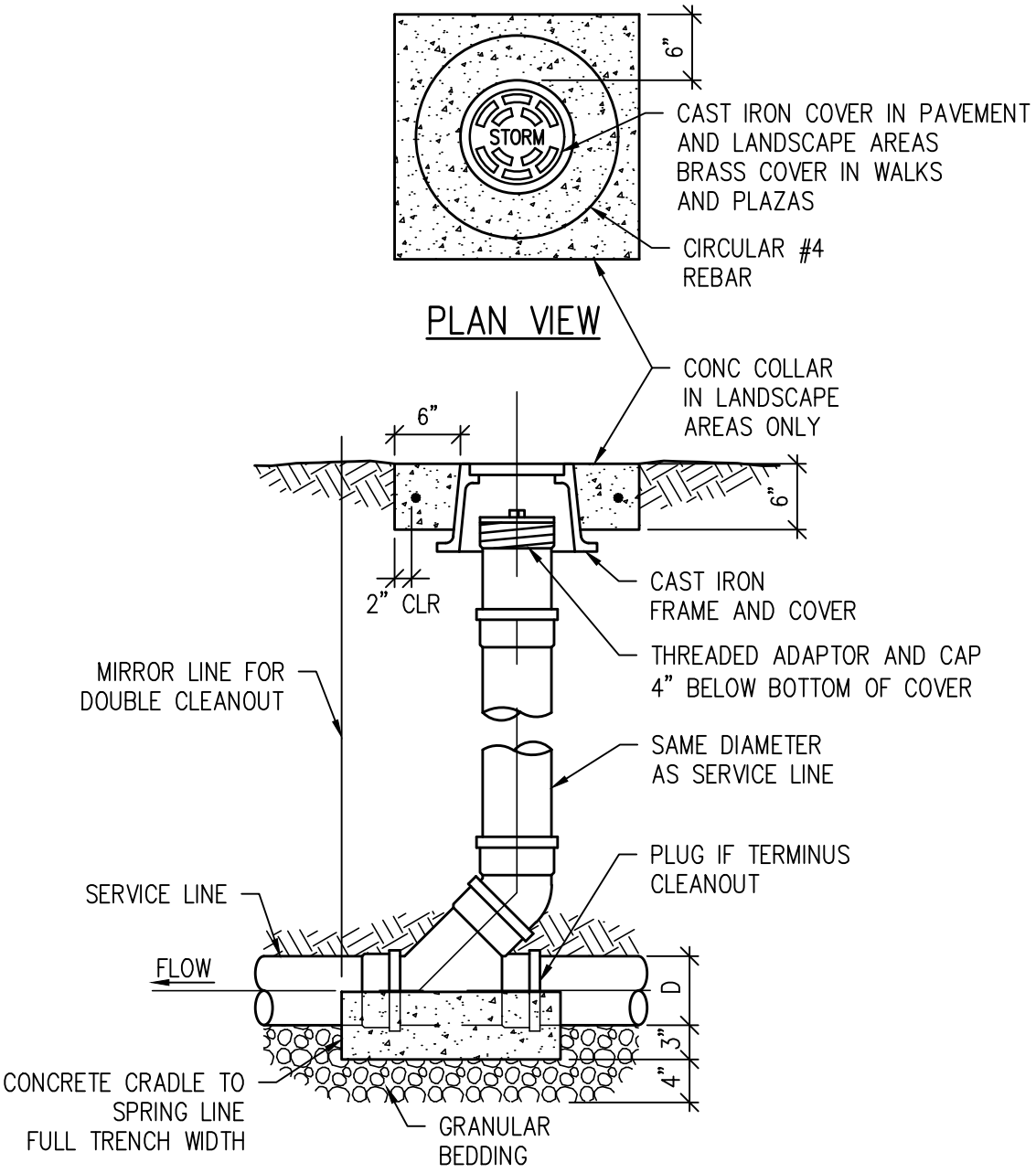
STEP–3 ADJACENT TUBE OVERLAPS FIRST TUBE AND IS SECURED WITH PLASTIC ADHESIVE TAPE. THE POLYETHYLENE TUBE MATERIAL COVERING THE PIPE WILL BE LOOSE. EXCESS MATERIAL AND SHOULD BE NEATLY DRAWN UP AROUND THE PIPE BARREL, FOLDED INTO AN OVERLAP ON TOP OF THE PIPE AND HELD IN PLACE BY MEANS OF PIECES OF THE PLASTIC TAPE AT APPROXIMATELY THREE TO FIVE FOOT INTERVALS

NOTE:

1. ALL RODDING TO BE ENCASED IN POLYETHYLENE SEPARATED FROM THE PIPE

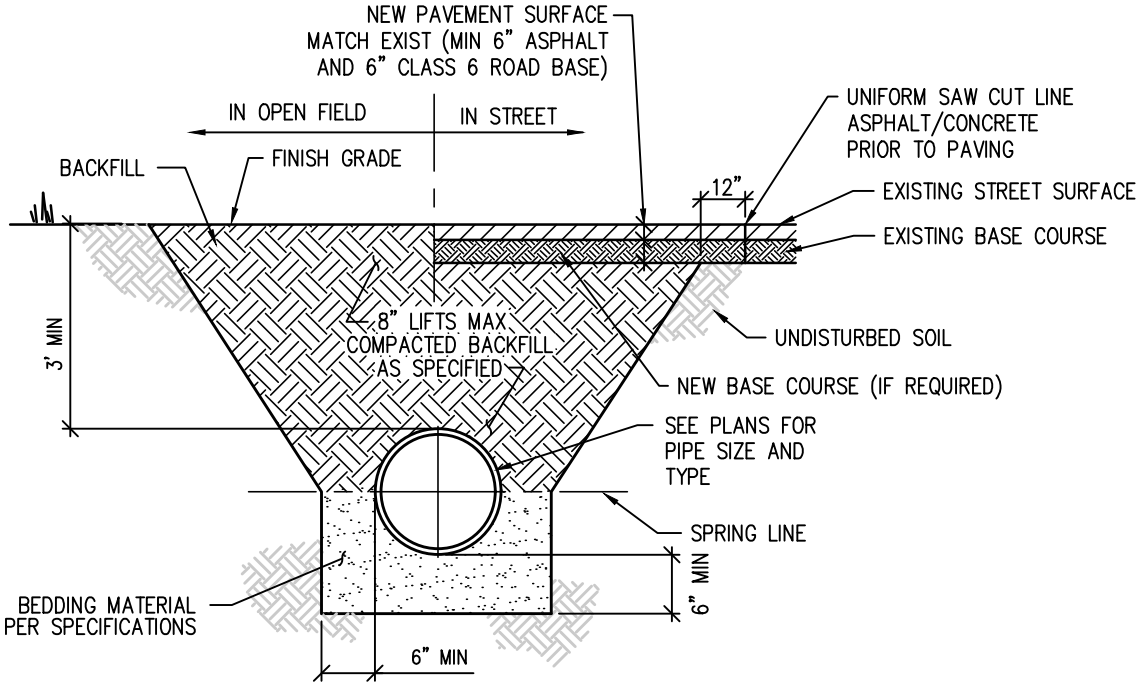
SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA WATER DETAILS	D5.27
	POLYETHYLENE WRAP	DATE: 12/2020

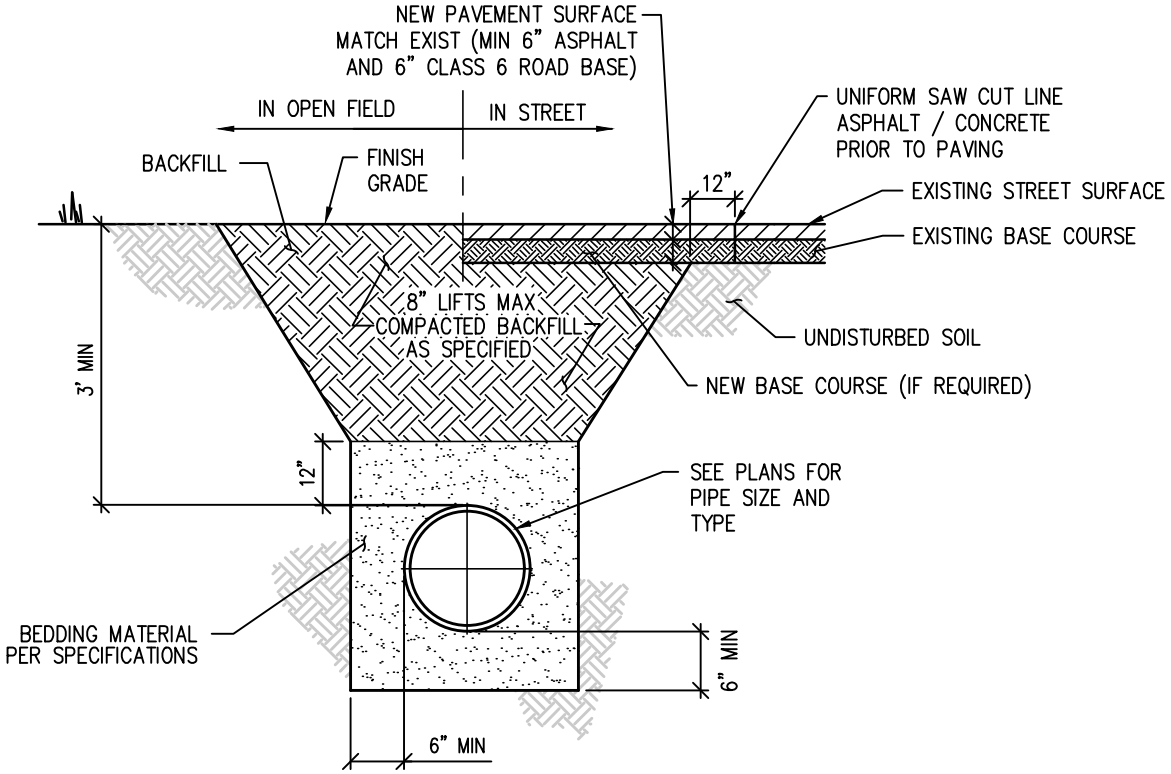


SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS	D6.01
	STORM CLEANOUT	DATE: 12/2020



REINFORCED CONCRETE PIPE



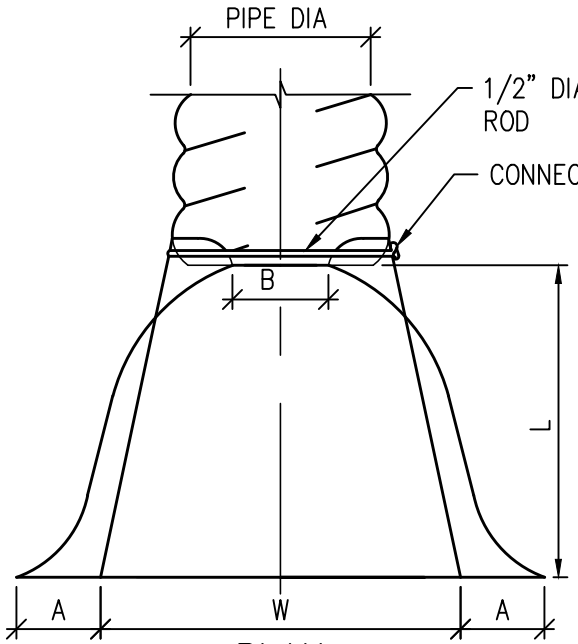
CMP/PVC/HDPE PIPE

NOTES:

1. IF UNSTABLE MATERIALS ARE FOUND IN TRENCH, OVEREXCAVATE PER SPECIFICATIONS OR AS REQUIRED.
2. TRENCH TO BE BRACED OR SHEETED AS NECESSARY FOR THE SAFETY OF THE WORKERS AND THE PROTECTION OF OTHER UTILITIES.

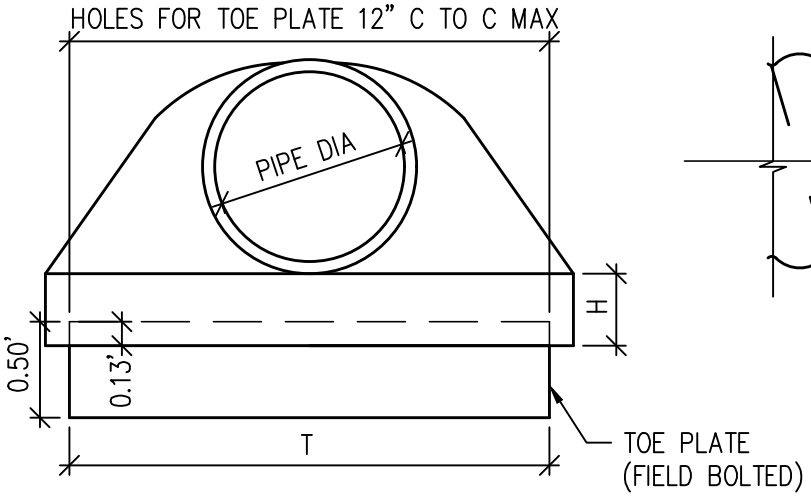
SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS	D6.02
	STORM SEWER BEDDING DETAIL	DATE: 12/2020

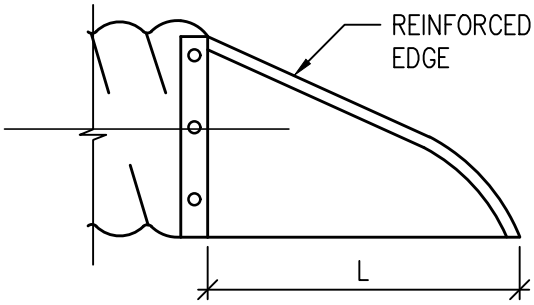


PLAN

PIPE DIA	GAUGE	A	B	H	L	W	T
6"	18	4"	1"	3"	8"	12"	20"
8"	18	5"	5"	4"	14"	16"	27"
10"	18	7"	6"	6"	14"	20"	35"
12"	16	6"	6"	6"	21"	24"	36"
15"	16	7"	8"	6"	26"	30"	44"
18"	16	8"	10"	6"	31"	36"	52"
21"	16	9"	12"	6"	36"	42"	60"
24"	16	10"	13"	6"	41	48"	68"



ELEVATION



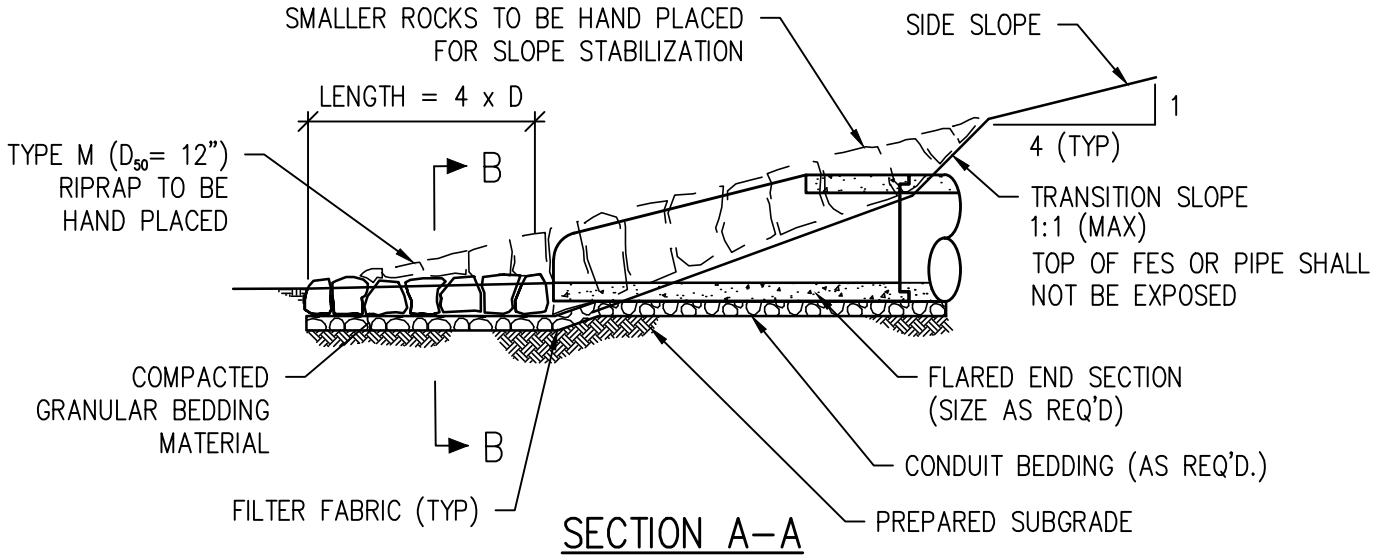
PROFILE

NOTES:

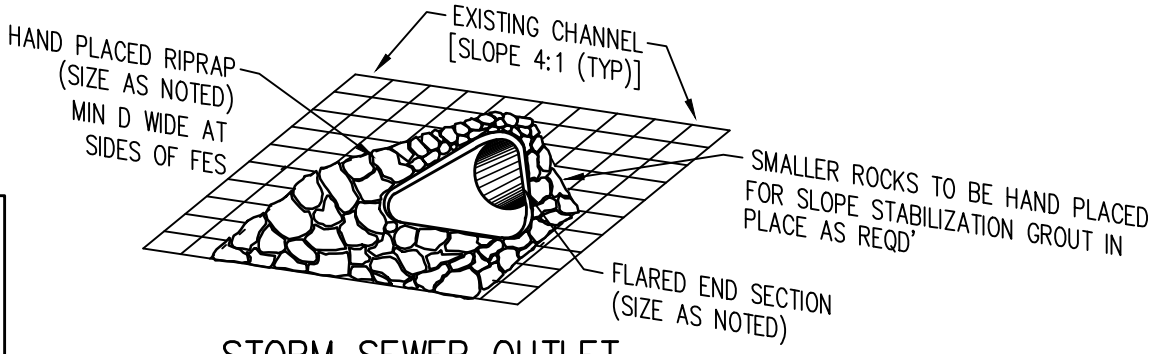
1. SEE DETAIL D6.04 FOR RIPRAP APRON SIZING AND PLACEMENT

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS	D6.03
	CMP TYPE 1 FLARED END SECTION	DATE: 12/2020



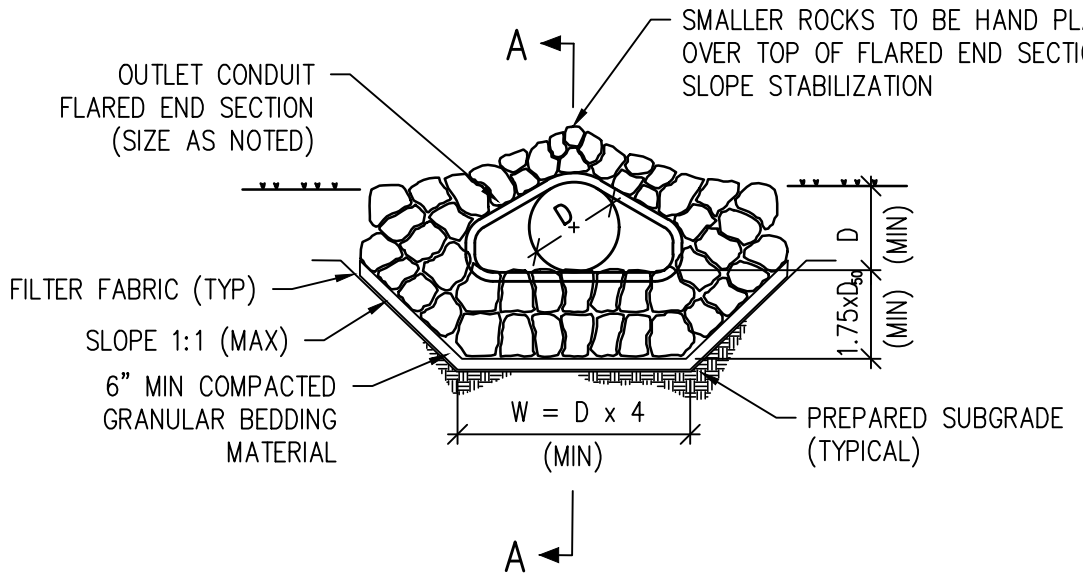
SECTION A–A



STORM SEWER OUTLET
ISOMETRIC VIEW

RIPRAP SIZING

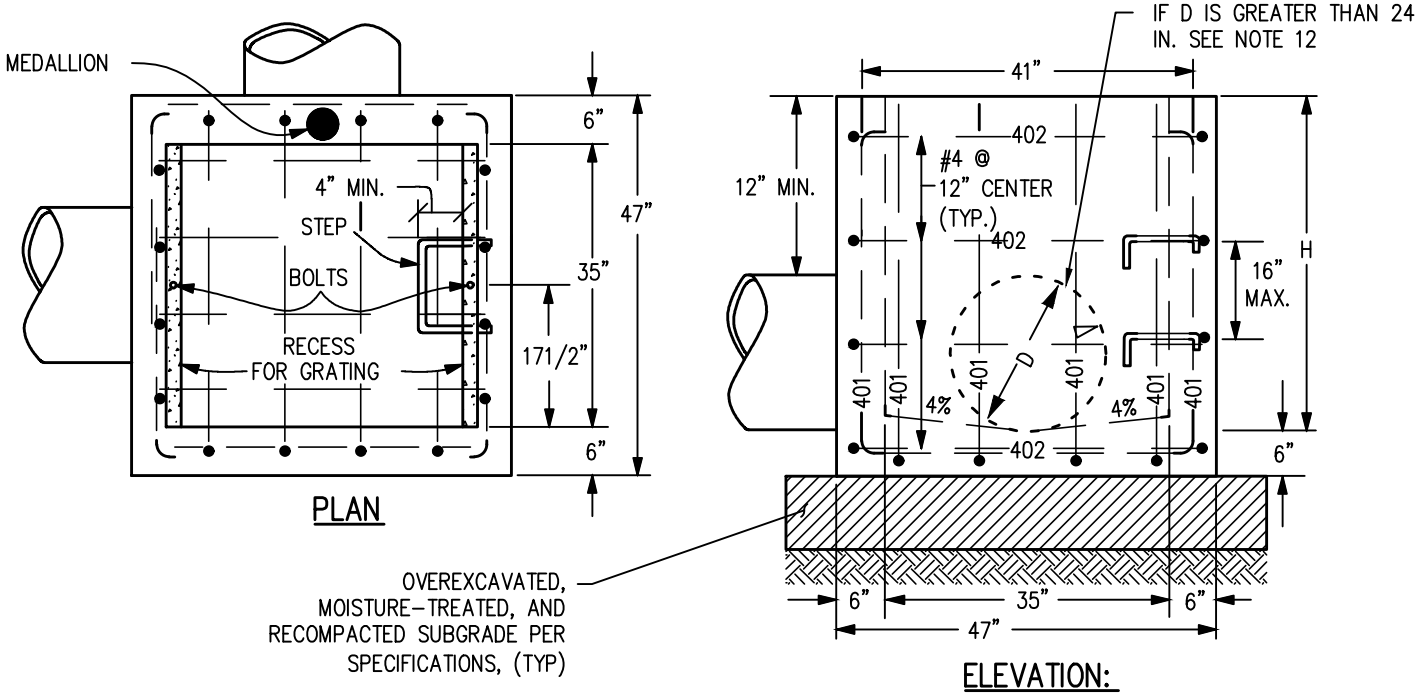
TYPE VL D50=6"
TYPE L D50=9"
TYPE M D50=12"
TYPE H D50=18"
TYPE VH D50=24"



SECTION B–B

SCALE: NTS

TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS		D6.04
RIPRAP APRON SIZING & PLACEMENT AT FLARED END SECTION		DATE: 12/2020

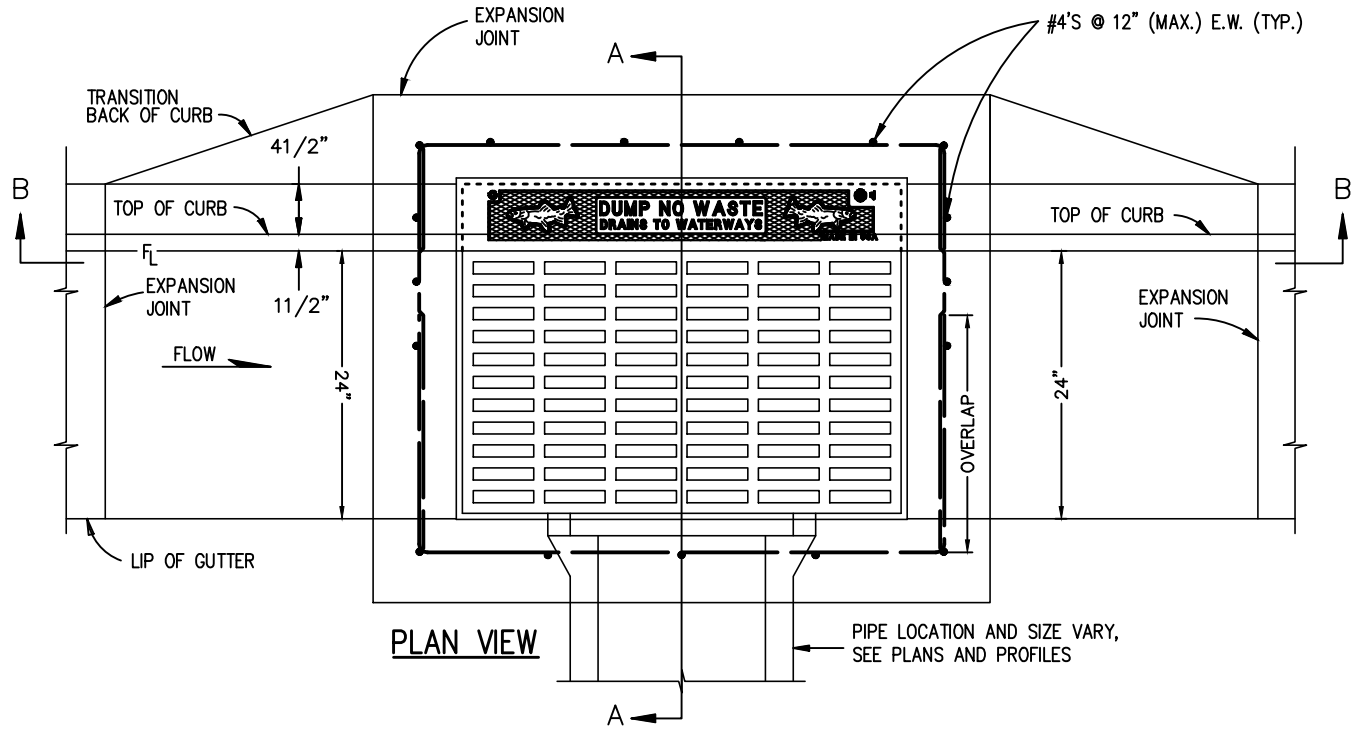


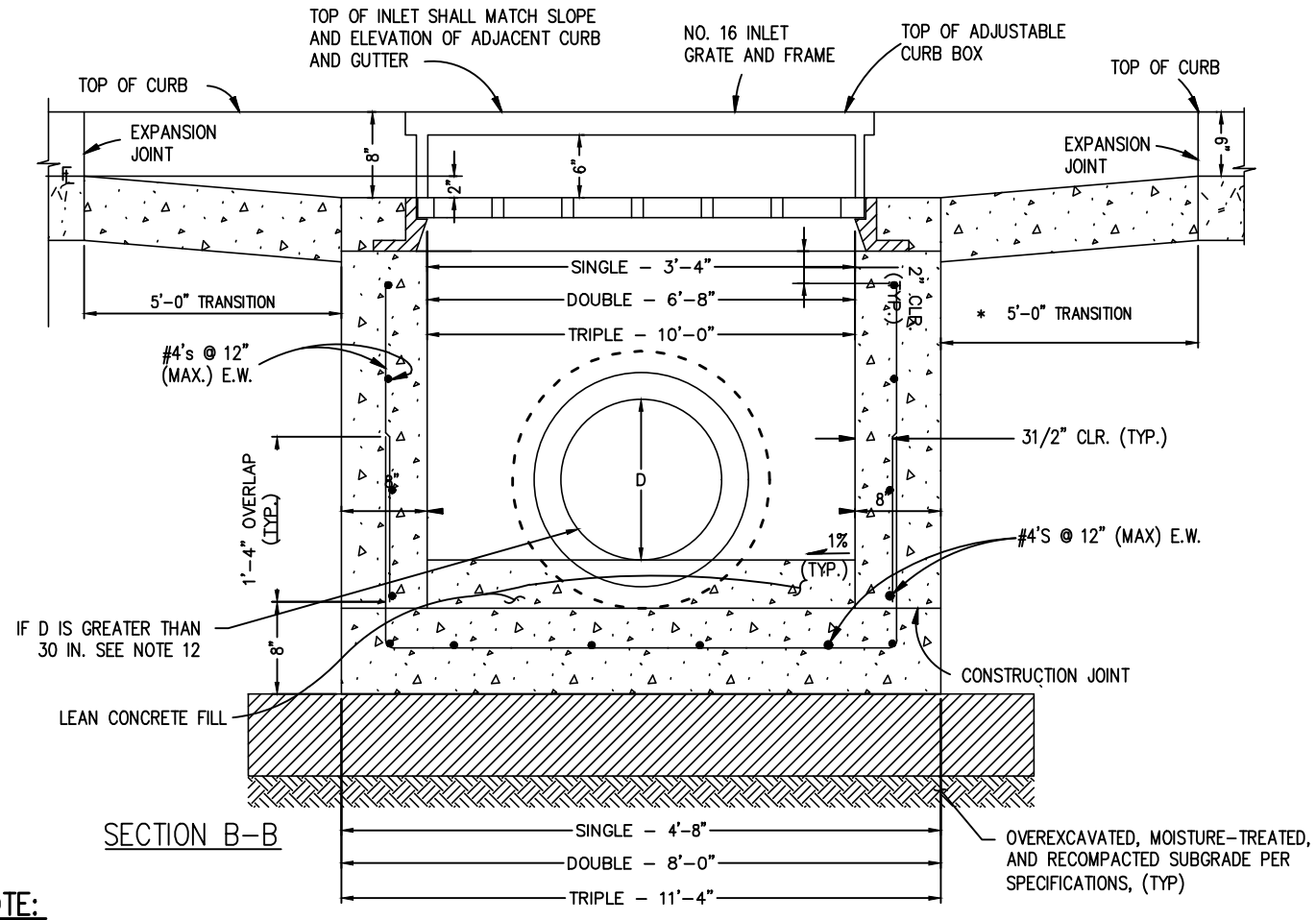
NOTES:

1. INLET TYPE C IS NOT HS-20 RATED AND SHALL NOT BE PLACED IN PAVED ROADWAYS. THIS INLET SHALL BE USED ONLY OUTSIDE PAVED ROADWAYS.
2. CONCRETE SHALL BE CLASS B. INLET MAY BE CAST-IN-PLACE OR PRECAST.
3. REINFORCING BARS SHALL BE EPOXY COATED AND DEFORMED #4, AND SHALL HAVE A MINIMUM 2 IN. CLEARANCE. CUT OR BEND AROUND PIPES AS REQUIRED
4. CONCRETE SLOPE AND DITCH PAVING SHALL BE IN ACCORDANCE WITH CDOT SECTION 507. REINFORCEMENT FOR CONCRETE SLOPE PAVING SHALL BE 6 X 6 – W1.4 X W1.4 OR 6 X 6 – W2.1 X W2.1.
5. STRUCTURAL STEEL FOR GRATES AND GRATE INSTALLATION HARDWARE SHALL BE GALVANIZED, AND SHALL BE IN ACCORDANCE WITH CDOT SUBSECTION 712.06
6. THE STANDARD INLET GRATES SHALL BE USED ON ALL TYPE C INLETS UNLESS CLOSE MESH GRATES ARE SPECIFIED ON THE PLANS
7. CLOSE MESH GRATES ARE RECOMMENDED WHERE FOOT TRAFFIC OR BICYCLE ROUTES ARE IN CLOSE PROXIMITY TO GRATE. THIS GRATE IS NOT ADA COMPLIANT OR BICYCLE FRIENDLY AND SHALL NOT BE PLACED DIRECTLY IN SIDEWALKS, CROSSWALKS OR BIKE PATHS.
8. STEPS SHALL BE PROVIDED WHEN INLET DIMENSION "H" IS EQUAL TO OR GREATER THAN 3 FT. – 6 IN., AND SHALL CONFORM TO AASHTO M 199.
9. ALL INLETS SHALL HAVE A 4 IN. DIA. METAL MEDALLION WITH A "NO DUMPING DRAINS TO WATERWAYS" MESSAGE ON IT. THE MEDALLION SHALL HAVE A FISH 9. SYMBOL WITH A BLUE BACKGROUND. IT SHALL BE FIRMLY ATTACHED TO THE TOP OF THE INLET WITH A PERMANENT FASTENER.
10. SEE PLANS FOR SIZE AND LOCATION OF PIPE
11. FOR FULL DETAIL INCLUDING BAR LIST, DIMENSIONS AND QTY. TABLE, SEE CDOT DETAIL M-604-10
12. ALL CONNECTED PIPES WITH A DIAMETER (D) GREATER THAN 24" AND/OR ENTERING AT AN ANGLE GREATER THAN 80° A CUSTOM CONC BOX MUST BE CONSTRUCTED. CONTRACTOR TO COORDINATE BOX DIMENSIONS AND SPECS WITH MANUFACTURER.

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS	D6.05
	TYPE C INLET	DATE: 12/2020





NOTE:

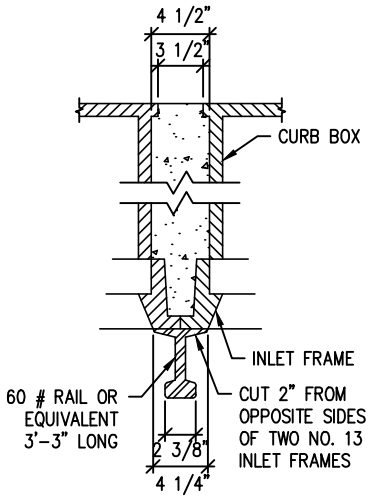
1. FOR FULL DETAIL INCLUDING BAR LIST, DIMENSIONS AND QTY. TABLE, SEE CDOT DETAILS

SCALE: NTS

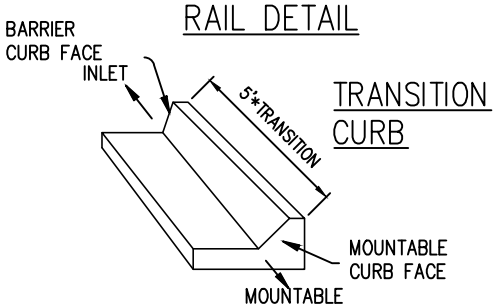
TOWN OF BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS	D6.06A
	COMBINATION INLET (1 OF 2)	DATE: 12/2020

NOTES:

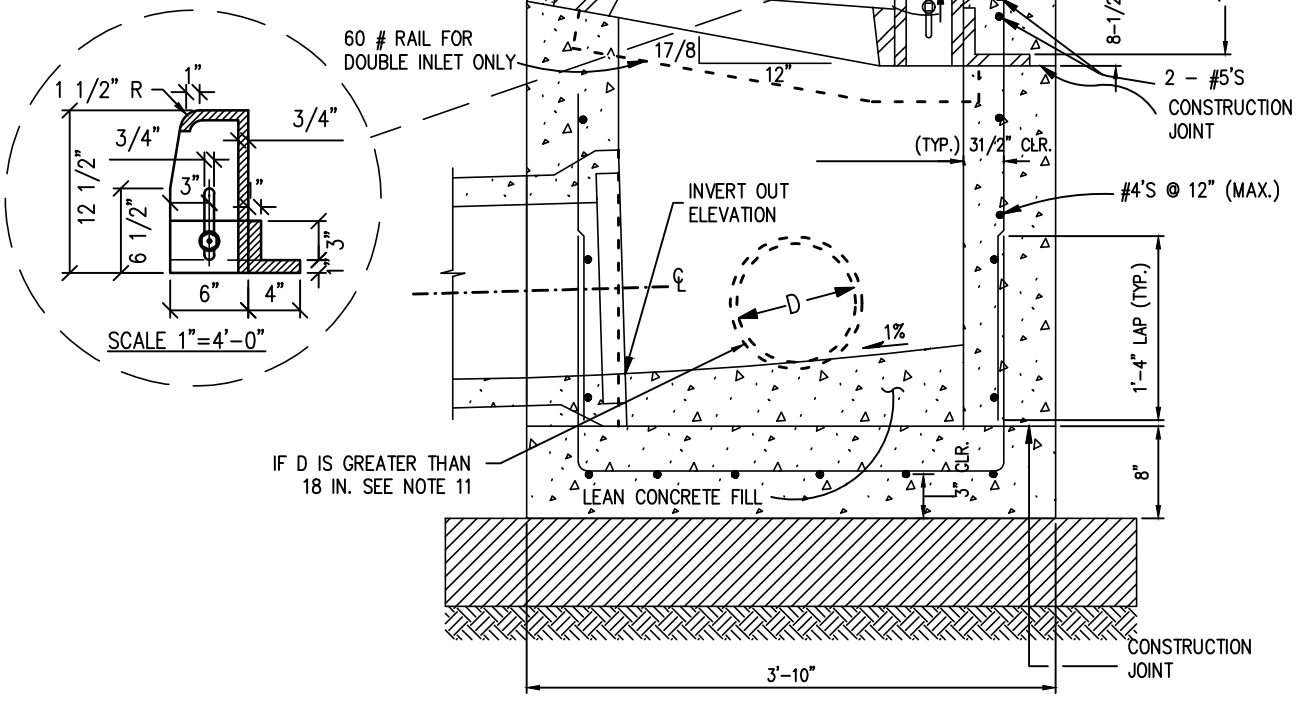
1. ALL CASTING SHALL CONFORM TO ASTM A-48(C1 35b) WITH A MINIMUM STRENGTH OF 35 ksi.
2. ALL CASTINGS SHALL BE HEAVY DUTY, AND CAPABLE OF WITHSTANDING AASHTO H20 LOADING.
3. FLOOR SLOPE MAY BE POURED MONOLITHIC WITH BASE.
4. ALL REINFORCING STEEL SHALL BE ASTM, A-615, GRADE 60 DEFORMED BARS. DIAMETER OF BEND MEASURED ON THE INSIDE OF THE BAR SHALL BE A MINIMUM OF 6 BAR DIAMETER. 5. ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS APPLICABLE TO THE PROJECT. 6. CONCRETE SHALL HAVE A 28 DAY STRENGTH OF 4000 PSI.
7. SUBGRADE SHALL HAVE A GRADATION EQUAL TO CLASS B BEDDING COMPACTED TO 100% MAXIMUM DRY DENSITY, AASHTO T-99. 8. NO FORM WORK SHALL REMAIN INSIDE STRUCTURE WHEN COMPLETE.
9. INLET WALLS SHALL BE FORMED BOTH INSIDE AND OUTSIDE. CASTING OF SIDEWALLS AGAINST EARTH IS NOT PERMITTED. 10. LEAN CONCRETE FILL TO BE f' = 2000 PSI.
11. ALL CONNECTED PIPES WITH A DIAMETER (D) GREATER THAN 30" FRONT AND 18" SIDE AND/OR ENTERING AT AN ANGLE GREATER THAN 80° A CUSTOM CONC BOX MUST BE CONSTRUCTED. CONTRACTOR TO COORDINATE BOX DIMENSIONS AND SPECS WITH MANUFACTURER.
12. USE RAIL FOR MULTIPLE INLET CONNECTION
13. WHEN THE SPECIAL INLET IS USED WITH MOUNTABLE CURB AND GUTTER, 5 FT. TRANSITION SHALL BE CONSTRUCTED. TRANSITION SHALL B E PAID FOR AS CURB AND GUTTER.
14. FOR FULL DETAIL INCLUDING BAR LIST. DIMENSIONS AND QTY. TABLE SEE CDOT DETAILS



RAIL DETAIL



TRANSITION CURB



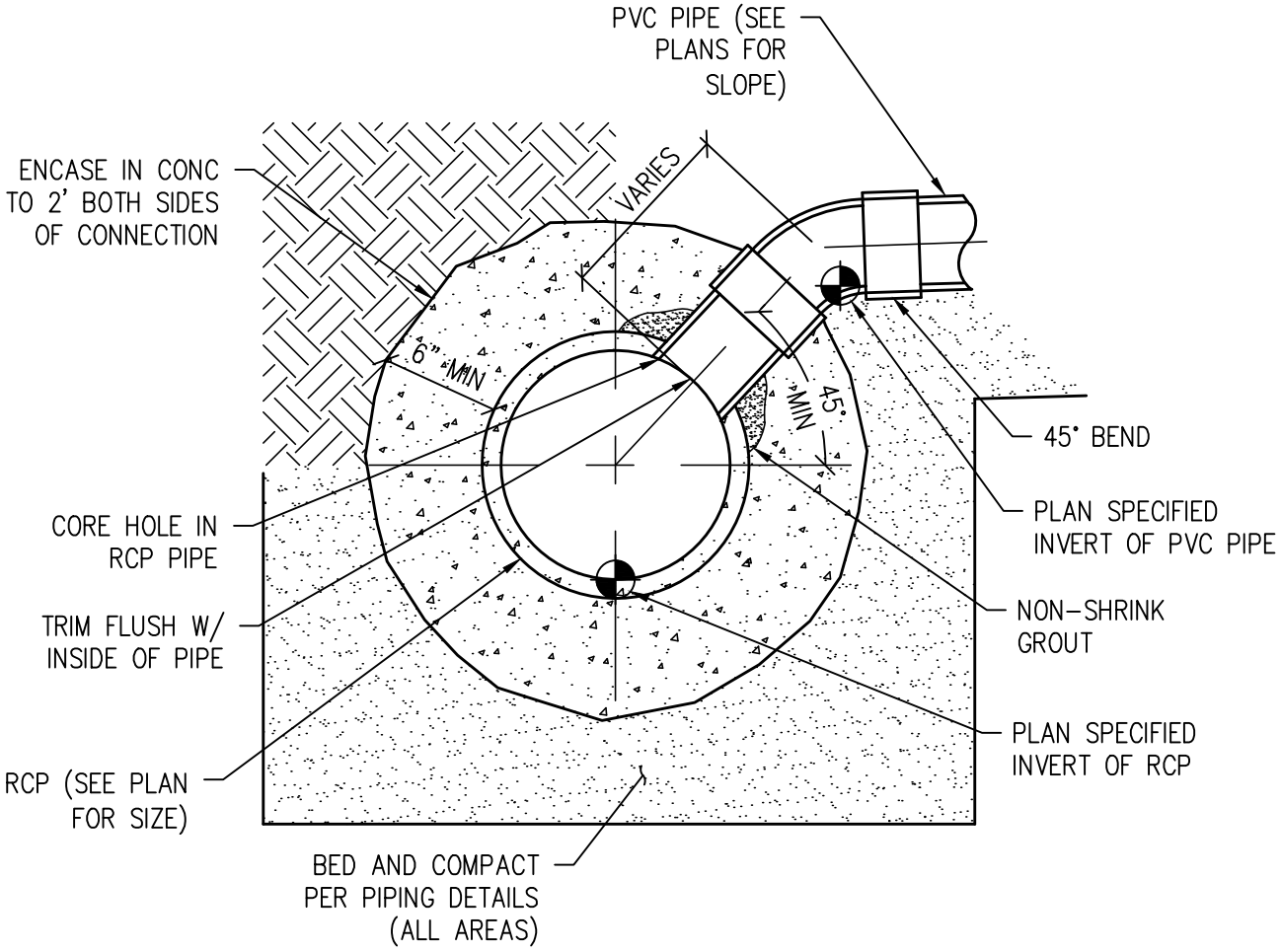
SECTION A-A

SCALE: NTS

TOWN OF BERTHOUD STANDARD DESIGN CRITERIA
STORM SEWER DETAILS
COMBINATION INLET (2 OF 2)

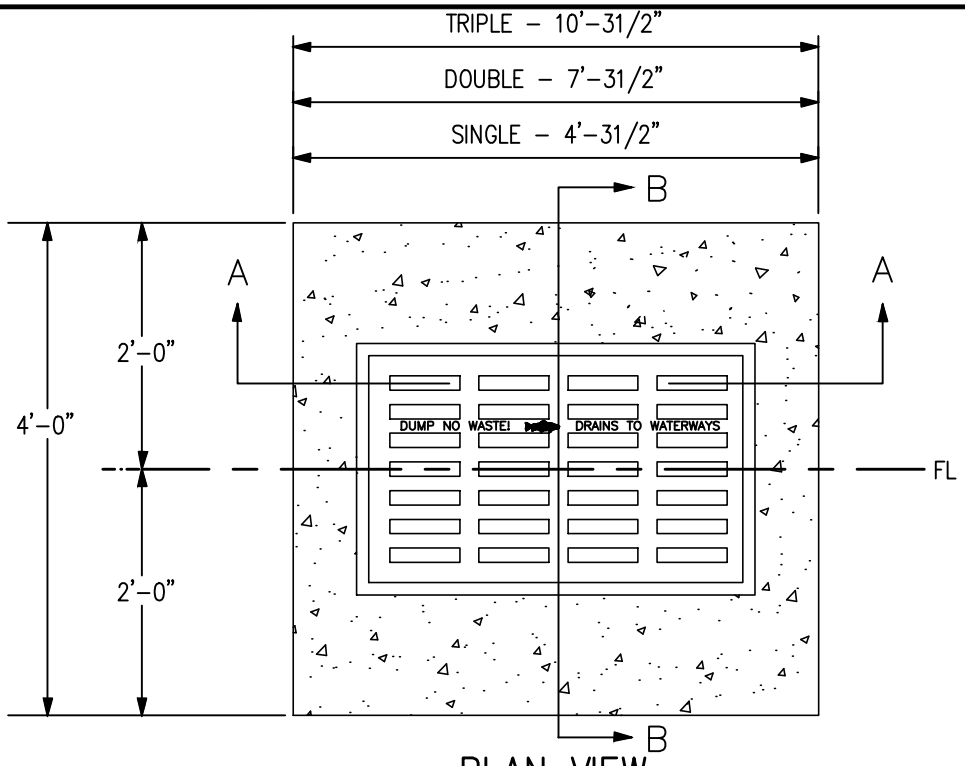
D6.06B

DATE: 12/2020

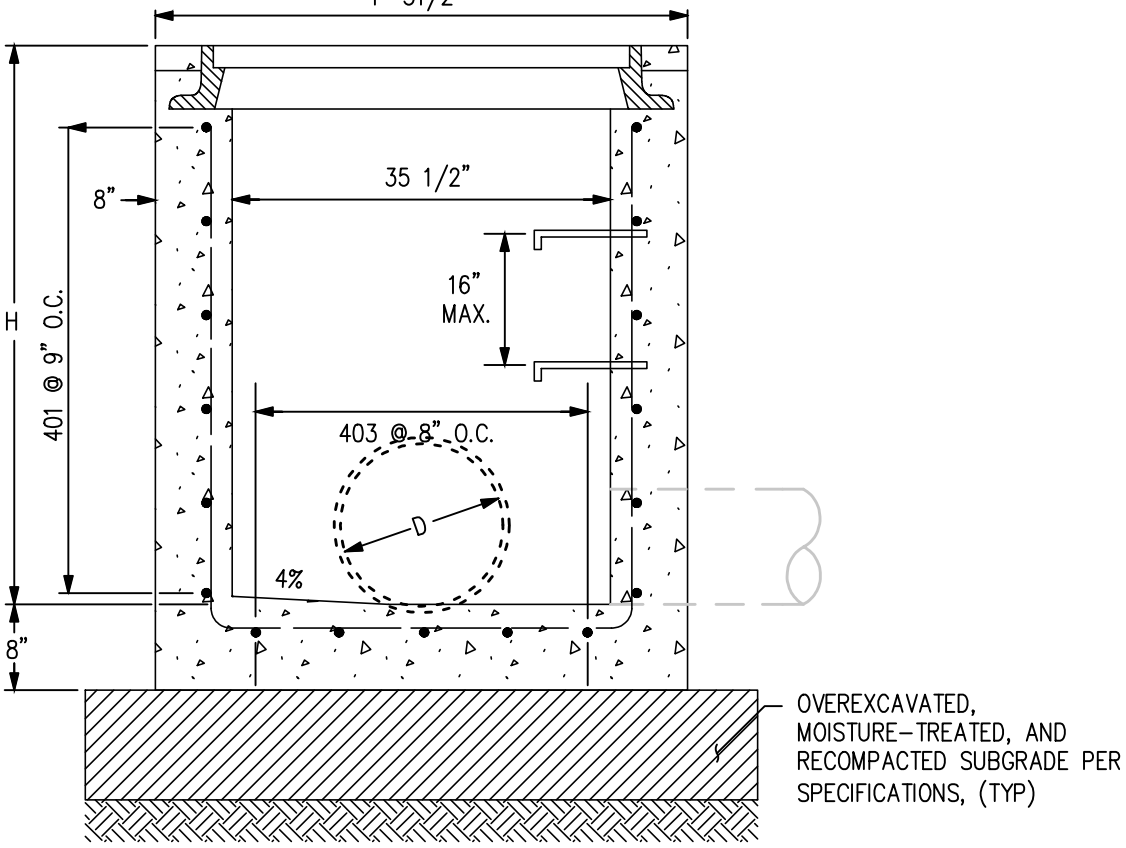


SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS	D6.07
	DIRECT CONNECTION RCP TO PVC CONNECTION	DATE: 12/2020



PLAN VIEW



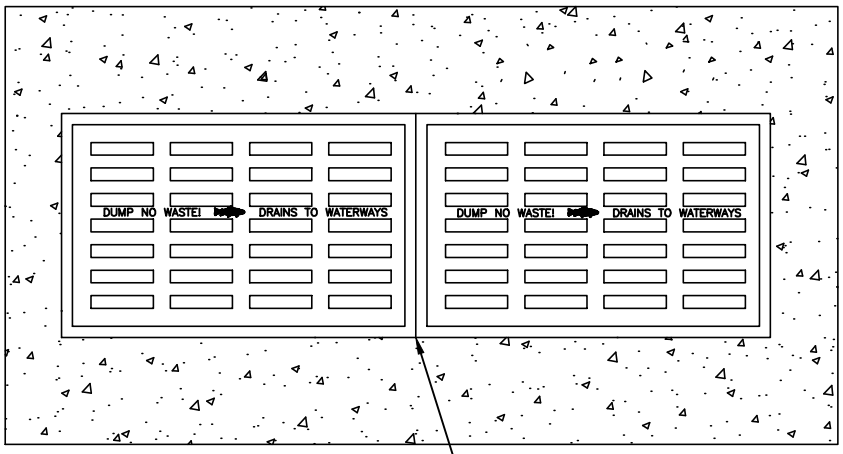
SECTION A–A

NOTES:

1. FOR FULL DETAIL INCLUDING BAR LIST, DIMENSIONS AND QTY. TABLE, SEE CDOT DETAILS

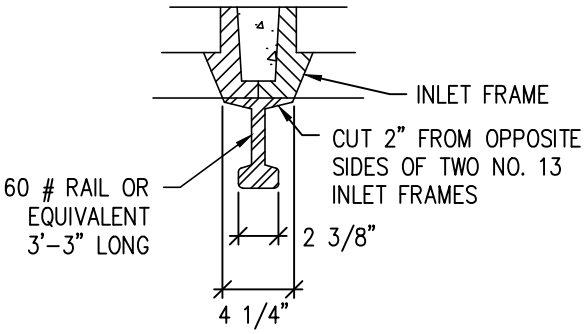
SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS	D6.08A
	VALLEY INLET (CDOT TYPE 13) (1 OF 2)	DATE: 12/2020

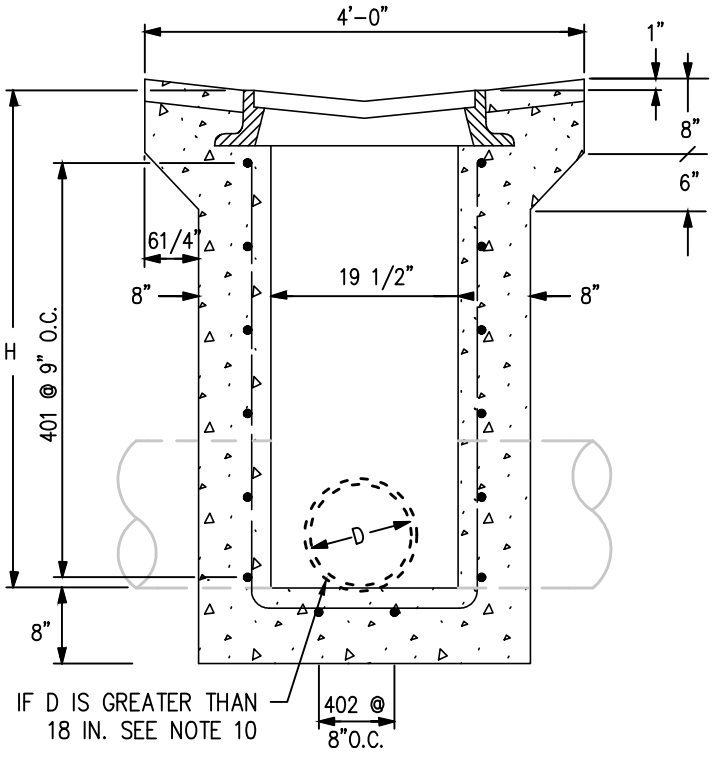


PLAN VIEW

USE RAIL FOR MULTIPLE INLET CONNECTION



RAIL DETAIL



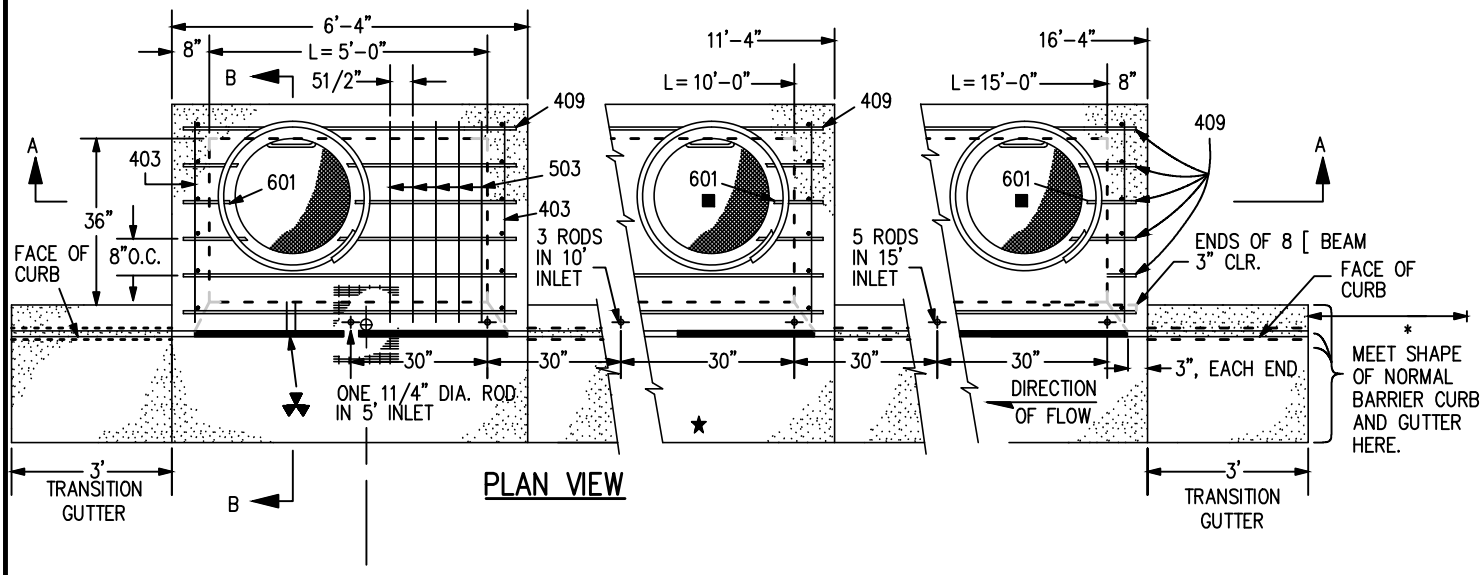
SECTION B-B

NOTES:

1. CONCRETE SHALL BE CLASS B. INLET MAY BE CAST-IN-PLACE OR PRECAST.
2. CAST-IN-PLACE CONCRETE WALLS SHALL BE FORMED ON BOTH SIDES.
3. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4 IN.
4. REINFORCING BARS SHALL BE DEFORMED #4 AND SHALL HAVE A 2 IN. MINIMUM CLEARANCE. ALL REINFORCING BARS SHALL BE EPOXY COATED.
5. STEPS SHALL BE PROVIDED WHEN INLET DIMENSION "H" IS EQUAL TO OR GREATER THAN 3 FT.-6 IN. AND SHALL CONFORM TO AASHTO M 199.
6. ALL GRATES AND FRAMES SHALL BE GRAY OR DUCTILE CAST IRON IN ACCORDANCE WITH SUBSECTION 712.06. GRATES AND FRAMES SHALL BE DESIGNED TO WITHSTAND HS 20 LOADING.
7. STATION POINT IS AT THE CENTER OF THE INLET.
8. GRATE SHALL HAVE "DUMP NO WASTE DRAINS TO STREAM" MESSAGE CAST ON SURFACE.
9. FOR FULL DETAIL INCLUDING BAR LIST, DIMENSIONS AND QTY. TABLE, SEE CDOT DETAIL M-604-13
10. ALL CONNECTED PIPES WITH A DIAMETER (D) GREATER THAN 30" FRONT AND 18" SIDE AND/OR ENTERING AT AN ANGLE GREATER THAN 80° A CUSTOM CONC BOX MUST BE CONSTRUCTED. CONTRACTOR TO COORDINATE BOX DIMENSIONS AND SPECS WITH MANUFACTURER.
11. FOR FULL DETAIL INCLUDING BAR LIST, DIMENSIONS AND QTY. TABLE, SEE CDOT DETAILS

SCALE: NTS

★ FOR LENGTH (L) 10 FT. OR MORE, PROVIDE MAINTENANCE ACCESS AT BOTH ENDS WITH AN ADDITIONAL MANHOLE RING AND COVER. CUT REINFORCEMENT BAR ACCORDINGLY.

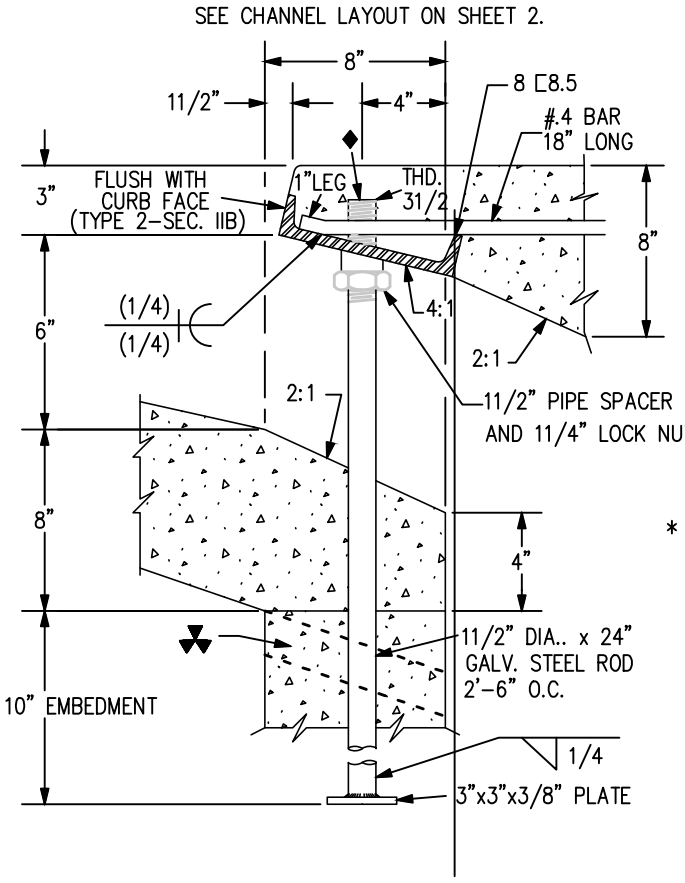


NOTES:

1. USE OF A TYPE R INLET MUST BE APPROVED BY THE TOWN.
2. CONCRETE SHALL BE CLASS B. INLET MAY BE CAST-IN-PLACE OR PRECAST.
3. CONCRETE WALLS SHALL BE FORMED ON BOTH SIDES AND SHALL BE 8 IN. THICK.
4. INLET STEPS SHALL BE IN CONFORMANCE WITH AASHTO M 199.
5. CURB FACE ASSEMBLY SHALL BE GALVANIZED AFTER WELDING. 5. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4 IN. CURB AND GUTTER CORNERS SHALL BE FINISHED TO MATCH THE EXISTING CURB AND GUTTER BEYOND THE TRANSITION GUTTER.
6. REINFORCING BARS SHALL BE DEFORMED AND SHALL HAVE A 2 IN. MINIMUM CLEARANCE. ALL REINFORCING BARS SHALL BE EPOXY COATED.
7. DIMENSIONS AND WEIGHTS OF TYPICAL MANHOLE RING AND COVER ARE NOMINAL.
8. MATERIAL FOR MANHOLE RINGS AND COVERS SHALL BE GRAY OR DUCTILE CAST IRON IN ACCORDANCE WITH SUBSECTION 712.06.
9. SINCE PIPE ENTRIES INTO THE INLET ARE VARIABLE, THE DIMENSIONS SHOWN ARE TYPICAL. ACTUAL DIMENSIONS AND QUANTITIES FOR CONCRETE AND REINFORCEMENT SHALL BE AS REQUIRED IN THE WORK. QUANTITIES INCLUDE VOLUMES OCCUPIED BY PIPES.
10. STRUCTURAL STEEL SHALL BE GALVANIZED AND SHALL BE IN ACCORDANCE WITH SUBSECTION 712.06.
11. ALL MANHOLE COVERS SHALL BE CAST WITH A "NO DUMPING DRAINS TO STREAM" MESSAGE AND A FISH SYMBOL. THE SURFACE OF THE MANHOLE COVER SHALL HAVE A NON-SLIP PATTERN.
12. FOR FULL DETAIL INCLUDING BAR LIST AND DIMENSION TABLE, SEE CDOT DETAIL M-604-12 SHEETS 1 AND 2

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS	D6.09A
	TYPE R CURB INLET (1 OF 3)	DATE: 12/2020

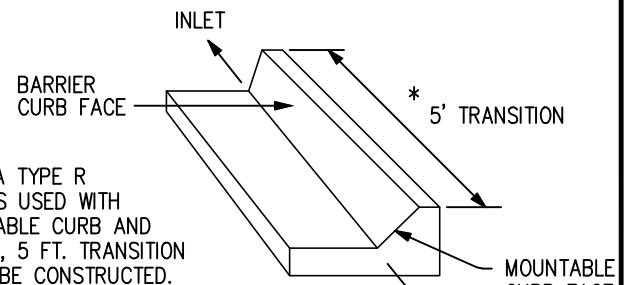


CURB FACE ASSEMBLY

◆PLACE ENTIRE ASSEMBLY BEFORE POURING CONCRETE.

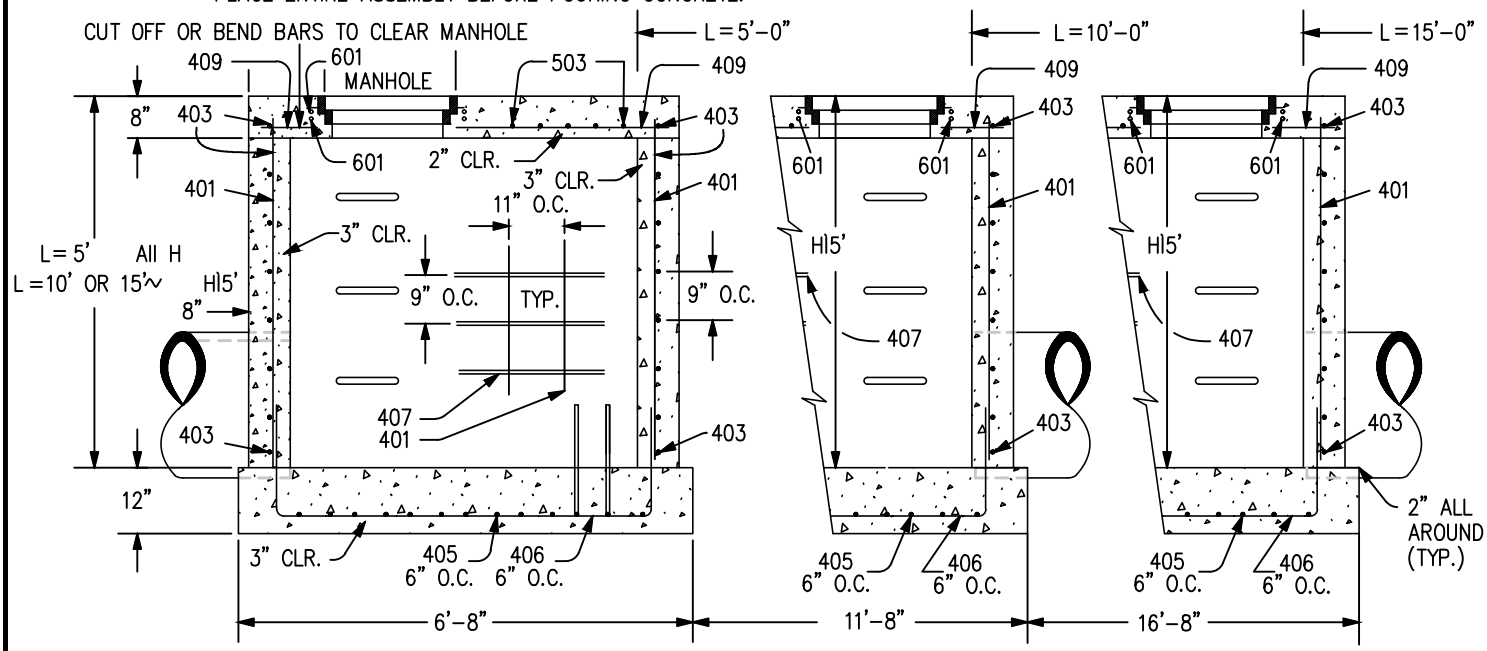
NOTE:

1. FOR FULL DETAIL INCLUDING BAR LIST, DIMENSIONS AND QTY. TABLE, SEE CDOT DETAILS



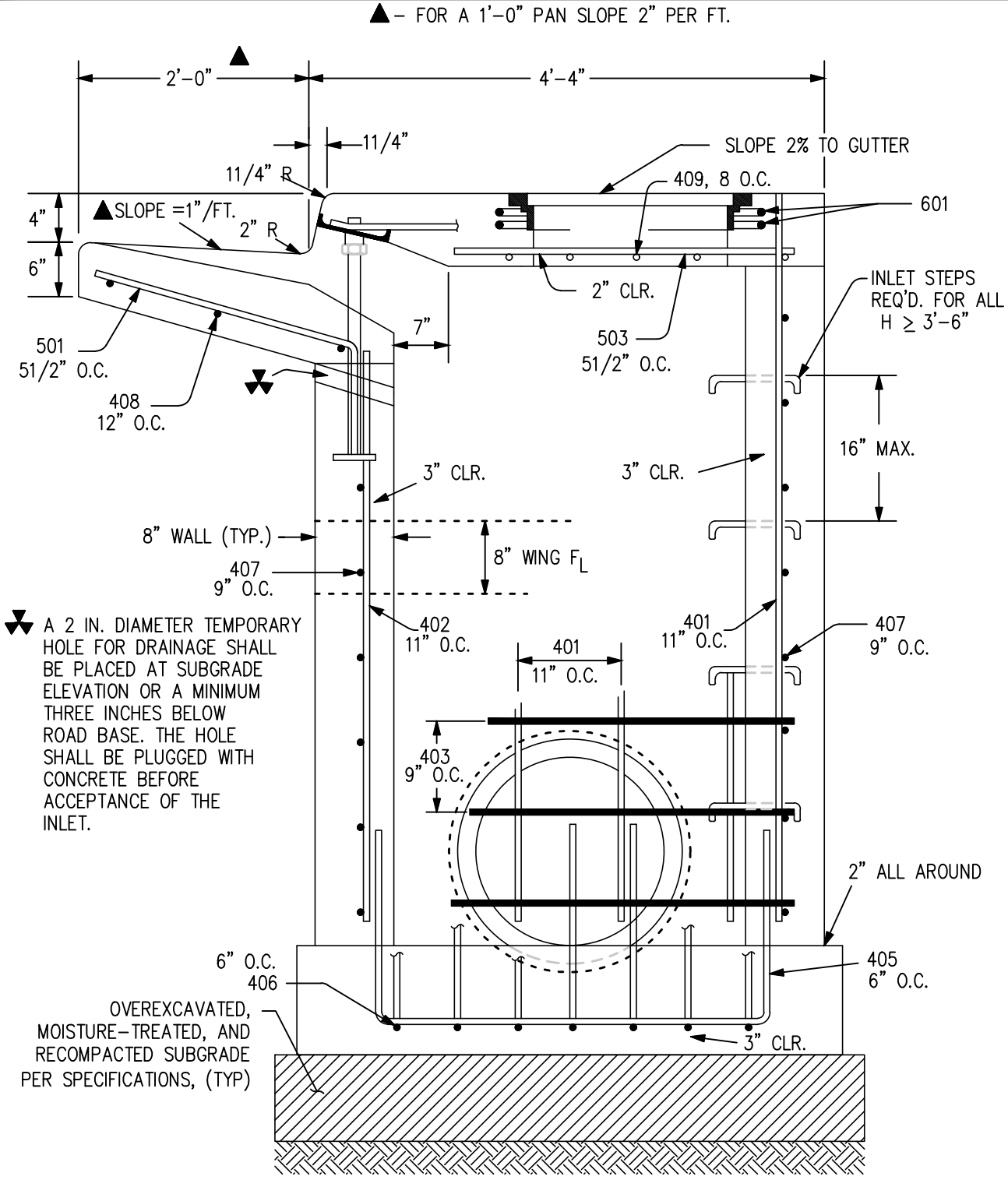
* WHEN A TYPE R INLET IS USED WITH MOUNTABLE CURB AND GUTTER, 5 FT. TRANSITION SHALL BE CONSTRUCTED. TRANSITION SHALL BE PAID FOR AS CURB AND GUTTER.

TRANSITION CURB



SECTION A-A

SCALE: NTS



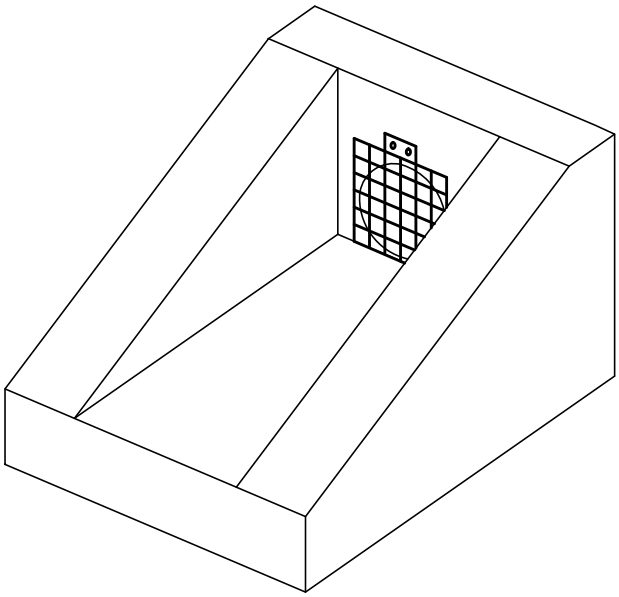
SECTION B–B – END VIEW

NOTES:

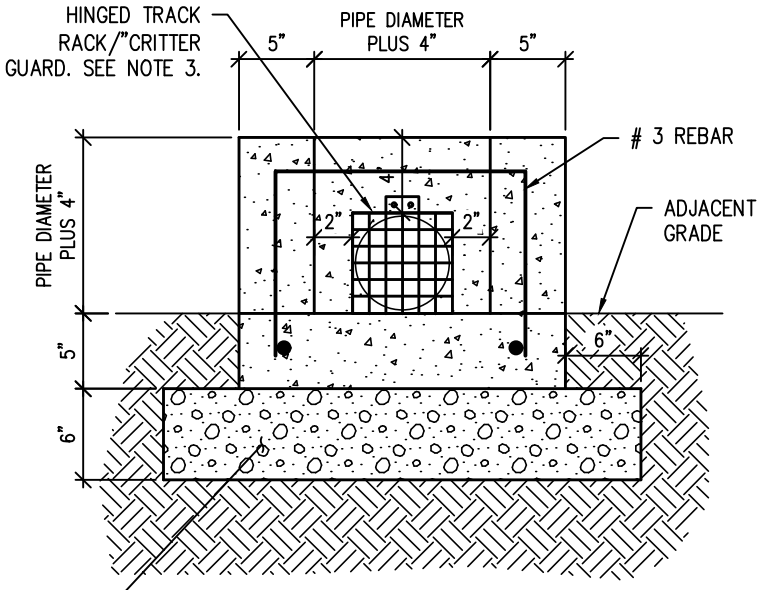
1. FOR FULL DETAIL INCLUDING BAR LIST, DIMENSIONS AND QTY. TABLE, SEE CDOT DETAILS
2. MANHOLE RING AND COVER, STATION POINT AND OUTFLOW PIPE SHALL BE LOCATED AT THE SAME END OF THE INLET

SCALE: NTS

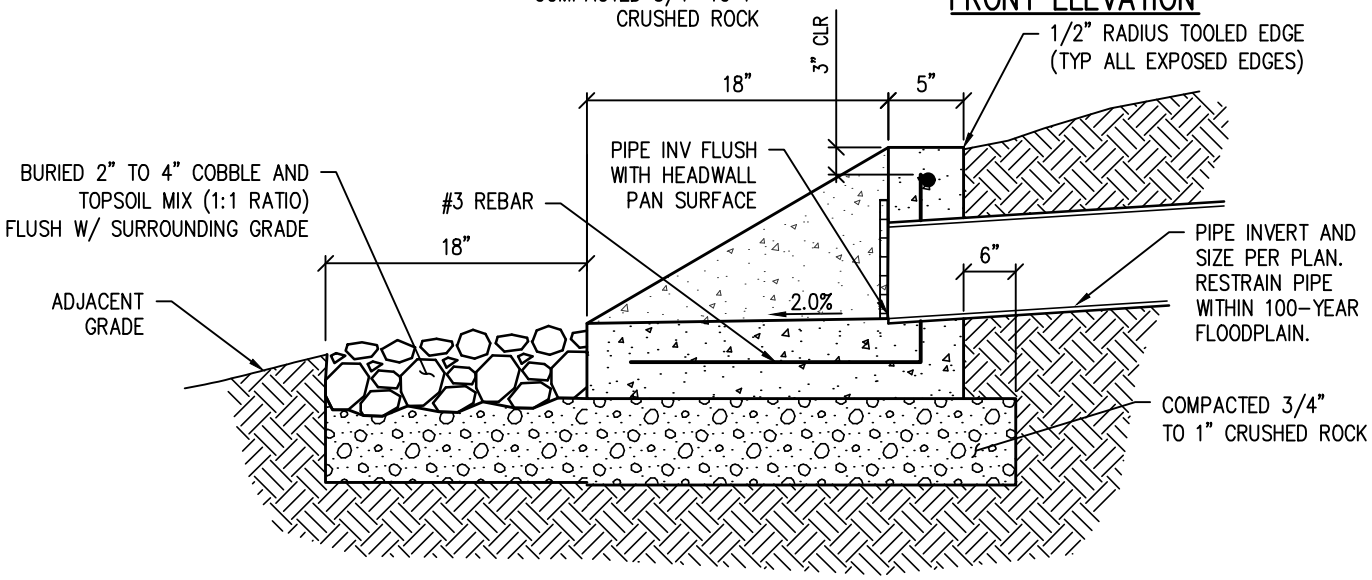
TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS	D6.09C
	TYPE R CURB INLET (3 OF 3)	DATE: 12/2020



ISOMETRIC VIEW



FRONT ELEVATION

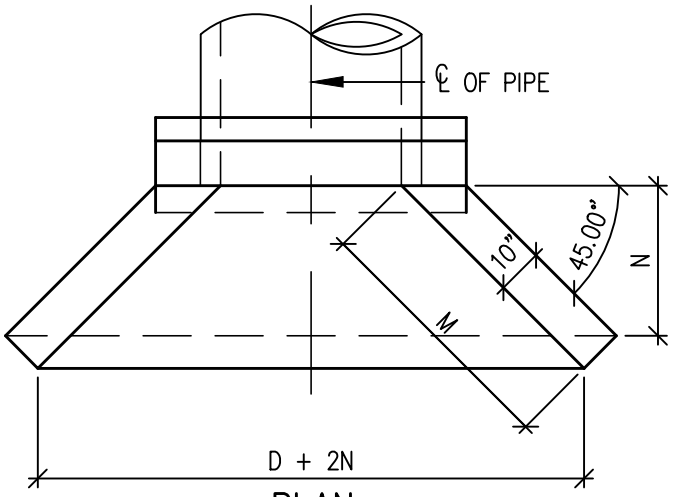


NOTES:

1. ALL CONCRETE AND BEDDING PER SPECIFICATIONS
2. INSTALL REMOVABLE, GALVANIZED STEEL, HINGED TRASH RACK WITH 2" MAX OPENINGS.
3. TRASH GUARD TO BE APPROVED BY TOWN

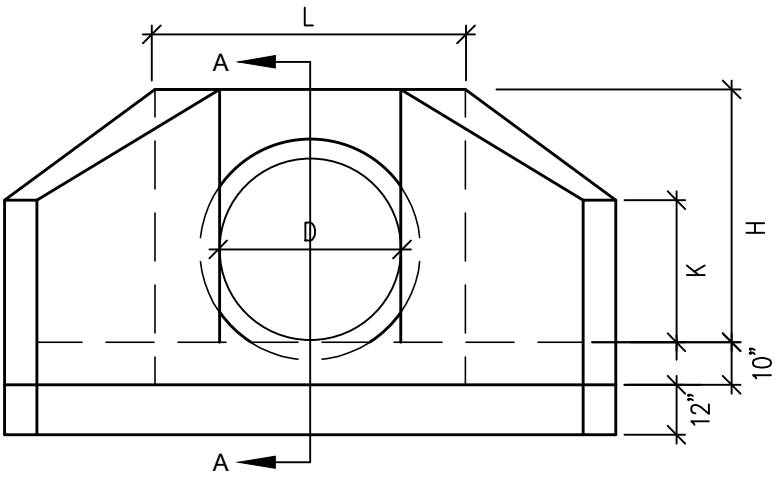
SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS	D6.10
	SMALL PIPE HEADWALL	DATE: 12/2020

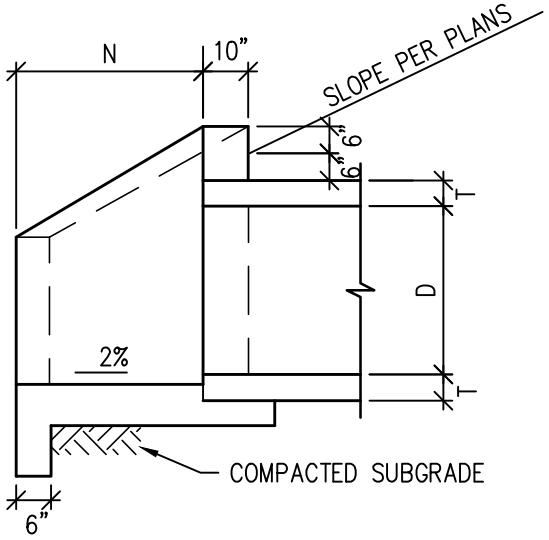


PLAN

DIMENSIONS							
D	AREA SQ FT	T	H	K	L	M	N
15"	1.23	2 1/4"	2'-5 1/4"	1'-5"	3'-7"	1'-9"	1'-3"
18"	1.77	2 1/2"	2'-8 1/2"	1'-7"	3'-10"	2'-1 1/2"	1'-6"
24"	3.14	3"	3'-3"	1'-10 1/2"	4'-4"	2'-10"	2'-0"
30"	4.91	3 1/2"	3'-9 1/2"	2'-2"	4'-10"	3'-6 1/2"	2'-6"
36"	7.07	4"	4'-4"	2'-5 1/2"	5'-4"	4'-3"	3'-0"
42"	9.62	4 1/2"	4'-10 1/2"	2'-9"	5'-10"	4'-1 1/2"	3'-6"



ELEVATION



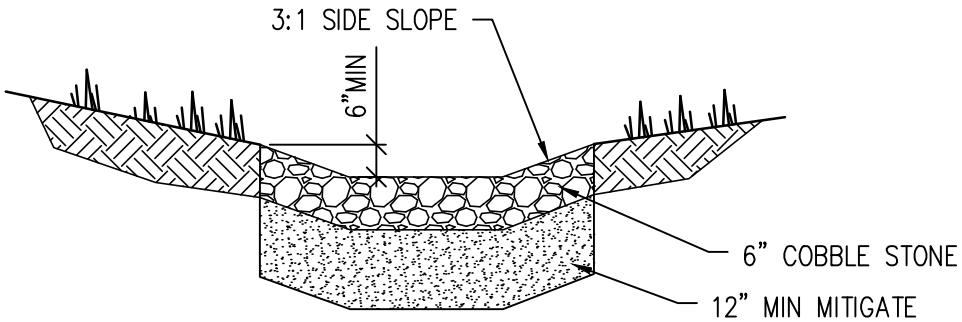
SECTION A–A

NOTES:

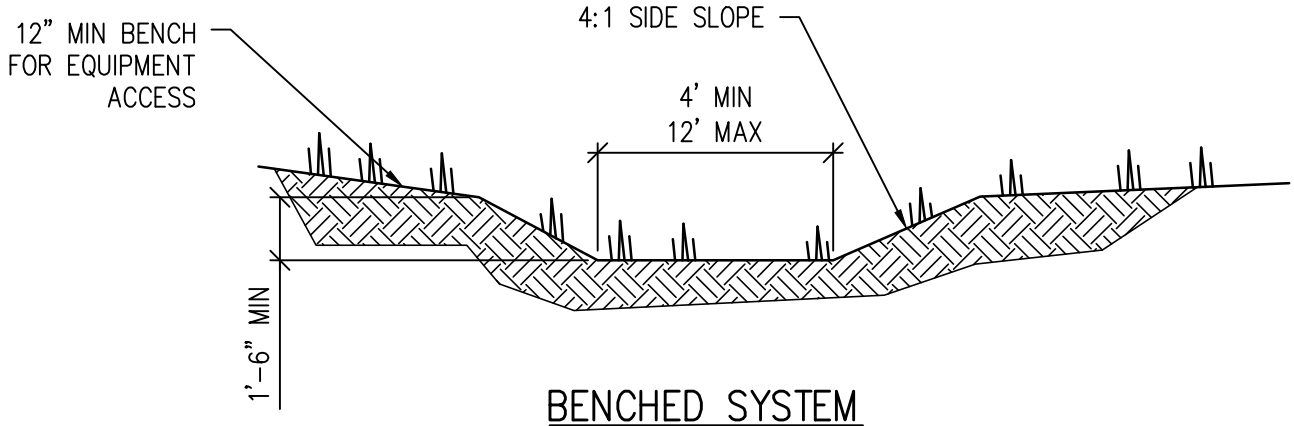
1. CONCRETE SHALL BE CLASS B. CAST–IN–PLACE CONCRETE SHALL CONFORM TO ASTM C478
2. CAST–IN–PLACE CONCRETE WALL EDGES SHALL BE CHAMFERED 3/4"
3. ALL WALLS AND BASE SHALL BE REINFORCED WITH #4'S @ 12" DC EACH WAY. REINFORCING BARS SHALL BE DEFORMED AN SHALL HAVE 3" MINIMUM CLEARANCE FROM FACE OF CONCRETE.
4. DIMENSIONS AND MATERIAL REQUIREMENTS VARY DEPENDING ON APPLICATION. FOR COMPLETE DETAILS, MEASUREMENTS, MATERIALS LIST, AND OTHER FACTORS REFER TO CURRENT CDOT M7S STANDARDS

SCALE: NTS

TOWN OF BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS	D6.11
	HEADWALL WITH CIRCULAR PIPE	DATE: 12/2020



COBBLE SYSTEM



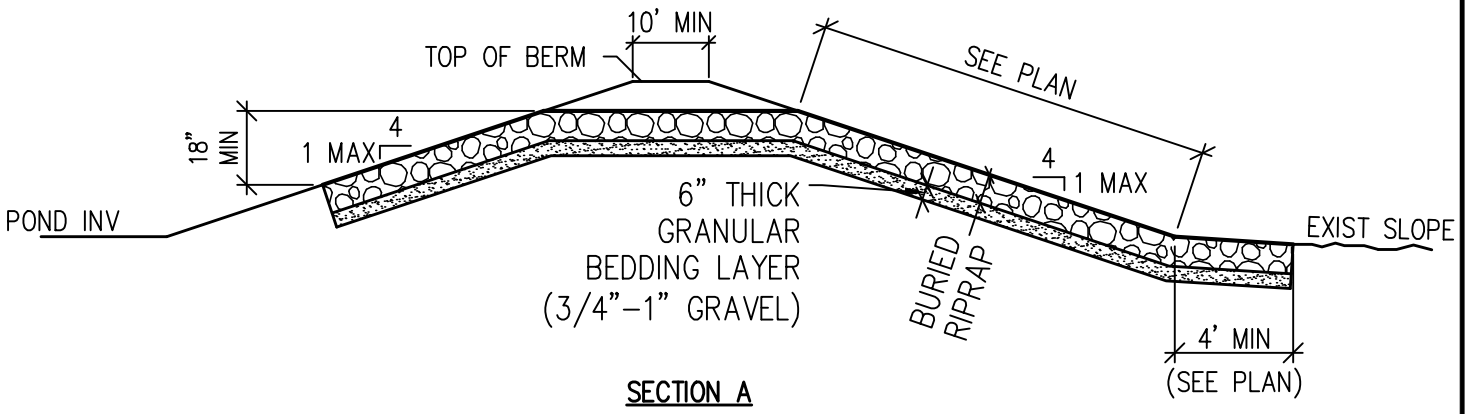
BENCHED SYSTEM

NOTES:

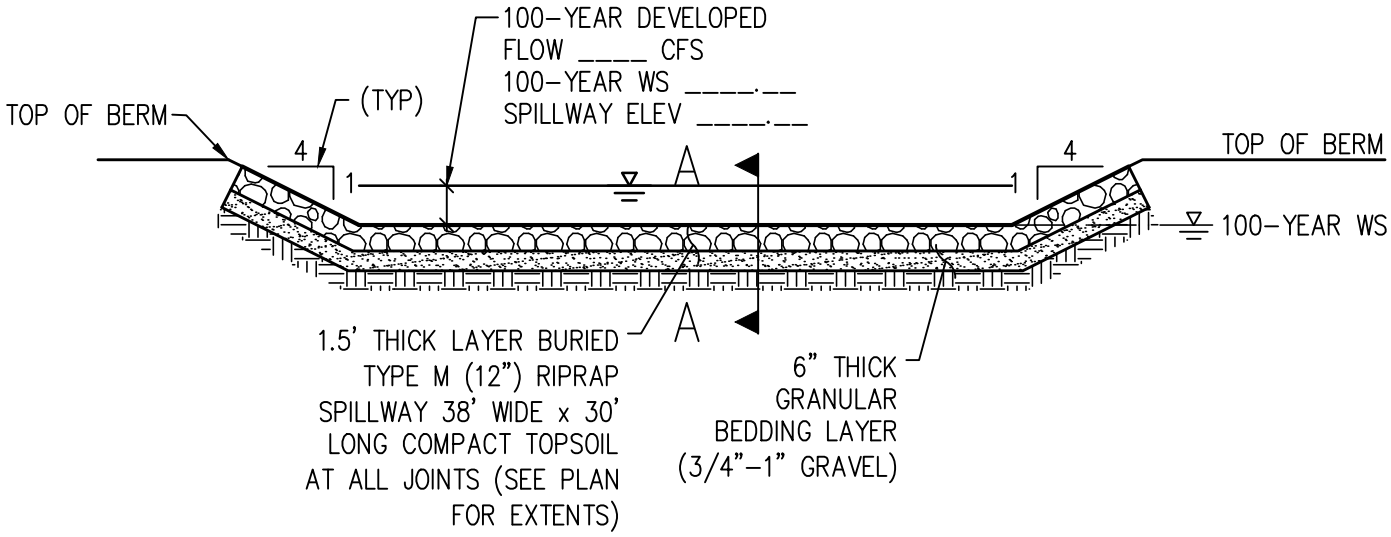
1. MITIGATED SOIL AND COBBLE AREA SHALL BE DESIGNED BY ENGINEER BASED ON ACTUAL HYDRAULIC CONDITIONS

SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS	D6.12
	LOW FLOW CHANNEL	DATE: 12/2020



SECTION A



SCALE: NTS

TOWN of BERTHOUD Est. 1888	TOWN OF BERTHOUD STANDARD DESIGN CRITERIA STORM SEWER DETAILS	D6.13
	EMERGENCY OVERFLOW	DATE: 12/2020

TOWN OF BERTHOUD ORDINANCE
NUMBER 13XX

AN ORDINANCE AMENDING THE TOWN OF BERTHOUD COMPREHENSIVE PLAN FOR THE PURPOSE OF REFERENCING THE TOWN'S ENGINEERING AND INFRASTRUCTURE DESIGN STANDARDS AND CONSTRUCTION SPECIFICATIONS BY REFERENCE

WHEREAS, the Town of Berthoud is a municipal corporation possessing all powers granted to a statutory town by Title 31 of the Colorado Revised Statutes; and

WHEREAS, the Town of Berthoud, Colorado, acting through its Planning Commission, is empowered pursuant to C.R.S. Section 31-23-201, *et seq*., to make and adopt a comprehensive plan; and

WHEREAS, the Town adopted Resolution 2021-19 on July 13, 2021 adopting the updated to the Town's Comprehensive Plan; and

WHEREAS, the Board of Trustees, have adopted the updated Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specifications by reference which requires a reference note to be added to the 2021 Comprehensive Plan; and

WHEREAS, the attached Exhibit A is the only amendment thereto and has been submitted to the Board of Trustees in writing and the Board of Trustees has determined that such amendment thereto should be adopted as herein set forth;

NOW, THEREFORE, BE IT ORDAINED BY THE TOWN BOARD OF TRUSTEES OF THE TOWN OF BERTHOUD, COLORADO:

Section 1. That reference to the Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specifications be inserted into the 2021 Comprehensive Plan following Figure 3.6 as set forth in Exhibit A, attached is hereby adopted;

Section 2. If any section, paragraph, sentence, clause, or phrase of this Ordinance is held to be unconstitutional or invalid for any reason, such decision shall not affect the validity or constitutionality of the remaining portions of this Ordinance.

Section 3. All other Ordinances or portions thereof inconsistent or conflicting with this Ordinance or any portion hereof are hereby repealed to the extent of such inconsistency or conflict.

Section 4. The repeal or modification of any provision of the Municipal Code of the Town of Berthoud by this Ordinance shall not release, extinguish, alter, modify, or change in whole or in part any penalty, forfeiture, or liability, either civil or criminal, which shall have been incurred under such provision, and each provision shall be treated and held as still remaining in force for the purpose of sustaining any and all property actions, suits, proceedings, and prosecutions for the enforcement of the penalty, forfeiture, or liability, as well as for the purpose of sustaining any judgment, decree, or order which can or may be rendered, entered, or made in such actions, suits, proceedings, or prosecutions.

Section 5. The provisions of this ordinance shall take effect thirty days after publication as required by law, and shall apply to all development and construction permitted after such date.

INTRODUCED, READ, AND APPROVED on this 25th day of November, 2025.

TOWN OF BERTHOUD

By _____

William Karspeck, Mayor

ATTEST:

By: _____

Christian Samora, Town Clerk

READ, ADOPTED, AND APPROVED on this 9th day of December, 2025.

TOWN OF BERTHOUD

By _____

William Karspeck, Mayor

ATTEST:

By: _____

Christian Samora, Town Clerk

The Town of Berthoud adopted updated Engineering and Infrastructure Design Standards and Construction Specifications through Ordinance 13XX (2025). These shall take precedence over the street sections found in the 2021 Comprehensive Plan.



TOWN OF BERTHOUD, COLORADO

NOTICE OF PUBLIC HEARING
Adoption of an update to the Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specifications by reference in Section 30-6-102 of the Berthoud Municipal Code and the 2021 Comprehensive Plan

AND

Annual adoption of the Town of Berthoud 3-Mile Plan

PUBLIC NOTICE IS HEREBY GIVEN of public hearings before the Planning Commission on November 13, 2025 at 6 p.m. and the Town Board on November 25, 2025 and December 9, 2025 both at 6:30 p.m. All public hearings will be for the purpose of adopting the updated Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specification Standards by reference in both Chapter 30 of the Municipal Code and the 2021 Comprehensive Plan for the purpose of updating the Town's engineering and construction specifications and standards as described in the Title of this announcement. The public hearings will also be to adopt the annual Town Three-Mile Plan which mirrors the Town's Future Land Use Map found in the 2021 Comprehensive Plan. The public hearings will be held at Town Hall 807 Mountain Avenue in Berthoud 80513.

Given and posted on this ____ day of October, 2025 and this _____ day of October, 2025.

Published: Loveland Reporter Herald October ____, 2025 -and _____, 2025.