Town of Berthoud Planning Commission
Town Hall
807 Mountain Avenue
Thursday, March 14, 2024, at 6:00 p.m.

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

   4.I. Meeting Minutes From 2/8/2024

   Documents:

   2024 02 08_FINAL MINUTES.PDF

5. Public Hearing To Consider A Request For A Final Plat Known As Westside Crossing Replat #2 Located North Of Mountain Avenue And West Of Meadowlark Drive, Resolution 2024 - 04

   Presented by: Anne Johnson, Community Development Director
   Lauren Richardson, Town Planner

   Documents:

   01 INFORMATION FORM.PDF
   02 RESOLUTION 2024 04.PDF
   03 STAFF REPORT REVISED 2024 03 11.PDF
   04 APPLICATION MATERIALS.PDF
   05 PUBLICATION.PDF

6. Report By Staff
7. Adjourn

Join Zoom Meeting https://us02web.zoom.us/j/86049631362 Meeting ID: 860 4963 1362
One tap mobile +17193594580,,86049631362# US

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.

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

Planning Commission Minutes – February 8, 2024, at 6:00 p.m.

1. **Call to Order** – The Planning Commission convened a regular meeting on. Commissioner Anderson called the meeting to order at 6:00 p.m.

2. **Pledge of Allegiance**

3. **Roll Call** – Members present:

Members present:	Karen Anderson	(Chairperson)
	Abigail Smith	(Vice Chairperson)
	Jon Van Benthem	(Secretary)
	Joe Donnelly	(Commissioner)
	Marc Hofmans	(Commissioner)
	Nick Semedalas	(Commissioner)
	Brett Wing	(Commissioner)
Staff present:	Anne Johnson	(Community Development Director)
	Teri Reger	(Planning Technician)
	Jeremy Olinger	(Deputy Town Administrator)
Consultants:	Gerald Dahl	
	Martin Landers	
	Erin Smith, Town Attorney	

4. **Approval of Minutes –** Minutes from January 11, 2024, Planning Commission Meeting.

   MOTION made by Commissioner Wing to APPROVE the Minutes for January 11, 2024.

   SECONDED by Commissioner Van Benthem.

   With those all-in favor, THE MOTION CARRIED.

5. **Update on Town Projects in 2023 and 2024**
   Presented by: Jeremy Olinger, Deputy Town Administrator

6. **Public Hearing: Sign Code**
   Community Development Director Anne Johnson introduced a recommendation to the Planning Commission regarding amendments to Section 7, Chapter 30, the Berthoud Sign Code, Ordinance 1334.

   Public Comment was opened at 7:24 p.m. ***Public Comment was closed at 7:25 p.m.***

   MOTION made by Commissioner Wing to forward our recommendation of approval of the amendments contained in Ordinance 1334 (Series 2024) with Appendices A, B, C and D to the Town Board of Trustees. The rationale for approval is that the proposed guidelines provide transparent expectations for future development in the Town of Berthoud, supports the Town's community identity outlined in the 2021 update to the Comprehensive Plan, and aligns the Town's Sign Code with current findings of the U.S. Supreme Court.

   SECONDED by Vice Chairperson Smith. With all in favor, THE MOTION CARRIED.

7. **Public Hearing: Amendments to the Berthoud Development Code specifically, adopting Section 3 of Chapter 30, Ordinance 1335**

Community Development Director Anne Johnson introduced a recommendation to the Planning Commission regarding adopting Section 3, Chapter 30 of the Municipal Code to recognize the adoption of the Innovation District Standards by the Town Board of Trustees on April 25, 2023

Public Comment was opened at 7:48 p.m. ***Public Comment was closed at 7:48 p.m.***

MOTION made by Commission Hofmans to *forward our recommendation of approval of the amendments contained in Ordinance 1335 (Series 2024) with Appendix A to the Town Board of Trustees. The rationale for approval is that the guidelines for the Berthoud Innovation District/1st Street Corridor were approved by the Town Board of Trustees on April 25, 2023. Inclusion of these standards by reference in the Town Development Code provides transparent expectations for future development in the Town of Berthoud and supports the Town's community identity outlined in 2023 Guidelines for the 1st Street Corridor.*

SECONDED by Commissioner Semedalas. With all in favor, THE MOTION CARRIED.

8. **Reports by Staff**

Planning Commission Field Trip is scheduled for March 16, 2024.
Planning Commission Meeting on February 25, 2024, has been cancelled the next meeting will be March 14, 2024.

Board of Trustees Update:

Commissioner Wing commended Deputy Town Administrator Olinger for his presentation and information he shared regarding Town Projects.
Commissioner Wing also asked, spurred by the upcoming field trip, how leaders can influence affordable housing.
Chairperson Anderson suggested that perhaps the Director for Habitat for Humanity could come and talk to the Commission.

9. **Adjourn** –

The meeting was adjourned at 7:58 p.m.

CHAIRPERSON

SECRETARY

PLANNING COMMISSION INFORMATION

COMMUNITY DEVELOPMENT DEPARTMENT

Meeting Date:	**March 14, 2024**
Agenda Title/Subject:	**Public Hearing to consider a request for a Final Plat known as Westside Crossing Replat #2 located north of Mountain Avenue and west of Meadowlark Drive, Resolution 2024 - 04**
Type of Item:	**Public Hearing**
Purpose:	**Request for approval of a Final Plat for Westside Crossing Replat #2 to provide seven commercial properties (Resolution 2024 – 04)**
Presented by:	**Anne Johnson, Community Development Director** **Lauren Richardson, Town Planner**

ATTACHMENTS:

- Resolution 2024 – 04
- Staff Report
- Application materials
- Publication notice

BACKGROUND:

The 11.9-acre property is zoned C-2 for Commercial uses. The location of this proposal is within the greater Gateway development and more specifically located north of Mountain Avenue and west of Meadowlark Drive. The property is within the Mountain Avenue Overlay District. The applicants are proposing seven commercial lots.

UPDATE/NEXT STEPS:

Planning Commission heard the request for the Preliminary Plat at their public hearing on August 10, 2023, followed by the Board of Trustees on August 22, 2023, where the Preliminary Plat was approved. The Final Plat is now being presented and the Planning Commission is the final approving body for Final Plats. If approved, there are Conditions of Approval which will be met at the stages represented in the Staff Report. Each individual lot within the proposed development will be required to apply for a Special Use Permit (public hearings) or a Site Plan (administrative review) for future land uses proposed for the property. The developer will be required to enter into a Development Agreement for on- and off-site improvements including a signalized intersection at Meadowlark and Mountain.

FISCAL IMPACT AND FUND SOURCE:

There is no negative impact to the Town in consideration of this request.

COMMUNITY TOUCHSTONES:
Consideration of this request does not negatively impact community touchstones. The property was zoned C-2 and this proposal is requesting a subdivision to accommodate commercial land uses.

RECOMMENDED ACTION(S):
Staff and referral agencies have reviewed the attached Final Plat application materials and had developed Conditions of Approval and Development Standards to address outstanding requirements for the development to proceed forward.

Staff recommends the Planning Commission approve the Final Plat application for Westside Crossing Replat #2 with the Conditions of Approval and Development Standards found in the Staff Report to be recorded with Resolution 2024 – 04 as the Criteria for Approval outlined in the Staff Report and Resolution have been satisfied.

RESOLUTION NUMBER 04

(SERIES 2024)

A RESOLUTION OF THE TOWN OF BERTHOUD PLANNING COMMISSION APPROVING A FINAL PLAT FOR WESTSIDE CROSSING REPLAT NO. 2 FOR A COMMERCIAL DEVELOPMENT IN THE TOWN OF BERTHOUD

WHEREAS, the property under consideration is known as the "Westside Commercial" development; and

WHEREAS, the Town of Berthoud ("Town") approved a Neighborhood Master Plan and Zoning change to Commercial, C-2; and

WHEREAS, the Town approved a Preliminary Plat; and

WHEREAS, the Final Plat application 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 March 14, 2024; a legal ad was published on February 14, 2024 and affected property owners within 500 feet of the site were notified by first-class mail before the Berthoud Planning Commission hearing on February 15, 2024; and

WHEREAS, the Berthoud Planning Commission approved the Final Plat with Development Standards and Conditions of Approval at their public hearing on March 14, 2024; and

WHEREAS, based on the testimony and evidence presented at the public hearing, the Planning Commission determines and finds that compliance with the Final Plat review criteria as provided in Section 30-6-108(C) 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. Final Plat Approval. The Final Plat is hereby approved with the following Conditions of Approval.

1. **Prior to Recording the Plat:**
    a. The applicant shall enter into a Development Agreement with the Town of Berthoud to cover all on-site and off-site improvements, as illustrated on the plans approved.
    b. The applicant shall provide plans for an entry treatment to the Town on the southwest corner of the Property. Additional landscaping, an art installation, or other treatment should be designed to signify the entrance to the Town of Berthoud.
    c. The applicant shall submit the suggested locally available sod mix for approval.

2. **Prior to Pre-Construction Meeting:**
    1. The applicant shall provide evidence of a written Agreement with the Welch Lateral Company addressing the comments in the referral letter dated 01/13/22. The Agreement shall be signed by all parties.

3. **Development Standards:** The following Development Standards shall be placed as notes on the Final Plat.
    1. Vested 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.
    2. Project approval. The plans contained on this Final Plat, the Construction Drawings/ Documents approved by the Town, the staff report, and Resolution 2024-04 are the limits of approval. Any changes to the approved plans may necessitate an amendment or new land use permit.
    3. All Development Improvements shall be constructed in accordance with the Plan and Plans as well as the requirements of the Berthoud Municipal Code, design standards and guidelines, and Master Plans governing the Property and the Development Agreement entered into between the Developer and the Town of Berthoud.
        a. Future lot owners shall construct curbs, gutters, sidewalks, irrigated tree lawns, street trees and provide a connection to the external trail system.
        b. Developer is required to construct the final lift on the internal street after all lots have been constructed or in three years past the approval date of this Final Plat, whichever comes first.
        c. The Architectural Design Standards for the development.
        d. The Comprehensive Sign Plan approved for the development.
    4. Prior to scheduling the Pre-Construction meeting for overall site grading or submittal of the first Site Plan or Special Use Permit application within the Subdivision, whichever occurs first:
        a. The applicant shall provide a Comprehensive Sign Plan to the Town for review. The Comprehensive Sign Plan shall adhere to the requirements of the Land Use Code, including the Dark Sky Standards, the Sign Code, and the Mountain Avenue Overlay District Guidelines for the entire development.
            i. All signage within CDOT right-of-way along State Highway 2897 and Mountain Avenue, shall be submitted to the Town for approval first, followed by the applicant's submittal to CDOT for approval.
        b. The applicant shall provide Architectural Design Standards for the overall development to the Town for review. The Town's Architectural Standards found in the Town Code, the separate Architectural Standards Guidelines, and the Mountain Avenue Overlay District shall govern the creation of these standards.
        c. Construction Plans and Profiles shall be submitted, reviewed by the Town, and receive approval by the Town.
        d. The irrigation plan for the common areas shall be provided to the Town.
    5. Construction activities shall adhere to the Construction Rules and Regulations found in Chapter 30 of the Berthoud Municipal Code at all times.
        a. Prior to Substantial Completion as defined in the Development Agreement, a street lighting plan shall be submitted to and approved by the Town. The street lighting shall be installed prior to start of warranty.
        b. A site sign shall be posted in accordance with Section 30-5-102 of the Berthoud Municipal Code.
        c. Grading Permit: According to the Berthoud Design and Construction Standards, all utility installation outside of the Town Right-of-Way (on private property) requires a Grading Permit before any installation activity commences. Detailed regulations for obtaining a Grading Permit are outlined in Chapter 20 of the Berthoud standards.

d. 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.

e. Stormwater Management Plan (SWMP)/MS4 Compliance: The Town mandates the preparation and submission of a site-specific Stormwater Management Plan (SWMP) by the owner of the construction site. This plan must be approved by the Town prior to scheduling the pre-construction meeting. The SWMP submission is necessary for obtaining permit certification issued by the State of Colorado for any construction activity that falls under the category of a General Construction Stormwater Permit as defined by the Colorado Department of Public Health and Environment (CDPHE). A CDPS General Permit for stormwater discharges associated with construction activities are required at least ten calendar days before construction begins but must also be noted on the Town Grading Permit.

6. A tree lawn on the north side of Lots 6 & 7 shall be installed as part of the Residential portion of the Gateway Development approved with Final Plat. The Final Plat Landscape Plan was prepared by StackLot LLC on 7/31/2023 and approved by the Town.

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.

[LEFT BLANK INTENTIONALLY]

APPROVED AND ADOPTED this 14th day of March 2024.

TOWN OF BERTHOUD

By _____

Karen Anderson, Chairperson

ATTEST:

By: _____

Teri Reger, Planning Technician

Exhibit A: Staff Report

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

STAFF REPORT: WESTSIDE CROSSING REPLAT #2 FINAL PLAT

DATE: March 14, 2024

GENERAL INFORMATION		
Applicant:	**Scott Charpentier**	**Size: 11.90 acres**
Site Location:	**The property is located at the NE corner of Mountain Avenue and US Highway 287**	
Applicant's Request:	**The Applicant is requesting a final plat for the creation of 7 commercial lots.**	
Current Zoning:	**C2 General Commercial District with Mountain Ave Overlay**	

ZONING DISTRICT INFORMATION		
	C2 (underlying zoning)	**Mountain Avenue Overlay District Criteria for Berthoud West**
Max Density	**20 per acre**	**Per underlying zoning**
Min. Lot Area	**N/A**	**N/A**
Min. Lot Width	**50'**	**Per underlying zoning**
Front Setback	**25'**	***see Mountain Ave Development Criteria**
Side Setback	**0'/25' depending on adjacent land uses**	***see Mountain Ave Development Criteria**
Rear Setback	**0'/35' depending on adjacent land uses**	**Per underlying zoning**
Max Building Height:	**50'**	**40'**

SURROUNDING ZONING, LAND USE AND REQUIRED BUFFERS			
	Adjacent Zoning	**Adjacent Land Uses**	**Setbacks for Adjacent Zoning/ Buffer required**
North	**R4**	**Single/multi-family**	**Buffer Areas from Residential: All C-2, require no less than a 35-foot setback buffer from the property line of a residential zoning district.**
South	**C2**	**Commercial**	**Mountain Avenue Overlay District: Building setback for Hwy 56 - 14' min, 20' max**
East	**PUD**	**Single Family / Vacant**	**Mountain Avenue Overlay District: Building setback for secondary street – 20' min**
West	**PUD**	**Vacant**	**Separated by State Highway 287**

Proposal

The applicant proposes to subdivide the existing parcel into seven lots. These commercial lots would be sold individually at a later date. Development on individual lots will require either a Site Plan or a Use by Special Review permit. The purpose of this application is to create lots for commercial uses.

Background

This property is part of the Westside Crossing development. In April of 2021, a neighborhood masterplan and rezoning were approved for this commercial area of the site, as well as the residential neighborhood directly to the North. Additionally, in March of 2022, a preliminary plat was approved for this area that had a slightly different lot configuration from what is currently being proposed. Due to development interest in the property, the lot configuration has been adjusted to work with end-user designs.

Final Plat Review Criteria

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

30-6-108(C) Review Criteria	Finding	Rationale
1. The Final Plat is in substantial conformance with the approved Preliminary Plat. For the purposes of this Code, "substantial conformance", includes design adjustments made to meet any conditions of preliminary plat approval and is determined as follows: a. Does not change any land use of the proposed plat. b. Does not change the number of lots or residential density by more than 5%. c. Does not contain changes which would render the final plat in nonconformance with requirements of this Code. d. Does not contain significant changes in street alignment and/or access points, or other public elements such as drainage improvements, utility lines or facilities. e. Does not change any measurable standard (other than above) by more than 15 percent. f. How the Applicant has addressed comments received from the public, during the Public Comment portion of the process.	Yes	The Final Plat is a functional system of land use that connects with the existing road network, the developing community-wide trail network, and the Town's sidewalk network. The proposed subdivision meets the standards of the C2 zone district and the Mountain Avenue Overlay District. The Final Plat does not propose any land use changes of the proposed plat, nor does it contain changes that would render this in nonconformance with the Code. The Final Plat does not contain significant changes to the approved Preliminary Plat. Staff finds this Final Plat in substantial conformance with the approved Preliminary Plat.

30-6-108(C) Review Criteria	Finding	Rationale
2. The development complies with this Code, the Comprehensive Plan and the PORT Plan.	Yes	The proposed Final Plat and the associated documents comply with this Code, the Comprehensive Plan and the PORT Plan. The Future Land Use Plan identifies this area as a future Suburban Business, envisioned as a vibrant, walkable commercial district that includes preferred land uses such as retail stores, restaurants, and offices. The importance of pedestrian connectivity has been satisfied with detached sidewalks, tree lawns, and regional trail connections.
3. All applicable technical standards including the provision of water in sufficient amount and quality have been met.	Yes	Plans were reviewed by Town Staff as well as outside referral agencies. The applicant has provided adequate plans for utilities and transportation designs.

PUBLIC NOTICE AND COMMENT

Notice of the Board of Trustees Public Hearing was mailed to property owners within 500 feet of the subject property at least five days before the public hearing. A legal ad was published on February 15, 2024, as required by the Development Code. In addition, the application was sent out to all property owners within 500 feet, with an invitation to comment on the request within three weeks of receipt. Comments received are attached to this submittal.

FINDINGS AND RECOMMENDATIONS

- **Staff recommends Planning Commission make a motion to recommend approval of the Final Plat to the Board of Trustees with the following Conditions of Approval and Development Standards.**

Prior to Recording the Plat:

1. The applicant shall enter into a Development Agreement with the Town of Berthoud to cover all on-site and off-site improvements, as illustrated on the plans approved.

2. The applicant shall provide plans for an entry treatment to the Town on the southwest corner of the Property. Additional landscaping, an art installation, or other treatment should be designed to signify the entrance to the Town of Berthoud.

3. The applicant shall submit the suggested locally available sod mix for approval.

4. The developer shall provide a copy of the right-of-way dedication/donation of land to the Colorado Department of Transportation that is required to complete the ADA ramp at the northeast corner of Mountain and Meadowlark Avenues.

Prior to Pre-Construction Meeting:

1. The applicant shall provide evidence of a written Agreement with the Welch Lateral Company addressing the comments in the referral letter dated 01/13/22. The Agreement shall be signed by all parties.

Development Standards for the Plat:

1. Vested 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.

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    c. The Architectural Design Standards for the development.
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    c. Construction Plans and Profiles shall be submitted, reviewed by the Town, and receive approval by the Town.
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construction activity that falls under the category of a General Construction Stormwater Permit as defined by the Colorado Department of Public Health and Environment (CDPHE). A CDPS General Permit for stormwater discharges associated with construction activities are required at least ten calendar days before construction begins but must also be noted on the Town Grading Permit.

6. A tree lawn on the north side of Lots 6 & 7 shall be installed as part of the Residential portion of the Gateway Development approved with Final Plat. The Final Plat Landscape Plan was prepared by StackLot LLC on 7/31/2023 and approved by the Town.

Attachments

1. Conditions of Approval and Development Standards
2. Resolution 2024-04
3. Application form
4. Narrative
5. Final Plat
6. Final Drainage Plan
7. Final Landscape Plan
8. Preliminary Plat
9. Neighborhood Master Plan – Illustrative Masterplan
10. Traffic Impact Study and Traffic Signal Plans

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):

Site Address: NE corner of US HWY 287 Bypass and HWY 56

Project Name: Westside Crossing

Brief description of project:
Final plat and commercial development of approximately 11.9 acres

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: Scott Charpentier

E-mail: scott@fcmmoney.com
Phone: 970-566-4891
Mailing Address: 8340 Louden Circle
City/State/Zip: Windsor, CO 80528

CONTACT PERSON *(will receive correspondence from Town Staff/Referral Agencies)*

Name:

E-mail:
Phone:
Mailing Address:
City/State/Zip:

OWNER(S) *(If different than applicant)*

Name:

E-mail:
Phone:
Mailing Address:
City/State/Zip:

CONSULTANT *(Engineer, Surveyor, or Planner)*

Name: Jacob McMillen

E-mail: Jmcmillen@kiowaengineering.com
Phone: 303-692-0369
Mailing Address: 5951 Middlefield Rd., Suite 200
City/State/Zip: Littleton, CO 80123

LAND USE INFORMATION

Existing Use: Vacant Land

Proposed Use: Commercial

Existing Zoning: C2

Proposed Zoning: (if applicable):

Number of acres: 11.901 acres commercial

Proposed Access: Meadowlark Drive

Adjacent zoning / land use:	
East Side: Residential	North Side: Residential
West Side: HWY 287	South Side: HWY 56

UTILITY SERVICE INFORMATION

Water: Berthoud	Sewer: Berthoud

PROJECT INFORMATION

Number of proposed units:
N/A
Number of phases:
One for commercial
Number of Units per phase:
N/A
Number of lots proposed:
7
Lot size minimum:
35,439 SF
Lot size maximum:
204,986 SF
Lot size average:
71,071 SF
Gross density (units/acre):
N/A
Net density (units/acre):
N/A
Area and percent open space:
N/A

Non-Residential Building Area (Sq. Ft.) Proposed:
N/A (Plat and public improvements only)
Non-Residential Construction Floor Area Ratio Proposed: N/A
Total Number of Parking Spaces: N/A
Acreage of Site:
a. Gross: 11.901
b. Right-of-Way: 0
c. Net (a-b) 11.901

Type of Housing Proposed (*please check*):

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

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): _____ Date: 8-20-23

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: _____ Date: 8-20-23

FOR OFFICE USE ONLY	Received By:	Date:

Written Statement & Graphics

To:	Town of Berthoud
From:	Kiowa Engineering Corp.
Date:	September 1, 2023
Project:	Westside Crossing – Commercial Phase
Subject:	Written Statement – Final Plat Submittal

The following letter has been written to provide a description of how the proposed development is consistent with the concept plan, how items of concern that were expressed during concept phase have been addressed, and how the plan is consistent with the Development Code, Comprehensive Plan, and PORT plan.

The Westside Crossing project is proposed along the north side of Highway 56 between Meadowlark Drive and Highway 287 in Berthoud, Colorado. The total site area is approximately 20.94 acres and has been approved for a rezone from PUD to the current zoning of C-2 and R-4. Existing site conditions consist of undeveloped land, covered with native prairie grasses and sparse trees.

This project consists of two phases – Residential (Phase I) and Commercial (Phase II). Phase I of this project has already completed construction of the public improvements portion of the development and is currently under development for the individual residential lots. Phase I consists of 7.9 ac of R-4. The R-4 residential phase consists of 56 residential multi-family units. The remainder of the total site area makes up the C-2 zoning portion of the project – Phase II – and is currently being platted. Properties that bound the northern and eastern edges of the project site are comprised of single-family residential homes. The proposed development integrates an upscale walkable residential and commercial development into the fabric of the community. The residential/north portion of the development consists of multi-family/condominium uses and is specifically located in this area to serve as a transition use between the existing single-family detached product and the commercial development. The commercial district comprising the middle/southern portions of the Phase II development is planned for uses allowed within the Town of Berthoud Commercial C-2 zone district. The developer anticipates constructing mid-size retail, inline service retail, restaurant(s) and a convenience store in this area. Buildings adjacent to Highway 56 and Highway 287 in commercial zone will be placed close to the right-of-way, forming an urban edge, setting the framework for a vibrant and successful development.

Open space is consistent with code and provides pedestrian connections to the development from entry points along Meadowlark Drive. Specifically, a greenway element is located between the commercial and residential development, connecting to the urban public plans.

The proposed development is designed to integrate the recommendations from the Mountain Avenue Corridor Plan, meet or exceed open space code requirements, satisfy development parking requirements and infill a growing demand residential product and commercial services into the

7175 West Jefferson Avenue Suite 2200, Lakewood, Colorado 80235
Ph: (303) 692-0369 www.kiowaengineering.com

community.

The Westside Crossing Owners Association will own and maintain all common area open spaces. The covenants and bylaws can be provided if needed.

This proposal supports the Town's land use designation in the 2021 Comprehensive Plan. The 2021 Comprehensive Plan identifies the parcel as commercial/office. The Neighborhood Master Plan and rezoning for the property was approved by the Town Board on April 13, 2021. Concerns expressed at the hearing and the means by which they have been addressed are described below:

1. Berming and additional landscaping will be required for every site plan along Meadowlark and HWY 287.
   RESPONSE: Additional landscape screening to the west of the central commercial areas (Tract A) will be met at the time these lots are developed.
2. A 10' trail connection from the trailhead to the HWY 287 must be provided.
   RESPONSE: A 10' regional trail network is proposed as part of this development and provides connection from the existing trail within the Estates at Matthews Farm development to the north to Highway 287. A parking area for the trail is planned as part of the residential development.
3. Additional park area to serve the residential area must be provided as per 30-2-109.
   RESPONSE: A pocket park has been proposed adjacent to the residential area and meets code section 30-2-109.
4. The Applicant verify by Preliminary Plat that the detention area is useable for recreational purposes.
   RESPONSE: The retaining wall adjacent to the park has been removed and replaced with sloping landscaped area to integrate the detention area with the pocket park so that the detention area becomes useable park space. The detention area in the middle of the development will also be usable for recreational purposes. Park benches, picnic tables, playground area, grill, and other amenities are also proposed to enhance the usable detention areas to meet section 30-2-109 D5a.
5. A study to consider pedestrian traffic on the nearby connecting residential streets (such as signage) be completed at platting.
   RESPONSE: The consultant team has been particularly conscious of the need for pedestrian safety and connectivity throughout the plan development process. Sidewalks are provided on both sides of all street frontages. The sidewalk along the SH-56 frontage connects directly to the pedestrian crosswalks and push button actuation at signalized intersection at US-287. Likewise, it connects to the future signalized crossing at Meadowlark Dr. Notably, there are direct connections from the residential and commercial areas to the major pedestrian/bike trail along US-287. The trail will be connected to the existing section to the north and to the sidewalk along the SH-56 frontage. Internally, the streets are very low volume and there is no necessity for crosswalk markings or enhancements such as signing, bump outs, refuge islands, or flashing beacons. In the event a pedestrian movement is observed crossing Meadowlark Dr. and/or SH-56 at a mid-block location, then a MUTCD warrant study should be conducted to determine what treatments are required to ensure the safety of the pedestrian movement.
6. That the north row of residential be limited to one story.

RESPONSE: This condition has been met.

7. That a trail connection be added from Meadowlark over to the regional trail on the north side, in the buffer area.
   RESPONSE: The buffer area on the north side of the residential area is an existing drainage path. Placing a trail in this area constricts the drainageway in a way that does not accommodate the 30 CFS that is going through this area via offsite flows under HWY 287 from the west. This area needs to be free of encumbrances to ensure that the residential properties to the north are not affected by this development. There was also public comment received from a resident to the north that this trail was not desired. Per comment from Marty Goss on November 15, 2021,
   > **"please do not allow an 8' trail between our backyards and the attached homes. Everyone on our street has dogs and this would be a constant issue with barking dogs and would be uncomfortable not only for us but for the residents in the attached homes. It would also be a security and safety concern. Have a trail on all other sides of the lot just not the north side please."**

   Included with the 58' ROW in front of the duplexes is a detached sidewalk that has been proposed to connect the sidewalk along Meadowlark Drive to the regional trail on the west side of the development, satisfying the request for this connection as well as satisfying the concern of the adjacent homeowner.
8. That the internal north/south sidewalk be connected from Tundra to Mountain Avenue on the west side of the detention area:
   RESPONSE: Sidewalk connection is proposed.
9. A feasibility study on the use of a round-a-bout is required by the Town at the intersection of Highway 56 and Meadowlark Drive.
   RESPONSE: A traffic study has been included with the submittal that analyzes the use of a roundabout. The Town has confirmed that a traffic signal will be built in lieu of the roundabout.

FINAL PLAT
WESTSIDE CROSSING REPLAT #2

Being a Replat of Tract A, Westside Crossing,
Situate in the South Half of the Southwest Quarter of Section 15, Township 4 North, Range 69 West of the 6th P.M.,
Town of Berthoud, County of Larimer, State of Colorado

LEGAL DESCRIPTION:

KNOW ALL MEN BY THESE PRESENTS: That the undersigned, being the owners of a portion of the Southwest Quarter Section Fifteen (15), Township Four North (T.4N.), Range Sixty–nine West (R.69W.) of the 6th Principal Meridian, Town of Berthoud, County of Larimer, State of Colorado, more particularly described as follows:

Tract A, Westside Crossing, recorded July 5, 2022 as Reception No. 20220042194 of the Records of Larimer County.

Said described parcel of land contains 11.901 Acres, more or less (±).

Have laid out, platted, and subdivided the above described land, under the name and style of WESTSIDE CROSSING REPLAT #2, 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 plats, which are hereby dedicated for public use forever as such, including those streets and rights–of–way labeled as "access easements" hereon, 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: Berthoud Gateway LLC, a Colorado limited liability company

By: _____
Scott T. Charpentier as Manager Member

NOTARIAL CERTIFICATE

STATE OF _____)
ss
COUNTY OF _____)

The foregoing dedication was acknowledged before me this _____day of _____, 20 __,

by Scott T. Charpentier as Manager Member.

Witness my hand and official seal. (SEAL)

My commission expires _____

_____
Notary Public

LEINHOLDER: Westland Holdings, Inc.

By: _____
James D. Ditzel as President

NOTARIAL CERTIFICATE

STATE OF _____)
ss
COUNTY OF _____)

The foregoing dedication was acknowledged before me this _____day of _____, 20 __,

by James D. Ditzel as President.

Witness my hand and official seal. (SEAL)

My commission expires _____

_____
Notary Public

BASIS OF BEARINGS AND LINEAL UNIT DEFINITION

Assuming the East line of the South Half of the Southwest Quarter of Section 15, T.4N., R.69W., being monumentalized by a #6 rebar with a 2" Aluminum Cap stamped "LS 27936" on the North end and by a #6 rebar with a 3 1/4" aluminum cap stamped "LS 16415" on the South end, as bearing South 00°34'48" East, being a Grid Bearing of the Colorado State Plane Coordinate System, North Zone, North American Datum 1983/2011, a distance of 1330.11 feet with all other bearings contained herein relative thereto.

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

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)

TITLE COMMITMENT NOTE

This survey does not constitute a title search by King Surveyors to determine ownership or easements of record. For all information regarding easements, rights–of–way and title of records, King Surveyors relied upon Title Commitment Number FC25193574.1–10, dated February 21, 2024 as prepared by Land Title Guarantee Company and Old Republic National Title Insurance Company to delineate the aforesaid information.

SURVEYOR'S CERTIFICATE:

I, Paul B. Groves, a Registered Land Surveyor in the State of Colorado, do hereby certify that the survey of WESTSIDE CROSSING REPLAT #2 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.

FINAL

_____
Paul B. Groves – On Behalf Of King Surveyors
Colorado Licensed Professional
Land Surveyor #38209

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.

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.

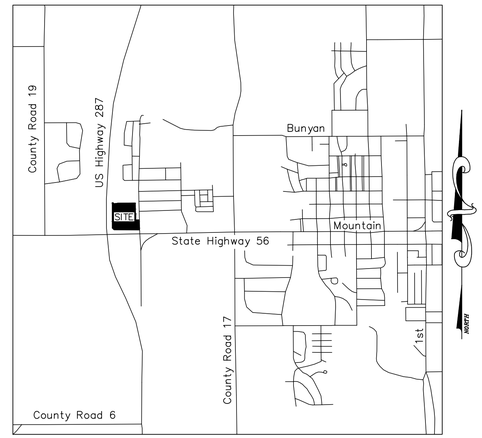
PROJECT APPROVAL
The plans contained on this plat as well as the staff report dated March 14, 2024 and Resolution 2024–04 are the limits of the approval. Any changes to the approved plans may necessitate an amendment or new permit.

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: The development improvements 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.



VICINITY MAP
SCALE: 1"=2000'

APPROVAL CERTIFICATES:

Approved by the Planning Commission of the Town of Berthoud, Colorado,

this_____ day of _____, A.D., 20___.

_____
Chairperson

The foregoing plat is approved for filing and accepted by the Town of Berthoud, Colorado,

this_____ day of _____, A.D., 20___.

ATTEST: _____
Community Development Director

DEVELOPMENT STANDARDS

1. Vested 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.

2. Project approval. The plans contained on this Final Plat, the Construction Drawings/Documents approved by the Town, the staff report, and Resolution 2024–04 are the limits of approval. Any changes to the approved plans may necessitate an amendment or new land use permit.

3. All Development Improvements shall be constructed in accordance with the Plan and Plans as well as the requirements of the Berthoud Municipal Code, design standards and guidelines, and Master Plans governing the Property and the Development Agreement entered into between the Developer and the Town of Berthoud.

a. Future lot owners shall construct curb, gutters, sidewalks, irrigated tree lawns, street trees and provide a connection to the external trail system.

b. Developer is required to construct the final lift on the internal street after all lots have been constructed or in three years past the approval date of this Final Plat, whichever comes first.

c. The Architectural Design Standards for the development.

d. The Comprehensive Sign Plan approved for the development.

4. Prior to scheduling the Pre–Construction meeting for overall site grading or submittal of the first Site Plan or Special Use Permit application within the Subdivision, whichever occurs first:

a. The applicant shall provide a Comprehensive Sign Plan to the Town for review. The Comprehensive Sign Plan shall adhere to the requirements of the Land Use Code, including the Dark Sky Standards, the Sign Code, and the Mountain Avenue Overlay District Guidelines for the entire development.

i. All signage within CDOT right–of–way along State Highway 2897 and Mountain Avenue, shall be submitted to the Town for approval first, followed by the applicant's submittal to CDOT for approval.

b. The applicant shall provide Architectural Design Standards for the overall development to the Town for review. The Town's Architectural Standards found in the Town Code, the separate Architectural Standards Guidelines, and the Mountain Avenue Overlay District shall govern the creation of these standards.

c. Construction Plans and Profiles shall be submitted, reviewed by the Town, and receive approval by the Town.

d. The irrigation plan for the common areas shall be provided to the Town.

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

a. Prior to Substantial Completion as defined in the Development Agreement, a street lighting plan shall be submitted to and approved by the Town. The street lighting shall be installed prior to start of warranty.

b. A site sign shall be posted in accordance with Section 30–5–102 of the Berthoud Municipal Code.

c. Grading Permit: According to the Berthoud Design and Construction Standards, all utility installation outside of the Town Right–of–Way (on private property) requires a Grading Permit before any installation activity commences. Detailed regulations for obtaining a Grading Permit are outlined in Chapter 20 of the Berthoud standards.

d. 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.

e. Stormwater Management Plan (SWMP)/MS4 Compliance: The Town mandates the preparation and submission of a site–specific Stormwater Management Plan (SWMP) by the owner of the construction site. This plan must be approved by the Town prior to scheduling the pre–construction meeting. The SWMP submission is necessary for obtaining permit certification issued by the State of Colorado for any construction activity that falls under the category of a General Construction Stormwater Permit as defined by the Colorado Department of Public Health and Environment (CDPHE). A CDPS General Permit for stormwater discharges associated with construction activities are required at least ten calendar days before construction begins but must also be noted on the Town Grading Permit.

6. A tree lawn on the north side of Lots 6 & 7 shall be installed as part of the Residential portion of the Gateway Development approved with Final Plat. The Final Plat Landscape Plan was prepared by StackLot on 07/31/23 and approved by The Town.

DATE: 12/13/2022
FILE NAME: 20220491A–SUB
SCALE: 1"=30'
DRAWN BY: CSK
CHECKED BY: PG

KING SURVEYORS
650 E. Garden Drive | Windsor, Colorado 80550
phone: (970) 686-5011 | email: contact@KingSurveyors.com

REVISIONS:		DATE:
REVISED PER COMMENTS	CSK	2/15/24
REVISED PER COMMENTS	CSK	2/26/24

WESTSIDE CROSSING REPLAT #2
FOR
BERTHOUD GATEWAY LLC
8340 LOUDEN CIRCLE
WINDSOR, CO 80528

PROJECT #: 20220491–A

1

SHEET 1 OF 2

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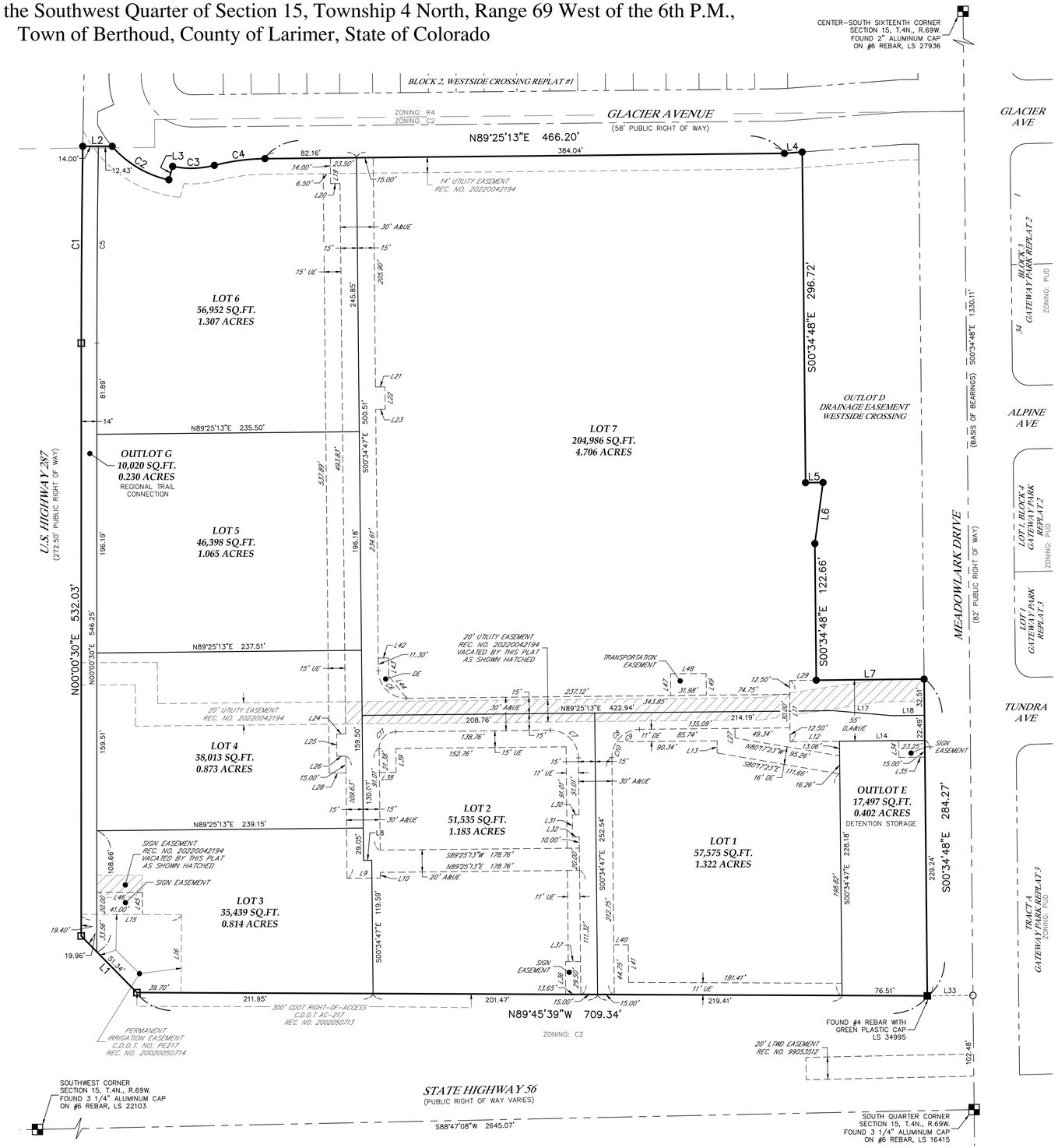
FINAL PLAT
WESTSIDE CROSSING REPLAT #2

Being a Replat of Tract A, Westside Crossing,
Situate in the South Half of the Southwest Quarter of Section 15, Township 4 North, Range 69 West of the 6th P.M.,
Town of Berthoud, County of Larimer, State of Colorado



CURVE TABLE					
CURVE	LENGTH	RADIUS	DELTA	CHORD	CH BEARING
C1	176.56'	11862.50'	0°51'10"	176.56'	N00°26'05"E
C2	60.06'	94.50'	36°24'51"	59.05'	S59°25'52"E
C3	37.80'	82.00'	26°24'53"	37.47'	N88°38'43"E
C4	45.88'	188.00'	13°58'56"	45.77'	N82°25'45"E
C5	176.56'	11848.50'	0°51'14"	176.56'	S00°26'07"W
C6	39.27'	25.00'	90°00'00"	35.36'	S45°34'47"E
C7	39.27'	25.00'	90°00'00"	35.36'	N45°34'47"W
C8	39.27'	25.00'	90°00'00"	35.36'	S44°25'13"W
C9	24.41'	25.00'	55°56'38"	23.45'	S61°26'53"W
C10	14.86'	25.00'	34°03'22"	14.64'	S16°26'53"W
C11	23.56'	15.00'	90°00'00"	21.21'	S44°25'13"W

LINE TABLE		
LINE	BEARING	LENGTH
L1	N44°32'38"W	71.30'
L2	N90°00'00"E	26.43'
L3	N15°41'54"E	12.52'
L4	N85°37'33"E	16.04'
L5	N89°25'50"E	15.68'
L6	S07°37'15"W	55.26'
L7	N89°25'13"E	96.80'
L8	S89°25'13"W	7.31'
L9	N89°25'13"E	30.00'
L10	N00°34'47"W	5.00'
L11	N00°34'54"W	55.00'
L12	N89°25'13"E	44.30'
L13	S00°00'00"E	10.91'
L14	S89°25'13"W	76.50'
L15	N89°45'25"W	90.00'
L16	N00°14'21"E	70.00'
L17	S85°09'21"E	52.95'
L18	N89°25'13"E	28.98'
L19	S00°34'47"E	23.06'
L20	N89°25'13"E	8.50'
L21	N89°25'13"E	8.50'
L22	S00°34'47"E	20.00'
L23	S89°25'13"W	8.50'
L24	N89°25'13"E	8.00'
L25	N00°34'47"W	20.00'

LINE TABLE		
LINE	BEARING	LENGTH
L26	S89°25'13"W	8.00'
L27	N00°00'00"E	8.58'
L28	S89°25'13"W	15.00'
L29	N89°25'13"E	24.00'
L30	N89°25'13"E	6.00'
L31	N00°34'47"W	20.00'
L32	S89°25'13"W	6.00'
L33	N89°25'12"E	41.00'
L34	N00°34'47"W	15.00'
L35	S89°25'13"W	23.25'
L36	N00°06'27"W	29.41'
L37	N89°53'36"E	13.44'
L38	S89°25'13"W	15.00'
L39	S00°34'47"E	21.38'
L40	S89°45'39"E	13.00'
L41	S00°34'47"E	33.75'
L42	N88°50'25"E	9.22'
L43	S00°34'47"E	16.34'
L44	S38°46'55"E	25.52'
L45	N00°00'30"E	20.00'
L46	N89°45'25"W	41.00'
L47	N00°34'47"W	19.61'
L48	N89°36'33"E	32.00'
L49	S00°31'13"E	19.50'

SCALE IN FEET
SCALE: 1"=50'

LEGEND

- EASEMENT LINE
- CENTERLINE
- SECTION LINE
- RIGHT OF WAY LINE
- BOUNDARY LINE
- FOUND ALIQUOT CORNER AS DESCRIBED
- FOUND MONUMENT AS DESCRIBED
- FOUND #6 REBAR WITH 3 1/4" ALUMINUM CAP LS 22103
- SET 24" OF #4 REBAR WITH A BLUE PLASTIC CAP STAMPED KS, LS 38209
- CALCULATED POSITION
- DE — DRAINAGE EASEMENT
- UE — UTILITY EASEMENT
- A&UE — ACCESS & UTILITY EASEMENT
- D,A&UE — DRAINAGE, ACCESS & UTILITY EASEMENT

FINAL

Paul B. Groves – On Behalf Of King Surveyors
Colorado Licensed Professional
Land Surveyor #38209

DATE: 12/13/2022
FILE NAME: 20220491A-SUB
SCALE: 1"=30'
DRAWN BY: CSK
CHECKED BY: PG

KING SURVEYORS
650 E. Garden Drive | Windsor, Colorado 80550
phone: (970) 686-5011 | email: contact@KingSurveyors.com

REVISIONS:		DATE:
REVISED PER COMMENTS	CSK	2/15/24
REVISED PER COMMENTS	CSK	2/26/24

WESTSIDE CROSSING REPLAT #2
FOR
BERTHOUD GATEWAY LLC
8340 LOUDEN CIRCLE
WINDSOR, CO 80528

PROJECT #: 20220491-A

2

SHEET 2 OF 2

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Final Drainage Report
Westside Crossing (Commercial Lots)
Berthoud, Colorado

Prepared for:
Berthoud Gateway, LLC
8040 Louden Circle, Windsor, CO 80528
Phone Number: (970) 222-7268

Prepared by:

Kiowa
Engineering Corporation
7175 West Jefferson Avenue, Suite 2200
Lakewood, Colorado 80235
Ph: (303)692-0369

Kiowa Project No. 19043.2

January 23, 2024

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III. Drainage Criteria 1
IV. Existing Drainage Conditions 2
V. Proposed Drainage Conditions 4
VI. Water Quality and Detention Design 6
VII. Floodplain Statement 7
VIII. Summary 7
IX. References 7
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SIGNATURE PAGE

RESPONSIBLE PARTY STATEMENT:

Berthoud Gateway, LLC hereby certifies that the drainage facilities for Westside Crossing (Commercial Lots) 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 Westside Crossing (Commercial Lots) guarantee that final drainage design review will absolve Berthoud Gateway, LLC 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: _____

Berthoud Gateway, LLC

_____

Authorized Signature

ENGINEER'S STATEMENT:

I hereby certify that this report (plan) for the final drainage design of Westside Crossing (Commercial Lots) 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
Matthew W. Erichsen, PE (PE #36713)

I. GENERAL DESCRIPTION

The purpose of this Final Drainage Report is to describe and discuss the drainage patterns and impacts associated with the commercial portion (Phase II) of the proposed Westside Crossing development. The commercial phase of the Westside Crossing project is located on an undeveloped parcel at the northwest corner of State Highway 56 and Meadowlark Drive. The total area of the site including the residential phase (Phase I) and commercial phase (Phase II) is 20.94 acres (ac). The proposed development will consist of approximately 11.9 acres of commercial use. The residential use to the north consists of Lot 1, Block 2, Westside Crossing, and the commercial use on the southern portion of the site is comprised of Lots 1 thru 7, Block 1, Westside Crossing. The properties are situated in the South Half of the Southwest Quarter of Section 15, Township 4 North, Range 69 West of the 6th Principal Meridian, City of Berthoud, County of Larimer, State of Colorado. The property is bounded on the east by Meadowlark Drive, on the south by Highway 56, on the west by U.S. Highway 287 by-pass, and on the north by Village at Matthews Farm residential development. The location of the site is shown on the Vicinity Map (Figure 1).

The Phase II portion of the project site is currently covered with native grasses and sparse trees located on the southern boundary of the site along Highway 56.

This development will include construction of the public improvements associated with Phase II including lane widenings within Meadowlark Drive and Highway 56 ROWs, curb and gutter, and landscaping. An internal private drive, public water and sanitary utilities, and associated stormwater quality and detention facilities will also be constructed at this time. Future internal development of the individual lots to be platted will consist of the commercial buildings, parking lots, paved drives, landscaping, and internal utility services. This drainage report has anticipated the future full buildout of all internal lots for drainage conveyance and design.

II. SOILS CONDITIONS

The majority of soils within the property are classified to be within Hydrologic Soils Group C based on the NRCS Soil Survey for the Berthoud area. Soils on the site are predominantly Nunn Clay Loam (Soil Group C). For the site drainage calculations, the soils were assumed to be Hydrologic Soil Group C. The existing vegetative cover within the development is in fair condition with mostly grasses and scattered trees throughout the site. The existing ground slopes for the majority of the property range from 0.5 to 1.5 percent with the steepest slopes occurring near the southeast corner of the site at an existing soil mound. Steep slopes also parallel the northern and eastern property boundaries where existing drainage swales convey stormwater and irrigation water from the west side of Highway 287 and from northern residential development's detention facility release as well as minor undetained runoff.

III. DRAINAGE CRITERIA

Hydrologic Criteria

The hydrology for the site was performed using the methods outlined in the Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specifications as well as the *Larimer County Stormwater Design Standards*, which is an addendum to the Mile High Flood District (MHFD) Criteria Manuals. Existing topography for the site was surveyed and compiled using one-foot contour intervals and is presented on the Existing Conditions Drainage Plan (Exhibit A). The hydrological calculations were made for the proposed site conditions, which are depicted on the Proposed Conditions Drainage Plan (Exhibit B). Peak Flow Rates for the sub-basins were estimated using the Rational Method. The 10-Year (Minor Storm) and 100-Year (Major Storm) recurrence intervals were determined.

Rainfall intensity was determined using NOAA Atlas 14, Volume 8, Version 2 point-based precipitation frequency estimates. Runoff Coefficients for the existing and proposed sub basins were determined by Table 600-2 of the Town of Berthoud Design and Construction Specifications.

Hydraulic Criteria

The design of the drainage system for Phase II has been designed in conformance with the Town Standards. Hydraulic calculations are provided for the proposed drainage facilities. MHFD spreadsheets were used to size the proposed inlets, determine street capacity, and design the water quality and detention facilities. The MHFD-Inlet spreadsheet was used for inlet and street capacity calculations and MHFD-Detention spreadsheet was used for water quality and detention design. UD-Sewer software has been used to analyze the interior storm network as well as the outfall trunkline that parallels Meadowlark Drive, which transfers all offsite stormwater and irrigation flows as well as developed site runoff. Due to excessively flat topography in and around the subject site area, the outfall trunkline has been sized as large as possible and conveys the Minor Storm Runoff. Major Storm Runoff is transferred via the outfall trunkline in conjunction with Meadowlark Drive.

IV. EXISTING DRAINAGE CONDITIONS

Existing drainage conditions for the site are inclusive of both onsite sheet flow across the site in a southeasterly direction as well offsite pass thru flows. The pass thru flows as well as adjacent flows that bypass the project site have been identified by the *U.S Highway 287 Berthoud Bypass Segment #2, Final Hydrology & Hydraulics Report Prepared by URS Corporation, dated January 2002, Revised October 2002*, hereafter referred to as the 287 Report. Per the 287 Report, the construction of the U.S. Highway 287 bypass resulted in several changes in the nature of existing runoff conditions from sheet flow generally west-to-east across the project site to what are now concentrated flows directed under U.S. Highway 287 via culverts in order to maintain ultimate downstream uses of irrigation ditch water and transference of stormwater.

Two culverts located at the northwest corner of the site comprise the majority of pass thru flows and transfer both irrigation and stormwater flows from the west side of U.S. Highway 287, into an existing swale that parallels the northern property boundary (see Design Point 6 and I-6 located on the *Berthoud Bypass Segment #2 Drainage Map* extracted from the 287 Report located in the appendix). The 30-inch RCP storm water culvert transfers flows from the western portion of the Estate at Matthews Farms residential development along with remaining flows from Basin 2-U per the 287 Report (the western portion of the Estate at Matthews Farm residential development is inclusive of Basin 2-U and a max capacity of 31 cfs is assumed from this area during a 100-Year Event). The 24-inch irrigation culvert flows were originally designed to service the agricultural needs of the subject site and the property to the east (Gateway Park Subdivision). It is believed that this ditch has been abandoned as it does not appear that there are any downstream users receiving flows, however, this report accounts for the original flow as pass-thru and has been accounted for in the design calculations. These flows combine with flows identified by the *Final Drainage Report, The Village at Matthews Farms, Prepared by Gorton Scott Engineering, LLC* hereafter referred to as the Matthews Report at existing Design Point EX1 (see Existing Conditions Drainage Plan, Exhibit A, located in the appendix). Combined flows travel south within the roadside ditch that parallels the eastern site boundary adjacent to Meadowlark Drive until they reach Design Point EX2. Flows are then directed east under Meadowlark Drive via an existing 30-inch RCP culvert into a roadside ditch along the north side of Highway 56. Per the *Final Drainage Report, Gateway Park Prepared by Drexel, Barrel & Co.*, developed flows have been accounted for and have been used to size the culvert crossing under the intersection of Highway 56 and County Road 17 (Berthoud Pkwy). The ultimate outfall for these flows is the Little Thompson River located approximately 2.25 miles southeast of the project site.

A high point is located approximately one-quarter mile north of the intersection of U.S. Highway 287 and Highway 56. Flows north of the high point continue north and eventually outfall in the Loveland Reservoir. The majority of flows south of the highpoint and west of U.S. Highway 287 (Offsite Basin 2-OS-A and Basin 2-A per the 287 Report) are directed to a 60-inch culvert which directs flows east under U.S. Highway 287 at the intersection with Highway 56. Runoff from the eastern half of U.S. Highway 287 and west of the project site concentrate within a roadside ditch and are also transferred to the 60-inch culvert via existing storm inlet located at the northeast intersection of U.S. Highway 287 and Highway 56. The culvert turns south and crosses Highway 56 to outfall in a roadside swale that parallels the east side of U.S. Highway 287. The ultimate outfall for these flows is Dry Creek approximately 4,500 feet south of the project site.

The 30-inch RCP culvert under Meadowlark Drive does not have sufficient capacity to transfer 100-Year Event flows from the subject site to the drainage swale on the north side of Highway 56. 100-Year Event flows at DP EX2 total 81.2 cfs but only approximately 39 cfs can enter the culvert due to inlet capacity restrictions and available ponding depths. It is believed that flows in excess of the 30-inch culvert capacity (~42 cfs) currently back up within the swale near Design Point EX2 until overtopping Meadowlark Drive at a low point approximately 200-feet north of the intersection with Highway 56. Once flows have overtopped the low point within Meadowlark Drive, they continue eastward and eventually enter the existing drainage swale on the north side of Highway 56. Existing culvert at DP EX2 capacity calculation is included in the appendix.

Following is a description of the existing drainage sub-basins.

Basins E1 & E2: These basins generally slope toward the southeast at approximately one percent. The existing runoff pattern is sheet flow to the east until entering the existing roadside swale along Meadowlark Drive as shown in Exhibit A. Once within the Meadowlark Drive roadside swale, concentrated flows are directed south to Design Point EX2.

Basin E3: This basin is composed of a section of the north half of Highway 56 and the existing roadside swale on the north side of Highway 56. Runoff from this basin is directed toward the swale and heads east along the north side of Highway 56.

Basins EOS3 & EOS4: Per the Matthews Report, these flows are released undetained from the southern extents of the eastern portion of the Estates at Matthews Farm residential development and are captured within the existing ditch that parallels the site's northern property boundary. Once collected within the swale, concentrated flows are directed eastward where they combine with existing Matthews Farm detention pond release flows at Design Point EX1. Flows combined at Design Point EX1 then travel south within the Meadowlark Drive roadside swale toward Design Point EX2. The two off-site basins along with the Matthews Farm detention pond release generate a 10-Year and 100-Year Runoff of 10.2 and 20.3 cfs, respectively. (Note: 10-Year Runoff from Basins EOS3 & EOS4 were not identified in the Matthews Report so Rational Method Calculations were performed using impervious values and areas identified within the Matthews Report. Additionally, the 10-Year release from the Matthews Farm detention pond was not included in the Matthews Report so a conservative estimate was used).

Basin EOS1: Basin EOS1 is made up of the western half of Meadowlark Drive and sheet flows west into the Meadowlark Drive roadside swale. Once within the swale, concentrated flows are directed south to Design Point EX2.

All existing site sub-basins, as well as the aforementioned pass-thru flows (24-inch irrigation culvert and 30-inch storm water culvert located at the northwestern property corner) eventually reach Design Point EX2 and cross under Meadowlark Drive via 30-inch RCP culvert.

V. PROPOSED DRAINAGE CONDITIONS

The proposed drainage plan will follow the existing site drainage patterns and direct flows toward the southeast corner of the site. Runoff from the development will generally be conveyed as sheet flow through paved areas to curb and gutter that will direct flows either to inlets with storm sewer or directly to the detention basins along the eastern boundary of the site. All on-site drainage structures are designed for developed 100-Year flow capacity. Due to site design limitations, the detention facility at the southeast corner of the site has been designed to allow flows to back up into grassed areas located to the north as well as underground detention located to the west. A storm culvert under the drive separating the two above ground detention areas will connect the basins. The underground detention will be connected to the rest of the detention areas via storm pipe penetration through the detention basin retaining walls. The three areas will function as one detention facility and collect runoff from all 'A' Basins and will hereafter be referred to as Detention Basin 'A'. Detention Basin B is located along the middle of the eastern property boundary and will collect storm runoff from all 'B' Basins. Detention Basin 'C' has been shown as the collection point for Basin C developed residential runoff for the purposes of sizing the public trunkline outfall. The developed flows generated from all A, B and C Basins will be routed and detained to historic levels in the three Full Spectrum Detention Basins prior to being released to the proposed outfall trunkline. Pass-thru flows that previously travelled south along the Meadowlark Drive roadside swale will be collected and conveyed via the outfall trunkline as well, following historic patterns. Once collected within the Outfall Trunkline, flows will be conveyed directly to the existing 30-inch culvert at Meadowlark and Highway 56. As previously mentioned, the Outfall Trunkline has the capacity to transfer the 10-Year Event Runoff but the 100-Year Event Runoff is transferred via a combination of the Outfall Trunkline and Meadowlark Drive. MHFD street capacity spreadsheets were used to confirm Meadowlark Drive capacity met conditions set forth in Section 602.4 (C) of the Town Specifications.

The storm sewer facilities to be constructed as part of this development will be both public and private facilities. Easements will be provided for the public facilities. Outlots will be created to encompass the proposed detention basins. Following is a description of each of the drainage basins associated with this phase of the development:

Drainage Basin OS1: This basin is located along the eastern margin of the development, within Meadowlark Drive ROW. This basin includes the western half of Meadowlark Drive ROW (which is a crowned street) and consists of street, sidewalk, hardscaped, and landscaped areas. Runoff from this basin sheet flows from the crown in a southwesterly direction until entering curb and gutter. Once within the gutter, concentrated flows are directed south to Drainage Inlet 1 located near Design Point 33. Once captured within the Inlet, flows are directed across Meadowlark Drive to an existing storm pipe that is to be upsized to accommodate new flows from this basin. The existing storm pipe directs runoff into the existing drainage channel on the north side of Highway 56, following historic patterns.

Drainage Basin OS2: This basin is located near the southeast margin of the development, within Meadowlark Drive ROW. This basin includes a portion of the eastern half of Meadowlark Drive ROW and consists of street, sidewalk, hardscaped, and landscaped areas. Runoff from this basin sheet flows from the crown in a southeasterly direction until entering curb and gutter. Once within the gutter, concentrated flows are directed south to an existing curb inlet. There is currently no curb and gutter south of Tundra Avenue on the east side of Meadowlark Drive so concentrated flows from this basin that are captured in curb and gutter release into the undeveloped area surrounding the existing curb inlet. Existing topography in this area directs runoff to the existing drainage channel on the north side of Highway 56 until such time that curb and gutter is installed on the east side of Meadowlark Drive at which point concentrated flows will enter the existing inlet instead. This inlet

is tied to the existing storm infrastructure which releases into the existing drainage channel via 42" FES.

Drainage Basin OS3: This basin is located near the southern margin of the development, within Highway 56 ROW. This basin includes the northern half of Highway 56 ROW along the property frontage and consists of street, sidewalk, hardscaped, and landscaped areas. Runoff from this basin sheet flows in a northeasterly direction toward proposed curb and gutter on the north side of Highway 56. Once captured within the gutter, concentrated flows are directed east to proposed Drainage Inlet 2. This inlet and attached pipe has been proposed to replace the two existing 18" FES's and pipe sections that currently transfer runoff from an existing valley inlet within Highway 56 ROW, under the street section into an existing drainage swale on the north side of Highway 56 which then enters another 18" FES that transfers runoff under Meadowlark Drive to an existing drainage swale on the north side of Highway 56, east of Meadowlark Drive. The replacement of existing infrastructure will maintain existing drainage patterns.

Drainage Basin OS4: This basin is located along the southern margin of the site and consists of landscaped areas. Runoff from this basin sheet flows north into the site and will eventually enter the storm sewer system which is directed to Detention Basin A.

Drainage Basin OS10: This basin is located near the southwest corner of the development, within Highway 56 right-of-way. This basin is resultant from an existing low point along the north side of Highway 56, near the intersection with U.S. Highway 287. A drain pan with curb cut has been proposed at the low point in order to direct tributary flows out of the road section and into the existing storm inlet located just northwest of the end of the drain pan. In the existing condition, curb and gutter does not exist along the north side of Highway 56 and runoff from Basin OS10 enters this inlet via overland flow. The proposed condition will maintain historic drainage patterns for this area.

Drainage Basin A1: This basin is located at the southeast corner of the development and will consist of roof, street, sidewalk, parking, hardscaped, and landscaped areas. This basin is also inclusive of the southern portion of Detention Basin A and its' associated appurtenances. Runoff from this area will sheet flow into gutter sections which will convey concentrated flows generally southeast to Drainage Inlet 14 located at Design Point 5, which outfalls directly into Detention Basin 'A' located within Outlots D and E.

Drainage Basin A2: This basin is located within the southern margin of the development and will consist of street, sidewalk, and landscaped areas. Runoff from this area will sheet flow generally southeast into gutter sections which will convey concentrated flows eastward to Drainage Inlet 13 located at Design Point 4. Once collected within the Inlet, runoff is transferred via underground storm sewer located within drainage easements until outfall within Detention Basin 'A' located within Outlots D and E.

Drainage Basin A3: This basin is located directly west of Basin A2 and will consist of street, sidewalk, and landscaped areas. Runoff from this area will sheet flow generally southeast into gutter sections which will convey concentrated flows eastward to Drainage Inlet 12 located at Design Point 3. Once collected within the Inlet, runoff is transferred via underground storm sewer located within drainage easements until outfall within Detention Basin 'A' located within Outlots D and E.

Drainage Basin A4: This basin is located along the southern margin of the development and will consist of roof, street, sidewalk, parking, hardscaped, and landscaped areas. Runoff from this area will sheet flow generally southeast into gutter sections which will convey concentrated flows eastward to Drainage Inlet 12 located at Design Point 3. Once collected within the Inlet, runoff is transferred via underground storm sewer located within drainage easements until outfall within Detention Basin 'A' located within Outlots D and E.

Drainage Basin A5: This basin is located southwest corner of the development and will consist of roof, street, sidewalk, parking, hardscaped, and landscaped areas. Runoff from this area will sheet flow generally eastward into gutter sections which will convey concentrated flows eastward to Drainage Inlet 11 located at Design Point 2. Once collected within the Inlet, runoff is transferred via underground storm sewer located within drainage easements until outfall within Detention Basin 'A' located within Outlots D and E.

Drainage Basin A6: This basin is located south along the western margin of the development and will consist of roof, street, sidewalk, parking, hardscaped, and landscaped areas. Runoff from this area will sheet flow generally southeast into gutter sections which will convey concentrated flows to future on-site drainage inlets. Once collected within the Inlet, runoff is transferred via underground storm sewer located within drainage easements until outfall within Detention Basin 'A' located within Outlots D and E.

Drainage Basin A7: This basin is located along the western margin of the development and will consist of street, sidewalk, and landscaped areas. Runoff from this area will sheet flow generally southeast into gutter sections which will convey concentrated flows south to Drainage Inlet 10 located at Design Point 1. Once collected within the Inlet, runoff is transferred via underground storm sewer located within drainage easements until outfall within Detention Basin 'A' located within Outlots D and E.

Drainage Basin A8: This basin is located in the middle of the development and will consist of street, sidewalk, parking, hardscaped, and landscaped areas. Runoff from this area will sheet flow generally southeast into gutter sections which will convey concentrated flows to future onsite inlets. Once captured within the inlets, runoff will be transferred via underground storm sewer that will outfall directly into the northern portion of Detention Basin 'A' located within Outlot D.

Runoff from Drainage Basins A1-A8 are directed to Detention Basin A. Detained release from this Basin ties into the adjacent Outfall Trunkline.

All 'B' and 'C' Drainage Basins are directed to Detention Basins 'B' and 'C', which were constructed as part of the residential phase of this project (Phase I) which entered into warranty period with the Town of Berthoud in August of 2023. Refer to "Final Drainage Report Westside Crossing (Residential Lots)" for information related to all 'B' and 'C' drainage basins and design information.

VI. WATER QUALITY AND DETENTION DESIGN

The development of the property will include storm water quality and detention measures meeting the requirements of the Town's Drainage Criteria. The water quality and detention measures to be instituted for the site will include:

The Full Spectrum Detention (FSD) Basin will include concrete low flow channels, an FSD outlet structure with micropool, forebay, emergency spillway, outlet pipe and maintenance access paths. The outlet structure has been designed to release the WQCV, EURV and 100-Year flow at the allowable release rates as outlined by MHFD. The detention basin will include the Water Quality Capture Volume within the 100-Year detention volume. The emergency spillways will be constructed along the eastern edge of the detention basin to release flows in excess of the 100-Year Event and in an emergency situation to Meadowlark Drive. The MHFD-Detention workbook along with MHFD equations have been used to design the facility. Refer to the Appendix for associated calculations. The WQ/EURV orifice plate will be designed as a 3-hole plate sized to drain the WQCV in approximately 40 hours and to drain the EURV in approximately 72 hours. The detention basin has been designed to account for the final buildout of all 'A' Basins using MHFD standard Impervious and Runoff

Coefficients. Due to depth constraints presented by the subject site, retaining walls have been proposed on slightly more than 50% of the perimeter of the southern portion of Detention Basin 'A' in order to meet storage volume requirements dictated by current MHFD criteria. The walls are planned to extend above the exterior finished grade to maximize the volume and minimize the footprint.

VII. FLOODPLAIN STATEMENT

The site is located approximately three quarters of a mile North of Dry Creek and is within Zone X, designated as an area of Minimal Flood Hazard. Floodplain information is shown on Flood Insurance Rate Map (FIRM) No. 08069C1386H, revised 01/15/2021 (included in the appendix).

VIII. VARIANCES

No variances from Berthoud criteria are being requested with this development.

IX. SUMMARY

This Final Drainage Report has been prepared in general conformance with the Town of Berthoud Engineering and Infrastructure Standards and the *Larimer County Stormwater Design Standards (Addendum to the Mile High Flood District Criteria Manual, Volumes 1, 2 and 3)*. The proposed Full Spectrum Detention facility has been designed in accordance with the criteria set forth in the MHFD Manuals to provide detention and water quality for the WQCV, EURV, and 100-Year Storm Event. As previously mentioned, the Outfall Trunkline has been designed to convey the Minor Storm Event (10-Year), but due to site constraints the Trunkline alone does not have the capacity to convey the 100-Year Event. During a Major Storm Event, flows not able to enter the Outfall Trunkline will enter Meadowlark Drive and overtop the street crown at the low point within Meadowlark Drive and continue eastward to enter the drainage swale on the north side of Highway 56, following historic patterns. Meadowlark Drive has been analyzed for a half-street section to ensure that the 100-Year Event flows conform to Section 602.4.C of the Town of Berthoud Engineering and Infrastructure Standards. The proposed public drainage improvements associated with Westside Crossing have been designed with the intent to not cause adverse impacts to the downstream and surrounding developments while improving the existing drainage condition for the Minor Storm Event by releasing developed flows at a lower rate than that of the predeveloped condition. Major Storm Event Flows will follow historic patterns during the peak period of the Storm Event hydrograph.

X. REFERENCES

1) Final Drainage Report for The Village and Matthews Farms, Berthoud, Colorado, Gorton Scott Engineering, LLC July 14, 2002.

2) Final Drainage Report for The Estate and Matthews Farms, Berthoud, Colorado, Gorton Scott Engineering, LLC June 23, 2003.

3) Final Drainage Report for Collings Park P.U.D., Town of Berthoud, Colorado, Park Engineering, July, 2004.

4) Final Drainage Report for Gateway Park, Berthoud, Colorado, Drexel, Barrel & Co., January 2002.

5) Final Drainage and Erosion Control Study for Gateway Park 1st Filing Phase 2, North Star Design January 2006.

6) Town of Berthoud Engineering and Infrastructure Design Standards and Construction Specifications, October 2021.

7) Flood Insurance Rate Map No. 08069C1386H, Federal Emergency Management Administration, revised January 15, 2021.

8) Larimer County Stormwater Design Standards (Addendum to Urban Storm Drainage Criteria Manual volume 1-3), Larimer County, Colorado. June 20, 2005.

9) Mile High Flood District Criteria Manual - Volumes 1 and 2, Urban Drainage and Flood Control District, Denver, Colorado, June 2001 (with current revisions).

10) Mile High Flood District - Volume 3, Urban Drainage and Flood Control District, Denver, Colorado, June 2002 (with current revisions).

11) U.S. Highway 287 Berthoud Bypass Segment #2; Final Hydrology and Hydraulics Report, Colorado Department of Transportation October 2002

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APPENDIX A

Figure 1: Vicinity Map

Soils Map

FEMA Flood Insurance Rate Map

SCALE: NTS

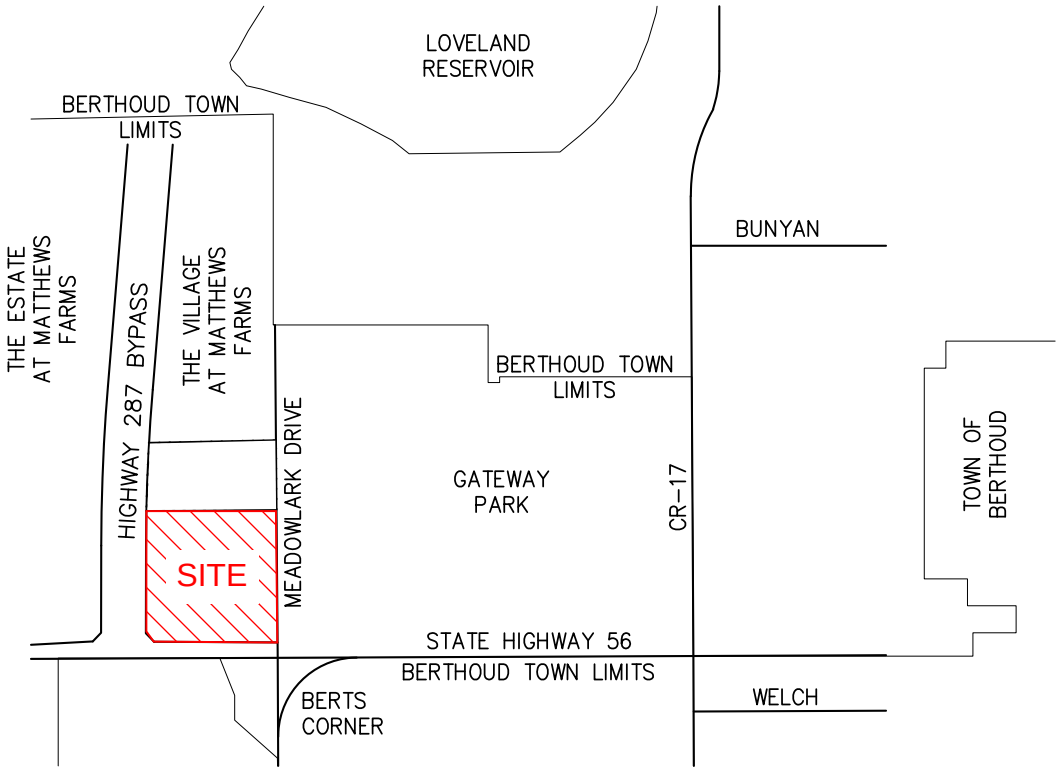


FIGURE 1
VICINITY MAP
WESTSIDE CROSSING
(COMMERCIAL LOTS, PHASE II)

Map Scale: 1:2,280 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Larimer County Area, Colorado
Survey Area Data: Version 13, Sep 10, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 20, 2015—Oct 21, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
5	Aquepts, loamy	A/D	0.5	2.3%
73	Nunn clay loam, 0 to 1 percent slopes	C	1.0	4.4%
74	Nunn clay loam, 1 to 3 percent slopes	C	8.9	40.2%
76	Nunn clay loam, wet, 1 to 3 percent slopes	C	11.7	52.7%
95	Satanta loam, 1 to 3 percent slopes	C	0.1	0.4%
Totals for Area of Interest			**22.3**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

National Flood Hazard Layer FIRMette

FEMA

105°6'36"W 40°18'40"N

105°5'58"W 40°18'13"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- B 20.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/14/2023 at 7:04 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

APPENDIX B

Hydrologic Calculations

Runoff Coefficient and Percent Impervious Calculations
Time of Concentration and Drainage Basin Runoff Calculations

Westside Crossing - Berthoud

Runoff Coeficient and Percent Impervious Calculation

Basin / DP	Basin or DP Area (DP contributing basins)		Soil Type	PV	Area 1 Land Use			LA	Area 2 Land Use			RO	Area 3 Land Use			RES	Area 4 Land Use			Basin % Imperv	Basin Runoff Coef	
				% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp	% Imperv	Land Use Area	% Area	Comp Land Use % Imp		C_{10}	C_{100}
E1	300,118 sf	6.89ac	C	100%	0.00ac	0%	0%	2%	6.89ac	100%	2%	90%		0%	0%	75%		0%	0%	**2.0%**	**0.15**	**0.49**
E2	610,841 sf	14.02ac	C	100%	0.00ac	0%	0%	2%	14.02ac	100%	2%	90%		0%	0%	75%		0%	0%	**2.0%**	**0.15**	**0.49**
E3	66,183 sf	1.52ac	C	100%	0.75ac	49%	49%	2%	0.77ac	51%	1%	90%		0%	0%	75%		0%	0%	**50.1%**	**0.50**	**0.69**
EOS1	51,297 sf	1.18ac	C	100%	0.47ac	40%	40%	2%	0.71ac	60%	1%	90%		0%	0%	75%		0%	0%	**41.2%**	**0.44**	**0.65**
OS1	66,703 sf	1.53ac	C	100%	1.12ac	73%	73%	2%	0.48ac	31%	1%	90%		0%	0%	75%		0%	0%	**74.0%**	**0.68**	**0.79**
OS2	19,218 sf	0.44ac	C	100%	0.30ac	67%	67%	2%	0.15ac	33%	1%	90%		0%	0%	75%		0%	0%	**67.8%**	**0.63**	**0.76**
OS3	38,089 sf	0.87ac	C	100%	0.63ac	72%	72%	2%	0.24ac	28%	1%	90%		0%	0%	75%		0%	0%	**72.7%**	**0.67**	**0.78**
OS4	7,701 sf	0.18ac	C	100%	0.01ac	4%	4%	2%	0.17ac	96%	2%	90%		0%	0%	75%		0%	0%	**5.9%**	**0.18**	**0.51**
EOS3		2.30ac	C	BASINS EOS3 & EOS4 RUNOFF VALUES ARE TAKEN FROM "THE ESTATES AT MATTHEWS FARM DRAINAGE REPORT"																**16.0%**	**0.25**	**0.39**
EOS4		0.17ac	C																	**36.0%**	**0.40**	**0.63**
OS10	16,023 sf	0.37ac	C	100%	0.33ac	89%	89%	2%	0.04ac	11%	0%	90%		0%	0%	75%		0%	0%	**89.7%**	**0.80**	**0.85**
U-2		38.10ac	C	BASIN U-2 RUNOFF VALUES ARE TAKEN FROM "U.S. HIGHWAY 287 BERTHOUD BYPASS SEGMENT #2 DRAINAGE REPORT"																		**0.27**
A1	59,869 sf	1.37ac	C	100%	0.73ac	53%	53%	2%	0.42ac	30%	1%	90%	0.23ac	17%	15%	75%		0%	0%	**68.4%**	**0.64**	**0.76**
A2	29,621 sf	0.68ac	C	100%	0.48ac	71%	71%	2%	0.20ac	29%	1%	90%		0%	0%	75%		0%	0%	**71.3%**	**0.66**	**0.78**
A3	10,563 sf	0.24ac	C	100%	0.14ac	58%	58%	2%	0.10ac	42%	1%	90%		0%	0%	75%		0%	0%	**59.1%**	**0.57**	**0.73**
A4	38,767 sf	0.89ac	C	100%	0.39ac	44%	44%	2%	0.26ac	29%	1%	90%	0.24ac	27%	25%	75%		0%	0%	**68.9%**	**0.64**	**0.77**
A5	81,967 sf	1.88ac	C	100%	0.95ac	50%	50%	2%	0.70ac	37%	1%	90%	0.23ac	12%	11%	75%		0%	0%	**62.1%**	**0.59**	**0.74**
A6	46,222 sf	1.06ac	C	100%	0.51ac	48%	48%	2%	0.47ac	45%	1%	90%	0.08ac	8%	7%	75%		0%	0%	**55.5%**	**0.54**	**0.71**
A7	6,421 sf	0.15ac	C	100%	0.13ac	87%	87%	2%	0.02ac	13%	0%	90%		0%	0%	75%		0%	0%	**87.5%**	**0.78**	**0.84**
A8	123,214 sf	2.83ac	C	100%	2.11ac	74%	74%	2%	0.72ac	26%	1%	90%		0%	0%	75%		0%	0%	**75.0%**	**0.69**	**0.79**
B1	48,023 sf	1.10ac	C	100%	0.00ac	0%	0%	2%		0%	0%	90%	1.10ac	100%	90%	75%		0%	0%	**90.0%**	**0.80**	**0.85**
B2	38,307 sf	0.88ac	C	100%	0.42ac	48%	48%	2%	0.26ac	30%	1%	90%	0.20ac	23%	20%	75%		0%	0%	**69.0%**	**0.64**	**0.77**
B3	38,486 sf	0.88ac	C	100%	0.47ac	54%	54%	2%	0.41ac	46%	1%	90%		0%	0%	75%		0%	0%	**54.7%**	**0.54**	**0.71**
B4	37,288 sf	0.86ac	C	100%	0.24ac	28%	28%	2%		0%	0%	90%		0%	0%	75%	0.62ac	72%	54%	**82.0%**	**0.74**	**0.82**
B5	14,180 sf	0.33ac	C	100%	0.08ac	24%	24%	2%		0%	0%	90%		0%	0%	75%	0.25ac	76%	57%	**80.9%**	**0.73**	**0.82**
B6	10,224 sf	0.23ac	C	100%	0.09ac	40%	40%	2%	0.14ac	60%	1%	90%		0%	0%	75%		0%	0%	**41.4%**	**0.44**	**0.65**
B7	38,708 sf	0.89ac	C	100%	0.36ac	40%	40%	2%	0.53ac	60%	1%	90%		0%	0%	75%		0%	0%	**41.6%**	**0.44**	**0.65**
C1	137,739 sf	3.16ac	C	100%	0.81ac	26%	26%	2%	0.51ac	16%	0%	90%	0.01ac	0%	0%	75%	1.83ac	58%	43%	**69.7%**	**0.65**	**0.77**
C2	95,745 sf	2.20ac	C	100%	0.52ac	24%	24%	2%	0.27ac	12%	0%	90%		0%	0%	75%	1.41ac	64%	48%	**72.1%**	**0.67**	**0.78**
D	25,913 sf	0.59ac	C	100%	0.03ac	4%	4%	2%	0.57ac	96%	2%	90%		0%	0%	75%		0%	0%	**6.1%**	**0.18**	**0.51**
DP 6	A1-A8	9.11ac	C	100%	5.42ac	60%	60%	2%	2.90ac	32%	1%	90%	0.79ac	9%	8%	75%	0.00ac	0%	0%	**68.0%**	**0.64**	**0.76**
DP 12	B1-B7	5.17ac	C	100%	1.66ac	32%	32%	2%	1.34ac	26%	1%	90%	1.30ac	25%	23%	75%	0.87ac	17%	13%	**68.0%**	**0.63**	**0.76**
DP 20	C1-C2	5.36ac	C	100%	1.34ac	25%	25%	2%	0.78ac	14%	0%	90%	0.01ac	0%	0%	75%	3.24ac	60%	45%	**70.7%**	**0.66**	**0.77**

Basin Runoff Coeff. is per Town of Berthoud Design & Construction Specs, Table 600-2

Runoff Coefficients and Percents Impervious (USDCM Table 6-3)

Hydrologic Soil Type:	**C**		**Runoff Coef Calc Method**					%Imp	
Land Use	Abb	%	C_2	C_5	C_{10}	C_{25}	C_{50}	C_{100}	Weighted
Lawns	LA	2%	0.01	0.05	0.15	0.33	0.40	0.49	D
Streets - Paved	PV	100%	0.83	0.86	0.87	0.88	0.88	0.89	
Residential (MF, Attached)	RES	75%	0.60	0.65	0.69	0.74	0.76	0.79	
Roofs	RO	90%	0.74	0.77	0.80	0.82	0.83	0.85	

Equations (% Impervious Calculation-UDSDCM Table 6-4):

Westside Crossing - Berthoud
Time of Concentration Calculation

Sub-Basin Data					Time of Concentration Estimate										t_c (1st DP in Urban Catchments)		Final t_c
					Initial/Overland Time (t_i)			Travel Time (t_t)						Comp.			
Basin / Design Point	Contributing Basins	Area	C_5	i	Length	Slope	t_i	Length	Slope	Land Type	K	Velocity	t_t	t_c	Chan. Flow	t_c (1st DP)	
E1		6.89ac	0.05	2.0%	25lf	43.0%	2.7 min.	1101lf	0.7%	SP	7	0.6 ft/sec	31.3 min.	34.1 min.	1101lf	49.3 min.	**34.1 min.**
E2		14.02ac	0.05	2.0%	405lf	1.1%	37.4 min.	832lf	1.0%	SP	7	0.7 ft/sec	19.8 min.	57.2 min.	832lf	40.6 min.	**40.6 min.**
E3		1.52ac	0.45	50.1%	90lf	1.9%	9.2 min.	690lf	1.4%	SP	7	0.8 ft/sec	13.9 min.	23.1 min.	690lf	23.6 min.	**23.1 min.**
EOS1		1.18ac	0.37	41.2%	56lf	10.8%	4.5 min.	377lf	0.2%	SP	7	0.3 ft/sec	20.1 min.	24.6 min.	377lf	28.5 min.	**24.6 min.**
OS1		1.53ac	0.64	74.0%	29lf	2.0%	3.6 min.	1079lf	0.5%	PV	20	1.4 ft/sec	12.7 min.	16.3 min.	1079lf	26.6 min.	**16.3 min.**
OS2		0.44ac	0.59	67.8%	30lf	2.0%	4.1 min.	340lf	0.8%	PV	20	1.8 ft/sec	3.2 min.	7.2 min.	340lf	17.9 min.	**7.2 min.**
OS3		0.87ac	0.63	72.7%	26lf	2.0%	3.5 min.	606lf	0.9%	PV	20	1.8 ft/sec	5.5 min.	8.9 min.	606lf	19.3 min.	**8.9 min.**
OS4		0.18ac	0.08	5.9%	20lf	2.0%	6.6 min.	10lf	2.0%	PV	20	2.8 ft/sec	0.1 min.	6.7 min.	10lf	25.1 min.	**6.7 min.**
EOS3		2.30ac	BASINS EOS3 & EOS4 RUNOFF VALUES ARE TAKEN FROM 'THE ESTATES AT MATTHEWS FARM DRAINAGE REPORT"														**12.6 min.**
EOS4		0.17ac															**7.3 min.**
OS10		0.37ac	0.77	89.7%	80lf	1.0%	5.4 min.	130lf	0.5%	PV	20	1.4 ft/sec	1.5 min.	6.9 min.	130lf	12.2 min.	**6.9 min.**
U-2		38.10ac	BASIN U-2 Tc VALUES ARE TAKEN FROM "U.S. HIGHWAY 287 BERTHOUD BYPASS SEGMENT #2 DRAINAGE REPORT"														**74.0 min.**
A1		1.37ac	0.60	68.4%	40lf	2.0%	4.6 min.	370lf	0.6%	PV	20	1.5 ft/sec	4.0 min.	8.6 min.	370lf	18.6 min.	**8.6 min.**
A2		0.68ac	0.62	71.3%	50lf	2.3%	4.7 min.	150lf	0.8%	PV	20	1.7 ft/sec	1.4 min.	6.2 min.	150lf	15.4 min.	**6.2 min.**
A3		0.24ac	0.52	59.1%	80lf	2.1%	7.4 min.	130lf	1.0%	PV	20	2.0 ft/sec	1.1 min.	8.5 min.	130lf	17.2 min.	**8.5 min.**
A4		0.89ac	0.60	68.9%	20lf	2.0%	3.2 min.	300lf	1.0%	PV	20	2.0 ft/sec	2.5 min.	5.7 min.	300lf	17.0 min.	**5.7 min.**
A5		1.88ac	0.54	62.1%	70lf	1.2%	8.0 min.	280lf	1.5%	PV	20	2.4 ft/sec	1.9 min.	9.9 min.	280lf	17.6 min.	**9.9 min.**
A6		1.06ac	0.49	55.5%	50lf	2.0%	6.3 min.	240lf	1.0%	PV	20	2.0 ft/sec	2.0 min.	8.3 min.	240lf	18.9 min.	**8.3 min.**
A7		0.15ac	0.75	87.5%	30lf	2.0%	2.8 min.	180lf	1.0%	PV	20	2.0 ft/sec	1.5 min.	5.0 min.	180lf	12.5 min.	**5.0 min.**
A8		2.83ac	0.65	75.0%	30lf	2.0%	3.6 min.	600lf	1.0%	PV	20	2.0 ft/sec	5.0 min.	8.6 min.	600lf	18.4 min.	**8.6 min.**
B1		1.10ac	0.77	90.0%	50lf	0.5%	5.3 min.	200lf	1.0%	PV	20	1.9 ft/sec	1.7 min.	7.0 min.	200lf	12.3 min.	**7.0 min.**
B2		0.88ac	0.60	69.0%	50lf	2.0%	5.1 min.	240lf	1.5%	PV	20	2.4 ft/sec	1.6 min.	6.8 min.	240lf	16.0 min.	**6.8 min.**
B3		0.88ac	0.48	54.7%	50lf	2.0%	6.3 min.	560lf	0.8%	PV	20	1.8 ft/sec	5.2 min.	11.6 min.	560lf	23.0 min.	**11.6 min.**
B4		0.86ac	0.71	82.0%	60lf	2.0%	4.4 min.	500lf	0.8%	PV	20	1.8 ft/sec	4.7 min.	9.1 min.	500lf	16.6 min.	**9.1 min.**
B5		0.33ac	0.70	80.9%	70lf	4.5%	3.7 min.	150lf	0.8%	PV	20	1.8 ft/sec	1.4 min.	5.1 min.	150lf	13.6 min.	**5.1 min.**
B6		0.23ac	0.37	41.4%	40lf	5.0%	4.9 min.	160lf	1.1%	PV	20	2.1 ft/sec	1.3 min.	6.2 min.	160lf	20.7 min.	**6.2 min.**
B7		0.89ac	0.38	41.6%	20lf	2.0%	4.7 min.	100lf	2.0%	PV	20	2.8 ft/sec	0.6 min.	5.3 min.	100lf	19.7 min.	**5.3 min.**
C1		3.16ac	0.61	69.7%	40lf	1.0%	5.7 min.	600lf	1.1%	PV	20	2.1 ft/sec	4.8 min.	10.5 min.	600lf	19.2 min.	**10.5 min.**
C2		2.20ac	0.63	72.1%	30lf	2.0%	3.8 min.	700lf	1.0%	PV	20	2.0 ft/sec	5.9 min.	9.7 min.	700lf	20.0 min.	**9.7 min.**
D		0.59ac	0.09	6.1%	90lf	3.0%	12.2 min.	700lf	1.1%	NBG	10	1.0 ft/sec	11.1 min.	23.3 min.	700lf	36.2 min.	**23.3 min.**

Westside Crossing - Berthoud
Time of Concentration Calculation

Equations:

t_i (Overland) = $0.395(1.1-C_5)L^{0.5} S^{-0.333}$ (USDCM Eqn 6-3)

C_5 = Runoff coefficient for 5-year

L = Length of overland flow (ft)

S = Average slope of overland flow path (ft/ft)

t_c (1st DP) = $(26-17i) + L_t / (60 (14i+9)S^{0.5})$ (USDCM Eqn 6-5)

t_c (1st DP) = First DP Time of Concentration in urban catchments

L_t = Length of Channelized Flow Path

i = imperviousness (expressed as a decimal)

$t_t = L_t / 60KS^{0.5}$ (USDCM Eqn 6-4)

t_t = Channelized flow time (travel time)(min.)

L_t = Waterway length (ft)

K = Conveyance Factor (see Table 6-2)

S = Watercourse slope (ft/ft)

Table 6-2

Type of Land Surface	Land Type	K
Grassed Waterway	GW	15
Heavy Meadow	HM	2.5
Nearly Bare Ground	NBG	10
Paved Area	PV	20
Riprap (Not Buried)	RR	6.5
Short Pasture/Lawns	SP	7
Tillage/Fields	TF	5

Westside Crossing - Berthoud
Runoff Calculation

Design Storm: 10 Year

	Direct Runoff							Total Runoff				Street/Chan		Pipe			Travel Time			
Basin ID/ Design Point	Area Designation	Area	C	T_c	C*A (acre)	i (in/hr)	Q	T_c	Sum C*A	i (in/hr)	Q	Slope	Q	Q	Slope	Pipe Size	L (ft)	Vel (ft/s)	T_t	Remarks
E1	E1	6.89 ac	0.15	34.1min	1.01	2.0	2.0 cfs			---	---								---	
E2	E2	14.02 ac	0.15	40.6min	2.06	1.8	3.7 cfs													
E3	E3	1.52 ac	0.50	23.1min	0.76	2.5	1.9 cfs													
EOS1	EOS1	1.18 ac	0.44	24.6min	0.51	2.4	1.2 cfs													
OS1	OS1	1.53 ac	0.68	16.3min	1.04	3.0	3.1 cfs													
OS2	OS2	0.44 ac	0.63	7.2min	0.28	4.2	1.2 cfs													
OS3	OS3	0.87 ac	0.67	8.9min	0.59	3.9	2.3 cfs													
OS4	OS4	0.18 ac	0.18	6.7min	0.03	4.3	0.1 cfs													
EOS3	EOS3	2.30 ac	0.25	12.6min	0.58	3.4	1.8 cfs					1.0%	1.8cfs				620'	4.4	2.3min	To DP30/EX1
EOS4	EOS4	0.17 ac	0.40	7.3min	0.07	4.2	0.3 cfs													
OS10	OS10	0.37 ac	0.80	6.9min	0.29	4.3	1.2 cfs													
U-2	U-2	38.10 ac	0.20	74.0min	7.62	1.2	9.2 cfs					1.0%	9.2cfs				730'	5.5	2.2min	To DP30/EX1
Ex. Village at Matthews Farm Detention Basin Outfall (M):							8.0 cfs													
EX1	EOS3,EOS4, U-2	40.57 ac						51.9min	8.26	1.5	12.7 cfs									
	add M										20.7 cfs	0.2%	35.8cfs				1180'	5.8	3.4min	To EX2
EX2	DP EX1, EOS1, E1, E2	50.16 ac						55.3min	10.55	1.5	15.5 cfs									
	add M										23.5 cfs									
A1	A1	1.37 ac	0.64	8.6min	0.88	4.0	3.5 cfs			---	---									
A2	A2	0.68 ac	0.66	6.2min	0.45	4.4	2.0 cfs			---	---								---	
A3	A3	0.24 ac	0.57	8.5min	0.14	4.0	0.5 cfs			---	---								---	
A4	A4	0.89 ac	0.64	5.7min	0.57	4.5	2.6 cfs			---	---								---	
A5	A5	1.88 ac	0.59	9.9min	1.11	3.7	4.2 cfs			---	---								---	
A6	A6	1.06 ac	0.54	8.3min	0.58	4.0	2.3 cfs			---	---								---	
A7	A7	0.15 ac	0.78	5.0min	0.11	4.7	0.5 cfs			---	---								---	
A8	A8	2.83 ac	0.69	8.6min	1.94	4.0	7.7 cfs			---	---								---	
B1	B1	1.10 ac	0.80	7.0min	0.88	4.2	3.7 cfs			---	---			3.7cfs	1.0%	12-in	480'	4.5	1.8min	To DP11
B2	B2	0.88 ac	0.64	6.8min	0.57	4.3	2.4 cfs			---	---			4.2cfs	0.5%	18-in	330'	4.2	1.3min	To DP10
B3	B3	0.88 ac	0.54	11.6min	0.47	3.5	1.7 cfs			---	---								---	
B4	B4	0.86 ac	0.74	9.1min	0.63	3.9	2.4 cfs			---	---								---	
B5	B5	0.33 ac	0.73	5.1min	0.24	4.6	1.1 cfs												---	
B6	B6	0.23 ac	0.44	6.2min	0.10	4.4	0.5 cfs												---	
B7	B7	0.89 ac	0.44	5.3min	0.39	4.6	1.8 cfs												---	
C1	C1	3.16 ac	0.65	10.5min	2.05	3.7	7.5 cfs			---	---								---	

Westside Crossing - Berthoud
Runoff Calculation

Design Storm: 10 Year

	Direct Runoff							Total Runoff				Street/Chan		Pipe			Travel Time			
Basin ID/ Design Point	Area Designation	Area	C	T_c	C*A (acre)	i (in/hr)	Q	T_c	Sum C*A	i (in/hr)	Q	Slope	Q	Q	Slope	Pipe Size	L (ft)	Vel (ft/s)	T_t	Remarks
C2	C2	2.20 ac	0.67	9.7min	1.46	3.8	5.5 cfs			---	---								---	
D	D	0.59 ac	0.18	23.3min	0.11	2.5	0.3 cfs			---	---								---	
										---	---									
Detention Basin A Release Rate:							0.6 cfs													
Detention Basin B Release Rate:							0.9 cfs													
Detention Basin C Release Rate:							0.8 cfs													
1	A6+A7	1.21 ac						8.3min	0.69	4.0	2.8 cfs			2.8cfs	2.0%	18-in	59'	8.4	0.1min	To DP2
2	DP1+A5	3.09 ac						10.0min	1.80	3.7	6.7 cfs			6.7cfs	0.8%	24-in	120'	6.5	0.3min	To DP3
3	DP2+A3+A4	4.22 ac						10.3min	2.51	3.7	9.3 cfs			9.3cfs	0.5%	24-in	151'	5.1	0.5min	To DP4
4	DP3+A2	4.90 ac						10.8min	2.96	3.6	10.7 cfs			10.7cfs	0.5%	24-in	132'	5.1	0.4min	To DP5
5	DP4+A1	6.28 ac						11.3min	3.84	3.6	13.7 cfs	0.5%	13.7cfs				107'	3	0.6min	To DP6
6	DP5+A8	9.11 ac						11.9min	4.90	3.5	17.1 cfs								---	
10	B1+B2+B3+B4	3.72 ac						11.6min	2.55	3.5	9.0 cfs			9.0cfs	0.5%	24-in	180'	5.1	0.6min	To DP11
11	B1-B6	4.28 ac						12.1min	2.89	3.4	10.0 cfs	0.5%	10.0cfs				245'	2.1	1.9min	To DP12
12	B1-B7	5.17 ac						14.1min	3.28	3.2	10.6 cfs									
20	C1-C2	5.36 ac						10.5min	3.51	3.7	12.9 cfs									
30	EOS3,EOS4,D, U-2	41.16 ac						60.3min	8.37	1.4	11.6 cfs									
	add M										19.6 cfs			19.6cfs	0.5%	36-in	310'	6.7	0.8min	To DP31
31	DP30							61.1min	8.37	1.4	11.5 cfs									
	add M+C+Detention C										20.3 cfs			20.3cfs	0.5%	36-in	390'	6.7	1.0min	To DP32
32	DP31							62.1min	8.37	1.4	11.4 cfs									
	add M+Detention C+Detention B										21.1 cfs			37.9cfs	0.5%	36-in	400'	6.7	1.0min	To DP33
33	DP32							63.1min	8.37	1.3	11.3 cfs									
	add M+Detention C+Detention B+Detention A										21.6 cfs			39.5cfs	0.5%	36-in	100'	6.7	0.2min	To DP34
34	DP33+OS1+OS2							63.3min	9.69	1.3	13.0 cfs									
	add M+Detention C+Detention B+Detention A										23.3 cfs									

Equations (UDFCD):

$i_x = A*P1/(B+T_c)^C$ [IDF Formula]

A=28.5, B=10.00, C=0.786 for all return periods

P1=One-hour point rainfall depth (in.)

P1 from Table 600-1: Point Precipitation Frequency Estimates, Berthoud Design & Construction Standards

P1	Inches
10 yr	1.38 in

Q = CiA

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

Westside Crossing - Berthoud
Runoff Calculation

Design Storm: 100 Year

	Direct Runoff							Total Runoff				Street/Chan		Pipe			Travel Time			
Basin ID/ Design Point	Area Designation	Area	C	T_c	C*A (acre)	i (in/hr)	Q	T_c	Sum C*A	i (in/hr)	Q	Slope	Q	Q	Slope	Pipe Size	L (ft)	Vel (ft/s)	T_t	Remarks
E1	E1	6.89 ac	0.49	34.1min	3.39	4.1	14.0 cfs			---	---								---	
E2	E2	14.02 ac	0.49	40.6min	6.90	3.7	25.6 cfs													
E3	E3	1.52 ac	0.69	23.1min	1.05	5.2	5.4 cfs													
EOS1	EOS1	1.18 ac	0.65	24.6min	0.77	5.0	3.8 cfs													
OS1	OS1	1.53 ac	0.79	16.3min	1.21	6.2	7.5 cfs													
OS2	OS2	0.44 ac	0.76	7.2min	0.34	8.6	2.9 cfs													
OS3	OS3	0.87 ac	0.78	8.9min	0.68	8.0	5.5 cfs													
OS4	OS4	0.18 ac	0.51	6.7min	0.09	8.9	0.8 cfs													
EOS3	EOS3	2.30 ac	0.39	12.6min	0.90	7.0	5.9 cfs					1.0%	5.9cfs				620'	4.4	2.3min	To DP30/EX1
EOS4	EOS4	0.17 ac	0.63	7.3min	0.11	8.6	0.9 cfs													
OS10	OS10	0.37 ac	0.85	6.9min	0.31	8.8	2.7 cfs													
U-2	U-2	38.10 ac	0.27	74.0min	10.29	2.5	25.6 cfs					1.0%	25.6cfs				730'	5.5	2.2min	To DP30/EX1
Ex. Village at Matthews Farm Detention Basin Outfall (M):							13.5 cfs													
EX1	EOS3,EOS4, U-2	40.57 ac						51.9min	11.29	3.2	35.7 cfs									
	add M										49.2 cfs	0.2%	35.8cfs				1180'	5.8	3.4min	To EX2
EX2	DP EX1, EOS1, E1, E2	50.16 ac						55.3min	16.50	3.0	50.0 cfs									
	add M										63.5 cfs									
A1	A1	1.37 ac	0.76	8.6min	1.05	8.1	8.5 cfs			---	---									
A2	A2	0.68 ac	0.78	6.2min	0.53	9.1	4.8 cfs			---	---								---	
A3	A3	0.24 ac	0.73	8.5min	0.18	8.2	1.4 cfs			---	---								---	
A4	A4	0.89 ac	0.77	5.7min	0.68	9.3	6.3 cfs			---	---								---	
A5	A5	1.88 ac	0.74	9.9min	1.39	7.7	10.7 cfs			---	---								---	
A6	A6	1.06 ac	0.71	8.3min	0.76	8.3	6.2 cfs			---	---								---	
A7	A7	0.15 ac	0.84	5.0min	0.12	9.6	1.2 cfs			---	---								---	
A8	A8	2.83 ac	0.79	8.6min	2.24	8.1	18.2 cfs			---	---								---	
B1	B1	1.10 ac	0.85	7.0min	0.94	8.7	8.2 cfs			---	---			3.7cfs	1.0%	12-in	480'	4.5	1.8min	To DP11
B2	B2	0.88 ac	0.77	6.8min	0.67	8.8	6.0 cfs			---	---			4.2cfs	0.5%	18-in	330'	4.2	1.3min	To DP10
B3	B3	0.88 ac	0.71	11.6min	0.63	7.2	4.5 cfs			---	---								---	
B4	B4	0.86 ac	0.82	9.1min	0.70	8.0	5.6 cfs			---	---								---	
B5	B5	0.33 ac	0.82	5.1min	0.27	9.6	2.5 cfs												---	
B6	B6	0.23 ac	0.65	6.2min	0.15	9.1	1.4 cfs												---	
B7	B7	0.89 ac	0.65	5.3min	0.58	9.5	5.5 cfs												---	
C1	C1	3.16 ac	0.77	10.5min	2.43	7.5	18.4 cfs			---	---								---	

Westside Crossing - Berthoud
Runoff Calculation

Design Storm: 100 Year

	Direct Runoff							Total Runoff				Street/Chan		Pipe			Travel Time			
Basin ID/ Design Point	Area Designation	Area	C	T_c	C*A (acre)	i (in/hr)	Q	T_c	Sum C*A	i (in/hr)	Q	Slope	Q	Q	Slope	Pipe Size	L (ft)	Vel (ft/s)	T_t	Remarks
C2	C2	2.20 ac	0.78	9.7min	1.71	7.8	13.3 cfs			---	---								---	
D	D	0.59 ac	0.51	23.3min	0.30	5.1	1.6 cfs			---	---								---	
										---	---									
Detention Basin A Release Rate:							12.6 cfs													
Detention Basin B Release Rate:							6.8 cfs													
Detention Basin C Release Rate:							7.6 cfs													
1	A6+A7	1.21 ac						8.3min	0.88	8.3	7.3 cfs			7.3cfs	2.0%	18-in	59'	8.4	0.1min	To DP2
2	DP1+A5	3.09 ac						10.0min	2.27	7.7	17.4 cfs			17.4cfs	0.8%	24-in	120'	6.5	0.3min	To DP3
3	DP2+A3+A4	4.22 ac						10.3min	3.13	7.6	23.7 cfs			23.7cfs	0.5%	24-in	151'	5.1	0.5min	To DP4
4	DP3+A2	4.90 ac						10.8min	3.66	7.4	27.2 cfs			27.2cfs	0.5%	24-in	132'	5.1	0.4min	To DP5
5	DP4+A1	6.28 ac						11.3min	4.71	7.3	34.5 cfs	0.5%	34.5cfs				107'	3	0.6min	To DP6
6	DP5+A8	9.11 ac						11.9min	5.89	7.2	42.2 cfs								---	
10	B1+B2+B3+B4	3.72 ac						11.6min	2.94	7.2	21.3 cfs			21.3cfs	0.5%	24-in	180'	5.1	0.6min	To DP11
11	B1-B6	4.28 ac						12.1min	3.36	7.1	23.8 cfs	0.5%	23.8cfs				245'	2.1	1.9min	To DP12
12	B1-B7	5.17 ac						14.1min	3.94	6.6	26.2 cfs									
20	C1-C2	5.36 ac						10.5min	4.15	7.5	31.3 cfs									
30	EOS3,EOS4,D, U-2	41.16 ac						60.3min	11.59	2.9	33.2 cfs									
	add M										46.7 cfs			46.7cfs	0.5%	36-in	310'	6.7	0.8min	To DP31
31	DP30							61.1min	11.59	2.8	32.9 cfs									
	add M+C+Detention C										54.0 cfs			54.0cfs	0.5%	36-in	390'	6.7	1.0min	To DP32
32	DP31							62.1min	11.59	2.8	32.5 cfs									
	add M+Detention C+Detention B										60.4 cfs			37.9cfs	0.5%	36-in	400'	6.7	1.0min	To DP33
33	DP32							63.1min	11.59	2.8	32.2 cfs									
	add M+Detention C+Detention B+Detention A										72.7 cfs			39.5cfs	0.5%	36-in	100'	6.7	0.2min	To DP34
34	DP33+OS1+OS2							63.3min	13.14	2.8	36.4 cfs									
	add M+Detention C+Detention B+Detention A										76.9 cfs									

Equations (UDFCD):

$i_x = A*P1/(B+T_c)^C$ [IDF Formula]

A=28.5, B=10.00, C=0.786 for all return periods

P1=One-hour point rainfall depth (in.)

P1 from Table 600-1: Point Precipitation Frequency Estimates, Berthoud Design & Construction Standards

P1	Inches
100 yr	2.84 in

Q = CiA

Q = Peak Runoff Rate (cubic feet/second)

C = Runoff coef representing a ration of peak runoff rate to ave rainfall intensity for a duration equal to the runoff time of concentration.

i = average rainfall intensity in inches per hour

A = Drainage area in acres

APPENDIX B.1

Supporting Hydrologic Tables and Figures

D. Differences between the Town of Berthoud and the MHFD

1. 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.

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

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: 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.

Table 6-4. Runoff coefficient equations based on NRCS soil group and storm return period

NRCS Soil Group		Storm Return Period					
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
A	$C_A = 0.84i^{1.302}$	$C_A = 0.86i^{1.276}$	$C_A = 0.87i^{1.232}$	$C_A = 0.84i^{1.124}$	$C_A = 0.85i+0.025$	$C_A = 0.78i+0.110$	$C_A = 0.65i+0.254$
B	$C_B = 0.84i^{1.169}$	$C_B = 0.86i^{1.088}$	$C_B = 0.81i+0.057$	$C_B = 0.63i+0.249$	$C_B = 0.56i+0.328$	$C_B = 0.47i+0.426$	$C_B = 0.37i+0.536$
C/D	$C_{C/D} = 0.83i^{1.122}$	$C_{C/D} = 0.82i+0.035$	$C_{C/D} = 0.74i+0.132$	$C_{C/D} = 0.56i+0.319$	$C_{C/D} = 0.49i+0.393$	$C_{C/D} = 0.41i+0.484$	$C_{C/D} = 0.32i+0.588$

Where:

i = % imperviousness (expressed as a decimal)

C_A = Runoff coefficient for Natural Resources Conservation Service (NRCS) HSG A soils

C_B = Runoff coefficient for NRCS HSG B soils

$C_{C/D}$ = Runoff coefficient for NRCS HSG C and D soils.

The values for various catchment imperviousness and storm return periods are presented graphically in Figures 6-1 through 6-3, and are tabulated in Table 6-5. These coefficients were developed for the Denver region to work in conjunction with the time of concentration recommendations in Section 2.4. Use of these coefficients and this procedure outside of the semi-arid climate found in the Denver region may not be valid. The UD-Rational Excel workbook performs all the needed calculations to find the runoff coefficient given the soil type and imperviousness and the reader may want to take advantage of this macro-enabled Excel workbook that is available for download from the UDFCD's website www.udfcd.org.

See Examples 7.1 and 7.2 that illustrate the Rational Method.

Table 6-5. Runoff coefficients, *c*

Total or Effective % Impervious	NRCS Hydrologic Soil Group A						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
2%	0.01	0.01	0.01	0.01	0.04	0.13	0.27
5%	0.02	0.02	0.02	0.03	0.07	0.15	0.29
10%	0.04	0.05	0.05	0.07	0.11	0.19	0.32
15%	0.07	0.08	0.08	0.1	0.15	0.23	0.35
20%	0.1	0.11	0.12	0.14	0.2	0.27	0.38
25%	0.14	0.15	0.16	0.19	0.24	0.3	0.42
30%	0.18	0.19	0.2	0.23	0.28	0.34	0.45
35%	0.21	0.23	0.24	0.27	0.32	0.38	0.48
40%	0.25	0.27	0.28	0.32	0.37	0.42	0.51
45%	0.3	0.31	0.33	0.36	0.41	0.46	0.54
50%	0.34	0.36	0.37	0.41	0.45	0.5	0.58
55%	0.39	0.4	0.42	0.45	0.49	0.54	0.61
60%	0.43	0.45	0.47	0.5	0.54	0.58	0.64
65%	0.48	0.5	0.51	0.54	0.58	0.62	0.67
70%	0.53	0.55	0.56	0.59	0.62	0.65	0.71
75%	0.58	0.6	0.61	0.64	0.66	0.69	0.74
80%	0.63	0.65	0.66	0.69	0.71	0.73	0.77
85%	0.68	0.7	0.71	0.74	0.75	0.77	0.8
90%	0.73	0.75	0.77	0.79	0.79	0.81	0.84
95%	0.79	0.81	0.82	0.83	0.84	0.85	0.87
100%	0.84	0.86	0.87	0.88	0.88	0.89	0.9
Total or Effective % Impervious	**NRCS Hydrologic Soil Group B**						
	2-Year	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**	**500-Year**
2%	0.01	0.01	0.07	0.26	0.34	0.44	0.54
5%	0.03	0.03	0.1	0.28	0.36	0.45	0.55
10%	0.06	0.07	0.14	0.31	0.38	0.47	0.57
15%	0.09	0.11	0.18	0.34	0.41	0.5	0.59
20%	0.13	0.15	0.22	0.38	0.44	0.52	0.61
25%	0.17	0.19	0.26	0.41	0.47	0.54	0.63
30%	0.2	0.23	0.3	0.44	0.49	0.57	0.65
35%	0.24	0.27	0.34	0.47	0.52	0.59	0.66
40%	0.29	0.32	0.38	0.5	0.55	0.61	0.68
45%	0.33	0.36	0.42	0.53	0.58	0.64	0.7
50%	0.37	0.4	0.46	0.56	0.61	0.66	0.72
55%	0.42	0.45	0.5	0.6	0.63	0.68	0.74
60%	0.46	0.49	0.54	0.63	0.66	0.71	0.76
65%	0.5	0.54	0.58	0.66	0.69	0.73	0.77
70%	0.55	0.58	0.62	0.69	0.72	0.75	0.79
75%	0.6	0.63	0.66	0.72	0.75	0.78	0.81
80%	0.64	0.67	0.7	0.75	0.77	0.8	0.83
85%	0.69	0.72	0.74	0.78	0.8	0.82	0.85
90%	0.74	0.76	0.78	0.81	0.83	0.84	0.87
95%	0.79	0.81	0.82	0.85	0.86	0.87	0.88
100%	0.84	0.86	0.86	0.88	0.89	0.89	0.9

Table 6-5. Runoff coefficients, *c* (continued)

Total or Effective % Impervious	NRCS Hydrologic Soil Group C						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
2%	0.01	0.05	0.15	0.33	0.40	0.49	0.59
5%	0.03	0.08	0.17	0.35	0.42	0.5	0.6
10%	0.06	0.12	0.21	0.37	0.44	0.52	0.62
15%	0.1	0.16	0.24	0.4	0.47	0.55	0.64
20%	0.14	0.2	0.28	0.43	0.49	0.57	0.65
25%	0.18	0.24	0.32	0.46	0.52	0.59	0.67
30%	0.22	0.28	0.35	0.49	0.54	0.61	0.68
35%	0.26	0.32	0.39	0.51	0.57	0.63	0.7
40%	0.3	0.36	0.43	0.54	0.59	0.65	0.71
45%	0.34	0.4	0.46	0.57	0.62	0.67	0.73
50%	0.38	0.44	0.5	0.6	0.64	0.69	0.75
55%	0.43	0.48	0.54	0.63	0.66	0.71	0.76
60%	0.47	0.52	0.57	0.65	0.69	0.73	0.78
65%	0.51	0.56	0.61	0.68	0.71	0.75	0.79
70%	0.56	0.61	0.65	0.71	0.74	0.77	0.81
75%	0.6	0.65	0.68	0.74	0.76	0.79	0.82
80%	0.65	0.69	0.72	0.77	0.79	0.81	0.84
85%	0.7	0.73	0.76	0.79	0.81	0.83	0.86
90%	0.74	0.77	0.79	0.82	0.84	0.85	0.87
95%	0.79	0.81	0.83	0.85	0.86	0.87	0.89
100%	0.83	0.85	0.87	0.88	0.89	0.89	0.9

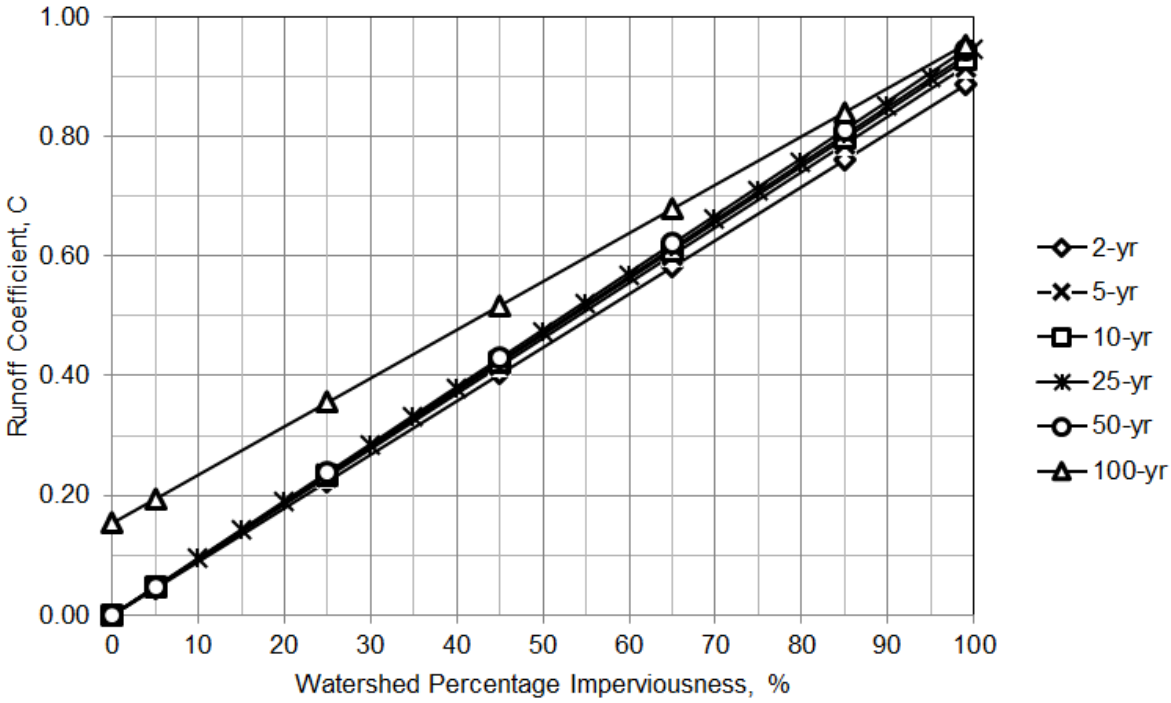


Figure 6-1. Runoff coefficient vs. watershed imperviousness NRCS HSG A

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.

   Table 600-1, shall be used but may be superseded if more recent NOAA data is published for the Town. The table below is based on NOAA Atlas 14, Volume 8, Version 2 for Berthoud, Colorado.

   Table 600- 1: Point Precipitation Frequency Estimates in Inches

Estimated Rainfall Depth in Inches									
	Average Return Interval (ARI) (Years)								
Duration	1	2	5	10	25	50	100	200	500
5-minutes	0.233	0.277	0.37	0.469	0.635	0.787	0.961	1.16	1.45
10-minutes	0.341	0.405	0.542	0.686	0.93	1.15	1.41	1.7	2.13
15-minutes	0.416	0.494	0.661	0.837	1.13	1.41	1.72	2.07	2.6
30-minutes	0.553	0.658	0.881	1.12	1.51	1.87	2.28	2.74	3.44
60-minutes	0.684	0.811	1.08	1.38	1.87	2.32	2.84	3.44	4.32
2-hours	0.816	0.963	1.29	1.63	2.23	2.78	3.41	4.13	5.21
3-hours	0.899	1.06	1.41	1.79	2.44	3.04	3.73	4.52	5.71
6-hours	1.07	1.26	1.66	2.09	2.81	3.48	4.24	5.11	6.4
24-hours	1.56	1.84	2.37	2.88	3.68	4.37	5.14	5.98	7.2

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 MHFD 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 MHFD USDCM Manual (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.

APPENDIX C

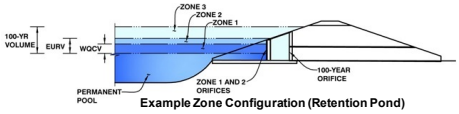
Water Quality and Detention Calcs – Detention Basin A

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Westside Crossing**

Basin ID: **Detention Basin A**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**			
Watershed Area =	9.11	acres		
Watershed Length =	888	ft		
Watershed Length to Centroid =	430	ft		
Watershed Slope =	0.011	ft/ft		
Watershed Imperviousness =	67.98%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	100.0%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

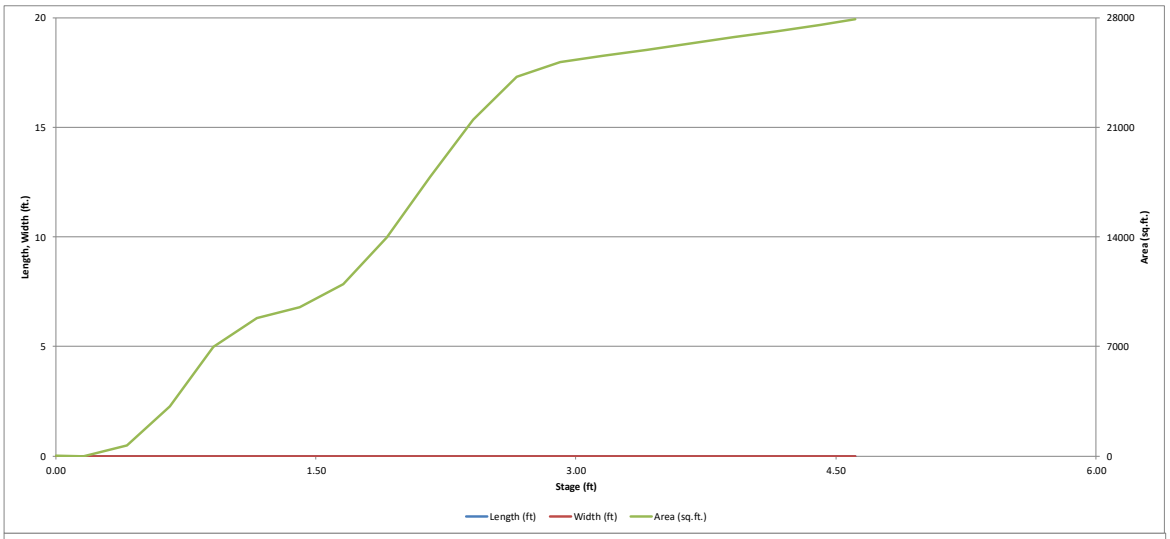
			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.202	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.600	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.81 in.) =	0.379	acre-feet	0.81	inches
5-yr Runoff Volume (P1 = 1.08 in.) =	0.547	acre-feet	1.08	inches
10-yr Runoff Volume (P1 = 1.38 in.) =	0.763	acre-feet	1.38	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	1.157	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.32 in.) =	1.510	acre-feet	2.32	inches
100-yr Runoff Volume (P1 = 2.84 in.) =	1.936	acre-feet	2.84	inches
500-yr Runoff Volume (P1 = 4.32 in.) =	3.124	acre-feet	4.32	inches
Approximate 2-yr Detention Volume =	0.367	acre-feet		
Approximate 5-yr Detention Volume =	0.544	acre-feet		
Approximate 10-yr Detention Volume =	0.683	acre-feet		
Approximate 25-yr Detention Volume =	0.862	acre-feet		
Approximate 50-yr Detention Volume =	0.977	acre-feet		
Approximate 100-yr Detention Volume =	1.159	acre-feet		

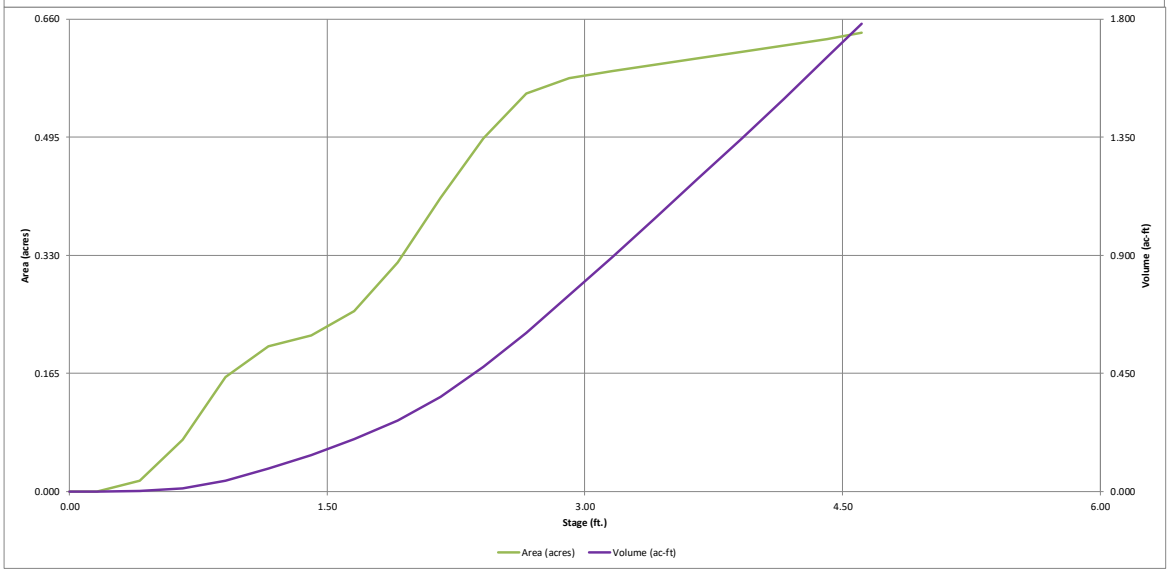
Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.202	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.398	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.558	acre-feet
Total Detention Basin Volume =	1.159	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	12	0.000		
5070.25	--	0.16	--	--	--	3	0.000	1	0.000
5070.5	--	0.41	--	--	--	659	0.015	84	0.002
5070.75	--	0.66	--	--	--	3,143	0.072	559	0.013
5071	--	0.91	--	--	--	6,978	0.160	1,824	0.042
5071.25	--	1.16	--	--	--	8,827	0.203	3,800	0.087
5071.5	--	1.41	--	--	--	9,504	0.218	6,091	0.140
5071.75	--	1.66	--	--	--	10,990	0.252	8,653	0.199
5072	--	1.91	--	--	--	13,956	0.320	11,771	0.270
5072.25	--	2.16	--	--	--	17,862	0.410	15,748	0.362
5072.5	--	2.41	--	--	--	21,488	0.493	20,667	0.474
5072.75	--	2.66	--	--	--	24,219	0.556	26,380	0.606
5073	--	2.91	--	--	--	25,162	0.578	32,553	0.747
5073.25	--	3.16	--	--	--	25,568	0.587	38,894	0.893
5073.5	--	3.41	--	--	--	25,967	0.596	45,336	1.041
5073.75	--	3.66	--	--	--	26,363	0.605	51,877	1.191
5074	--	3.91	--	--	--	26,757	0.614	58,517	1.343
5074.25	--	4.16	--	--	--	27,149	0.623	65,256	1.498
5074.5	--	4.41	--	--	--	27,539	0.632	72,092	1.655
5074.7	--	4.61	--	--	--	27,926	0.641	77,638	1.782


20
15
10
5
0
Length, Width (ft.)
28000
21000
14000
7000
0
Area (sq.ft.)
0.00
1.50
3.00
4.50
6.00
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

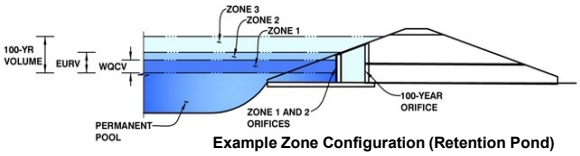

0.660
0.495
0.330
0.165
0.000
Area (acres)
1.800
1.350
0.900
0.450
0.000
Volume (ac-ft)
0.00
1.50
3.00
4.50
6.00
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Westside Crossing**

Basin ID: **Detention Basin A**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.68	0.202	Orifice Plate
Zone 2 (EURV)	2.66	0.398	Orifice Plate
Zone 3 (100-year)	3.61	0.558	Weir&Pipe (Restrict)
Total (all zones)		1.159	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	8.750E-03	ft^2
Depth at top of Zone using Orifice Plate =	2.66	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	10.60	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.26	sq. inches (diameter = 1-1/4 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.89	1.77					
Orifice Area (sq. inches)	1.26	1.26	1.26					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.66	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Type =	Close Mesh Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	2.66	N/A	feet
Overflow Weir Slope Length =	3.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	4.50	N/A	
Overflow Grate Open Area w/o Debris =	7.12	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.56	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.17	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	15.10		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.58	N/A	ft^2
Outlet Orifice Centroid =	0.68	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	2.32	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.52	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	100.00	feet
Spillway End Slopes =	0.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.22	feet
Stage at Top of Freeboard =	4.74	feet
Basin Area at Top of Freeboard =	0.64	acres
Basin Volume at Top of Freeboard =	1.78	acre-ft

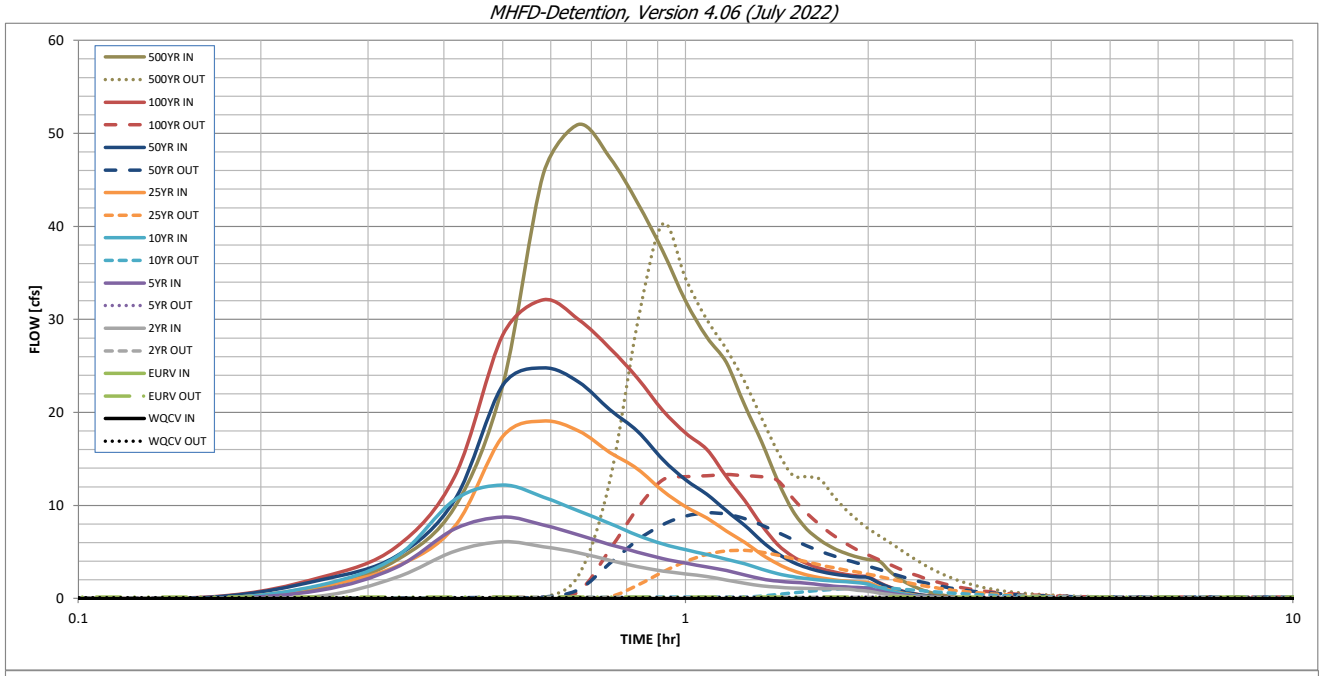
Routed Hydrograph Results

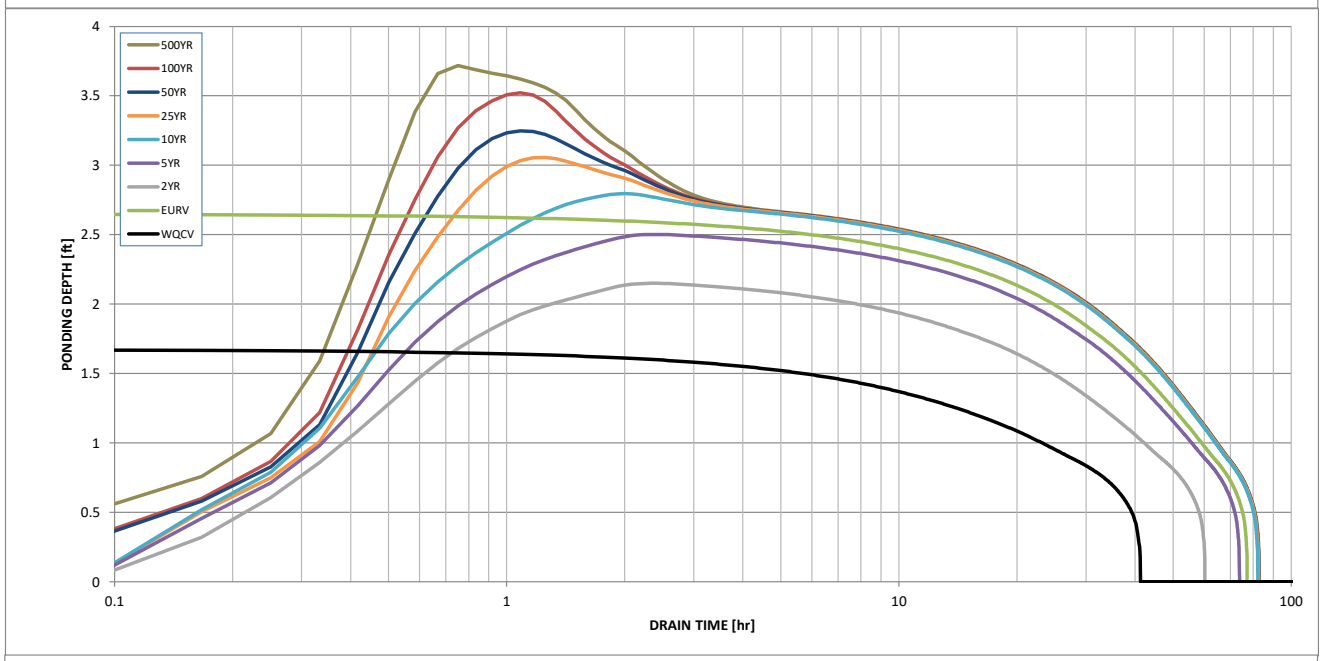
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

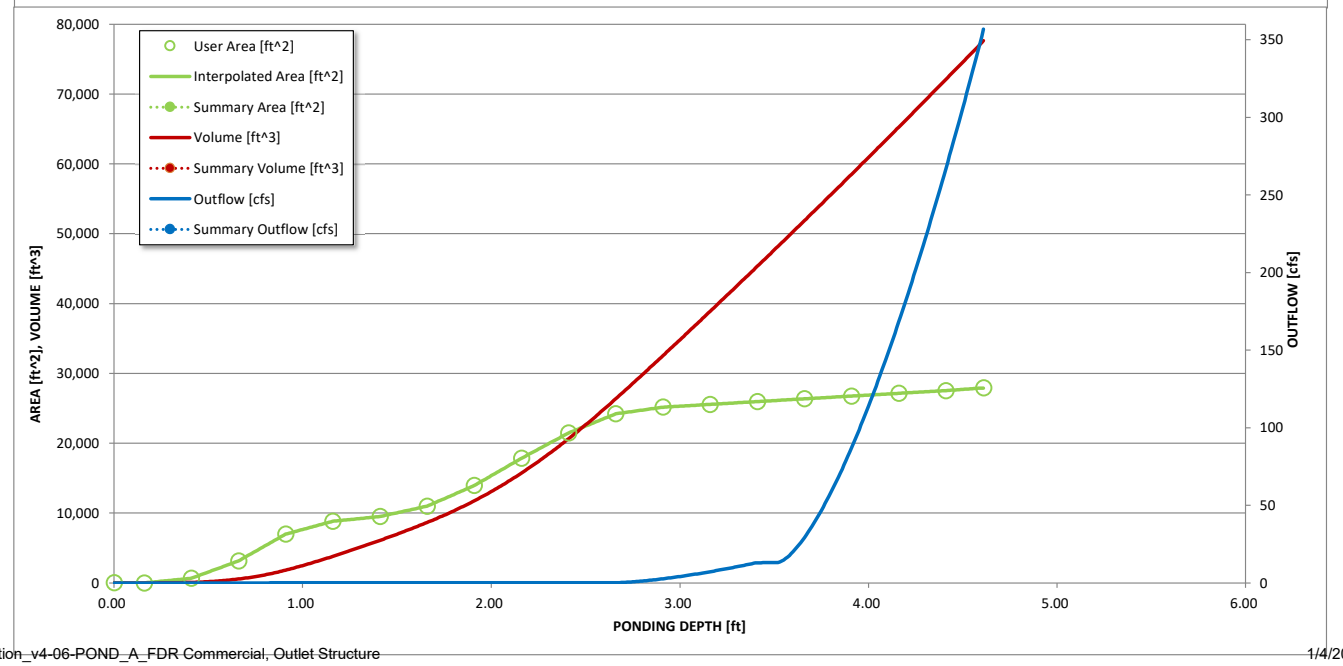
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.81	1.08	1.38	1.87	2.32	2.84	4.32
CUHP Runoff Volume (acre-ft) =	0.202	0.600	0.379	0.547	0.763	1.157	1.510	1.936	3.124
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.379	0.547	0.763	1.157	1.510	1.936	3.124
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.7	2.5	6.8	10.0	14.3	25.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.07	0.27	0.74	1.10	1.56	2.74
Peak Inflow Q (cfs) =	N/A	N/A	6.1	8.8	12.2	19.1	24.8	32.1	51.0
Peak Outflow Q (cfs) =	0.1	0.2	0.1	0.2	1.2	5.2	9.2	13.3	40.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.5	0.8	0.9	0.9	1.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.7	1.3	1.8	1.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	70	56	67	74	70	67	64	58
Time to Drain 99% of Inflow Volume (hours) =	**40**	75	58	71	79	78	77	75	72
Maximum Ponding Depth (ft) =	1.68	2.65	2.15	2.50	2.80	3.06	3.25	3.52	3.72
Area at Maximum Ponding Depth (acres) =	0.26	0.55	0.41	0.52	0.57	0.58	0.59	0.60	0.61
Maximum Volume Stored (acre-ft) =	0.204	0.600	0.357	0.520	0.679	0.829	0.940	1.107	1.221

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







Presedementation / Forebay Sizing - Detention Basin A

Forebay	100 Yr Flow	Detention WQCV	Total Req'd Forebay Vol 2.0% WQCV	Tributary Area	% Total Trib Area	Required Forebay Volume	Forebay Design Area	Forebay Design Depth	Forebay Design Volume	Discharge Design Flow 2.0% 100yr	Calc'd Open Width (1" min)	**Design Width**
DP 6	42.2cfs	8,798cf	176cf	9.11ac	100.0%	176cf	125sf	1.50-ft	188 cf	0.84 cfs	5.4-inch	**6.0-inch**
					0.0%	---			---	---	---	
					0.0%	---			---	---	---	
Totals		8,798cf	176cf	9.11ac	100.0%							

Opening Width Equation for Rectangular Opening

$L = Q / (CH^{1.5}) \times 12 + 0.2xHx12$ (UD-BMP Spreadsheet -- EDB tab)

C = 3.0

Emergency Spillway Calculation

Detention Area	100yr Flow	Water Surf Elev	Crest Elev	Crest Length	Z	C	Flow Depth (H)	**Calc'd Flow**	Check
A (DP6)	42.2 cfs	100.3	100.0	100 ft	0:1	3.0	0.28 ft	44.4 cfs	OK

Broad Crested Weir Equation (USDCM Eqn 12-20 and 12-21):

$Q = CLH^{1.5} + 2x((2/5)CZH^{5/2})$

H = Head above weir crest, in ft

C = Weir coefficient, C = 3.0 (most cases)

Z = Side slope (horizontal:vertical)

L = Length of weir at Crest, in ft. Not including sideslopes.

APPENDIX C.1

Hydraulic Calculations

Existing Culvert Capacity at DP EX2
Inlet and Street Capacity Calculations
UD-Sewer Profiles and Results Summaries (10-Year & 100-Year)

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Sep 8 2023

Culvert Condition @ DP EX1 (100-Year Event)

Invert Elev Dn (ft)	=	5067.95
Pipe Length (ft)	=	123.00
Slope (%)	=	0.69
Invert Elev Up (ft)	=	5068.80
Rise (in)	=	30.0
Shape	=	Circular
Span (in)	=	30.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end projecting (C)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

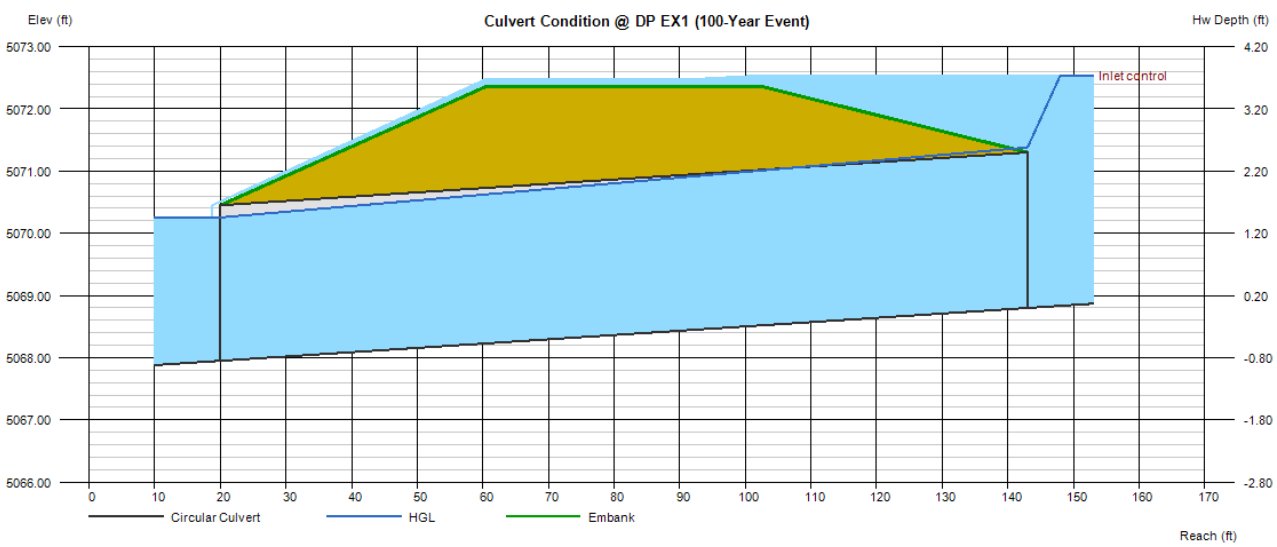
Top Elevation (ft)	=	5072.36
Top Width (ft)	=	42.00
Crest Width (ft)	=	191.00

Calculations

Qmin (cfs)	=	80.00
Qmax (cfs)	=	81.20
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	81.20
Qpipe (cfs)	=	39.21
Qovertop (cfs)	=	41.99
Veloc Dn (ft/s)	=	8.29
Veloc Up (ft/s)	=	7.99
HGL Dn (ft)	=	5070.26
HGL Up (ft)	=	5071.38
Hw Elev (ft)	=	5072.54
Hw/D (ft)	=	1.50
Flow Regime	=	Inlet Control



MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	Inlet 10	Inlet 11	Inlet 12
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	0.5	4.2	0.5
Major Q_{Known} (cfs)	1.2	10.7	1.4

Bypass (Carry-Over) Flow from Upstream Inlets must be organized from upstream (left) to downstream (right) in order for bypass flows to be linked.

Receive Bypass Flow from:	No Bypass Flow Received	Inlet 10	Inlet 11
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	1.9
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	7.3

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**0.5**	**4.2**	**2.4**
Major Total Design Peak Flow, Q (cfs)	**1.2**	**10.7**	**8.7**
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	1.9	0.6
Major Flow Bypassed Downstream, Q_b (cfs)	0.0	7.3	5.5

MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	Inlet 13	Inlet 14	Inlet 2
Site Type (Urban or Rural)	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET
Hydraulic Condition	In Sump	In Sump	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	2.0	3.5	2.4
Major Q_{Known} (cfs)	4.8	8.5	6.3

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	Inlet 12	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.6	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	5.5	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)			
Percent Impervious			
NRCS Soil Type			

Watershed Profile

Overland Slope (ft/ft)			
Overland Length (ft)			
Channel Slope (ft/ft)			
Channel Length (ft)			

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)			
One-Hour Precipitation, P_1 (inches)			

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	**2.6**	**3.5**	**2.4**
Major Total Design Peak Flow, Q (cfs)	**10.3**	**8.5**	**6.3**
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A	N/A	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	N/A	N/A	0.5

MHFD-Inlet, Version 5.02 (August 2022)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	Inlet 1
Site Type (Urban or Rural)	URBAN
Inlet Application (Street or Area)	STREET
Hydraulic Condition	In Sump
Inlet Type	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	3.1
Major Q_{Known} (cfs)	25.1

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0

Watershed Characteristics

Subcatchment Area (acres)	
Percent Impervious	
NRCS Soil Type	

Watershed Profile

Overland Slope (ft/ft)	
Overland Length (ft)	
Channel Slope (ft/ft)	
Channel Length (ft)	

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)	
One-Hour Precipitation, P_1 (inches)	

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)	
One-Hour Precipitation, P_1 (inches)	

CALCULATED OUTPUT

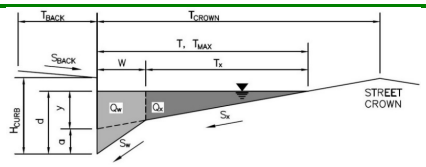
Minor Total Design Peak Flow, Q (cfs)	**3.1**
Major Total Design Peak Flow, Q (cfs)	**25.1**
Minor Flow Bypassed Downstream, Q_b (cfs)	N/A
Major Flow Bypassed Downstream, Q_b (cfs)	N/A

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Westside Crossing - Commercial

Inlet ID: Inlet 10



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.023	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.010	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.015	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	25.0	30.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

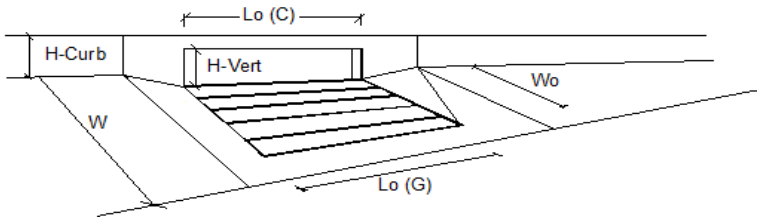
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**18.5**	**60.7**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.50 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.20 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	

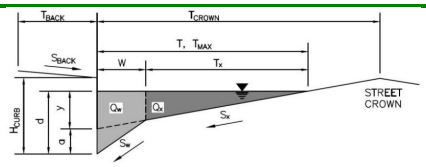
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.5**	**1.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**98**	**%**

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Westside Crossing - Commercial

Inlet ID: Inlet 11



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	15.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.040	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.018	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.010	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.015	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	28.0	30.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

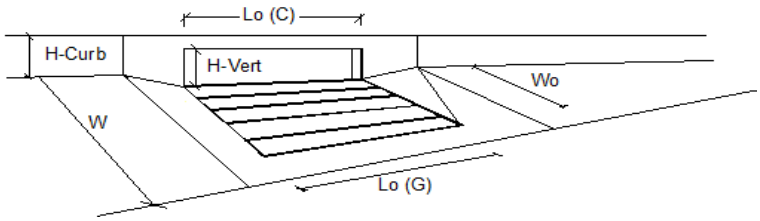
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion MAJOR STORM Allowable Capacity is based on Spread Criterion	Q_{allow} =	**22.8**	**40.7**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 4.20 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 10.73 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input) CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f (C) =	0.10	0.10	

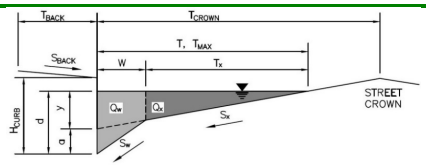
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.3**	**3.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**1.9**	**7.3**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**55**	**32**	**%**

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Westside Crossing - Commercial

Inlet ID: Inlet 12



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	15.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.040	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.018	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.010	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.015	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	28.0	30.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

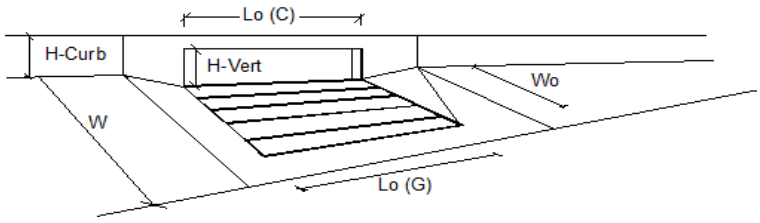
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	Q_{allow} =	**22.8**	**40.7**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 2.38 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 8.66 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	

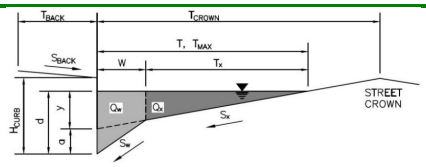
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.8**	**3.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.6**	**5.5**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**74**	**37**	**%**

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Westside Crossing - Commercial

Inlet ID: Inlet 13



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	15.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.040	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	30.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.015	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	28.0	30.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

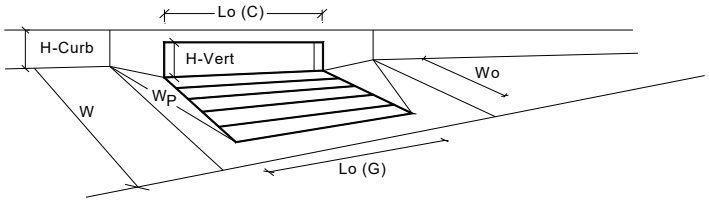
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



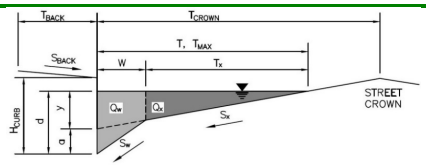
Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	8.0	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.42	0.58	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.93	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**10.0**	**17.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	2.6	10.3	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Westside Crossing - Commercial

Inlet ID: Inlet 14



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0	ft
Gutter Width	W =	1.00	ft
Street Transverse Slope	S_X =	0.005	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.015	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

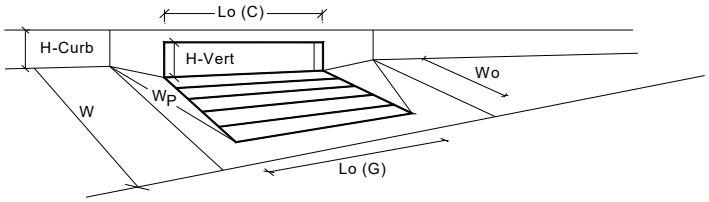
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



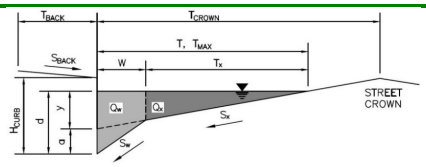
Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	2	2	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	2.1	2.1	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	1.00	1.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.10	0.10	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.56	0.56	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**0.7**	**0.7**	**cfs**
WARNING: Inlet Capacity < Q Peak for Minor and Major Storms	$Q_{PEAK\ REQUIRED}$ =	3.5	8.5	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Westside Crossing - Commercial

Inlet ID: Inlet 2



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	35.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	34.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.050	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.010	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.015	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	12.0	32.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.3	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

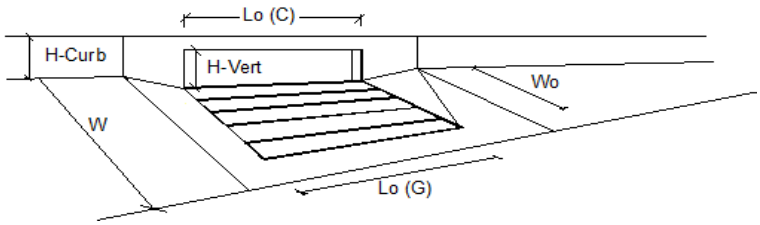
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**8.7**	**23.9**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 2.40 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 6.30 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	

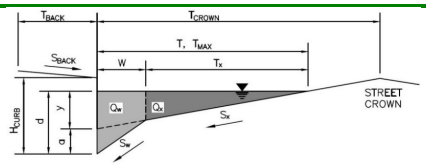
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**2.4**	**5.8**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.5**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**92**	**%**

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Westside Crossing - Commercial

Inlet ID: Inlet 1



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	17.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	24.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.020	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	24.0	24.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	7.2	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

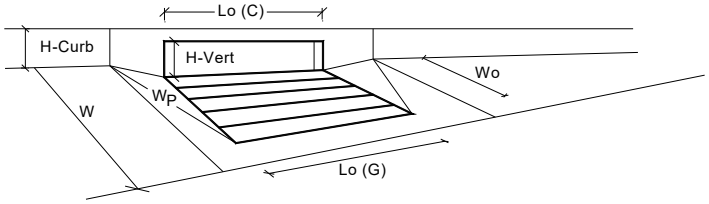
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	7.2	inches
Grate Information			MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate		L_o (G) =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	15.00	15.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)			MINOR	MAJOR	
Depth for Grate Midwidth		d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d_{Curb} =	0.33	0.43	ft
Grated Inlet Performance Reduction Factor for Long Inlets		RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets		RF_{Curb} =	0.79	0.85	
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	N/A	N/A	
			MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)		**Q_a =**	**7.8**	**12.6**	**cfs**
WARNING: Inlet Capacity < Q Peak for Major Storm		$Q_{PEAK\ REQUIRED}$ =	3.1	25.1	cfs

The peak runoff at Inlet 1 during the 100-Year Event is 25.1 cfs. 47.63 cfs is conveyed via the outfall trunkline (See 100-Year UDSewer Results summary for Outfall Trunkline) while 25.1 cfs (72.7 cfs total at Design Point 33 minus the 47.63 cfs conveyed within the trunkline) will enter Meadowlark Drive and be conveyed to Inlet 1 via gutter flow. Inlet 1 capacity is 12.6 cfs, resulting in 12.5 cfs overtopping the low point within Meadowlark Drive and continuing east toward the existing roadside swale along Highway 56.

Berthoud Design and Construction Specification Section 602.4 (C) states that the allowable ponding depth within a street gutter during the 100-Year Event is 1-ft. 1-ft of ponding depth at Inlet 1 results in a weir capacity of 13.77 cfs. The flow needing to pass over Meadowlark is only 12.5 cfs, therefore this condition meets Town of Berthoud street criteria.

Flowline elevation of Inlet 1=5071.80
Low point elevation within Meadowlark Drive=5072.40 (see proposed drainage map)
Available ponding depth (1-ft max) above Meadowlark Drive low point to pass the required 12.5 cfs=0.40-ft.

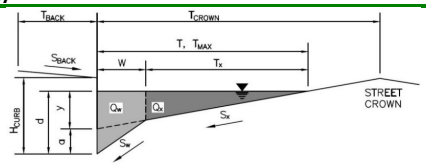
See 'Meadowlark Low Point (100-YR Overtopping at Design Point 33)' Weir Report.

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Westside Crossing - Commercial Phase

Inlet ID: Meadowlark Capacity



Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	17.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	24.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.021		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.006		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.014		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	24.0	24.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	7.8	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression ($T * S_x * 12$)	y =	6.05	6.05	inches
Vertical Depth between Gutter Lip and Gutter Flowline ($W * S_w * 12$)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - ($W * S_x * 12$))	a =	1.49	1.49	inches
Water Depth at Gutter Flowline (y + a)	d =	7.54	7.54	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	22.0	22.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.243	0.243	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	18.8	18.8	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	6.0	6.0	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.4	0.4	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**25.2**	**25.2**	**cfs**
Flow Velocity within the Gutter Section	V =	5.5	5.5	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	3.5	3.5	

Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	17.9	25.0	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\ TH}$ =	15.9	23.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.328	0.232	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\ TH}$	$Q_{X\ TH}$ =	7.9	21.3	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	7.9	21.2	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	3.9	6.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.7	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	11.8	28.4	cfs
Average Flow Velocity Within the Gutter Section	V =	4.6	5.7	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	2.3	3.7	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	1.00	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**11.8**	**28.4**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	7.80	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	0.26	inches
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**11.8**	**25.2**	**cfs**

This calculation reflects the capacity of Meadowlark Drive to transfer the remaining 25.1 cfs that is not captured within the outfall trunkline. Per the calculations above, Meadowlark Drive is capable of conveying 25.2 cfs based on allowable spread criteria.

Weir Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Sep 6 2023

Meadowlark Low Point (100-YR Overtopping at Design Point 33)

Circular Weir

Crest	= Sharp
Diameter (ft)	= 277.00
Total Depth (ft)	= 138.50

Calculations

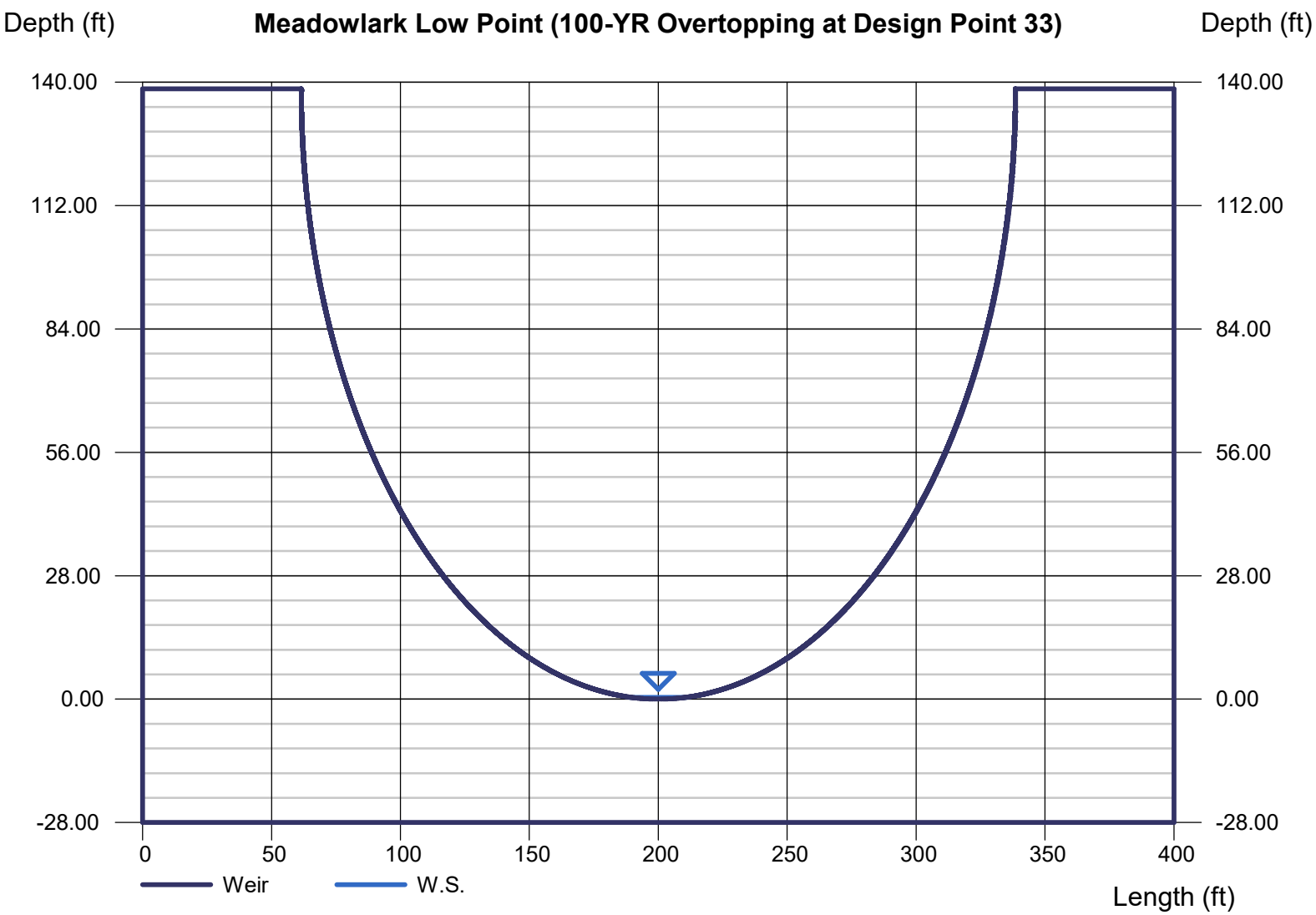
Weir Coeff. Cw	= 3.33
Compute by:	Known Depth
Known Depth (ft)	= 0.40

Highlighted

Depth (ft)	= 0.40
Q (cfs)	= 13.77
Area (sqft)	= 6.54
Velocity (ft/s)	= 2.11
Top Width (ft)	= 22.14

Available ponding depth above the low point within Meadowlark Drive that results in a 1-ft ponding depth at Inlet 1

12.5 cfs required to pass over Meadowlark Drive during a 100-Year Event. Capacity is good.



Program:
UDSEWER Math Model Interface 2.1.1.4
Run Date:
8/15/2023 1:09:10 PM

UDSewer Results Summary

Project Title: WESTSIDE CROSSING - COMMERCIAL
Project Description: STORM 1.0_100-YR

Table of Contents
System Input
Manhole Input
Manhole Output
Sewer Input
Sewer Flow
Sewer Sizing
EGL/HGL Summary

System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in):
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 5073.40

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
DETENTION BASIN 'A'	5074.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I-5 S-15	5075.65	34.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-1 S-14	5075.59	27.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I-4 S-13	5075.60	27.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I-3 S-12	5076.38	23.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I-2 S-11	5078.09	17.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I-1 S-10	5078.85	7.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
DETENTION BASIN 'A'	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
I-5 S-15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.50	
MH-1 S-14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.20	
I-4 S-13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.20	
I-3 S-12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.70	
I-2 S-11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.40	
I-1 S-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.30	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
I-5 S-15	18.40	5070.76	0.5	5070.85	0.013	0.00	0.00	CIRCULAR	30.00 in	30.00 in
MH-1 S-14	121.50	5070.95	0.5	5071.55	0.013	0.05	0.00	ELLIPSE	24.00 in	38.00 in
I-4 S-13	13.00	5071.65	0.5	5071.71	0.013	1.58	0.00	ELLIPSE	24.00 in	38.00 in
I-3 S-12	158.90	5071.81	0.5	5072.53	0.013	1.32	0.00	ELLIPSE	24.00 in	38.00 in
I-2 S-11	134.40	5072.63	0.7	5073.61	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in
I-1 S-10	62.30	5073.71	1.9	5074.90	0.013	1.80	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
I-5 S-15	29.08	5.92	30.00	7.03	30.00	7.03	0.00	Pressurized	34.50	18.40	
MH-1 S-14	29.80	6.84	21.15	7.14	22.21	6.77	0.91	Pressurized	27.20	121.50	
I-4 S-13	28.83	6.62	21.15	7.14	22.81	6.58	0.86	Pressurized	27.20	13.00	
I-3 S-12	28.55	6.56	19.70	6.75	20.68	6.38	0.91	Pressurized	23.70	158.90	
I-2 S-11	19.37	6.17	18.04	6.87	17.77	6.98	1.03	Pressurized	17.40	134.40	
I-1 S-10	14.56	8.24	12.56	5.55	9.02	8.24	1.89	Pressurized	7.30	62.30	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
I-5 S-15	34.50	CIRCULAR	30.00 in	30.00 in	33.00 in	33.00 in	30.00 in	30.00 in	4.91	
MH-1 S-14	27.20	ELLIPSE	24.00 in	38.00 in	30.00 in	30.00 in	24.00 in	38.00 in	4.35	
I-4 S-13	27.20	ELLIPSE	24.00 in	38.00 in	30.00 in	30.00 in	24.00 in	38.00 in	4.35	
I-3 S-12	23.70	ELLIPSE	24.00 in	38.00 in	30.00 in	30.00 in	24.00 in	38.00 in	4.35	
I-2 S-11	17.40	CIRCULAR	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	3.14	
I-1 S-10	7.30	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

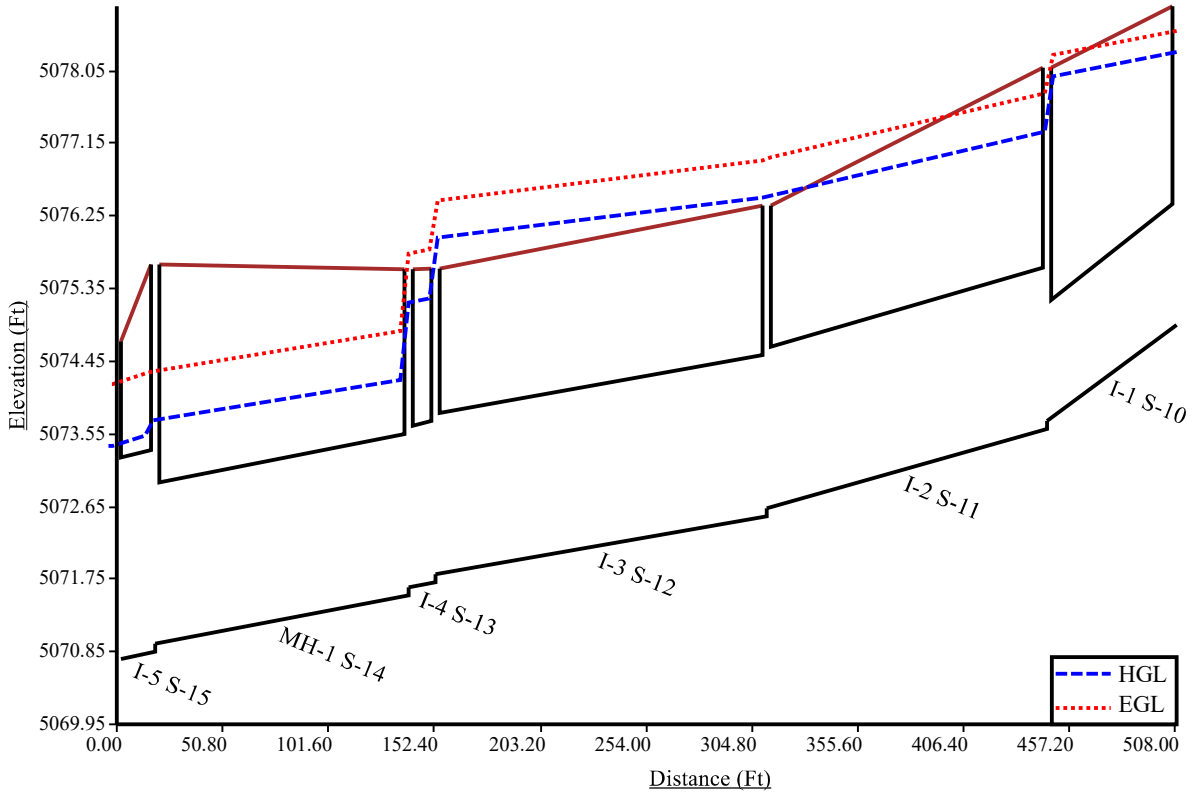
Grade Line Summary:

Tailwater Elevation (ft): 5073.40

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	**Downstream (ft)**	**Upstream (ft)**	**Bend Loss (ft)**	**Lateral Loss (ft)**	**Downstream (ft)**	**Upstream (ft)**	**Downstream (ft)**	**Friction Loss (ft)**	**Upstream (ft)**
I-5 S-15	5070.76	5070.85	0.00	0.00	5073.40	5073.53	5074.17	0.13	5074.30
MH-1 S-14	5070.95	5071.55	0.03	0.00	5073.72	5074.22	5074.33	0.50	5074.83
I-4 S-13	5071.65	5071.71	0.96	0.00	5075.18	5075.23	5075.78	0.05	5075.84
I-3 S-12	5071.81	5072.53	0.61	0.00	5075.98	5076.48	5076.44	0.50	5076.94
I-2 S-11	5072.63	5073.61	0.02	0.00	5076.50	5077.30	5076.98	0.79	5077.77
I-1 S-10	5073.71	5074.90	0.48	0.00	5077.98	5078.28	5078.25	0.30	5078.55

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

STORM 1.0_100-YR



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UDSewer Results Summary

Project Title: WESTSIDE CROSSING - COMMERCIAL
Project Description: STORM 1.0_10-YR

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System Input Summary

Rainfall Parameters

Rainfall Return Period: 10
Rainfall Calculation Method: Formula

One Hour Depth (in):
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 5072.64

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
DETENTION BASIN 'A'	5074.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I-5 S-15	5075.65	13.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-1 S-14	5075.59	10.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I-4 S-13	5075.60	10.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I-3 S-12	5076.38	9.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I-2 S-11	5078.09	6.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I-1 S-10	5078.85	2.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
DETENTION BASIN 'A'	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
I-5 S-15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.70	
MH-1 S-14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.70	
I-4 S-13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.70	
I-3 S-12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.30	
I-2 S-11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.70	
I-1 S-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.80	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
I-5 S-15	18.40	5070.76	0.5	5070.85	0.013	0.00	0.00	CIRCULAR	30.00 in	30.00 in
MH-1 S-14	121.50	5070.94	0.5	5071.55	0.013	0.05	0.00	ELLIPSE	24.00 in	38.00 in
I-4 S-13	13.00	5071.65	0.5	5071.71	0.013	1.58	0.00	ELLIPSE	24.00 in	38.00 in
I-3 S-12	158.90	5071.74	0.5	5072.53	0.013	1.32	0.00	ELLIPSE	24.00 in	38.00 in
I-2 S-11	134.40	5072.67	0.7	5073.61	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in
I-1 S-10	62.30	5073.72	1.9	5074.90	0.013	1.80	0.00	CIRCULAR	24.00 in	24.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
I-5 S-15	29.08	5.92	14.94	5.61	14.49	5.84	1.06	Supercritical	13.70	0.00	
MH-1 S-14	29.99	6.89	13.00	5.13	12.40	5.46	1.09	Supercritical	10.70	0.00	
I-4 S-13	29.99	6.89	13.00	5.13	12.40	5.46	1.09	Supercritical	10.70	0.00	
I-3 S-12	29.99	6.89	12.09	4.92	11.50	5.26	1.10	Supercritical	9.30	0.00	
I-2 S-11	18.98	6.04	11.01	4.77	9.85	5.52	1.24	Supercritical	6.70	0.00	
I-1 S-10	31.27	9.95	7.00	3.67	4.85	6.16	2.04	Supercritical	2.80	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
I-5 S-15	13.70	CIRCULAR	30.00 in	30.00 in	24.00 in	24.00 in	30.00 in	30.00 in	4.91	
MH-1 S-14	10.70	ELLIPSE	24.00 in	38.00 in	21.00 in	21.00 in	24.00 in	38.00 in	4.35	
I-4 S-13	10.70	ELLIPSE	24.00 in	38.00 in	21.00 in	21.00 in	24.00 in	38.00 in	4.35	
I-3 S-12	9.30	ELLIPSE	24.00 in	38.00 in	21.00 in	21.00 in	24.00 in	38.00 in	4.35	
I-2 S-11	6.70	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
I-1 S-10	2.80	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

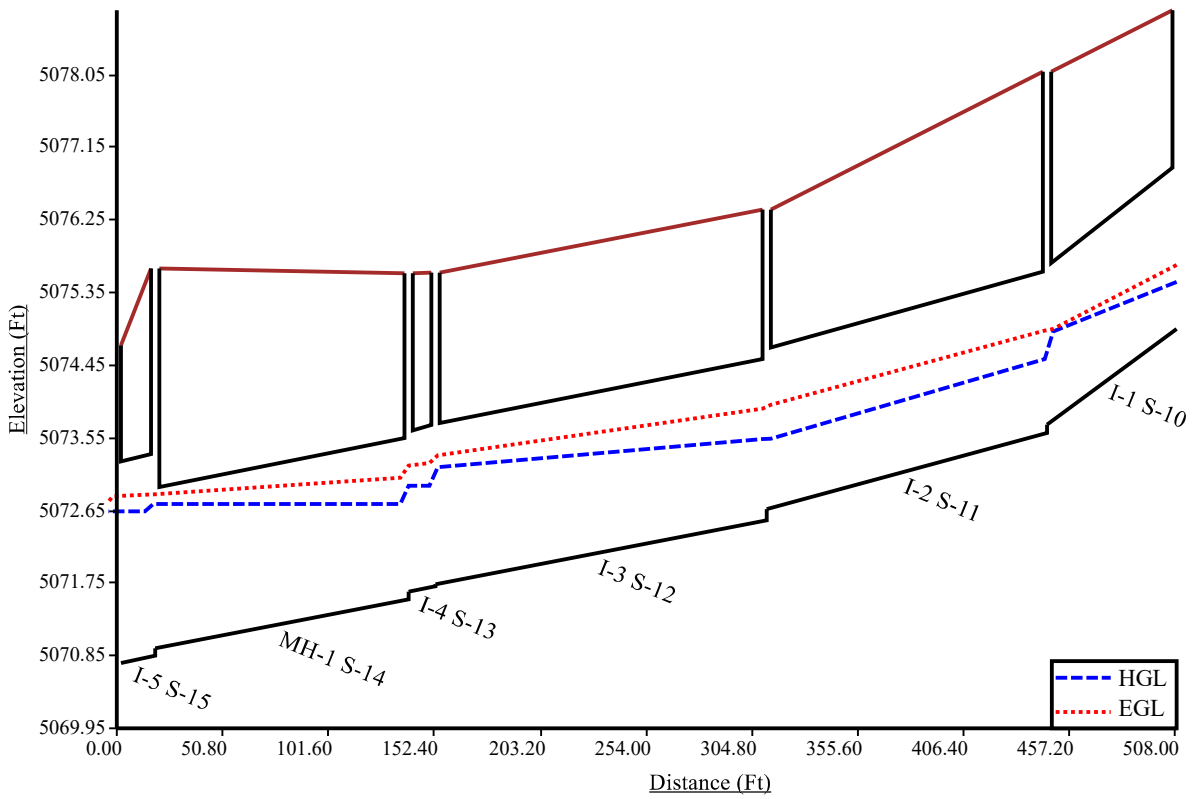
Grade Line Summary:

Tailwater Elevation (ft): 5072.64

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
I-5 S-15	5070.76	5070.85	0.00	0.00	5072.64	5072.64	5072.83	0.02	5072.85
MH-1 S-14	5070.94	5071.55	0.00	0.00	5072.73	5072.73	5072.85	0.21	5073.06
I-4 S-13	5071.65	5071.71	0.15	0.00	5072.96	5072.96	5073.21	0.03	5073.24
I-3 S-12	5071.74	5072.53	0.09	0.00	5073.19	5073.54	5073.33	0.58	5073.91
I-2 S-11	5072.67	5073.61	0.00	0.00	5073.54	5074.53	5073.96	0.92	5074.88
I-1 S-10	5073.72	5074.90	0.02	0.00	5074.87	5075.48	5074.90	0.79	5075.69

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

STORM 1.0_10-YR



Program:
UDSEWER Math Model Interface 2.1.1.4
Run Date:
8/16/2023 12:02:30 PM

UDSewer Results Summary

Project Title: WESTSIDE CROSSING - COMMERCIAL
Project Description: STORM 2.0_100YR

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System Input
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System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in):
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 5072.15

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
EX DRAINAGE SWALE	5073.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EX 18" RCP (2)	5073.88	6.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DRAINAGE INLET-2 S-21	5075.50	6.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S20	5075.59	6.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EX 18" RCP (1)	5075.91	6.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
EX DRAINAGE SWALE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
EX 18" RCP (2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.30	
DRAINAGE INLET-2 S-21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.30	
S20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.30	
EX 18" RCP (1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.30	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
EX 18" RCP (2)	58.10	5070.65	0.6	5070.98	0.013	0.00	0.00	CIRCULAR	18.00 in	18.00 in
DRAINAGE INLET-2 S-21	61.40	5070.98	0.5	5071.29	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in
S20	17.50	5071.40	0.5	5071.49	0.013	1.32	0.00	CIRCULAR	18.00 in	18.00 in
EX 18" RCP (1)	22.40	5071.49	4.5	5072.50	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
EX 18" RCP (2)	7.94	4.49	11.64	5.21	12.11	4.98	0.93	Subcritical Surcharged	6.30	0.04	
DRAINAGE INLET-2 S-21	7.48	4.24	11.64	5.21	12.65	4.75	0.85	Subcritical	6.30	0.00	
S20	7.57	4.28	11.64	5.21	12.55	4.79	0.86	Subcritical	6.30	0.00	
EX 18" RCP (1)	22.36	12.65	11.64	5.21	6.54	10.87	3.02	Supercritical	6.30	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
EX 18" RCP (2)	6.30	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
DRAINAGE INLET-2 S-21	6.30	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
S20	6.30	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
EX 18" RCP (1)	6.30	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

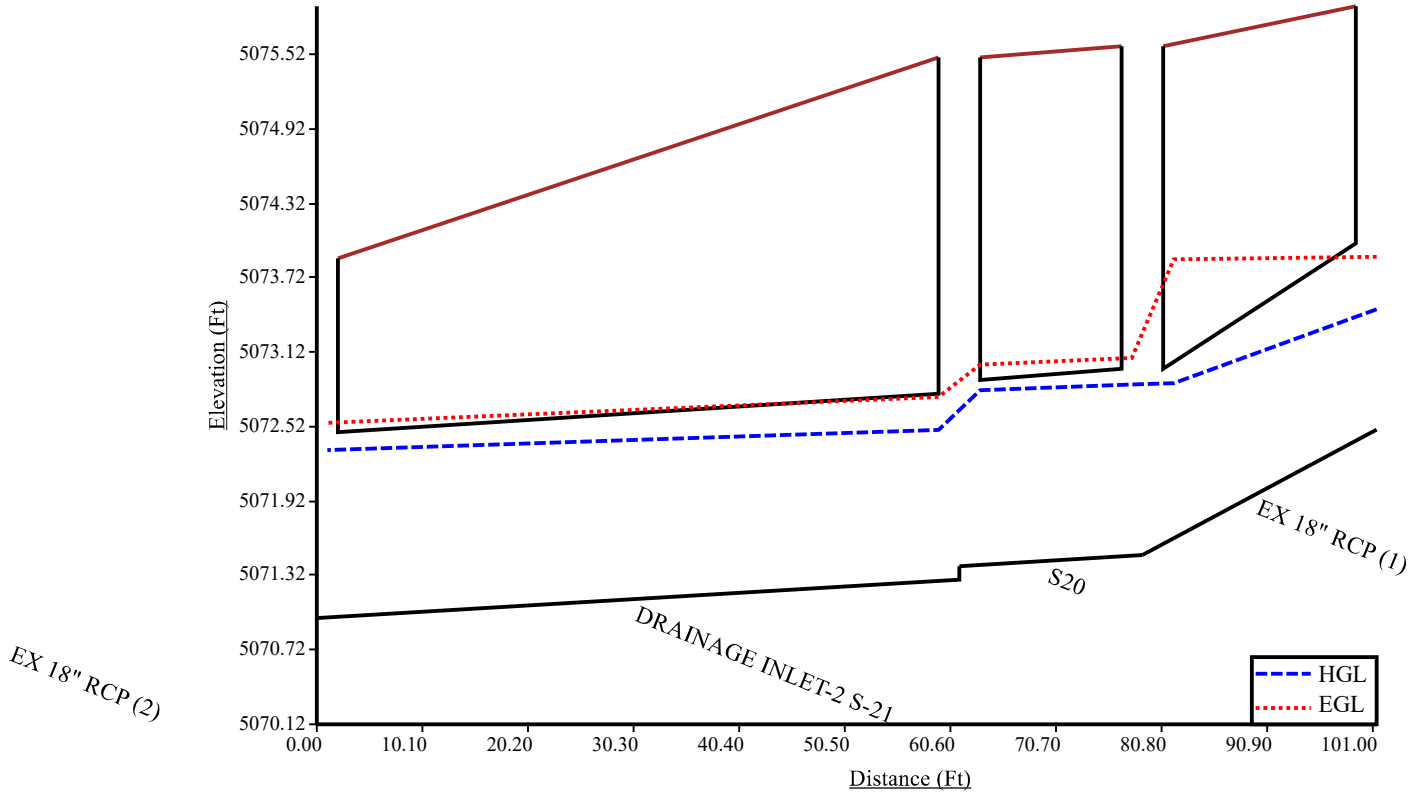
Grade Line Summary:

Tailwater Elevation (ft): 5072.15

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	**Downstream (ft)**	**Upstream (ft)**	**Bend Loss (ft)**	**Lateral Loss (ft)**	**Downstream (ft)**	**Upstream (ft)**	**Downstream (ft)**	**Friction Loss (ft)**	**Upstream (ft)**
EX 18" RCP (2)	5070.65	5070.98	0.00	0.00	5072.15	5072.32	5072.35	0.20	5072.54
DRAINAGE INLET-2 S-21	5070.98	5071.29	0.01	0.00	5072.33	5072.50	5072.55	0.21	5072.76
S20	5071.40	5071.49	0.26	0.00	5072.82	5072.86	5073.02	0.05	5073.08
EX 18" RCP (1)	5071.49	5072.50	0.01	0.00	5072.87	5073.47	5073.87	0.02	5073.89

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

STORM 2.0_100YR



Program:
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Run Date:
8/16/2023 12:06:48 PM

UDSewer Results Summary

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Project Description: STORM 2.0_10YR

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Rainfall Calculation Method: Formula

One Hour Depth (in):
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 5071.40

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
EX DRAINAGE SWALE	5073.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EX 18" RCP (2)	5073.88	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DRAINAGE INLET-2 S-21	5075.50	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S20	5075.59	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EX 18" RCP (1)	5075.91	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
EX DRAINAGE SWALE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
EX 18" RCP (2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.40	
DRAINAGE INLET-2 S-21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.40	
S20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.40	
EX 18" RCP (1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.40	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
EX 18" RCP (2)	58.10	5070.65	0.6	5070.98	0.013	0.00	0.00	CIRCULAR	18.00 in	18.00 in
DRAINAGE INLET-2 S-21	61.40	5070.98	0.5	5071.29	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in
S20	17.50	5071.40	0.5	5071.49	0.013	1.32	0.00	CIRCULAR	18.00 in	18.00 in
EX 18" RCP (1)	22.40	5071.49	4.5	5072.50	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
EX 18" RCP (2)	7.94	4.49	7.03	3.75	6.79	3.94	1.07	Supercritical	2.40	0.00	
DRAINAGE INLET-2 S-21	7.48	4.24	7.03	3.75	7.01	3.77	1.01	Supercritical	2.40	0.00	
S20	7.57	4.28	7.03	3.75	6.97	3.80	1.02	Supercritical	2.40	0.00	
EX 18" RCP (1)	22.36	12.65	7.03	3.75	3.98	8.26	3.01	Supercritical	2.40	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
EX 18" RCP (2)	2.40	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
DRAINAGE INLET-2 S-21	2.40	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
S20	2.40	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
EX 18" RCP (1)	2.40	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

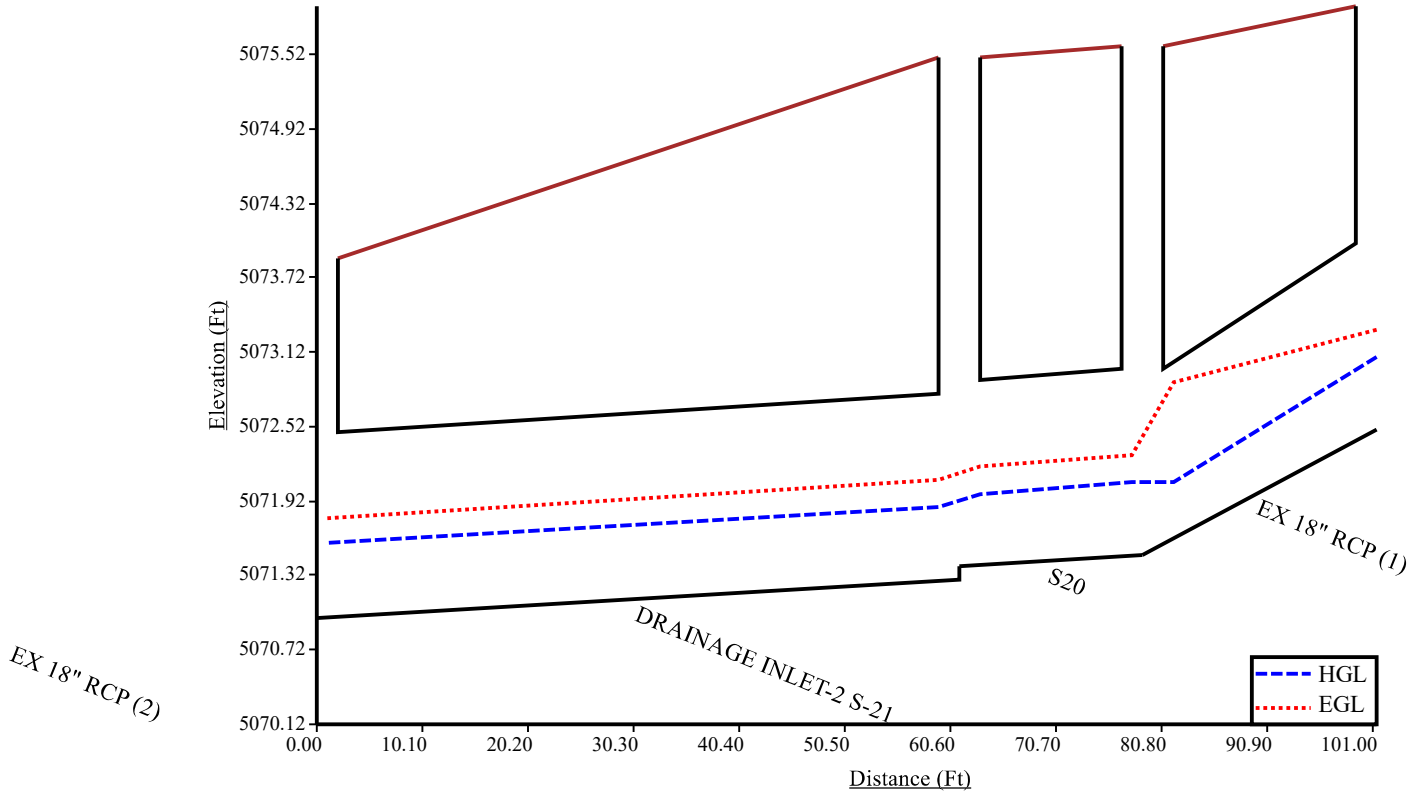
Grade Line Summary:

Tailwater Elevation (ft): 5071.40

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
EX 18" RCP (2)	5070.65	5070.98	0.00	0.00	5071.40	5071.57	5071.46	0.33	5071.78
DRAINAGE INLET-2 S-21	5070.98	5071.29	0.00	0.00	5071.59	5071.88	5071.79	0.31	5072.09
S20	5071.40	5071.49	0.04	0.00	5071.98	5072.08	5072.20	0.09	5072.29
EX 18" RCP (1)	5071.49	5072.50	0.00	0.00	5072.08	5073.09	5072.88	0.42	5073.30

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

STORM 2.0_10YR



Program:
UDSEWER Math Model Interface 2.1.1.4
Run Date:
8/15/2023 5:35:40 PM

UDSewer Results Summary

Project Title: WESTSIDE CROSSING - COMMERCIAL
Project Description: STORM 4.0_100YR

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System Input
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Sewer Flow
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System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in):
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 5073.40

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
DETENTION BASIN 'A'	5074.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S40	5074.70	18.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
DETENTION BASIN 'A'	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
S40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.20	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
S40	93.80	5070.88	0.6	5071.41	0.013	0.00	0.00	CIRCULAR	24.00 in	24.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
S40	17.06	5.43	24.00	5.79	24.00	5.79	0.00	Pressurized	18.20	93.80	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
S40	18.20	CIRCULAR	24.00 in	24.00 in	27.00 in	27.00 in	24.00 in	24.00 in	3.14	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

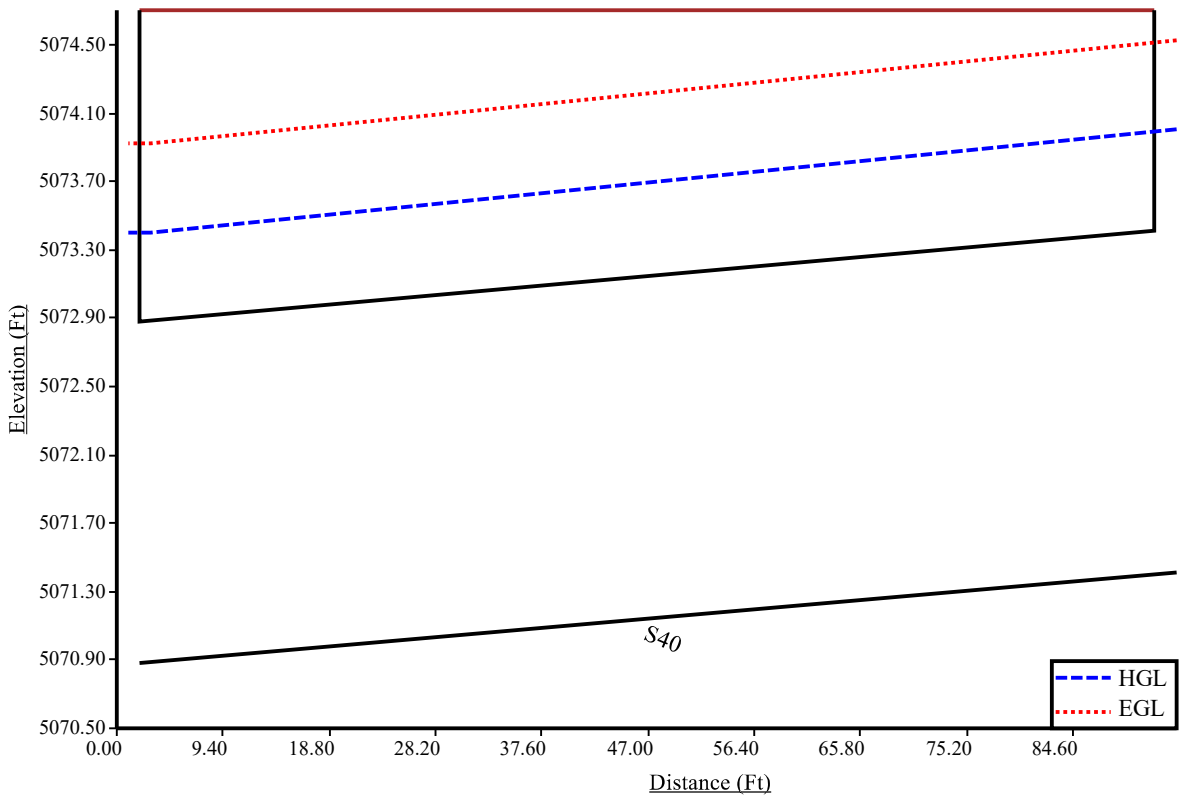
Grade Line Summary:

Tailwater Elevation (ft): 5073.40

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
S40	5070.88	5071.41	0.00	0.00	5073.40	5074.00	5073.92	0.60	5074.53

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

STORM 4.0_100YR



Program:
UDSEWER Math Model Interface 2.1.1.4
Run Date:
8/15/2023 5:44:35 PM

UDSewer Results Summary

Project Title: WESTSIDE CROSSING - COMMERCIAL
Project Description: STORM 4.0_10YR

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System Input Summary

Rainfall Parameters

Rainfall Return Period: 10
Rainfall Calculation Method: Formula

One Hour Depth (in):
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 5072.64

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
DETENTION BASIN 'A'	5074.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S40	5074.70	7.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
DETENTION BASIN 'A'	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
S40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.70	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
S40	93.80	5070.85	0.6	5071.41	0.013	0.00	0.00	CIRCULAR	24.00 in	24.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
S40	17.57	5.59	11.84	4.99	11.12	5.41	1.13	Supercritical	7.70	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
S40	7.70	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

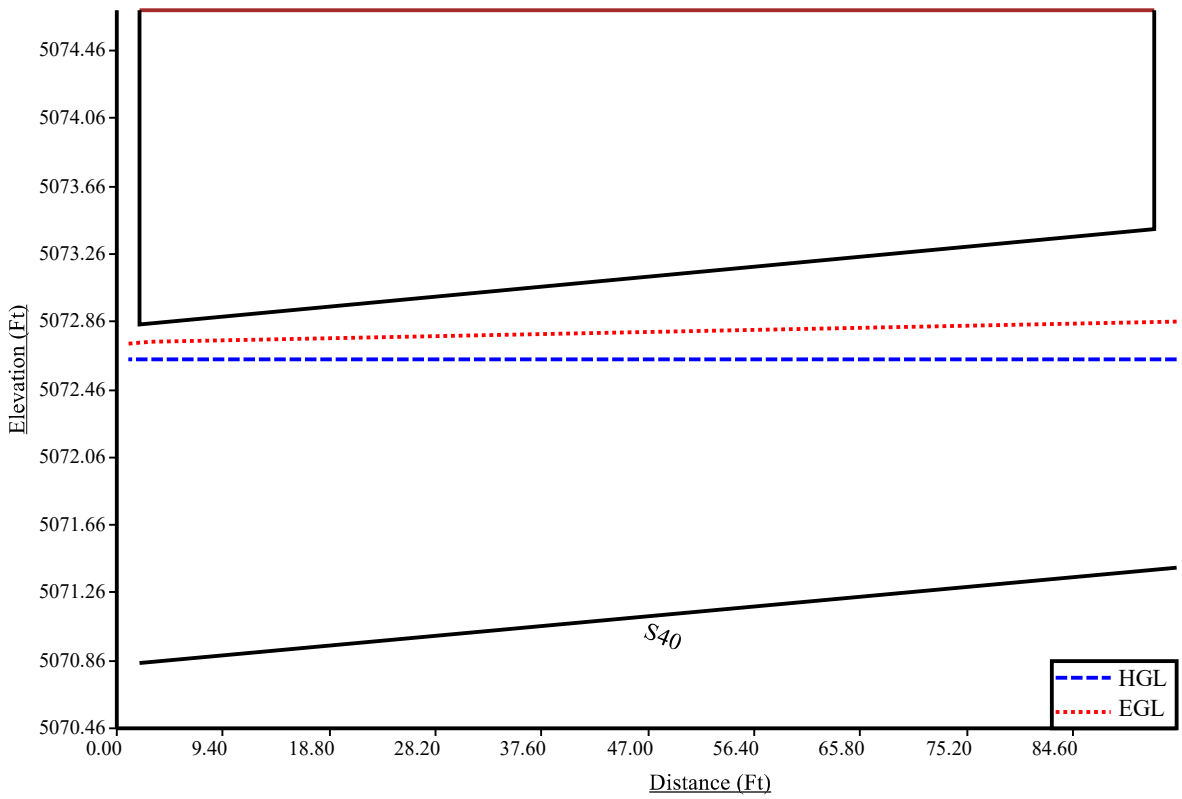
Grade Line Summary:

Tailwater Elevation (ft): 5072.64

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
S40	5070.85	5071.41	0.00	0.00	5072.64	5072.64	5072.74	0.12	5072.86

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

STORM 4.0_10YR



Program:
UDSEWER Math Model Interface 2.1.1.4
Run Date:
9/6/2023 9:51:28 AM

UDSewer Results Summary

Project Title: Westside Crossing-Phase II
Project Description: Outfall Trunkline-100YR

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System Input Summary

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in):
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 5069.17

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	5072.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EX MH-1 EX 42" RCP	5072.24	63.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-7 S8	5074.26	47.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-6 S7	5073.80	47.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DAP	5073.45	12.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-5 S6	5073.87	47.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-4 S5	5074.60	47.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-3 S4	5074.06	47.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-2 S3	5075.01	47.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DBP	5076.70	6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-1 S2	5076.82	47.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DCP	5076.70	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FES S1	5078.44	46.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-8 S31	5072.26	15.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INLET-1 S30	5071.80	12.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EX I-1 EX 18" RCP	5072.26	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
EX MH-1 EX 42" RCP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.13	
MH-7 S8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.63	

MH-6 S7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.63	
DAP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.70	
MH-5 S6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.63	
MH-4 S5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.63	
MH-3 S4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.63	
MH-2 S3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.63	
DBP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.90	
MH-1 S2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.63	
DCP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	
FES S1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.70	
MH-8 S31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.50	
INLET-1 S30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.60	
EX I-1 EX 18" RCP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.90	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	**Sewer Length (ft)**	**Downstream Invert (ft)**	**Slope (%)**	**Upstream Invert (ft)**	**Mannings n**	**Bend Loss**	**Lateral Loss**	**Cross Section**	**Rise (ft or in)**	**Span (ft or in)**
EX MH-1 EX 42" RCP	37.00	5067.42	0.5	5067.60	0.013	0.00	0.00	CIRCULAR	42.00 in	42.00 in
MH-7 S8	108.80	5067.94	0.7	5068.70	0.013	0.05	0.28	ELLIPSE	34.00 in	53.25 in
MH-6 S7	105.20	5068.76	0.3	5069.08	0.013	0.95	0.25	ELLIPSE	34.00 in	53.25 in
DAP	8.80	5070.60	2.0	5070.78	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in
MH-5 S6	85.70	5069.07	0.3	5069.33	0.013	0.05	0.25	ELLIPSE	34.00 in	53.25 in
MH-4 S5	30.00	5069.38	0.3	5069.47	0.013	0.49	0.00	ELLIPSE	34.00 in	53.25 in
MH-3 S4	106.30	5069.49	0.3	5069.81	0.013	0.71	0.00	ELLIPSE	34.00 in	53.25 in
MH-2 S3	183.30	5069.85	0.3	5070.40	0.013	0.06	0.00	ELLIPSE	34.00 in	53.25 in
DBP	13.00	5071.00	0.9	5071.12	0.013	1.00	0.00	CIRCULAR	18.00 in	18.00 in
MH-1 S2	387.30	5070.44	0.3	5071.60	0.013	0.05	0.25	ELLIPSE	29.00 in	45.00 in

DCP	11.50	5072.20	0.9	5072.30	0.013	1.00	0.00	CIRCULAR	18.00 in	18.00 in
FES S1	308.20	5071.59	0.3	5072.51	0.013	0.05	0.25	ELLIPSE	29.00 in	45.00 in
MH-8 S31	110.30	5067.86	0.3	5068.19	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in
INLET-1 S30	57.10	5068.19	0.7	5068.59	0.013	0.91	0.00	CIRCULAR	24.00 in	24.00 in
EX I-1 EX 18" RCP	16.44	5068.19	0.3	5068.24	0.013	0.05	0.27	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	**Flow (cfs)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Froude Number**	**Flow Condition**	**Flow (cfs)**	**Surcharged Length (ft)**	**Comment**
EX MH-1 EX 42" RCP	71.33	7.41	29.88	8.62	30.72	8.37	0.95	Subcritical	63.13	0.00	
MH-7 S8	88.88	10.24	25.56	7.54	22.07	9.04	1.32	Pressurized	47.63	108.80	
MH-6 S7	58.19	6.70	25.56	7.54	28.95	6.51	0.79	Pressurized	47.63	105.20	
DAP	14.90	8.43	16.09	7.62	12.78	9.47	1.68	Pressurized	12.70	8.80	
MH-5 S6	58.19	6.70	25.56	7.54	28.95	6.51	0.79	Pressurized	47.63	85.70	
MH-4 S5	58.19	6.70	25.56	7.54	28.95	6.51	0.79	Pressurized	47.63	30.00	
MH-3 S4	58.19	6.70	25.56	7.54	28.95	6.51	0.79	Pressurized	47.63	106.30	
MH-2 S3	58.19	6.70	25.56	7.54	28.95	6.51	0.79	Pressurized	47.63	183.30	
DBP	9.99	5.65	12.20	5.41	11.00	6.10	1.22	Pressurized	6.90	13.00	
MH-1 S2	37.73	6.01	29.00	7.59	29.00	7.59	0.00	Pressurized	47.63	387.30	
DCP	9.99	5.65	13.15	5.78	12.19	6.28	1.16	Pressurized	8.00	11.50	
FES S1	37.73	6.01	29.00	7.44	29.00	7.44	0.00	Pressurized	46.70	308.20	
MH-8 S31	12.42	3.95	24.00	4.93	24.00	4.93	0.00	Pressurized	15.50	110.30	
INLET-1 S30	18.98	6.04	15.32	5.95	14.29	6.46	1.14	Pressurized	12.60	57.10	
EX I-1 EX 18" RCP	5.77	3.26	7.76	3.98	9.03	3.27	0.75	Pressurized	2.90	16.44	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
EX MH-1 EX 42" RCP	63.13	CIRCULAR	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	9.62	
MH-7 S8	47.63	ELLIPSE	34.00 in	53.25 in	36.00 in	36.00 in	34.00 in	53.25 in	8.68	
MH-6 S7	47.63	ELLIPSE	34.00 in	53.25 in	42.00 in	42.00 in	34.00 in	53.25 in	8.68	
DAP	12.70	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
MH-5 S6	47.63	ELLIPSE	34.00 in	53.25 in	42.00 in	42.00 in	34.00 in	53.25 in	8.68	
MH-4 S5	47.63	ELLIPSE	34.00 in	53.25 in	42.00 in	42.00 in	34.00 in	53.25 in	8.68	
MH-3 S4	47.63	ELLIPSE	34.00 in	53.25 in	42.00 in	42.00 in	34.00 in	53.25 in	8.68	
MH-2 S3	47.63	ELLIPSE	34.00 in	53.25 in	42.00 in	42.00 in	34.00 in	53.25 in	8.68	
DBP	6.90	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
MH-1 S2	47.63	ELLIPSE	29.00 in	45.00 in	42.00 in	42.00 in	29.00 in	45.00 in	6.28	
DCP	8.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
FES S1	46.70	ELLIPSE	29.00 in	45.00 in	42.00 in	42.00 in	29.00 in	45.00 in	6.28	
MH-8 S31	15.50	CIRCULAR	24.00 in	24.00 in	27.00 in	27.00 in	24.00 in	24.00 in	3.14	
INLET-1 S30	12.60	CIRCULAR	24.00 in	24.00 in	21.00 in	21.00 in	24.00 in	24.00 in	3.14	
EX I-1 EX 18" RCP	2.90	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 5069.17

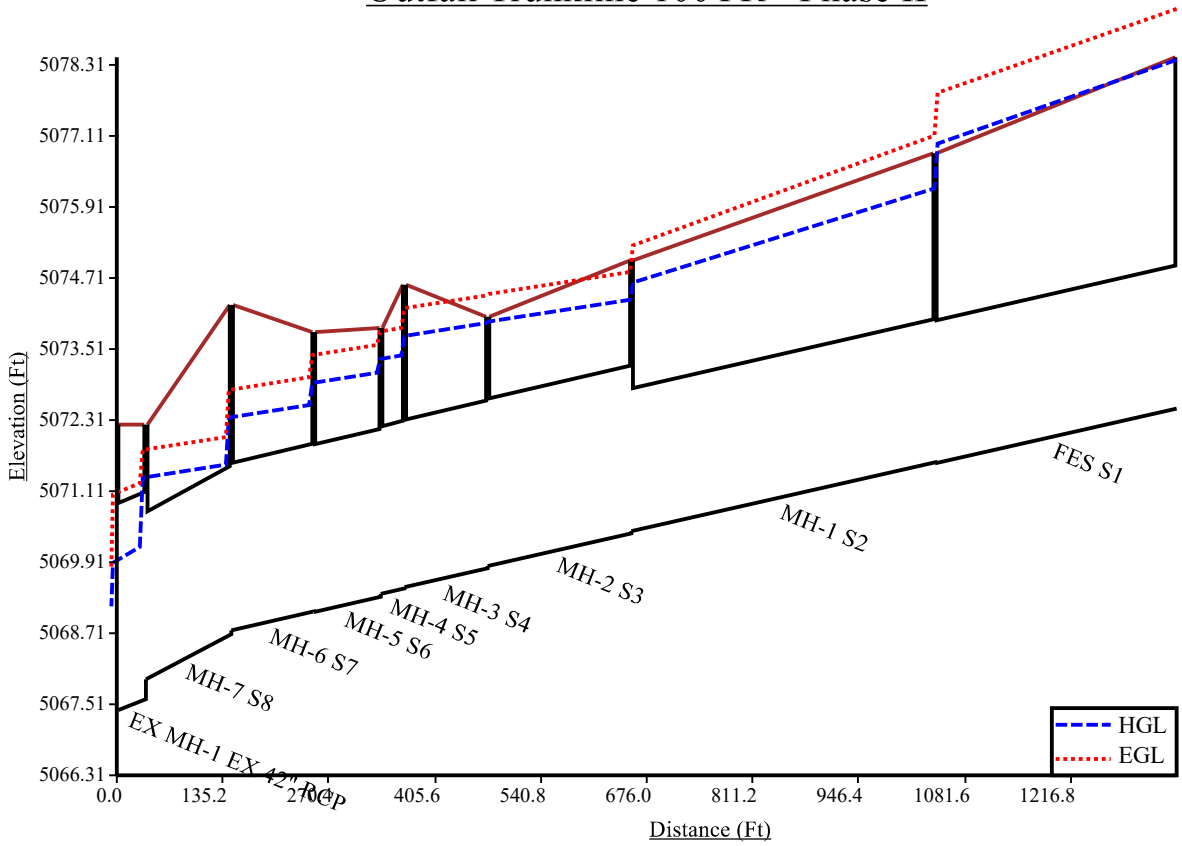
	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
EX MH-1 EX 42" RCP	5067.42	5067.60	0.00	0.00	5069.91	5070.17	5071.06	0.19	5071.25
MH-7 S8	5067.94	5068.70	0.02	0.54	5071.34	5071.56	5071.81	0.22	5072.03
MH-6 S7	5068.76	5069.08	0.44	0.35	5072.36	5072.57	5072.82	0.21	5073.04
DAP	5070.60	5070.78	0.04	0.00	5072.61	5072.74	5073.41	0.13	5073.54
MH-5 S6	5069.07	5069.33	0.02	0.35	5072.94	5073.11	5073.41	0.17	5073.58
MH-4 S5	5069.38	5069.47	0.23	0.00	5073.34	5073.40	5073.81	0.06	5073.87
MH-3 S4	5069.49	5069.81	0.33	0.00	5073.74	5073.95	5074.20	0.21	5074.42
MH-2 S3	5069.85	5070.40	0.03	0.00	5073.98	5074.35	5074.45	0.37	5074.81
DBP	5071.00	5071.12	0.24	0.00	5074.81	5074.87	5075.05	0.06	5075.11
MH-1 S2	5070.44	5071.60	0.04	0.24	5074.64	5076.23	5075.27	1.85	5077.12
DCP	5072.20	5072.30	0.32	0.00	5077.12	5077.19	5077.44	0.07	5077.50
FES S1	5071.59	5072.51	0.04	0.68	5076.98	**5078.40**	5077.84	1.42	5079.26
MH-8 S31	5067.86	5068.19	0.02	0.00	5070.89	5071.41	5071.27	0.52	5071.78
INLET-1 S30	5068.19	5068.59	0.23	0.00	5071.76	5071.94	5072.01	0.18	5072.19
EX I-1 EX 18" RCP	5068.19	5068.24	0.00	0.37	5072.11	5072.12	5072.15	0.01	5072.17

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Note:

A Peak Flow Rate of 47.63 cfs was chosen for the 100-YR flow through the Trunkline Outfall as this resulted in an HGL elevation of 5078.40 at the upstream flared end section. This elevation is reflects the adjacent as-built top-of-curb elevation where flows overtop and enter Meadowlark Avenue at Design Point 30 (see Proposed Conditions Drainage Map, Exhibit B, located in the appendix of this report). All remaining flows that aren't anticipated to enter the Trunkline Outfall system will enter Meadowlark Ave. and be analyzed using allowable street capacities per Town of Berthoud Design and Construction Specifications, Section 602.4 (C).

Outfall Trunkline 100YR - Phase II



Program:
UDSEWER Math Model Interface 2.1.1.4
Run Date:
9/6/2023 9:16:19 AM

UDSewer Results Summary

Project Title: Westside Crossing-Phase II
Project Description: Outfall Trunkline-10YR

Table of Contents

System Input
Manhole Input
Manhole Output
Sewer Input
Sewer Flow
Sewer Sizing
EGL/HGL Summary

System Input Summary

Rainfall Parameters

Rainfall Return Period: 10
Rainfall Calculation Method: Formula

One Hour Depth (in):
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 5068.58

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	5072.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EX MH-1 EX 42" RCP	5072.24	23.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-7 S8	5074.26	21.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-6 S7	5073.80	21.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DAP	5073.45	12.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-5 S6	5073.87	21.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-4 S5	5074.60	21.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-3 S4	5074.06	21.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-2 S3	5075.01	21.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DBP	5076.70	6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-1 S2	5076.82	20.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DCP	5076.70	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FES S1	5078.00	19.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MH-8 S31	5072.26	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INLET-1 S30	5071.80	3.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EX I-1 EX 18" RCP	5072.26	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
EX MH-1 EX 42" RCP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.30	
MH-7 S8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.60	

MH-6 S7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.60	
DAP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.70	
MH-5 S6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.10	
MH-4 S5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.10	
MH-3 S4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.10	
MH-2 S3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.10	
DBP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.90	
MH-1 S2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.30	
DCP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	
FES S1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.60	
MH-8 S31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.30	
INLET-1 S30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.10	
EX I-1 EX 18" RCP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	**Sewer Length (ft)**	**Downstream Invert (ft)**	**Slope (%)**	**Upstream Invert (ft)**	**Mannings n**	**Bend Loss**	**Lateral Loss**	**Cross Section**	**Rise (ft or in)**	**Span (ft or in)**
EX MH-1 EX 42" RCP	37.00	5067.42	0.5	5067.60	0.013	0.00	0.00	CIRCULAR	42.00 in	42.00 in
MH-7 S8	108.80	5067.94	0.7	5068.70	0.013	0.05	0.28	ELLIPSE	34.00 in	53.25 in
MH-6 S7	105.20	5068.76	0.3	5069.08	0.013	0.95	0.25	ELLIPSE	34.00 in	53.25 in
DAP	8.80	5070.60	2.0	5070.78	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in
MH-5 S6	85.70	5069.07	0.3	5069.33	0.013	0.05	0.25	ELLIPSE	34.00 in	53.25 in
MH-4 S5	30.00	5069.38	0.3	5069.47	0.013	0.49	0.00	ELLIPSE	34.00 in	53.25 in
MH-3 S4	106.30	5069.49	0.3	5069.81	0.013	0.71	0.00	ELLIPSE	34.00 in	53.25 in
MH-2 S3	183.30	5069.85	0.3	5070.40	0.013	0.06	0.00	ELLIPSE	34.00 in	53.25 in
DBP	13.00	5071.00	0.9	5071.12	0.013	1.00	0.00	CIRCULAR	18.00 in	18.00 in
MH-1 S2	387.30	5070.44	0.3	5071.60	0.013	0.05	0.25	ELLIPSE	29.00 in	45.00 in

DCP	11.50	5072.20	0.9	5072.30	0.013	1.00	0.00	CIRCULAR	18.00 in	18.00 in
FES S1	308.20	5071.59	0.3	5072.51	0.013	0.05	0.25	ELLIPSE	29.00 in	45.00 in
MH-8 S31	110.30	5067.86	0.3	5068.19	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in
INLET-1 S30	57.10	5068.19	0.7	5068.59	0.013	0.91	0.00	CIRCULAR	24.00 in	24.00 in
EX I-1 EX 18" RCP	16.44	5068.19	0.3	5068.24	0.013	0.05	0.27	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	**Flow (cfs)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Froude Number**	**Flow Condition**	**Flow (cfs)**	**Surcharged Length (ft)**	**Comment**
EX MH-1 EX 42" RCP	71.33	7.41	17.79	6.01	16.52	6.63	1.15	Supercritical	23.30	0.00	
MH-7 S8	88.88	10.24	16.91	5.81	14.27	7.32	1.39	Supercritical	21.60	0.00	
MH-6 S7	58.19	6.70	16.91	5.81	17.91	5.38	0.90	Subcritical	21.60	0.00	
DAP	14.90	8.43	16.09	7.62	12.78	9.47	1.68	Supercritical	12.70	0.00	
MH-5 S6	58.19	6.70	16.70	5.77	17.68	5.35	0.90	Subcritical	21.10	0.00	
MH-4 S5	58.19	6.70	16.70	5.77	17.68	5.35	0.90	Subcritical	21.10	0.00	
MH-3 S4	58.19	6.70	16.70	5.77	17.68	5.35	0.90	Subcritical	21.10	0.00	
MH-2 S3	58.19	6.70	16.70	5.77	17.68	5.35	0.90	Subcritical	21.10	0.00	
DBP	9.99	5.65	12.20	5.41	11.00	6.10	1.22	Supercritical	6.90	0.00	
MH-1 S2	37.73	6.01	17.21	5.97	18.83	5.32	0.84	Subcritical	20.30	0.00	
DCP	9.99	5.65	13.15	5.78	12.19	6.28	1.16	Supercritical	8.00	0.00	
FES S1	37.73	6.01	16.90	5.90	18.44	5.27	0.85	Subcritical	19.60	0.00	
MH-8 S31	12.42	3.95	8.74	4.16	9.74	3.59	0.81	Subcritical	4.30	0.00	
INLET-1 S30	18.98	6.04	7.38	3.78	6.56	4.45	1.26	Supercritical	3.10	0.00	
EX I-1 EX 18" RCP	5.77	3.26	4.91	3.07	5.57	2.58	0.78	Subcritical Surcharged	1.20	6.26	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
EX MH-1 EX 42" RCP	23.30	CIRCULAR	42.00 in	42.00 in	30.00 in	30.00 in	42.00 in	42.00 in	9.62	
MH-7 S8	21.60	ELLIPSE	34.00 in	53.25 in	27.00 in	27.00 in	34.00 in	53.25 in	8.68	
MH-6 S7	21.60	ELLIPSE	34.00 in	53.25 in	30.00 in	30.00 in	34.00 in	53.25 in	8.68	
DAP	12.70	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
MH-5 S6	21.10	ELLIPSE	34.00 in	53.25 in	30.00 in	30.00 in	34.00 in	53.25 in	8.68	
MH-4 S5	21.10	ELLIPSE	34.00 in	53.25 in	30.00 in	30.00 in	34.00 in	53.25 in	8.68	
MH-3 S4	21.10	ELLIPSE	34.00 in	53.25 in	30.00 in	30.00 in	34.00 in	53.25 in	8.68	
MH-2 S3	21.10	ELLIPSE	34.00 in	53.25 in	30.00 in	30.00 in	34.00 in	53.25 in	8.68	
DBP	6.90	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
MH-1 S2	20.30	ELLIPSE	29.00 in	45.00 in	30.00 in	30.00 in	29.00 in	45.00 in	6.28	
DCP	8.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
FES S1	19.60	ELLIPSE	29.00 in	45.00 in	30.00 in	30.00 in	29.00 in	45.00 in	6.28	
MH-8 S31	4.30	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
INLET-1 S30	3.10	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
EX I-1 EX 18" RCP	1.20	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

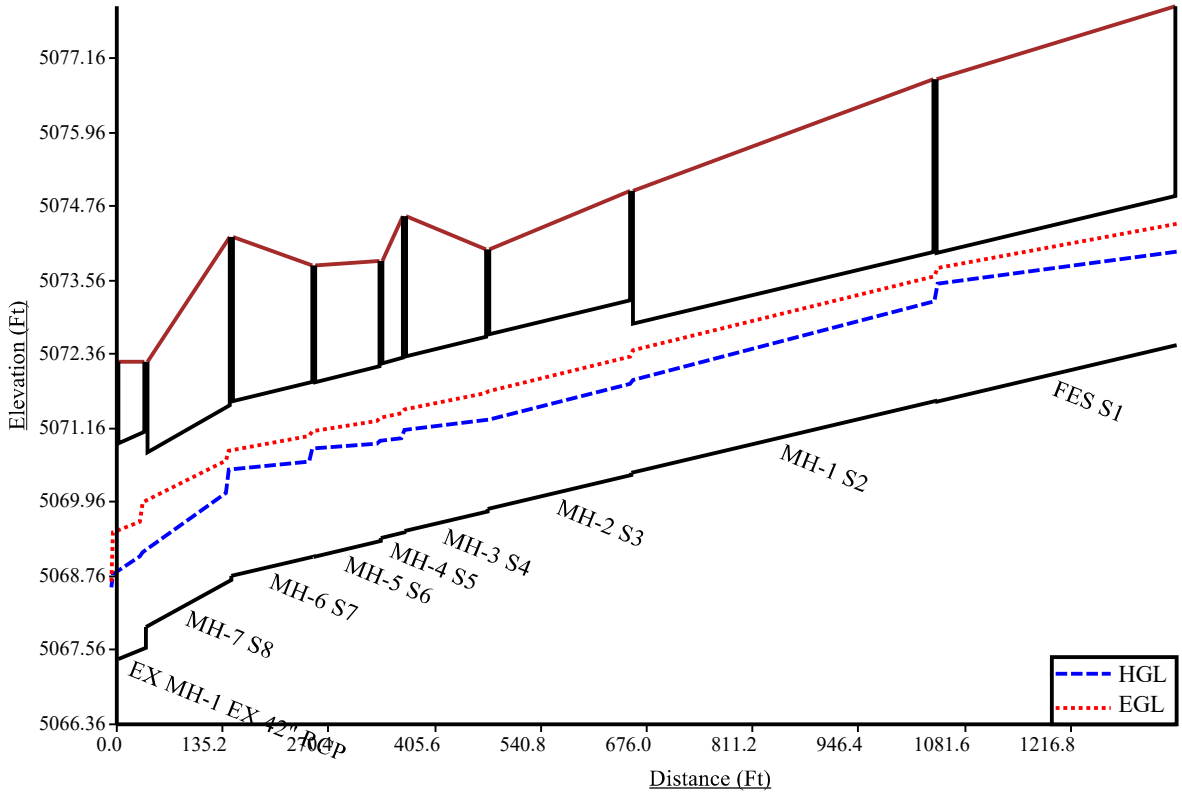
Grade Line Summary:

Tailwater Elevation (ft): 5068.58

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
EX MH-1 EX 42" RCP	5067.42	5067.60	0.00	0.00	5068.79	5069.08	5069.47	0.17	5069.64
MH-7 S8	5067.94	5068.70	0.00	0.06	5069.15	5070.11	5069.96	0.67	5070.63
MH-6 S7	5068.76	5069.08	0.09	0.07	5070.49	5070.62	5070.80	0.24	5071.03
DAP	5070.60	5070.78	0.04	0.00	5071.80	5072.12	5072.90	0.13	5073.02
MH-5 S6	5069.07	5069.33	0.00	0.07	5070.83	5070.91	5071.11	0.17	5071.28
MH-4 S5	5069.38	5069.47	0.04	0.00	5070.96	5071.00	5071.33	0.07	5071.40
MH-3 S4	5069.49	5069.81	0.07	0.00	5071.13	5071.29	5071.47	0.26	5071.73
MH-2 S3	5069.85	5070.40	0.01	0.00	5071.30	5071.88	5071.76	0.56	5072.32
DBP	5071.00	5071.12	0.24	0.00	5072.26	5072.26	5072.56	0.06	5072.62
MH-1 S2	5070.44	5071.60	0.01	0.05	5071.94	5073.22	5072.43	1.20	5073.62
DCP	5072.20	5072.30	0.32	0.00	5073.61	5073.61	5073.94	0.04	5073.98
FES S1	5071.59	5072.51	0.01	0.12	5073.51	5074.02	5073.76	0.72	5074.47
MH-8 S31	5067.86	5068.19	0.00	0.00	5069.61	5069.64	5069.64	0.04	5069.69
INLET-1 S30	5068.19	5068.59	0.01	0.00	5069.68	5069.68	5069.70	0.03	5069.73
EX I-1 EX 18" RCP	5068.19	5068.24	0.00	0.03	5069.71	5069.71	5069.72	0.00	5069.72

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Outfall Trunkline 10YR - Phase II



APPENDIX D

Relevant Pages from other Drainage Studies

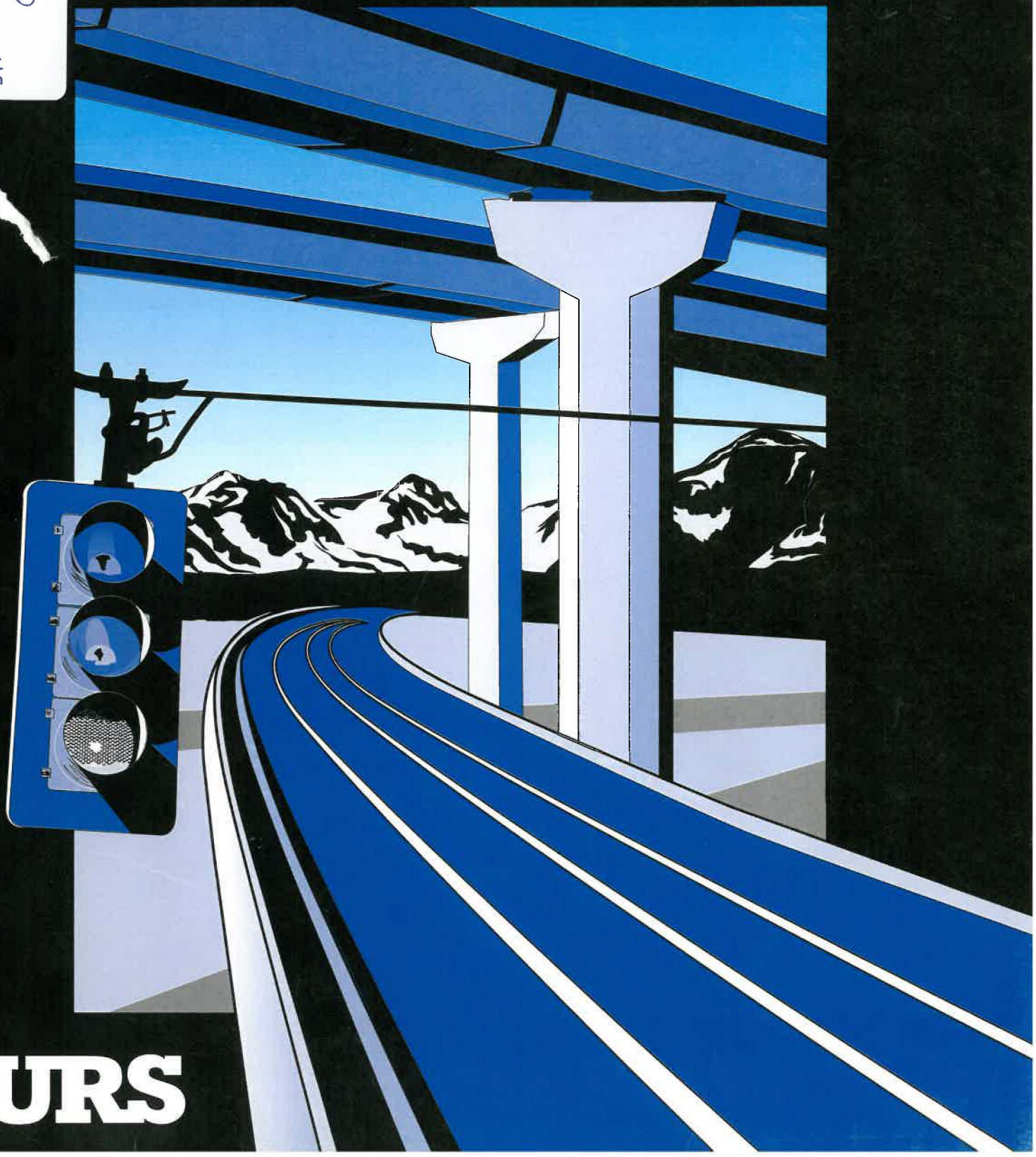
January 2002 / Revised October 2002

U.S. Highway 287 Berthoud Bypass Segment #2
Final Hydrology & Hydraulics Report

CDOT Project No. NH2873-114

SH287 UR 2002
Copy 2

Colorado Department of Transportation
Region 4 • 1420 Second Street • Greeley, Colorado • 80631



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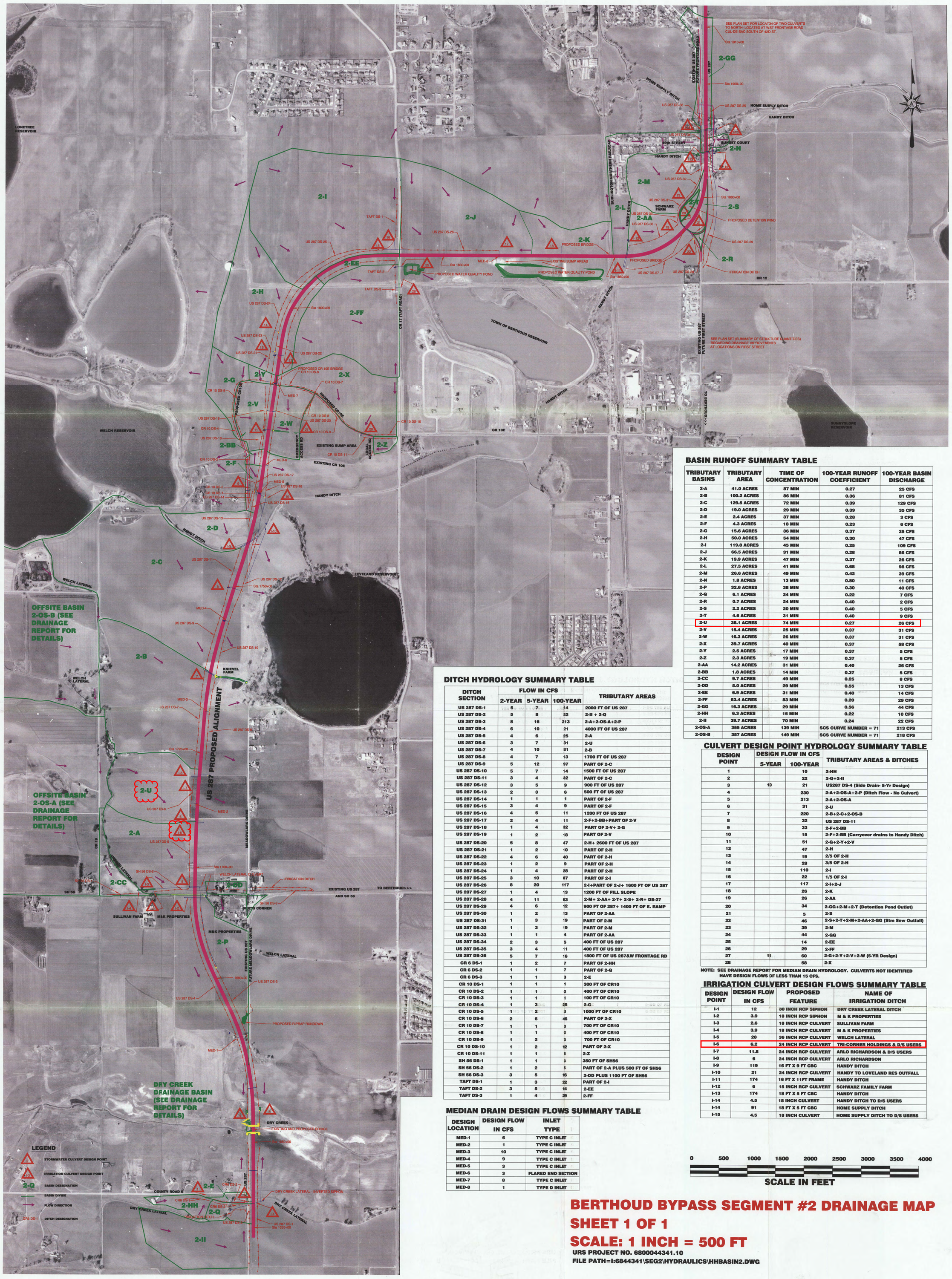

BASIN RUNOFF SUMMARY TABLE

TRIBUTARY BASINS	TRIBUTARY AREA	TIME OF CONCENTRATION	100-YEAR RUNOFF COEFFICIENT	100-YEAR BASIN DISCHARGE
2-A	41.0 ACRES	87 MIN	0.27	25 CFS
2-B	100.2 ACRES	86 MIN	0.36	81 CFS
2-C	129.5 ACRES	72 MIN	0.39	129 CFS
2-D	19.0 ACRES	29 MIN	0.39	35 CFS
2-E	2.4 ACRES	37 MIN	0.28	3 CFS
2-F	4.3 ACRES	18 MIN	0.23	6 CFS
2-G	15.6 ACRES	36 MIN	0.37	25 CFS
2-H	50.0 ACRES	54 MIN	0.30	47 CFS
2-I	119.8 ACRES	45 MIN	0.25	109 CFS
2-J	66.5 ACRES	31 MIN	0.28	86 CFS
2-K	19.9 ACRES	47 MIN	0.37	26 CFS
2-L	27.5 ACRES	41 MIN	0.68	98 CFS
2-M	26.6 ACRES	49 MIN	0.42	39 CFS
2-N	1.8 ACRES	13 MIN	0.80	11 CFS
2-P	32.6 ACRES	38 MIN	0.30	40 CFS
2-Q	6.1 ACRES	24 MIN	0.22	7 CFS
2-R	0.7 ACRES	24 MIN	0.40	2 CFS
2-S	2.2 ACRES	20 MIN	0.40	5 CFS
2-T	4.6 ACRES	31 MIN	0.40	9 CFS
2-U	38.1 ACRES	74 MIN	0.27	26 CFS
2-V	15.4 ACRES	25 MIN	0.37	31 CFS
2-W	16.3 ACRES	26 MIN	0.37	31 CFS
2-X	39.7 ACRES	40 MIN	0.37	58 CFS
2-Y	2.5 ACRES	17 MIN	0.37	5 CFS
2-Z	2.3 ACRES	19 MIN	0.37	5 CFS
2-AA	14.2 ACRES	31 MIN	0.40	26 CFS
2-BB	1.8 ACRES	14 MIN	0.37	5 CFS
2-CC	9.7 ACRES	49 MIN	0.25	8 CFS
2-DD	5.0 ACRES	29 MIN	0.55	13 CFS
2-EE	6.9 ACRES	31 MIN	0.40	14 CFS
2-FF	63.4 ACRES	83 MIN	0.20	29 CFS
2-GG	16.3 ACRES	29 MIN	0.56	44 CFS
2-HH	6.3 ACRES	16 MIN	0.22	10 CFS
2-II	39.7 ACRES	70 MIN	0.24	22 CFS
2-OS-A	355 ACRES	139 MIN	SCS CURVE NUMBER = 71	213 CFS
2-OS-B	357 ACRES	149 MIN	SCS CURVE NUMBER = 71	218 CFS

DITCH HYDROLOGY SUMMARY TABLE

DITCH SECTION	FLOW IN CFS			TRIBUTARY AREAS
	2-YEAR	5-YEAR	100-YEAR	
US 287 DS-1	5	7	14	2000 FT OF US 287
US 287 DS-2	5	8	22	2-II + 2-Q
US 287 DS-3	8	16	213	2-A+2-OS-A+2-P
US 287 DS-4	6	10	21	4000 FT OF US 287
US 287 DS-5	4	6	25	2-A
US 287 DS-6	3	7	31	2-U
US 287 DS-7	4	10	81	2-B
US 287 DS-8	4	7	13	1700 FT OF US 287
US 287 DS-9	5	12	97	PART OF 2-C
US 287 DS-10	5	7	14	1500 FT OF US 287
US 287 DS-11	3	4	32	PART OF 2-C
US 287 DS-12	3	5	9	900 FT OF US 287
US 287 DS-13	2	3	6	500 FT OF US 287
US 287 DS-14	1	1	1	PART OF 2-F
US 287 DS-15	3	4	9	PART OF 2-F
US 287 DS-16	4	5	11	1200 FT OF US 287
US 287 DS-17	2	4	11	2-F+2-BB+PART OF 2-V
US 287 DS-18	1	4	32	PART OF 2-V+ 2-G
US 287 DS-19	1	2	18	PART OF 2-V
US 287 DS-20	5	8	47	2-H+ 2600 FT OF US 287
US 287 DS-21	1	2	10	PART OF 2-H
US 287 DS-22	4	6	40	PART OF 2-H
US 287 DS-23	1	2	9	PART OF 2-H
US 287 DS-24	1	4	28	PART OF 2-H
US 287 DS-25	3	10	87	PART OF 2-I
US 287 DS-26	8	20	117	2-I+PART OF 2-J+ 1600 FT OF US 287
US 287 DS-27	1	4	13	1200 FT OF FILL SLOPE
US 287 DS-28	4	11	63	2-M+ 2-AA+ 2-T+ 2-S+ 2-R+ DS-27
US 287 DS-29	4	6	12	900 FT OF 287+ 1400 FT OF E. RAMP
US 287 DS-30	1	2	13	PART OF 2-AA
US 287 DS-31	1	3	19	PART OF 2-M
US 287 DS-32	1	3	19	PART OF 2-M
US 287 DS-33	1	1	4	PART OF 2-AA
US 287 DS-34	2	3	5	400 FT OF US 287
US 287 DS-35	3	4	11	400 FT OF US 287
US 287 DS-36	5	7	16	1800 FT OF US 287&W FRONTAGE RD
CR 6 DS-1	1	2	7	PART OF 2-HH
CR 6 DS-2	1	1	7	PART OF 2-Q
CR 6 DS-3	1	1	3	2-E
CR 10 DS-1	1	1	1	300 FT OF CR10
CR 10 DS-2	1	1	2	400 FT OF CR10
CR 10 DS-3	1	1	1	100 FT OF CR10
CR 10 DS-4	1	3	25	2-G
CR 10 DS-5	1	2	3	1000 FT OF CR10
CR 10 DS-6	2	6	46	PART OF 2-X
CR 10 DS-7	1	1	3	700 FT OF CR10
CR 10 DS-8	1	1	2	400 FT OF CR10
CR 10 DS-9	1	2	3	700 FT OF CR10
CR 10 DS-10	1	2	12	PART OF 2-X
CR 10 DS-11	1	1	5	2-Z
SH 56 DS-1	1	1	3	350 FT OF SH56
SH 56 DS-2	1	2	5	PART OF 2-A PLUS 500 FT OF SH56
SH 56 DS-3	3	5	16	2-DD PLUS 1100 FT OF SH56
TAFT DS-1	1	3	22	PART OF 2-I
TAFT DS-2	3	5	14	2-EE
TAFT DS-3	1	4	29	2-FF

MEDIAN DRAIN DESIGN FLOWS SUMMARY TABLE

DESIGN LOCATION	DESIGN FLOW IN CFS	INLET TYPE
MED-1	6	TYPE C INLET
MED-2	1	TYPE C INLET
MED-3	10	TYPE C INLET
MED-4	9	TYPE C INLET
MED-5	3	TYPE C INLET
MED-6	3	FLARED END SECTION
MED-7	8	TYPE C INLET
MED-8	1	TYPE D INLET

CULVERT DESIGN POINT HYDROLOGY SUMMARY TABLE

DESIGN POINT	DESIGN FLOW IN CFS		TRIBUTARY AREAS & DITCHES
	5-YEAR	100-YEAR	
1		10	2-HH
2		22	2-Q+2-II
3	10	21	US287 DS-4 (Side Drain- 5-Yr Design)
4		230	2-A+2-OS-A+2-P (Ditch Flow - No Culvert)
5		213	2-A+2-OS-A
6		31	2-U
7		220	2-B+2-C+2-OS-B
8		32	US 287 DS-11
9		33	2-F+2-BB
10		15	2-F+2-BB (Carryover drains to Handy Ditch)
11		51	2-G+2-Y+2-V
12		47	2-H
13		19	2/5 OF 2-H
14		28	3/5 OF 2-H
15		110	2-I
16		22	1/5 OF 2-I
17		117	2-I+2-J
18		26	2-K
19		26	2-AA
20		34	2-GG+2-M+2-T (Detention Pond Outlet)
21		5	2-S
22		46	2-S+2-T+2-M+2-AA+2-GG (Stm Sew Outfall)
23		39	2-M
24		44	2-GG
25		14	2-EE
26		29	2-FF
27	11	60	2-G+2-Y+2-V+2-W (5-YR Design)
28		58	2-X

NOTE: SEE DRAINAGE REPORT FOR MEDIAN DRAIN HYDROLOGY. CULVERTS NOT IDENTIFIED HAVE DESIGN FLOWS OF LESS THAN 15 CFS.

IRRIGATION CULVERT DESIGN FLOWS SUMMARY TABLE

DESIGN POINT	DESIGN FLOW IN CFS	PROPOSED FEATURE	NAME OF IRRIGATION DITCH
I-1	12	30 INCH RCP SIPHON	DRY CREEK LATERAL DITCH
I-2	3.9	18 INCH RCP SIPHON	M & K PROPERTIES
I-3	2.6	18 INCH RCP CULVERT	SULLIVAN FARM
I-4	3.9	18 INCH RCP CULVERT	M & K PROPERTIES
I-5	28	36 INCH RCP CULVERT	WELCH LATERAL
I-6	6.2	24 INCH RCP CULVERT	TRI-CORNER HOLDINGS & D/S USERS
I-7	11.8	24 INCH RCP CULVERT	ARLO RICHARDSON & D/S USERS
I-8	6	24 INCH RCP CULVERT	ARLO RICHARDSON
I-9	119	16 FT X 9 FT CBC	HANDY DITCH
I-10	21	24 INCH RCP CULVERT	HANDY TO LOVELAND RES OUTFALL
I-11	174	16 FT X 11FT FRAME	HANDY DITCH
I-12	6	15 INCH RCP CULVERT	SCHWARZ FAMILY FARM
I-13	174	18 FT X 5 FT CBC	HANDY DITCH
I-14	4.5	18 INCH CULVERT	HANDY DITCH TO D/S USERS
I-14	91	18 FT X 5 FT CBC	HOME SUPPLY DITCH
I-15	4.5	18 INCH CULVERT	HOME SUPPLY DITCH TO D/S USERS

0 500 1000 1500 2000 2500 3000 3500 4000

SCALE IN FEET

BERTHOUD BYPASS SEGMENT #2 DRAINAGE MAP

SHEET 1 OF 1

SCALE: 1 INCH = 500 FT

URS PROJECT NO. 6800044341.10

FILE PATH=I:6844341\SEG2\HYDRAULICS\HHBASIN2.DWG

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FINAL DRAINAGE REPORT

GATEWAY PARK

BERTHOUD, COLORADO

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Prepared For:
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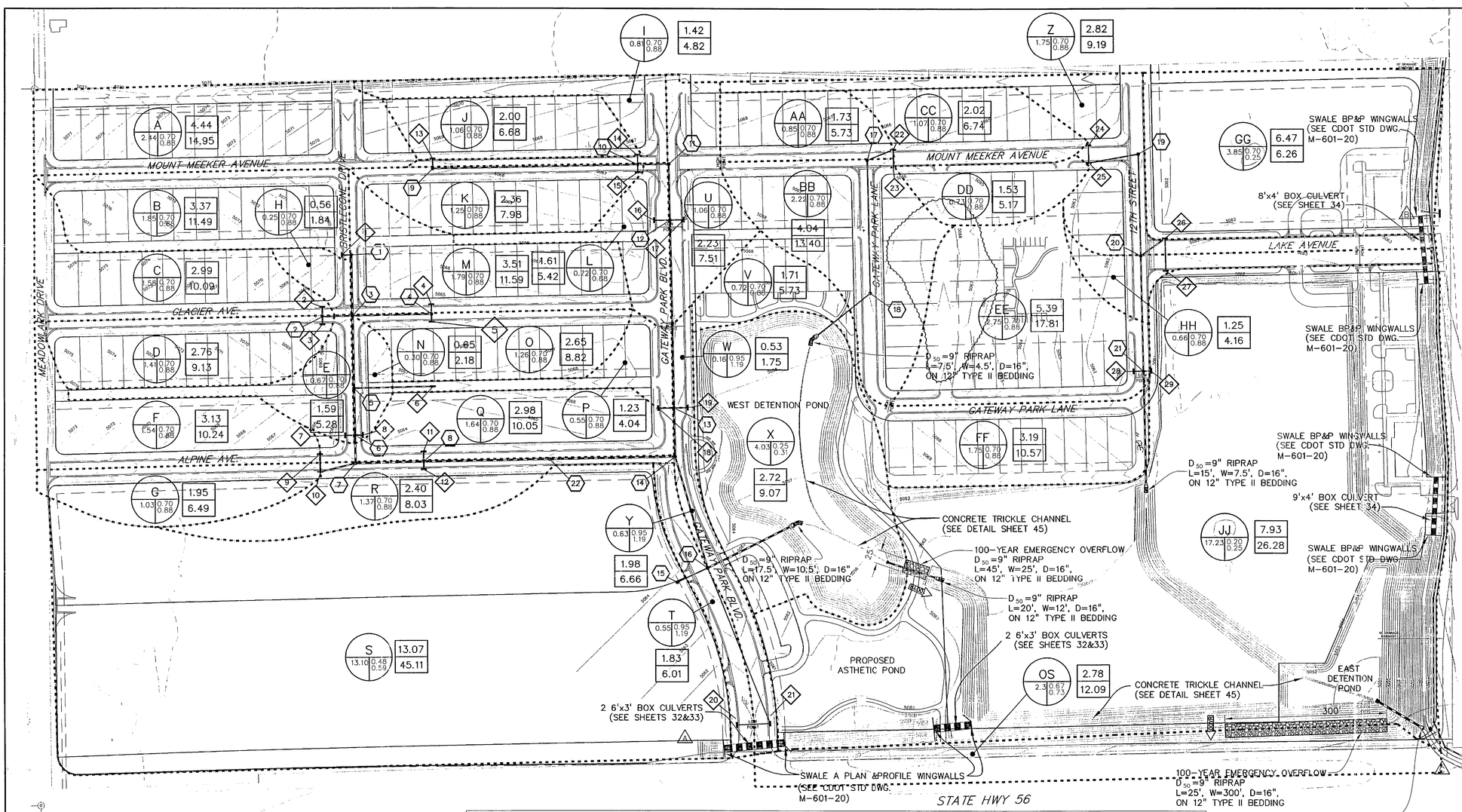
Date Prepared: April 5, 2001
Revised May 26, 2001
Revised January 8, 2002
Project No. E5082.3

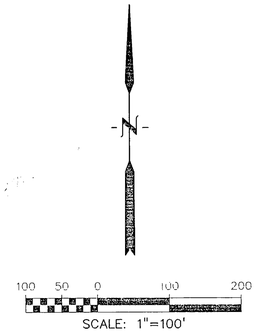
As can be seen in the CUHP Output Summary, located in Appendix B, Sub-Basin 42 has a 2-year historic peak flow of 9.7 cfs and a 100-year historic peak flow of 30.6 cfs. Similarly, Sub-Basin 43 has a 2-year historic peak flow of 8.6 cfs and a 100-year historic peak flow of 28.4 cfs. Once developed, the peak discharge from the West Pond will be 4.8 cfs and 25.4 cfs for 2-year and the 100-year storms respectively. Similarly, the peak discharge from the East Pond will be 5.8 cfs and 28.0 cfs for the 2-year and 100-year storms respectively. While the on-site detention ponds have the effect of reducing the peak flows from the developed site, the overall flows are slightly higher when offsite flows are considered. This phenomenon is due primarily to the coincidence of peak flows from offsite and developed sources. This condition was considered in the preliminary design phase with the recommendation to include the detention ponds in the final design even though it results in a higher peak discharge from on-site and off-site sources.

Off-site runoff from the west of the project (Sub-Basins 1 and 2) will be directed into a swale that will be designed to carry the runoff along the southern boundary to the southeast corner of the site. Similarly, off site runoff from the north (Sub-Basins 3, 15 and 16) will be directed into a swale that will begin at the approximate midpoint of the northern boundary line and flow east and south along the northern and eastern boundaries to the southeast corner of the site. Although this latter swale will not have the capacity to handle an emergency surge in excess of that generated during a 100-year storm event, the park area located at the center of this project will provide for a means of flood transmission through the development.

As discussed previously, runoff collected at the intersection of U.S. 287 and County Road 17 currently sheet flows to the southeast across the intersection. A significant portion of this project will be the elimination of this problem and will involve the installation of a 9'x4' box culvert beneath the intersection. The box culvert will terminate in a swale, designed as part of Berthoud Common Subdivision, that begins at the southeast corner of the intersection, flows to the south until reaching the south side of Welch Avenue, and then turns east, paralleling Welch Avenue. The design of this swale considered the eventuality of further upstream development and was sized to accommodate the flow rates suggested in the Bein SID Study. In addition, the swale lies within an easement that extends to U.S. 287 right-of-way, allowing it to be directly accessed from either the north or the northwest.

A subsurface irrigation pipe will be installed along the eastern property line of this project, replacing the existing open channel ditch owned by the Loveland Lake and Ditch Company. The integrity of this ditch will be maintained throughout the course of this project.





LEGEND

- DRAINAGE BASIN BOUNDARY
- DRAINAGE BASIN DESIGN POINT
- 2 YEAR DEVELOPED FLOW (cfs)
- 100 YEAR DEVELOPED FLOW (cfs)
- BASIN I.D.
- BASIN AREA (Acres)
- 2 YEAR RUNOFF COEFFICIENT
- 100 YEAR RUNOFF COEFFICIENT
- DIRECTION OF FLOW
- 100 YEAR DETENTION POND OVERFLOW
- EX. INTERMEDIATE CONTOUR
- EX. INDEX CONTOUR
- EX. SPOT ELEVATIONS (45.34±)
- PROPOSED INTERMEDIATE CONTOUR
- PROPOSED INDEX CONTOUR (65)
- PROPOSED SPOT ELEVATION (54.67)
- HIGH POINT (HP)
- GRADE BREAK (GB)
- LOW POINT (LP)
- TOP BACK OF CURB (TC)
- FLOWLINE (FL or FL)
- INLET IDENTIFICATION
- MANHOLE IDENTIFICATION

CALL UTILITY NOTIFICATION CENTER OF COLORADO

1-800-922-1987

CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

DESIGN INFORMATION

DESIGN PT	2-YEAR FLOW PERMANENT SYSTEM (CFS)	100-YEAR FLOW PERMANENT SYSTEM (CFS)	100-YEAR FLOW TEMPORARY SYSTEM (CFS)
A	4.70	26.82	350.62
B	24.99	375.76	375.76
C	28.11	409.05	430.90

INLET DESIGNATION

INLET ID	TYPE	DETAIL LOCATION	INLET ID	TYPE	DETAIL LOCATION	INLET ID	TYPE	DETAIL LOCATION
1	15' TYPE R	SHEETS 48 & 49	11	5' TYPE R	SHEETS 48 & 49	21	SINGLE NO. 16	SHEET 51
2	15' TYPE R	SHEETS 48 & 49	12	5' TYPE R	SHEETS 48 & 49	22	10' TYPE R	SHEETS 48 & 49
3	15' TYPE R	SHEETS 48 & 49	13	15' TYPE R	SHEETS 48 & 49	23	15' TYPE R	SHEETS 48 & 49
4	5' TYPE R	SHEETS 48 & 49	14	10' TYPE R	SHEETS 48 & 49	24	10' TYPE R	SHEETS 48 & 49
5	5' TYPE R	SHEETS 48 & 49	15	15' TYPE R	SHEETS 48 & 49	25	10' TYPE R	SHEETS 48 & 49
6	TYPE C	SHEET 50	16	5' TYPE R	SHEETS 48 & 49	26	10' TYPE R	SHEETS 48 & 49
7	10' TYPE R	SHEETS 48 & 49	17	5' TYPE R	SHEETS 48 & 49	27	10' TYPE R	SHEETS 48 & 49
8	5' TYPE R	SHEETS 48 & 49	18	10' TYPE R	SHEETS 48 & 49	28	5' TYPE R	SHEETS 48 & 49
9	15' TYPE R	SHEETS 48 & 49	19	5' TYPE R	SHEETS 48 & 49	29	5' TYPE R	SHEETS 48 & 49
10	10' TYPE R	SHEETS 48 & 49	20	SINGLE NO. 16	SHEET 51			

	WEST POND	EAST POND
2-YEAR HISTORIC RUNOFF RATE (CFS)	7.73	3.20
2-YEAR RELEASE RATE (CFS)	1.47	0.39
100-YEAR HISTORIC RUNOFF RATE (CFS)	25.50	10.54
100-YEAR RELEASE RATE (CFS)	24.79	10.05*
WQCV PROVIDED (AC-FT)	0.91	0.68
DETENTION VOLUME PROVIDED (AC-FT)	9.17	2.57*

NOTE: SEE SHEET 47 FOR DETENTION POND OUTLET INFORMATION.
* NUMBER IS FOR PERMANENT CONDITIONS ONLY. 100-YEAR RELEASE RATE IS 82.17 CFS AND DETENTION PROVIDED IS 34.18 AC-FT FOR TEMPORARY DETENTION OF RUNOFF UNTIL IMPROVEMENTS TO SH-287 ARE COMPLETED.

COLORADO REGISTERED PROFESSIONAL ENGINEER MICHAEL D. MIDDLETON 16325

NOT VALID WITHOUT ORIGINAL SIGNATURE AND DATE

Amber's Copy with notes

Gateway Park

PREPARED BY: Drexel Barrell & Co. Engineers Surveyors
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PROJECT INFO: GATEWAY PARK
BERTHOUD, COLORADO

DESIGNED BY: JAE
DRAWN BY: TAW
CHECKED BY:

REVISION DESCRIPTIONS	DATE
CONSTRUCTION SET	JANUARY 22, 2002
TOWN OF BERTHOUD APPROVAL SET	APRIL 2, 2002
REVISIONS PER AYRS & ASSOC. COMMENTS	JULY 26, 2002

DRAWING INFO. FINAL DRAINAGE PLAN

DATE:	JOB NO:	SHEET
02 APR 2001	E5082.3	12
SCALE: H: AS SHOWN V: AS SHOWN	DRAWING NO.: 5D 144	SHEETS 52

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FINAL DRAINAGE REPORT

THE VILLAGE AT MATTHEWS FARMS

BERTHOUD, COLORADO

Prepared By:

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Prepared For:

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Date Prepared: June 4, 2002
Revised: July 14, 2002

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Basin EOS3 – Basin EOS3 constitutes a portion of the largely undeveloped area and a portion of Block 4. The runoff generated within this basin will sheet flow off of the site to the south, as it does currently.

Basin EOS4 – Basin EOS4 is located in the southeast corner of the site and includes a portion of an outlot that is adjacent to Block 4 and a small portion of the southern extreme of Meadowlark Drive. The runoff generated in this basin will be collected in the swale that flows to the south, along the west side of Meadowlark Drive.

All of the calculations used to determine runoff coefficients, times of concentration and peak runoff rates (2 year and 100 year frequencies) can be found in Appendix B of this report.

STORM WATER DETENTION

Although separated, the three detention facilities located in The Village at Matthews Farms (Ponds EA, EB, and EC) will work as one facility. Ponds EA and EB will be connected to Pond EC with the use of subsurface piping, that will allow storm water to flow back and forth between the ponds. The combining of the three ponds will yield the following characteristics (the calculations used to determine this information are located in Appendix B):

Basins Intercepted: Basins E1 through E14
2 year Storage Volume Required: 0.59 acre-feet
2 year Storage Volume Provided: 0.59 acre-feet
2 year Allowable Release Rate: 3.5 cfs (adjusted down to account for the un-detained Basins EOS1 through EOS4)
2 year Release Rate: 3.5 cfs (adjusted down to account for the un-detained Basins EOS1 through EOS4)
2 year Water Surface Elevation: 5073.85
100 year Storage Volume Required: 2.04 acre-feet
100 year Storage Volume Provided: 2.06 acre-feet
100 year Allowable Release Rate: 13.5 cfs (adjusted down to account for the un-detained Basins EOS1 through EOS4)
100 year Release Rate: 13.5 cfs (adjusted down to account for the un-detained Basins EOS1 through EOS4)
100 year Water Surface Elevation: 5075.80
Outlet Description: The 2 year release rate will be metered with the use of a low flow orifice that will be partially blocked with a horizontal steel plate. The 100 year release will be metered with the use of a weir. Both of these structures will be placed in the side of a Type C inlet. The inlet will discharge, via a culvert, to the aforementioned Meadowlark Drive swale. Since the downstream invert of the culvert is below the flow line elevation of the ditch, it will be necessary to widen and deepen the ditch all the way to the intersection of Meadowlark Drive and State Highway 56.

Developed Runoff Coefficients

Matthews Farms (East Side)

Berthoud, Colorado

Basin	Area "A" (acres)	Description	C	CA	I (%)	IA(%)
EOS1		Residential (See Note)	0.47	0.00	37%	0%
		Parks	0.25	0.00	5%	0%
	0.58	Unimproved Areas	0.20	0.12	2%	1%
		Asphalt - Concrete - Roofs	0.95	0.00	90%	0%
		Lawns, Sandy Soil 2-7%	0.15	0.00	0%	0%
			ΣCA =	0.12		
			ΣA =	0.58		
		Weighted Runoff Coefficient (ΣCA/ΣA) =		0.20		
					ΣIA =	1%
					ΣA =	0.58
					Weighted Imperviousness (ΣIA/ΣA) =	2%
EOS2	0.77	Residential (See Note)	0.47	0.36	37%	28%
		Parks	0.25	0.00	5%	0%
	0.21	Unimproved Areas	0.20	0.04	2%	0%
	0.01	Asphalt - Concrete - Roofs	0.95	0.01	90%	1%
		Lawns, Sandy Soil 2-7%	0.15	0.00	0%	0%
			ΣCA =	0.41		
			ΣA =	0.99		
		Weighted Runoff Coefficient (ΣCA/ΣA) =		0.42		
					ΣIA =	30%
					ΣA =	0.99
					Weighted Imperviousness (ΣIA/ΣA) =	30%
EOS3	0.77	Residential (See Note)	0.47	0.36	37%	28%
	0.01	Parks	0.25	0.00	5%	0%
	1.45	Unimproved Areas	0.20	0.29	2%	3%
	0.07	Asphalt - Concrete - Roofs	0.95	0.07	90%	6%
		Lawns, Sandy Soil 2-7%	0.15	0.00	0%	0%
			ΣCA =	0.72		
			ΣA =	2.30		
		Weighted Runoff Coefficient (ΣCA/ΣA) =		0.31		
					ΣIA =	38%
					ΣA =	2.30
					Weighted Imperviousness (ΣIA/ΣA) =	16%
EOS4	0.01	Residential (See Note)	0.47	0.00	37%	0%
	0.08	Parks	0.25	0.02	5%	0%
		Unimproved Areas	0.20	0.00	2%	0%
	0.06	Asphalt - Concrete - Roofs	0.95	0.06	90%	5%
	0.02	Lawns, Sandy Soil 2-7%	0.15	0.00	0%	0%
			ΣCA =	0.08		
			ΣA =	0.17		
		Weighted Runoff Coefficient (ΣCA/ΣA) =		0.50		
					ΣIA =	6%
					ΣA =	0.17
					Weighted Imperviousness (ΣIA/ΣA) =	36%

Time of Concentration

Matthews Farms (East Side)

Berthoud, Colorado

Basin Data			Initial / Overland Time t_i			Travel Time t_t				t_i+t_t	t_c Check (Urbanized Basins)		Result
Basin	Area (ac)	C	Length (ft)	Slope (%)	t_i	Length (ft)	Slope (%)	Vel (fps)	t_t (min)	t_c (min)	Total Length (ft)	t_c = (L/180)+10	t_c (min)
EH	31.22	0.20	500	0.6	44.6	1730	0.5	1.1	26.2	70.8	N/A	N/A	70.8
E1	3.19	0.28	130	0.8	18.8	641	0.6	1.2	8.9	27.7	771	14.3	14.3
E2	5.27	0.43	145	0.9	15.6	472	0.6	1.6	4.9	20.5	617	13.4	13.4
E3	1.21	0.32	119	0.8	17.1	359	0.6	1.6	3.7	20.8	478	12.7	12.7
E4	4.20	0.47	97	1.9	9.4	1018	0.5	1.5	11.3	20.7	1115	16.2	16.2
E5	0.80	0.49	88	1.0	10.7	112	0.5	1.5	1.2	11.9	200	11.1	11.1
E6	0.70	0.33	80	2.8	9.1	445	0.5	1.5	4.9	14.0	525	12.9	12.9
E7	0.58	0.63	84	2.9	5.6	210	0.8	1.8	1.9	7.5	294	11.6	7.5
E8	1.65	0.29	153	1.1	18.1	409	0.7	1.3	5.2	23.3	562	13.1	13.1
E9	0.98	0.47	87	2.0	8.7	387	0.5	1.5	4.3	13.0	474	12.6	12.6
E10	2.77	0.39	500	0.8	32.0	407	0.5	1.5	4.5	36.5	907	15.0	15.0
E11	0.41	0.28	59	25.0	4.0	100	0.5	1.5	1.1	5.1	159	10.9	5.1
E12	2.16	0.47	94	2.0	9.1	826	0.6	1.6	8.6	17.7	920	15.1	15.1
E13	2.25	0.49	98	2.0	9.0	725	0.6	1.6	7.6	16.6	823	14.6	14.6
E14	1.01	0.34	47	11.9	4.3	573	0.5	1.5	6.4	10.7	620	13.4	10.7
EOS1	0.58	0.20	66	1.0	13.7	0			0.0	13.7	66	10.4	10.4
EOS2	0.99	0.42	73	1.5	9.5	0			0.0	9.5	73	10.4	9.5
EOS3	2.30	0.31	181	0.9	20.6	288	0.5	1.1	4.4	25.0	469	12.6	12.6
EOS4	0.17	0.50	78	2.7	7.1	24	0.7	1.7	0.2	7.3	102	10.6	7.3

Notes: Overland Flow Times were calculated using the following equation: $1.87 \times (1.1 - C) \times D^{1/2} / S^{1/3}$

Travel Times velocities were obtained from Figure 3-2, Volume I, Urban Drainage and Flood Control District Storm Drainage Criteria Manual. The "Shallow Gutter Flow" curve was used for all basins except Basins EH, E1, E8 and EOS3, which utilized the "Grassed Waterway" curve.

Since Basin EH has been analyzed under historic conditions, the "Urbanized Check" was not used.

Runoff

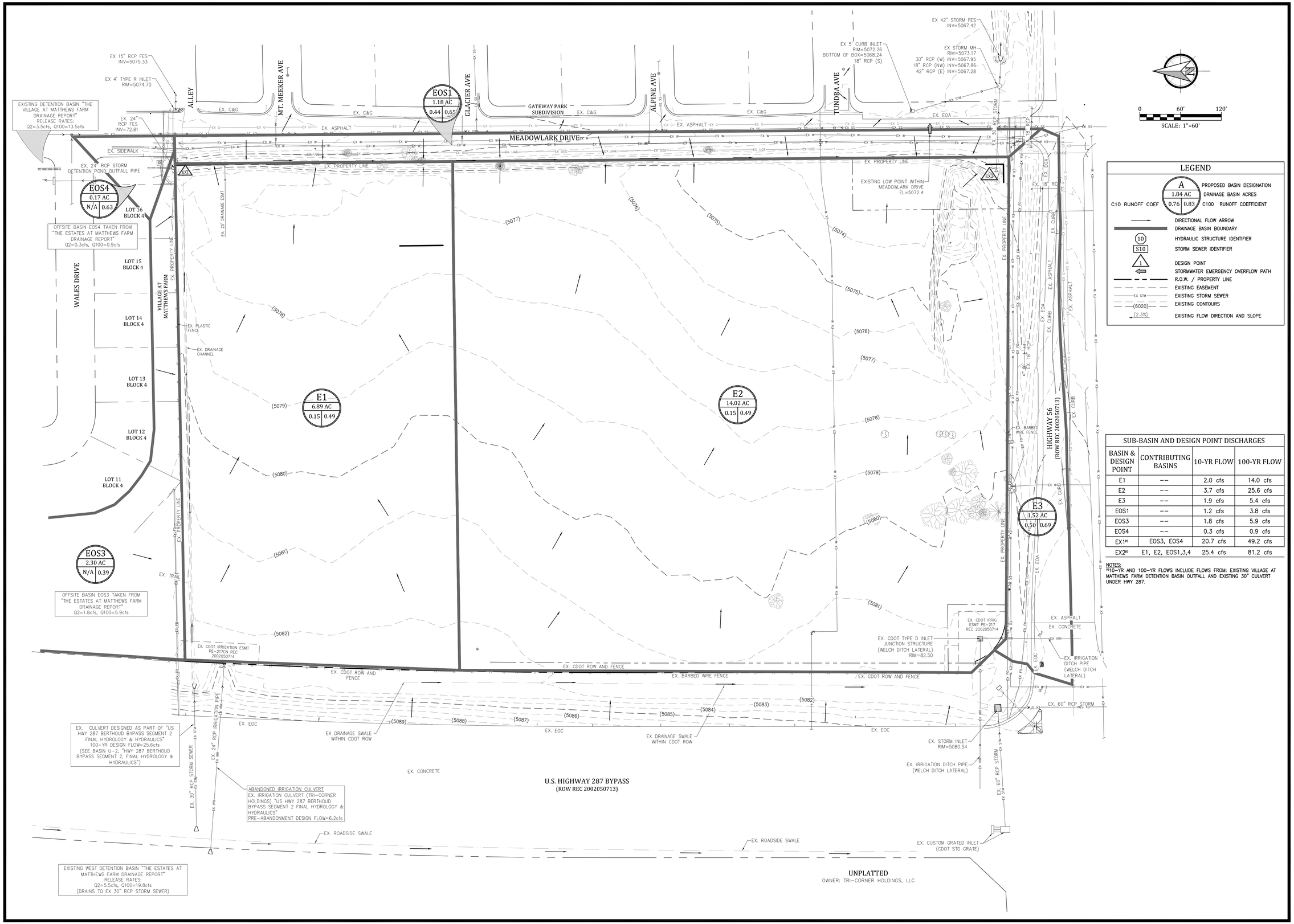
Matthews Farms (East Side)
Berthoud, Colorado

Basin	Area (acres)	CC_f (C_f=1.00)	CC_f (C_f=1.25)	Tc (min)	I_2 (in/hr)	I_{100} (in/hr)	Q_2 (cfs)	Q_{100} (cfs)
EH	31.22	0.20	0.25	70.8	0.9	2.4	5.6	18.7
E1	3.19	0.28	0.35	14.3	2.4	6.2	2.1	6.9
E2	5.27	0.43	0.54	13.4	2.4	6.4	5.4	18.2
E3	1.21	0.32	0.40	12.7	2.5	6.6	1.0	3.2
E4	4.20	0.47	0.59	16.2	2.2	5.9	4.3	14.6
E5	0.80	0.49	0.61	11.1	2.6	6.9	1.0	3.4
E6	0.70	0.33	0.41	12.9	2.5	6.5	0.6	1.9
E7	0.58	0.63	0.79	7.5	3.0	8.2	1.1	3.8
E8	1.65	0.29	0.36	13.1	2.5	6.5	1.2	3.9
E9	0.98	0.47	0.59	12.6	2.5	6.6	1.2	3.8
E10	2.77	0.39	0.49	15.0	2.3	6.1	2.5	8.3
E11	0.41	0.28	0.35	5.1	3.3	9.3	0.4	1.3
E12	2.16	0.47	0.59	15.1	2.3	6.1	2.3	7.8
E13	2.25	0.49	0.61	14.6	2.3	6.2	2.5	8.5
E14	1.01	0.34	0.43	10.7	2.6	7.0	0.9	3.0
EOS1	0.58	0.20	0.25	10.4	2.7	7.0	0.3	1.0
EOS2	0.99	0.42	0.53	9.5	2.8	7.3	1.2	3.8
EOS3	2.30	0.31	0.39	12.6	2.5	6.6	1.8	5.9
EOS4	0.17	0.50	0.63	7.3	3.0	8.3	0.3	0.9

APPENDIX E

Exhibit A: Existing Conditions Drainage Plan

Exhibit B: Proposed Conditions Drainage Plan



LEGEND

A / 1.84 AC	PROPOSED BASIN DESIGNATION
	DRAINAGE BASIN ACRES
C10 RUNOFF COEF 0.76	0.83 C100 RUNOFF COEFFICIENT
	DIRECTIONAL FLOW ARROW
	DRAINAGE BASIN BOUNDARY
10	HYDRAULIC STRUCTURE IDENTIFIER
S10	STORM SEWER IDENTIFIER
1	DESIGN POINT
	STORMWATER EMERGENCY OVERFLOW PATH
	R.O.W. / PROPERTY LINE
	EXISTING EASEMENT
EX STM	EXISTING STORM SEWER
(6020)	EXISTING CONTOURS
(2.3%)	EXISTING FLOW DIRECTION AND SLOPE

SUB-BASIN AND DESIGN POINT DISCHARGES

BASIN & DESIGN POINT	CONTRIBUTING BASINS	10-YR FLOW	100-YR FLOW
E1	--	2.0 cfs	14.0 cfs
E2	--	3.7 cfs	25.6 cfs
E3	--	1.9 cfs	5.4 cfs
EOS1	--	1.2 cfs	3.8 cfs
EOS3	--	1.8 cfs	5.9 cfs
EOS4	--	0.3 cfs	0.9 cfs
EX1[(1)]	EOS3, EOS4	20.7 cfs	49.2 cfs
EX2[(1)]	E1, E2, EOS1,3,4	25.4 cfs	81.2 cfs

NOTES:
[(1)]10-YR AND 100-YR FLOWS INCLUDE FLOWS FROM: EXISTING VILLAGE AT MATTHEWS FARM DETENTION BASIN OUTFALL AND EXISTING 30" CULVERT UNDER HWY 287.

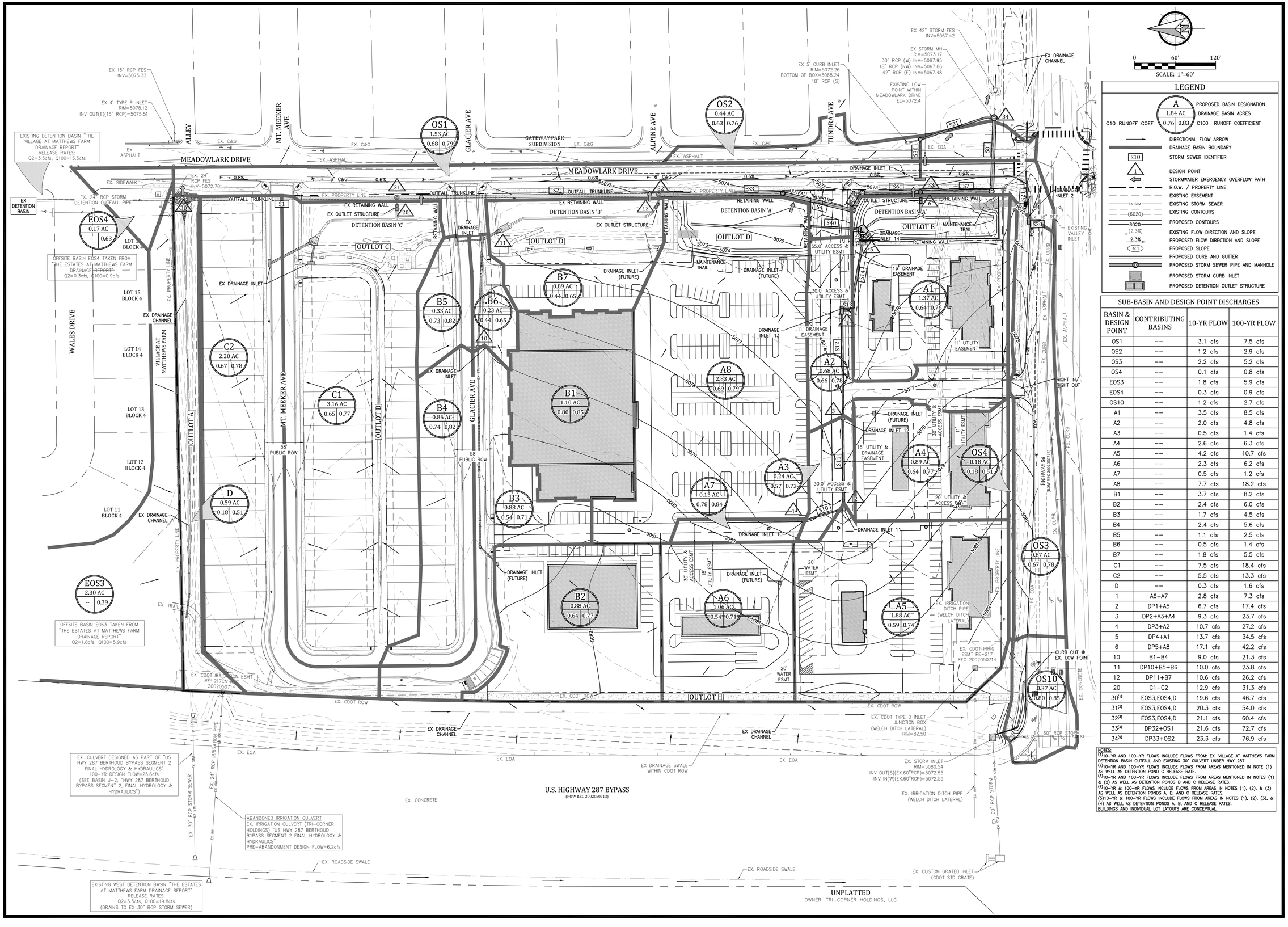
Kiowa Engineering Corporation
7175 West Jefferson Avenue, Suite 2200
Lakewood, Colorado 80235
(303) 692-0369

WESTSIDE CROSSING
DRAINAGE REPORT
DRAINAGE PLAN - EXISTING CONDITIONS
TOWN OF BERTHOUD, COLORADO

Project No.:	19043.2
Date:	December 1st, 2023
Design:	JIM/MWE
Drawn:	JIM
Check:	MWE
Revisions:	

EXHIBIT

A



SUB-BASIN AND DESIGN POINT DISCHARGES

BASIN & DESIGN POINT	CONTRIBUTING BASINS	10-YR FLOW	100-YR FLOW
OS1	--	3.1 cfs	7.5 cfs
OS2	--	1.2 cfs	2.9 cfs
OS3	--	2.2 cfs	5.2 cfs
OS4	--	0.1 cfs	0.8 cfs
EOS3	--	1.8 cfs	5.9 cfs
EOS4	--	0.3 cfs	0.9 cfs
OS10	--	1.2 cfs	2.7 cfs
A1	--	3.5 cfs	8.5 cfs
A2	--	2.0 cfs	4.8 cfs
A3	--	0.5 cfs	1.4 cfs
A4	--	2.6 cfs	6.3 cfs
A5	--	4.2 cfs	10.7 cfs
A6	--	2.3 cfs	6.2 cfs
A7	--	0.5 cfs	1.2 cfs
A8	--	7.7 cfs	18.2 cfs
B1	--	3.7 cfs	8.2 cfs
B2	--	2.4 cfs	6.0 cfs
B3	--	1.7 cfs	4.5 cfs
B4	--	2.4 cfs	5.6 cfs
B5	--	1.1 cfs	2.5 cfs
B6	--	0.5 cfs	1.4 cfs
B7	--	1.8 cfs	5.5 cfs
C1	--	7.5 cfs	18.4 cfs
C2	--	5.5 cfs	13.3 cfs
D	--	0.3 cfs	1.6 cfs
1	A6+A7	2.8 cfs	7.3 cfs
2	DP1+A5	6.7 cfs	17.4 cfs
3	DP2+A3+A4	9.3 cfs	23.7 cfs
4	DP3+A2	10.7 cfs	27.2 cfs
5	DP4+A1	13.7 cfs	34.5 cfs
6	DP5+A8	17.1 cfs	42.2 cfs
10	B1-B4	9.0 cfs	21.3 cfs
11	DP10+B5+B6	10.0 cfs	23.8 cfs
12	DP11+B7	10.6 cfs	26.2 cfs
20	C1-C2	12.9 cfs	31.3 cfs
30(1)	EOS3,EOS4,D	19.6 cfs	46.7 cfs
31(2)	EOS3,EOS4,D	20.3 cfs	54.0 cfs
32(3)	EOS3,EOS4,D	21.1 cfs	60.4 cfs
33(4)	DP32+OS1	21.6 cfs	72.7 cfs
34(5)	DP33+OS2	23.3 cfs	76.9 cfs

NOTES:
(1)10-YR AND 100-YR FLOWS INCLUDE FLOWS FROM: EX. VILLAGE AT MATTHEWS FARM DETENTION BASIN OUTFALL AND EXISTING 30" CULVERT UNDER HWY 287.
(2)10-YR AND 100-YR FLOWS INCLUDE FLOWS FROM AREAS MENTIONED IN NOTE (1) AS WELL AS DETENTION POND C RELEASE RATE.
(3)10-YR AND 100-YR FLOWS INCLUDE FLOWS FROM AREAS MENTIONED IN NOTES (1) & (2) AS WELL AS DETENTION PONDS B AND C RELEASE RATES.
(4)10-YR & 100-YR FLOWS INCLUDE FLOWS FROM AREAS IN NOTES (1), (2), & (3) AS WELL AS DETENTION PONDS A, B, AND C RELEASE RATES.
(5)10-YR & 100-YR FLOWS INCLUDE FLOWS FROM AREAS IN NOTES (1), (2), (3), & (4) AS WELL AS DETENTION PONDS A, B, AND C RELEASE RATES.
BUILDINGS AND INDIVIDUAL LOT LAYOUTS ARE CONCEPTUAL.

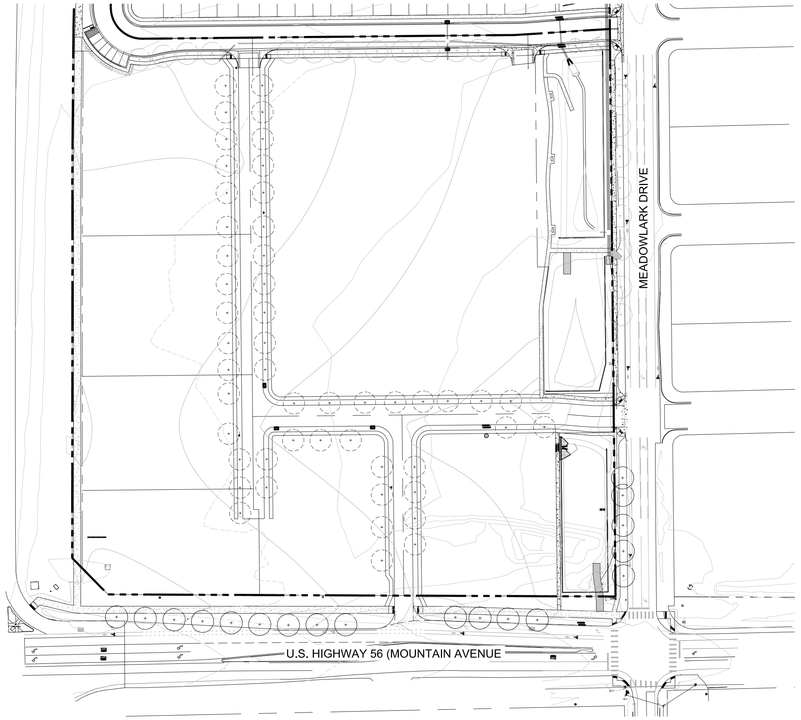
Kiowa Engineering Corporation
5951 Middlefield Road, Suite 200
Littleton, Colorado 80123
[303] 692-0369

WESTSIDE CROSSING
DRAINAGE REPORT
DRAINAGE PLAN - PROPOSED CONDITIONS
TOWN OF BERTHOUD, COLORADO

Project No.:	19043.2
Date:	January 22nd, 2024
Design:	JIM/MWE
Drawn:	JIM
Check:	MWE
Revisions:	

EXHIBIT

B



OVERALL LANDSCAPE PLAN

NORTH

0' 50' 100' 200' 300'

SCALE 1" = 100' - 0"

Note:
All Common Area Landscape within the private development shall be installed, irrigated and maintained by individual lot owners. Final location of trees is subject to change based upon drive entrances location to individual lots and easement requirements.

LEGEND:

DECIDUOUS SHADE TREES PROVIDED AS PART OF RESIDENTIAL PLAT

DECIDUOUS ORNAMENTAL TREES PROVIDED AS PART OF RESIDENTIAL PLAT

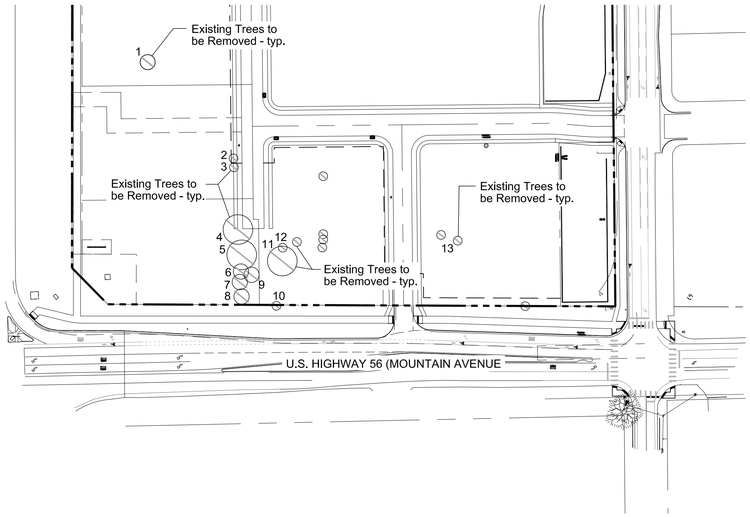
SHRUBS PROVIDED AS PART OF RESIDENTIAL PLAT

DECIDUOUS TREES INSTALLED BY FUTURE COMMERCIAL DEVELOPER

DECIDUOUS TREES

PROPERTY LINE

PROPOSED RETAINING WALL



TREE REMOVAL PLAN

NORTH

0' 50' 100' 200' 300'

SCALE 1" = 100' - 0"

LEGEND:

PROPERTY LINE

EXISTING TREE TO BE REMOVED

PROPOSED RETAINING WALL

EXISTING EASEMENT

TREE MITIGATION CHART:

EXISTING TREE ANALYSIS						
TREE #	SPECIES	DIAMETER	CONDITION	COLORADO DEPT OF AG NOXIOUS WEED SPECIES	REMOVE FROM SITE	REMAIN ON SITE
1	SIBERIAN ELM	6"	POOR	WATCH LIST SPECIES	YES	NO
2	SIBERIAN ELM	3"	POOR	WATCH LIST SPECIES	YES	NO
3	SIBERIAN ELM	6"	POOR	WATCH LIST SPECIES	YES	NO
4	EASTERN COTTONWOOD	12"	POOR	-	YES	NO
5	EASTERN COTTONWOOD	10"	POOR	-	YES	NO
6	APPLE	4"	POOR	-	YES	NO
7	APPLE	4"	POOR		YES	NO
8	PINE	12"	POOR	-	YES	NO
9	EASTERN COTTONWOOD	8"	POOR		YES	NO
10	SIBERIAN ELM	2"	POOR	WATCH LIST SPECIES	YES	NO
11	RUSSIAN OLIVE	8"	POOR	LIST B SPECIES	YES	NO
12	DEAD	6"	POOR	-	YES	NO
13	PINE	2"	POOR	-	YES	NO

PRIOR TO REMOVAL OF ANY TREES ON SITE, THE CONTRACTOR SHALL CONTACT MR. PAUL FURNAS WITH THE TOWN OF BERTHOUD TO ALLOW THE TOWN TO TAKE GENETIC SAMPLING OF EXISTING APPLE TREES. MR. FURNAS CONTACT INFORMATION IS: PFURNAS@BERTHOUD.ORG

STACK lot
5639 south curtice street littleton, colorado 80120
p. 303.808.4523

Westside Crossing
Final Plat

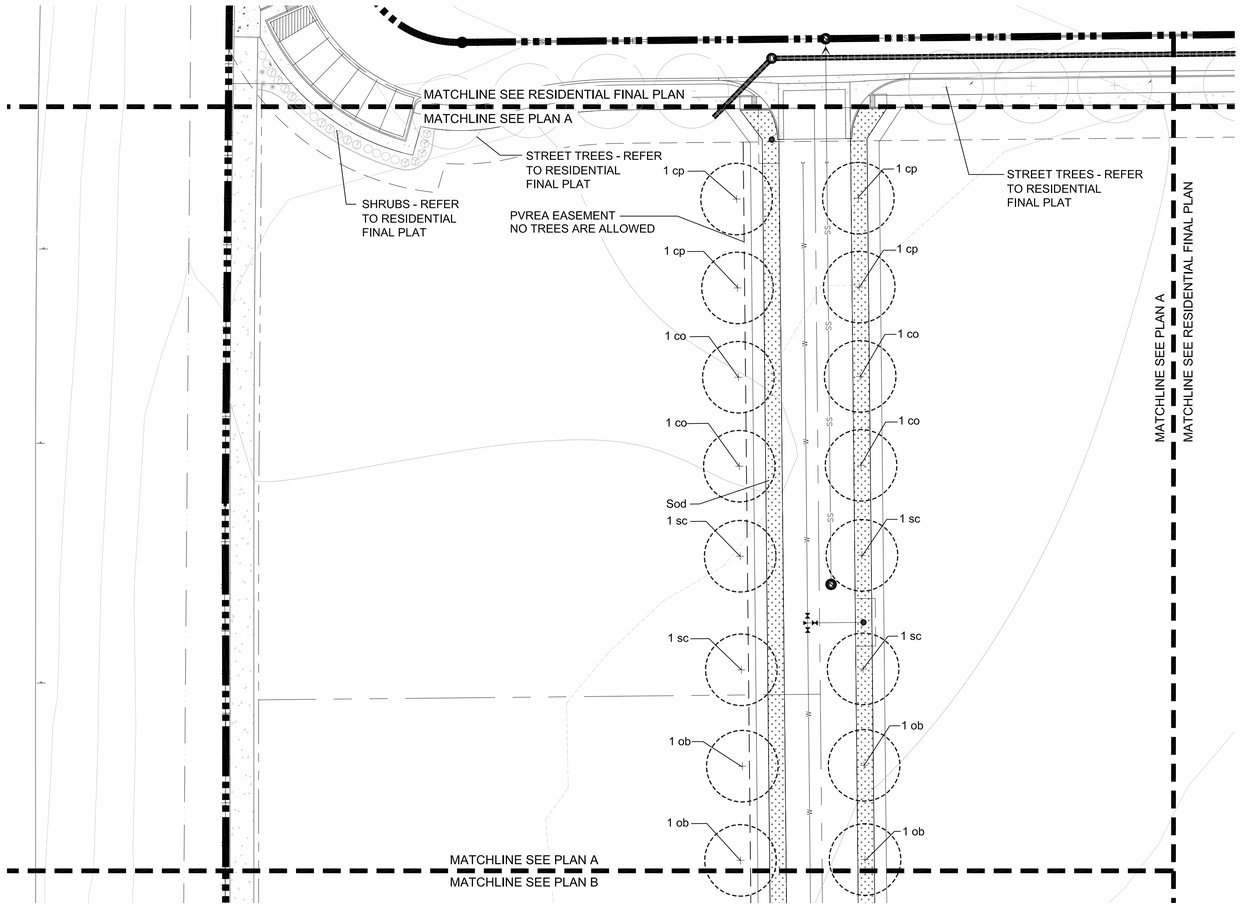
OVERALL PLANS

DATE:	REVISION:
12/1/23	SECOND SUBMITTAL
1/22/24	THIRD SUBMITTAL
2/16/24	FORTH SUBMITTAL
2/26/24	FIFTH SUBMITTAL

Project Mgr:	JAH
Drawn By:	SDW
Checked By:	JAH
Date:	8/25/23
Scale:	1" = 100'

SHEET

L1.1

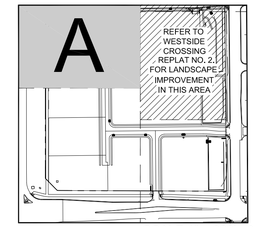


LANDSCAPE PLAN 'A'

NORTH

0' 15' 30' 60' 90'

SCALE 1" = 30' - 0"



KEYMAP

SCALE 1" = 300' - 0"

LEGEND:

- EXISTING SANITARY SEWER MANHOLE
- EXISTING TELEPHONE PEDESTAL
- EXISTING CABLE TV PEDESTAL
- EXISTING LIGHT POLE
- EXISTING ELECTRIC BOX
- EXISTING ELECTRIC MANHOLE
- EXISTING EASEMENT
- PROPOSED EASEMENT
- EX W — EXISTING WATER LINE
- EX SS — EXISTING SANITARY SEWER
- EX STM — EXISTING STORM SEWER
- EX UGE — EXISTING UNDERGROUND ELECTRIC LINE
- EX OHU — EXISTING OVERHEAD UTILITY LINE
- EX OHE — EXISTING OVERHEAD ELECTRIC LINE
- EX T — EXISTING UNDERGROUND TELEPHONE LINE
- EX FO — EXISTING FIBER OPTIC LINE
- EX G — EXISTING GAS LINE
- SS — PROPOSED SANITARY SERVICE
- W — PROPOSED WATER LINE OR SERVICE
- STM — PROPOSED STORM LINE
- PROPOSED FIRE HYDRANT
- D — PROPOSED STORM SEWER PIPE AND MANHOLE

- DECIDUOUS SHADE TREES PROVIDED AS PART OF RESIDENTIAL PLAT
- DECIDUOUS ORNAMENTAL TREES PROVIDED AS PART OF RESIDENTIAL PLAT
- SHRUBS PROVIDED AS PART OF RESIDENTIAL PLAT
- DECIDUOUS TREES INSTALLED BY FUTURE COMMERCIAL DEVELOPER
- DECIDUOUS TREES
- LOCALLY AVAILABLE FESCUE SOD MIX
- LOCALLY AVAILABLE FESCUE SOD MIX TO BE INSTALLED BY FUTURE COMMERCIAL DEVELOPER
- TEMPORARY IRRIGATION REQUIRED UNTIL NATIVE GRASS IS ESTABLISHED
  MIX RATIO:
  23% BLUE GRAMA
  10% BUFFALO GRASS
  20% GREEN NEEDLEGRASS
  20% SIDE OATS GRAMA
  25% WESTERN WHEATGRASS
  2% SAND DROPSEED
  NOTE: EROSION CONTROL BLANKET TO BE INSTALLED WHERE APPLICABLE
- MATCHLINE
- PROPERTY LINE
- 2' CONTOUR

Note:
All Common Area Landscape within the private development shall be installed, irrigated and maintained by individual lot owners. Final location of trees is subject to change based upon drive entrances location to individual lots and easement requirements.

STACK lot
5639 south curtice street littleton, colorado 80120
p. 303.808.4523

Westside Crossing
Final Plat

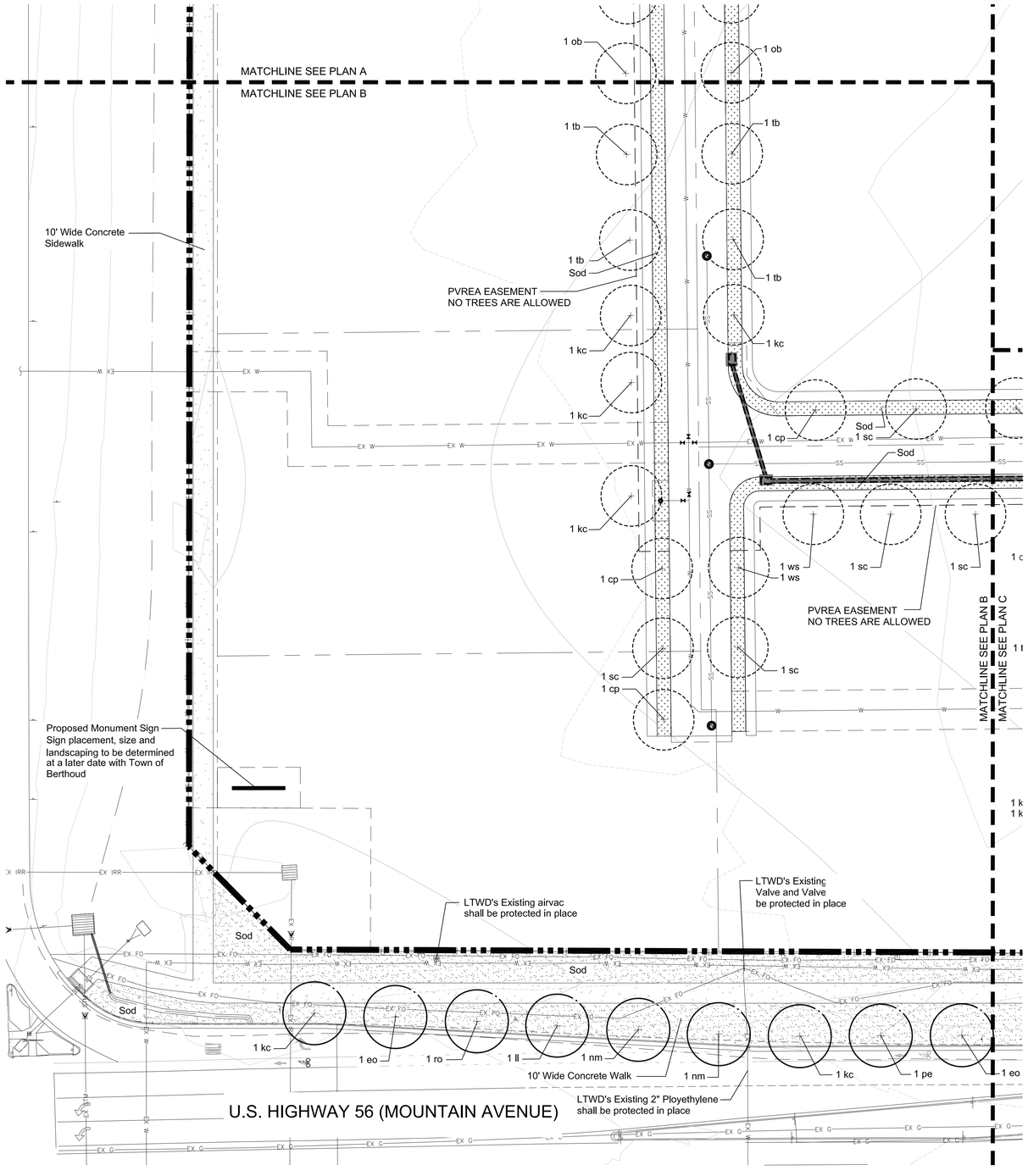
Final Landscape Plan 'A'

DATE:	REVISION:
12/1/23	SECOND SUBMITTAL
1/22/24	THIRD SUBMITTAL
2/16/24	FORTH SUBMITTAL
2/26/24	FIFTH SUBMITTAL

Project Mgr:	JAH
Drawn By:	SDW
Checked By:	JAH
Date:	8/25/23
Scale:	1" = 30'

SHEET

L1.2



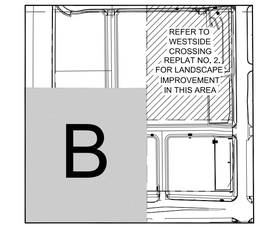
LANDSCAPE PLAN 'B'

NORTH

0' 15' 30' 60' 90'

SCALE 1" = 30' - 0"

Note:
All Common Area Landscape within the private development shall be installed, irrigated and maintained by individual lot owners. Final location of trees is subject to change based upon drive entrances location to individual lots and easement requirements.



KEYMAP

SCALE 1" = 300' - 0"

LEGEND:

- EXISTING SANITARY SEWER MANHOLE
- EXISTING TELEPHONE PEDESTAL
- EXISTING CABLE TV PEDESTAL
- EXISTING LIGHT POLE
- EXISTING ELECTRIC BOX
- EXISTING ELECTRIC MANHOLE
- EXISTING EASEMENT
- PROPOSED EASEMENT
- EXISTING WATER LINE
- EXISTING SANITARY SEWER
- EXISTING STORM SEWER
- EXISTING UNDERGROUND ELECTRIC LINE
- EXISTING OVERHEAD UTILITY LINE
- EXISTING OVERHEAD ELECTRIC LINE
- EXISTING UNDERGROUND TELEPHONE LINE
- EXISTING FIBER OPTIC LINE
- EXISTING GAS LINE
- PROPOSED SANITARY SERVICE
- PROPOSED WATER LINE OR SERVICE
- PROPOSED STORM LINE
- PROPOSED FIRE HYDRANT
- PROPOSED STORM SEWER PIPE AND MANHOLE

- DECIDUOUS SHADE TREES PROVIDED AS PART OF RESIDENTIAL PLAT
- DECIDUOUS ORNAMENTAL TREES PROVIDED AS PART OF RESIDENTIAL PLAT
- SHRUBS PROVIDED AS PART OF RESIDENTIAL PLAT
- DECIDUOUS TREES INSTALLED BY FUTURE COMMERCIAL DEVELOPER
- DECIDUOUS TREES
- LOCALLY AVAILABLE FESCUE SOD MIX
- LOCALLY AVAILABLE FESCUE SOD MIX TO BE INSTALLED BY FUTURE COMMERCIAL DEVELOPER
- TEMPORARY IRRIGATION REQUIRED UNTIL NATIVE GRASS IS ESTABLISHED
  MIX RATIO:
  23% BLUE GRAMA
  10% BUFFALO GRASS
  20% GREEN NEEDLEGRASS
  20% SIDE OATS GRAMA
  25% WESTERN WHEATGRASS
  2% SAND DROPSEED
  NOTE: EROSION CONTROL BLANKET TO BE INSTALLED WHERE APPLICABLE
- MATCHLINE
- PROPERTY LINE
- 2' CONTOUR

STACK lot
5639 south curtice street littleton, colorado 80120
p. 303.808.4523

Westside Crossing
Final Plat

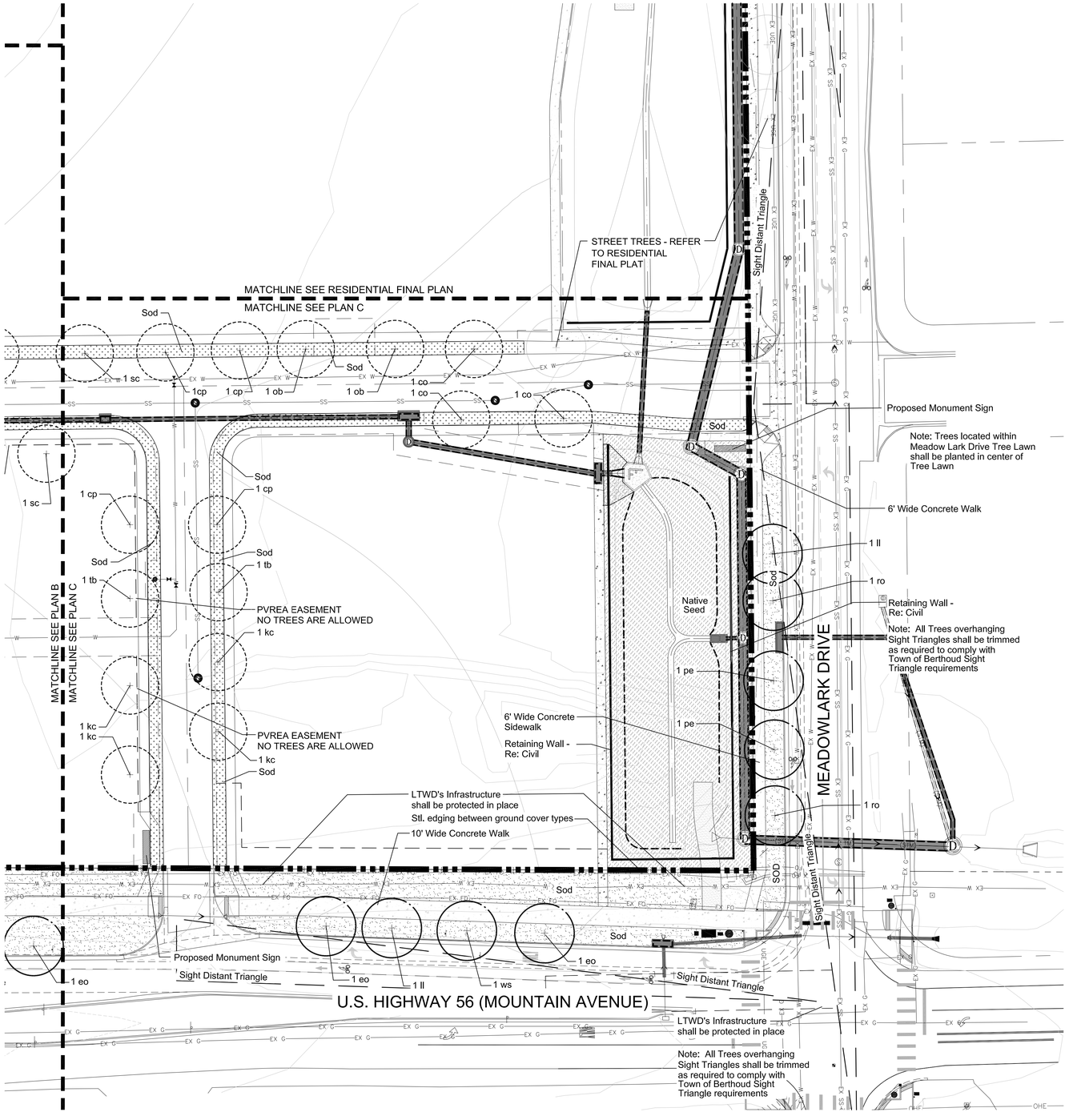
Final Landscape Plan 'B'

DATE:	REVISION:
12/1/23	SECOND SUBMITTAL
1/22/24	THIRD SUBMITTAL
2/16/24	FORTH SUBMITTAL
2/26/24	FIFTH SUBMITTAL

Project Mgr:	JAH
Drawn By:	SDW
Checked By:	JAH
Date:	8/25/23
Scale:	1" = 30'

SHEET

L1.3



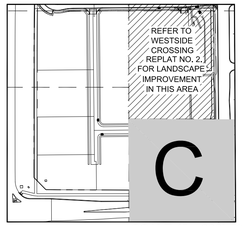
LANDSCAPE PLAN 'C'

NORTH

0' 15' 30' 60' 90'

SCALE 1" = 30' - 0"

Note:
All Common Area Landscape within the private development shall be installed, irrigated and maintained by individual lot owners. Final location of trees is subject to change based upon drive entrances location to individual lots and easement requirements.



KEYMAP

SCALE 1" = 300' - 0"

LEGEND:

- EXISTING SANITARY SEWER MANHOLE
- EXISTING TELEPHONE PEDESTAL
- EXISTING CABLE TV PEDESTAL
- EXISTING LIGHT POLE
- EXISTING ELECTRIC BOX
- EXISTING ELECTRIC MANHOLE
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- EXISTING WATER LINE
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- EXISTING UNDERGROUND ELECTRIC LINE
- EXISTING OVERHEAD UTILITY LINE
- EXISTING OVERHEAD ELECTRIC LINE
- EXISTING UNDERGROUND TELEPHONE LINE
- EXISTING FIBER OPTIC LINE
- EXISTING GAS LINE
- PROPOSED SANITARY SERVICE
- PROPOSED WATER LINE OR SERVICE
- PROPOSED STORM LINE
- PROPOSED FIRE HYDRANT
- PROPOSED STORM SEWER PIPE AND MANHOLE

- DECIDUOUS SHADE TREES PROVIDED AS PART OF RESIDENTIAL PLAT
- DECIDUOUS ORNAMENTAL TREES PROVIDED AS PART OF RESIDENTIAL PLAT
- SHRUBS PROVIDED AS PART OF RESIDENTIAL PLAT
- DECIDUOUS TREES INSTALLED BY FUTURE COMMERCIAL DEVELOPER
- DECIDUOUS TREES
- LOCALLY AVAILABLE FESCUE SOD MIX
- LOCALLY AVAILABLE FESCUE SOD MIX TO BE INSTALLED BY FUTURE COMMERCIAL DEVELOPER
- TEMPORARY IRRIGATION REQUIRED UNTIL NATIVE GRASS IS ESTABLISHED
  MIX RATIO:
  23% BLUE GRAMA
  10% BUFFALO GRASS
  20% GREEN NEEDLEGRASS
  20% SIDE OATS GRAMA
  25% WESTERN WHEATGRASS
  2% SAND DROPSEED
  NOTE: EROSION CONTROL BLANKET TO BE INSTALLED WHERE APPLICABLE
- MATCHLINE
- PROPERTY LINE
- 2' CONTOUR

STACK lot
5639 south curtice street littleton, colorado 80120
p. 303.808.4523

Westside Crossing
Final Plat

Landscape Plan 'C'

DATE:	REVISION:
12/1/23	SECOND SUBMITTAL
1/22/24	THIRD SUBMITTAL
2/16/24	FORTH SUBMITTAL
2/26/24	FIFTH SUBMITTAL

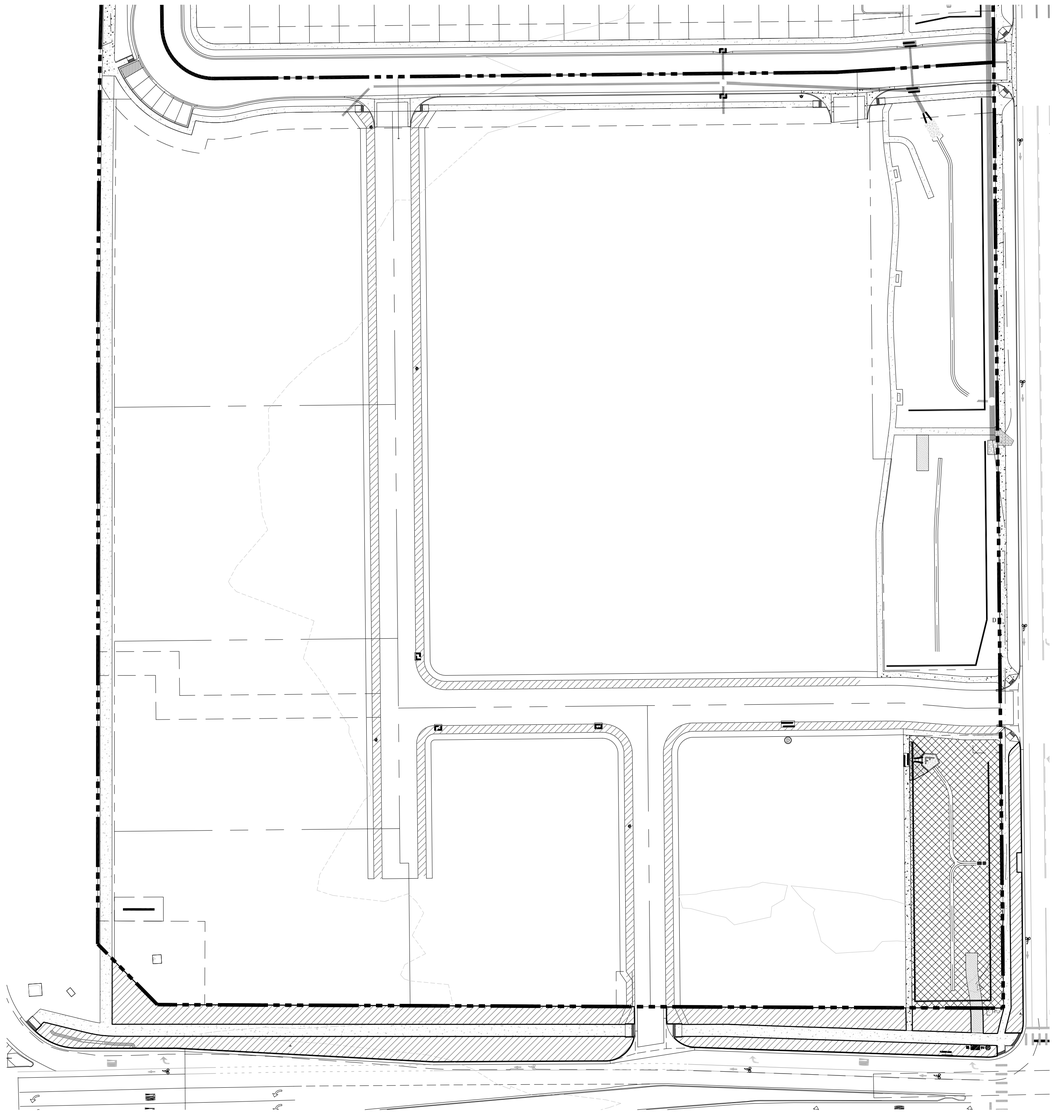
Project Mgr:	JAH
Drawn By:	SDW
Checked By:	JAH
Date:	8/25/23
Scale:	1" = 30'

SHEET

L1.4

PLANT MATERIAL SCHEDULE

QTY.	SYMBOL	COMMON NAME	BOTANICAL NAME	SIZE	CONDITION	REMARKS	HT. / WIDTH	PERCENTAGE
DECIDUOUS TREES								
2	nm	NORWAY MAPLE	ACER PLATANOIDES	2" CAL.	B&B	SINGLE STEM	30'x35'	3%
3	ll	LITTLE LEAF LINDEN	TILIA CORDOTA	2" CAL.	B&B	SINGLE STEM	35'x25'	4%
3	ro	RED OAK	QUERCUS RUBRA	2" CAL.	B&B	SINGLE STEM	65'x45'	4%
10	kc	KENTUCKY COFFEE TREE	GYMNOCLADUS DIOICUS 'EXPRESSO'	2" CAL.	B&B	SINGLE STEM	45'x35'	15%
3	pe	PROSPECTOR ELM	ULMUS WILSONIANA 'PROSPECTOR'	2" CAL.	B&B	SINGLE STEM	45'x25'	4%
4	eo	ENGLISH OAK	QUERCUS ROBUR	2" CAL.	B&B	SINGLE STEM	50'x35'	6%
3	ws	WHITE SWAMP OAK	QUERCUS ALBA	2" CAL.	B&B	SINGLE STEM	50'x35'	4%
6	tb	TEXAS BUCKEYE	AESCULUS ARGUTA	2" CAL.	B&B	SINGLE STEM	25'x25'	9%
6	ob	OHIO BUCKEYE	AESCULUS GLABRA	2" CAL.	B&B	SINGLE STEM	30'x25'	9%
10	sc	CATALPA	CATALPA SP.	2" CAL.	B&B	SINGLE STEM	50'x30'	15%
7	co	HACKBERRY	CELTIS OCCIDENTALIS	2" CAL.	B&B	SINGLE STEM	60'x40'	10%
10	cp	CHANTICLEER 'CLEVELAND'	PYRUS CALLERYANA 'CLEVELAND'	2" CAL.	B&B	SINGLE STEM	30'x20'	15%



HYDROZONE MAP

NORTH

0' 30' 60' 120' 180'

SCALE 1" = 60' - 0"

42,176 SF, HIGH HYDROZONE (FESCUE SOD MIX): 3 ACRE FEET

15,452 SF. LOW HYDROZONE (NATURAL GRASSES): 0.8 ACRE FEET

GENERAL PLANTING NOTES:

1. PRIOR TO BEGINNING ANY WORK ON THE SITE THE LANDSCAPE CONTRACTOR SHALL CONTACT THE OFFICE OF THE GENERAL CONTRACTOR AND LANDSCAPE ARCHITECT FOR SPECIFIC INSTRUCTIONS RELEVANT TO THE SEQUENCING OF WORK.
2. LANDSCAPE CONTRACTOR SHALL PROVIDE ALL LABOR, MATERIALS AND SERVICE NECESSARY TO FURNISH AND INSTALL PLANTINGS AND MATERIALS AS SPECIFIED HEREIN AND AS SHOWN ON PLANS.
3. NO MATERIAL SUBSTITUTIONS SHALL BE MADE WITHOUT THE LANDSCAPE ARCHITECTS AND TOWN OF BERTHOUD APPROVALS IN WRITING. ALTERNATE MATERIALS OF SIMILAR SIZE AND CHARACTER MAY BE CONSIDERED IF SPECIFIED PLANT MATERIALS CANNOT BE OBTAINED.
4. ALL PLANT LOCATIONS ARE APPROXIMATE. ADJUST AS NECESSARY TO AVOID CONFLICTS.
5. QUANTITIES OF MATERIALS SHOWN ON THE PLANTING PLAN TAKE PRECEDENCE OVER QUANTITIES SHOWN ON THE PLANT MATERIAL SCHEDULE. THE LANDSCAPE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFY ALL QUANTITIES ON THE PLANTING PLAN(S).
6. LANDSCAPE CONTRACTOR SHALL LOCATE ALL UTILITIES BEFORE COMMENCEMENT OF WORK. VERIFY EXACT LOCATION OF ALL UTILITIES BY CONTACTING APPROPRIATE UTILITY COMPANIES. LANDSCAPE CONTRACTOR IS RESPONSIBLE FOR THE REPAIR / REPLACEMENT FOR ANY DAMAGE CAUSED TO UTILITIES.
7. FINISH GRADE SHALL BE ADJUSTED FOR TURF THICKNESS.
8. ALL PLANT MATERIALS SHALL HAVE BACKFILL, CAREFULLY PLACED AROUND BASE AND IDES OF BALL TO TWO-THIRDS ($\frac{2}{3}$) DEPTH OF BALL THEN THOROUGHLY SOAKED WITH WATER TO ALLOW SETTLEMENT. ALL WIRE, BURLAP FASTENERS, TOP ONE-THIRD ($\frac{1}{3}$) OF BURLAP AND LOOSE BURLAP SHALL BE REMOVED AT THIS TIME THE REMAINDER OF HE PIT SHALL THEN BE BACKFILLED, ALLOWING FOR THE DEPTH OF THE MULCH SAUCER AND SETTLEMENT OF BACKFILL. BACKFILL SHALL THEN BE THOROUGHLY WATERED ONCE AGAIN.
9. AFTER PLANTING IS COMPLETED REPAIR INJURIES TO ALL PLANTS AS REQUIRED. LIMIT AMOUNT OF PRUNING TO A MINIMUM NECESSARY TO REMOVE DEAD OR INJURED TWIGS AND BRANCHES. PRUNE IN SUCH A MANNER AS NOT TO CHANGE THE NATURAL GROWING HABIT OR SHAPE OF THE PLANT. MAKE ALL CUTS FLUSH, LEAVING NO STUBS. CENTRAL LEADERS SHALL NOT BE REMOVED. IF THE CENTRAL LEADER OF A PLANT IS DEAD THE PLANT SHALL BE REPLACED.
10. PLANT SPECIFIED GROUND COVERS WITHIN ONE FOOT OF TRUNK OF TREES AND SHRUBS PLANTED WITHIN THE AREA. PLANTING ARRANGEMENTS SHALL BE TRIANGULAR WITH PROPER SPACING BETWEEN PLANTS.
11. COMMERCIAL GRADE PERFORATED WITH DRAINAGE HOLES, $\frac{3}{16}$ INCH BY 4" POWDER COATED STEEL EDGING WITH ROLLED EDGE SHALL BE USED TO SEPARATE ALL TURF AREAS FROM PLANTING BEDS. PLACE EDGING FLUSH WITH GRADE AND STAKE TO GROUND PER MANUFACTURES RECOMMENDATIONS.
12. LANDSCAPE CONTRACTOR TO PROVIDE THE LANDSCAPE ARCHITECT A SAMPLE OF PROPOSED STEEL EDGING FOR REVIEW AND APPROVAL PRIOR TO INSTALLATION.
13. USE SHREDDED CEDAR AND ROCK MULCH IN ALL PLANTING BEDS AS INDICATED ON PLANS. USE SHREDDED CEDAR IN ALL TREE SAUCERS. LANDSCAPE CONTRACTOR SHALL PROVIDE A 1 CUBIC FOOT SAMPLE OF PROPOSED MULCH TO LANDSCAPE ARCHITECT FOR REVIEW AND APPROVAL.
14. PLACE FOUR INCHES OF MULCH IN ALL SHRUB BEDS, PLACE FOUR INCHES OF MULCH IN ALL GROUND COVER, PERENNIAL BEDS AND PLACE 4 INCHES OF MULCH AT ALL TREE SAUCERS.
15. PLANTING BEDS RECEIVING MULCH MULCH ARE TO BE FREE OF WEEDS AND GRASS. TREAT BEDS WITH A PRE-EMMERGENT HERBICIDE PRIOR TO PLANTING AND MULCH PLACEMENT. DO NOT APPLY HERBICIDE IN PERENNIAL OR ANNUAL BEDS.
16. LANDSCAPE CONTRACTOR TO REMOVE TREE STAKES AND ALL DEAD WOOD ON TREES AND SHRUBS ONE YEAR AFTER SUBSTANTIAL COMPLETION IS GRANTED ON THE COMPLETE PROJECT.
17. REPORT ANY DISCREPANCIES IN THE PLANTING PLAN TO THE LANDSCAPE ARCHITECT PRIOR TO STARTING CONSTRUCTION.
18. THIS CODE MANDATES LANDSCAPING AND INSTALLATION OF PERMANENT AUTOMATIC UNDERGROUND SPRINKLER SYSTEMS CONTAINING MOISTURE SENSORS IN ALL PARKS AND OPEN SPACES WITHIN NEW DEVELOPMENTS, EXCEPT FOR (I) NATURAL AREAS, (II) OPEN WATER, (III) ALL IMPERVIOUS SURFACES, AND (IV) AS ALLOWED IN SECTION 7.C BELOW. ALL IRRIGATED LANDSCAPING SHALL BE ESTABLISHED AND MAINTAINED IN A LIVE AND WEED-FREE CONDITION. IRRIGATION SHALL BE APPROPRIATE TO THE TYPE AND SCOPE OF THE IMPROVEMENT.
19. SLEEVING FOR THE FUTURE INSTALLATION OF IRRIGATION LINES SHALL BE PROVIDED UNDER WALKWAYS AND PAVED AREAS WHERE IRRIGATION MAY BE INSTALLED IN ORDER TO PREVENT OR MINIMIZE DAMAGE AND REPLACEMENT TO PAVED AREAS.
20. IRRIGATION SYSTEMS SHALL BE DRIP IRRIGATION WHERE POSSIBLE IN PLANTING BEDS AND FOR SHRUBS, TREES, ETC. ALL IRRIGATION SYSTEMS SHALL BE DESIGNED TO PREVENT OVERSPRAY AND RUNOFF ONTO PAVED OR OTHER NON-LANDSCAPED AREAS.
21. ALL AUTOMATIC IRRIGATION SYSTEMS MUST BE INSTALLED WITH MOISTURE SENSORS.
22. SUCH STREET TREES SHALL BE PLACED AT LEAST FIVE FEET AWAY FROM THE EDGES OF DRIVEWAYS AND ALLEYS, AND 40 FEET AWAY FROM ANY STREETLIGHT AND TO THE EXTENT REASONABLY FEASIBLE, BE POSITIONED AT EVENLY SPACED INTERVALS
23. ALL LANDSCAPE AREAS AND PLAYGROUND WITHIN THE R4 ZONE DISTRICT SHALL BE MAINTAINED BY A HOME OWNERS ASSOCIATION. ALL LANDSCAPE AREAS AND PLAZA IN THE C2 ZONE DISTRICT SHALL BE MAINTAINED BY A BUSINESS IMPROVEMENT DISTRICT. DURING CONSTRUCTION, AREAS IN THE C2 AND R4 ZONE DISTRICTS SHALL BE MAINTAINED BY THE GENERAL CONTRACTOR.
24. 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 CONTINUAL RESPONSIBILITY OF THE OWNER DURING ALL PHASES OF LAND CLEARING AND CONSTRUCTION.
25. ALL IRRIGATED LANDSCAPING SHALL BE ESTABLISHED AND MAINTAINED IN A LIVE AND WEED FREE CONDITION.

Note:
Trees are not to planted within ten feet of either side water, sewer, or storm drain main lines or within five feet of either side of water or sewer service lines

STACK lot
5639 south curtice street littleton, colorado 80120
p. 303.808.4523

Westside Crossing
Final Plat

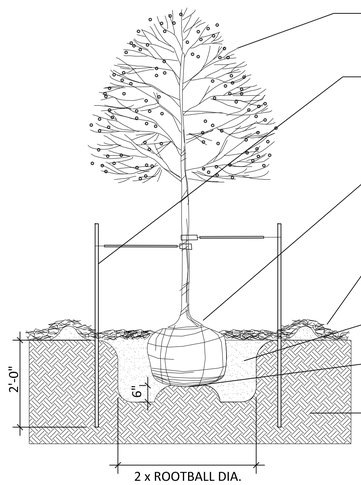
Landscape Notes & Plant Material Schedule

DATE:	REVISION:
12/1/23	SECOND SUBMITTAL
1/22/24	THIRD SUBMITTAL
2/16/24	FORTH SUBMITTAL
2/26/24	FIFTH SUBMITTAL

Project Mgr:	JAH
Drawn By:	SDW
Checked By:	JAH
Date:	8/25/23
Scale:	See Plan

SHEET

L1.5



DO NOT CUT TREE LEADER. PRUNE ONLY CROSSOVER LIMBS, CO- DOMINANT LEADERS AND INJURED OR DEAD BRANCHES FROM TREE.

SECURE WITH 3 SPECIFIED 8-FT WOOD TREE STAKES IN UNDISTURBED SOIL. INSTALL WIRE AND NON- GIRDLING FLAT FABRIC FASTENERS IMMEDIATELY AFTER PLANTING, ALLOWING 3"-4" TRUNK MOVEMENT. COVER WIRE WITH SPECIFIED RUBBER GARDEN HOSE AND INSTALL 4" FLORESCENT ORANGE FLAG ON EACH WIRE.

PLANT ROOT BALL 3"-4" HIGH WITH RESPECT TO FINISHED GRADE. DO NOT COVER TOP OF ROOTBALL WITH SOIL . CUT AND REMOVE TOP 2/3 OF WIRE BASKET AND REMOVE TOP 2/3 BURLAP. REMOVE ALL ROPE, TWINE AND WIRE OTHER THAN BASKET.

PLACE MULCH/COBBLE RING AROUND TREE. DO NOT PLACE MULCH/ COBBLE IN CONTACT WITH TREE TRUNK. RE: SPECIFICATIONS FOR MULCH/COBBLE TYPE AND DEPTH. ALL MULCH TO BE 2" SETTLED.

PREPARE AND PLACE BACKFILL SOIL MIX AS PER SPECIFICATIONS.

SET ROOTBALL ON UNDISTURBED SOIL. SET PLUMB AND CENTER IN PIT.

COMPACTED SUBGRADE

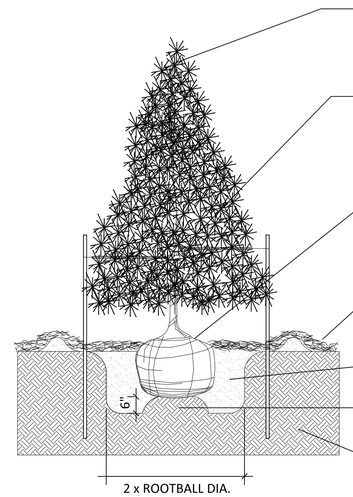
SHADE TREES: LOWEST LIMBS MIN. 6-8' FROM ROOT CROWN

AFTER TWO YEARS NO LIMBS SHALL BE WITHIN 8' OF PAVEMENT

REJECT TREES WITH BROKEN OR DAMAGED ROOTBALLS

1 DECIDUOUS TREE

NOT TO SCALE



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PLANT ROOT BALL 3"-4" HIGH WITH RESPECT TO FINISHED GRADE. DO NOT COVER TOP OF ROOTBALL WITH SOIL . CUT AND REMOVE TOP 2/3 OF WIRE BASKET AND REMOVE TOP 2/3 BURLAP. REMOVE ALL ROPE, TWINE AND WIRE OTHER THAN BASKET.

PLACE MULCH/COBBLE RING AROUND TREE. DO NOT PLACE MULCH/COBBLE IN CONTACT WITH TREE TRUNK. RE: SPECIFICATIONS FOR MULCH/COBBLE TYPE AND DEPTH. ALL MULCH TO BE 2" SETTLED.

PREPARE AND PLACE BACKFILL SOIL MIX AS PER SPECIFICATIONS.

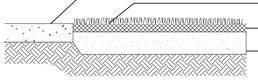
SET ROOTBALL ON UNDISTURBED SOIL. SET PLUMB AND CENTER IN PIT.

COMPACTED SUBGRADE

REJECT TREES WITH BROKEN OR DAMAGED ROOTBALLS

2 EVERGREEN TREE PLANTING

NOT TO SCALE



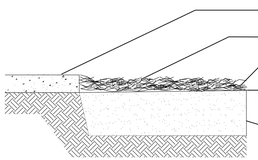
SIDEWALK, TOP OF CURB, OR TOP OF SEAT WALL

FINISHED GRADE OR TOP OF SOD LEVEL WITH PAVED EDGE

SPECIFIED SOD OR SEED

FULL DEPTH OF SPECIFIED AMENDED TOPSOIL PLACED APPROX. 1" BELOW TOP OF PAVED EDGE FOR SOD AND LEVEL FOR SEED

SOD ADJACENT TO WALKS AND CURBS



SIDEWALK, TOP OF CURB, OR TOP OF SEAT WALL

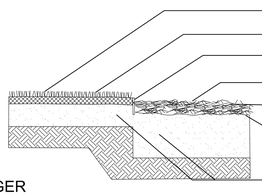
FINISHED GRADE OR TOP OF MULCH/COBBLE 1/2" BELOW PAVED EDGE

SPECIFIED COBBLE

SPECIFIED WEED BARRIER FABRIC UNDER MULCH/ COBBLE WITH SPECIFIED PRE-EMERGENT HERBICIDE BELOW FABRIC

FULL DEPTH OF SPECIFIED AMENDED TOPSOIL PLACED THE NECESSARY DISTANCE BELOW PAVED EDGE

MULCH ADJACENT TO WALKS AND CURBS



SPECIFIED SOD OR SEED

FINISHED GRADE OR TOP OF SOD LEVEL WITH TOP OF EDGER

STEEL EDGER W/ ROLLED TOP

FINISHED GRADE OR TOP OF MULCH/COBBLE 1/2" BELOW TOP OF EDGER

SPECIFIED MULCH/COBBLE

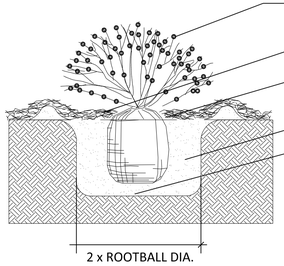
SPECIFIED WEED BARRIER FABRIC UNDER MULCH COBBLE SPECIFIED PRE-EMERGENT HERBICIDE BELOW FABRIC

FULL DEPTH OF SPECIFIED AMENDED TOPSOIL PLACED THE NECESSARY DISTANCE BELOW TOP OF EDGER

EDGER

3 EDGE TREATMENT

NOT TO SCALE



REMOVE ONLY INJURED OR DEAD BRANCHES FROM SHRUBS. SHRUB SPACING AS PER PLANS.

PLACE 3' DIA. MIN. RING OF MULCH/COBBLE UNDER SHRUB.

PLACE PLANT IN VERTICAL, PLUMB POSITION. REMOVE CONTAINER PRIOR TO PLACING BACKFILL.

PREPARE AND PLACE PLANTING SOIL MIX AS PER SPEC.

PLACE 3" OF SPECIFIED BACKFILL BELOW THE ROOTBALL.

4 SHRUB PLANTING

NOT TO SCALE

STACK lot
5639 south curtice street littleton, colorado 80120
p. 303.808.4523

Westside Crossing
Final Plat

Landscape Details

DATE:	REVISION:
12/1/23	SECOND SUBMITTAL
1/22/24	THIRD SUBMITTAL
2/16/24	FORTH SUBMITTAL
2/26/24	FIFTH SUBMITTAL

Project Mgr:	JAH
Drawn By:	SDW
Checked By:	JAH
Date:	8/25/23
Scale:	See Plan

SHEET

L1.6

PRELIMINARY PLAT

WESTSIDE CROSSING REPLAT #2

Being a Replat of Tract A, Westside Crossing,
Situate in the South Half of the Southwest Quarter of Section 15, Township 4 North, Range 69 West of the 6th P.M.,
Town of Berthoud, County of Larimer, State of Colorado

LEGAL DESCRIPTION:

KNOW ALL MEN BY THESE PRESENTS: That the undersigned, being the owners of a portion of the Southwest Quarter Section Fifteen (15), Township Four North (T.4N.), Range Sixty–nine West (R.69W.) of the 6th Principal Meridian, Town of Berthoud, County of Larimer, State of Colorado, more particularly described as follows:

Tract A, Westside Crossing, recorded July 5, 2022 as Reception No. 20220042194 of the Records of Larimer County.

Said described parcel of land contains 11.901 Acres, more or less (±).

Have laid out, platted, and subdivided the above described land, under the name and style of WESTSIDE CROSSING REPLAT #2, 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 plats, 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: Berthoud Gateway LLC, a Colorado limited liability company

By: _____ As: _____

NOTARIAL CERTIFICATE

STATE OF _____)
ss
COUNTY OF _____)

The foregoing dedication was acknowledged before me this _____day of _____, 20 __,

by _____ as _____

Witness my hand and official seal. (SEAL)

My commission expires _____

_____
Notary Public

LEINHOLDER: Westland Holdings, Inc.

By: _____ As: _____

NOTARIAL CERTIFICATE

STATE OF _____)
ss
COUNTY OF _____)

The foregoing dedication was acknowledged before me this _____day of _____, 20 __,

by _____ as _____

Witness my hand and official seal. (SEAL)

My commission expires _____

_____
Notary Public

LEINHOLDER: Camco LLC

By: _____ As: _____

NOTARIAL CERTIFICATE

STATE OF _____)
ss
COUNTY OF _____)

The foregoing dedication was acknowledged before me this _____day of _____, 20 __,

by _____ as _____

Witness my hand and official seal. (SEAL)

My commission expires _____

_____
Notary Public

BASIS OF BEARINGS AND LINEAL UNIT DEFINITION

Assuming the East line of the South Half of the Southwest Quarter of Section 15, T.4N., R.69W., being monumentalized by a #6 rebar with a 2" Aluminum Cap stamped "LS 27936" on the North end and by a #6 rebar with a 3 1/4" aluminum cap stamped "LS 16415" on the South end, as bearing South 00°34'48" East, being a Grid Bearing of the Colorado State Plane Coordinate System, North Zone, North American Datum 1983/2011, a distance of 1330.11 feet with all other bearings contained herein relative thereto.

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

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)

TITLE COMMITMENT NOTE

This survey does not constitute a title search by King Surveyors to determine ownership or easements of record. For all information regarding easements, rights–of–way and title of records, King Surveyors relied upon Title Commitment Number FC25193574.1–6, dated June 22, 2023 as prepared by Land Title Guarantee Company to delineate the aforesaid information.

SURVEYOR'S CERTIFICATE:

I, Paul B. Groves, a Registered Land Surveyor in the State of Colorado, do hereby certify that the survey of WESTSIDE CROSSING REPLAT #2 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

_____
Paul B. Groves – On Behalf Of King Surveyors
Colorado Licensed Professional
Land Surveyor #38209

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.

APPROVAL CERTIFICATES:

Approved by the Town of Berthoud, Colorado,

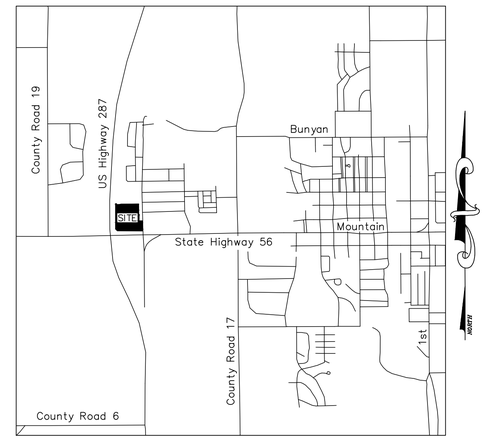
this_____ day of _____, A.D., 20___.

_____
Mayor

The foregoing plat is approved for filing and accepted by the Town of Berthoud, Colorado,

this_____ day of _____, A.D., 20___.

ATTEST: _____
Town Clerk



VICINITY MAP
SCALE: 1"=2000'

DATE: 12/13/2022
FILE NAME: 20220491A–SUB
SCALE: 1"=30'
DRAWN BY: CSK
CHECKED BY: PG

KING SURVEYORS
650 E. Garden Drive | Windsor, Colorado 80550
phone: (970) 686-5011 | email: contact@KingSurveyors.com

REVISIONS:		DATE:
REVISED ESMTS & LOTS	CSK	5/1/23
REVISED ESMTS & LOTS	CSK	7/6/23

WESTSIDE CROSSING REPLAT #2
FOR
BERTHOUD GATEWAY LLC
8340 LOUDEN CIRCLE
WINDSOR, CO 80528

PROJECT #: 20220491–A

1

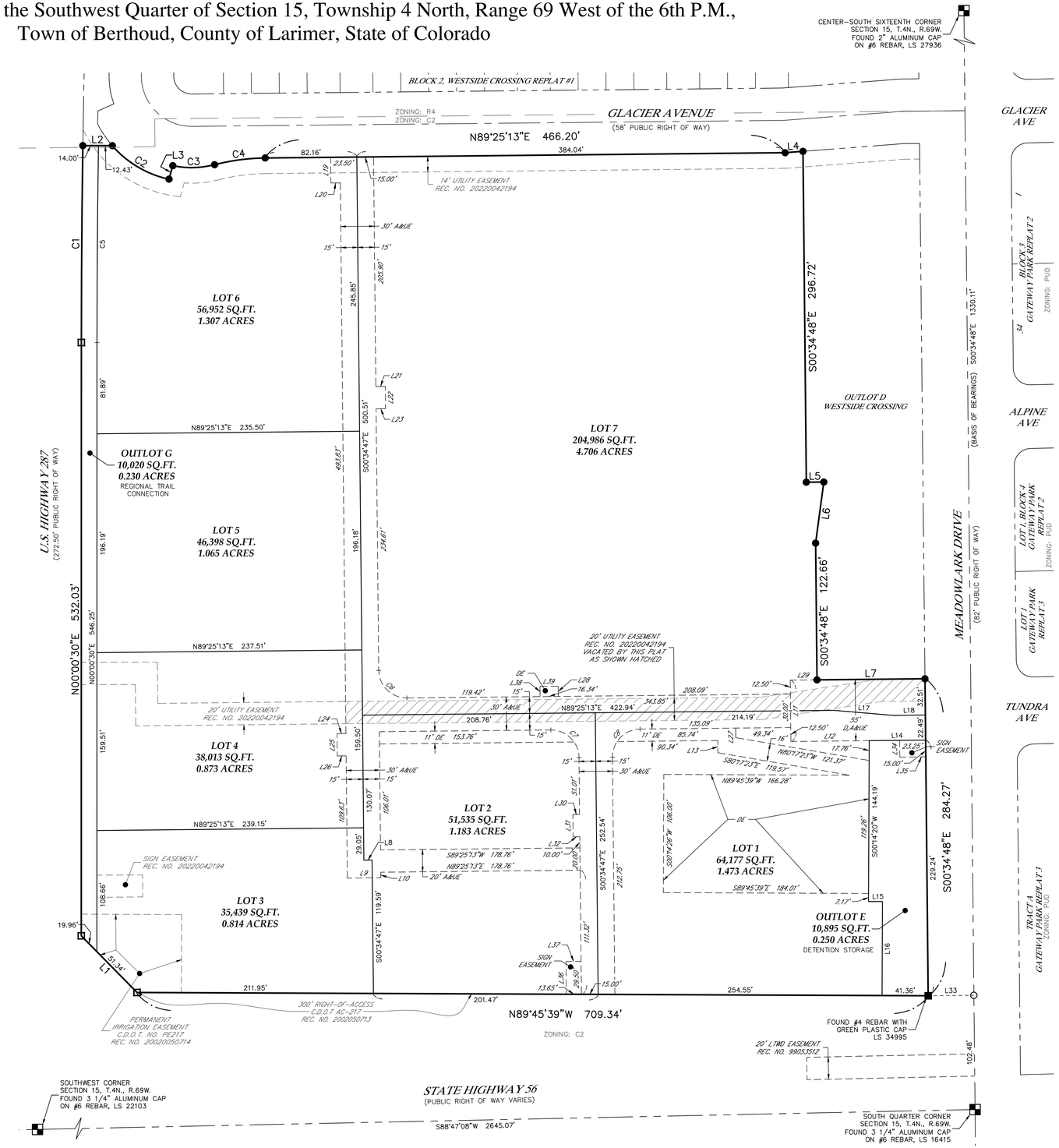
SHEET 1 OF 2

O:\20220491-A\dwg\20220491ASUB.dwg, ft (1), 7/6/2023 8:29:33 AM, 1:1

PRELIMINARY PLAT

WESTSIDE CROSSING REPLAT #2

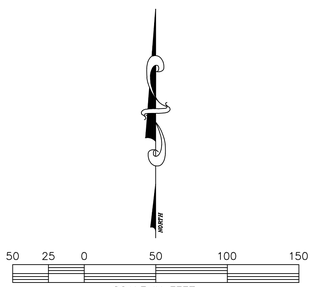
Being a Replat of Tract A, Westside Crossing,
Situate in the South Half of the Southwest Quarter of Section 15, Township 4 North, Range 69 West of the 6th P.M.,
Town of Berthoud, County of Larimer, State of Colorado



CURVE TABLE					
CURVE	LENGTH	RADIUS	DELTA	CHORD	CH BEARING
C1	176.56'	11862.50'	0°51'10"	176.56'	N00°26'05"E
C2	60.06'	94.50'	36°24'51"	59.05'	S59°25'52"E
C3	37.80'	82.00'	26°24'53"	37.47'	N88°38'43"E
C4	45.88'	188.00'	13°58'56"	45.77'	N82°25'45"E
C5	176.56'	11848.50'	0°51'14"	176.56'	S00°26'07"W
C6	39.27'	25.00'	90°00'00"	35.36'	S45°34'47"E
C7	39.27'	25.00'	90°00'00"	35.36'	N45°34'47"W
C8	39.27'	25.00'	90°00'00"	35.36'	S44°25'13"W

LINE TABLE		
LINE	BEARING	LENGTH
L1	N44°32'38"W	71.30'
L2	N90°00'00"E	26.43'
L3	N15°41'54"E	12.52'
L4	N85°37'33"E	16.04'
L5	N89°25'50"E	15.68'
L6	S07°37'15"W	55.26'
L7	N89°25'13"E	96.80'
L8	S89°25'13"W	7.31'
L9	N89°25'13"E	30.00'
L10	N00°34'47"W	5.00'
L11	N00°34'54"W	55.00'
L12	N89°25'13"E	70.24'
L13	S00°00'00"E	10.91'
L14	S89°25'13"W	50.55'
L15	S89°45'39"E	12.46'
L16	S00°14'21"W	84.33'
L17	S85°09'21"E	52.95'
L18	N89°25'13"E	28.98'
L19	S00°34'47"E	23.06'
L20	N89°25'13"E	8.50'

LINE TABLE		
LINE	BEARING	LENGTH
L21	N89°25'13"E	8.50'
L22	S00°34'47"E	20.00'
L23	S89°25'13"W	8.50'
L24	N89°25'13"E	8.00'
L25	N00°34'47"W	20.00'
L26	S89°25'13"W	8.00'
L27	N00°00'00"E	8.58'
L28	S00°34'58"E	9.06'
L29	N89°25'13"E	24.00'
L30	N89°25'13"E	6.00'
L31	N00°34'47"W	20.00'
L32	S89°25'13"W	6.00'
L33	N89°25'12"E	41.00'
L34	N00°34'47"W	15.00'
L35	S89°25'13"W	23.25'
L36	N00°06'27"W	29.41'
L37	N89°53'36"E	13.44'
L38	N00°34'47"W	9.22'
L39	N90°00'00"E	16.34'



LEGEND

- EASEMENT LINE
- CENTERLINE
- SECTION LINE
- RIGHT OF WAY LINE
- BOUNDARY LINE
- FOUND ALIQUOT CORNER AS DESCRIBED
- FOUND MONUMENT AS DESCRIBED
- FOUND #6 REBAR WITH 3 1/4" ALUMINUM CAP LS 22103
- SET 24" OF #4 REBAR WITH A BLUE PLASTIC CAP STAMPED KS, LS 38209
- CALCULATED POSITION
- A&UE — ACCESS & UTILITY EASEMENT
- DE — DRAINAGE EASEMENT
- D,A&UE — DRAINAGE, ACCESS & UTILITY EASEMENT

PRELIMINARY

Paul B. Groves – On Behalf Of King Surveyors
Colorado Licensed Professional
Land Surveyor #38209

DATE: 12/13/2022
FILE NAME: 20220491A-SUB
SCALE: 1"=30'
DRAWN BY: CSK
CHECKED BY: PG

KING SURVEYORS
650 E. Garden Drive | Windsor, Colorado 80550
phone: (970) 686-5011 | email: contact@KingSurveyors.com

REVISIONS:		DATE:
REVISED ESMT'S & LOTS	CSK	5/1/23
REVISED ESMT & LOTS	CSK	7/6/23

WESTSIDE CROSSING REPLAT #2
FOR
BERTHOUD GATEWAY LLC
8340 LOUDEN CIRCLE
WINDSOR, CO 80528

PROJECT #: 20220491-A

2

SHEET 2 OF 2

O:\20220491-A\Dwg\20220491A-SUB.dwg, ab (2), 7/6/2023 8:29:57 AM, 1:1

Scale: 1"=60'

N

STACK Lot
5639 S Curtice Street
Littleton, CO 80120
303.808.4523

CONCEPTUAL MASTERPLAN

Westside Crossing - Town of Berthoud, Colorado

2.18.21

ALDRIDGE TRANSPORTATION CONSULTANTS, LLC

Advanced Transportation Planning and Traffic Engineering

John M.W. Aldridge, PE
Colorado Licensed Professional Engineer

1082 Chimney Rock Road
Highlands Ranch, CO 80126
303-703-9112
Mobile: 303-594-4132
Email: john@atceng.com

January 2, 2023

Mr. Jay D. Stoner
President
Land Developers, Inc.
1035 37th Avenue Court
Greeley, CO 80634

Re: Transportation Impact Study with Comprehensive Signal Warrant Analysis
Westside Crossing - Berthoud, CO

Dear Mr. Stoner:

Aldridge Transportation Consultants (ATC) is pleased to present this Traffic Impact Study regarding the proposed development of Westside Crossing in Berthoud.

ATC is professional service firm specializing in traffic engineering and transportation planning. ATC's principal, John M.W. Aldridge, is a Colorado licensed professional engineer. In the past 20 years, ATC has prepared over 1,000 traffic impact studies, designed over 100 traffic signals, and has provided expert witness testimony on engineering design and access issues on multi-million dollar interchange and highway projects in Kansas and Colorado.

ATC appreciates the opportunity to be of service. Please call if you have any questions. We can be reached at 303-703-9112.

Respectfully submitted,
Aldridge Transportation Consultants, LLC

John M.W. Aldridge, P.E.
Principal

1. PROJECT DESCRIPTION

Land Developers, Inc. is proposing to construct a mixed-use development on the northeast corner of CO-287 and CO-56 in Berthoud, Colorado. The development includes a residential component, retail shops, restaurants, grocery store, and a gas station with a convenience store. Figure 1 shows the location of the site, site plan, and the adjacent streets and intersections. Note that the site plan is subject to changes.

Figure 1

2. GENERAL EXISTING CONDITIONS

CO-287 is a state highway categorized as F-W (Freeway) in this section. It currently carries 23,000 per CDOT OTIS data. The speed limit is 65 mph. SH-56 is a two-lane Arterial. Currently it carries 8,000 ADT and is posted at 45 mph in this section. Meadowlark Dr. is two-lane Collector that currently carries approximately 1,200 ADT. It is posted at 35 mph. The traffic signal at CO-287 and CO-56 is fully actuated and features protected/permitted left turn phasing on the north/south approaches and protected only on the east/west approaches. The intersection of CO-56 and Meadowlark Dr. is two-way stop sign controlled.

The AM and PM peak hours at intersections of CO-287/CO-56 and CO-56/Meadowlark were counted on October 15, 2019, by All Traffic Data. The counts are attached.

Both sides will be accessible from CO-56 at two locations. A full movement access at Meadowlark Dr. and a right in/right out access approximately 300 feet west of Meadowlark Dr. No access is allowed on CO-287.

3. DEVELOPMENT SITE CHARACTERISTICS

The trip generation for the residential development is defined in Table 1. It is based on the rates and values found in the ITE Trip Generation Manual, 11th Edition. Shown are the Average Daily Traffic and the AM and PM peak hours.

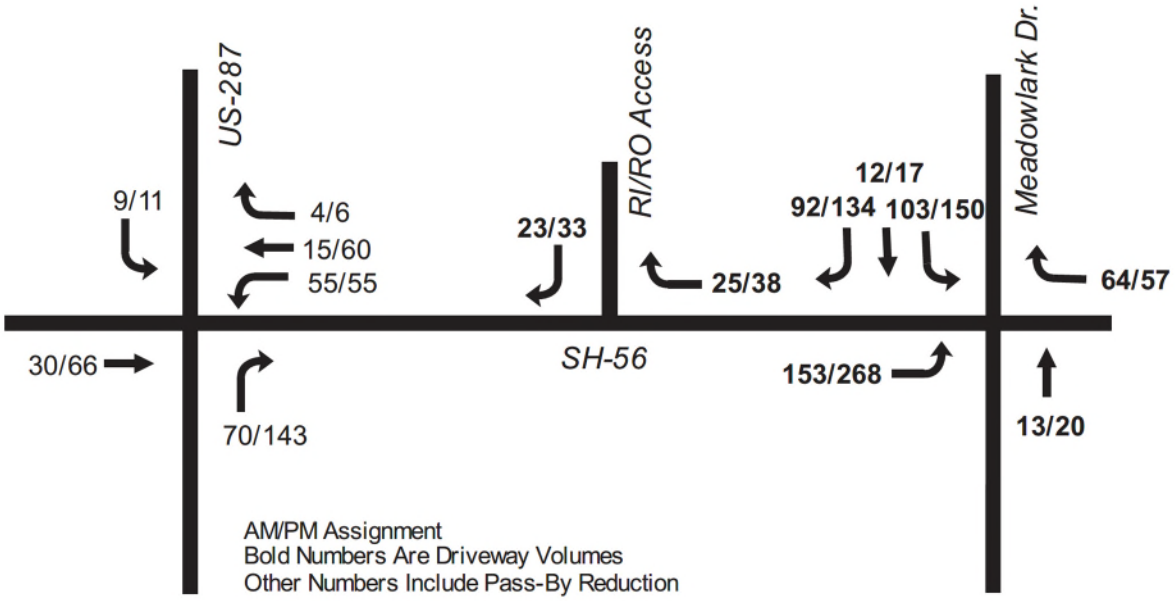
Table 1

Trip Generation Tablulation								
					AM		PM	
ITE Code	Land Use	Unit	Quantity	ADT	In	Out	In	Out
945	Gas Station w/ Convenience	Fueling	12	*265.12*	*8.03*	*8.03*	*9.21*	*9.21*
		Positions		**3181**	**96**	**96**	**111**	**111**
210	Single Family Detached	DU	56	*9.43*	*0.18*	*0.52*	*0.59*	*0.35*
				528	**10**	**29**	**33**	**20**
822	Strip Retail Plaza	KSF	29.7	*54.45*	*1.42*	*0.94*	*3.30*	*3.30*
				1617	**42**	**28**	**98**	**98**
850	Grocery Store	KSF	25.0	*93.84*	*1.69*	*1.17*	*4.48*	*4.48*
				2346	**42**	**29**	**112**	**112**
848	Tire Store	KSF	11.9	*27.69*	*1.67*	*0.94*	*1.61*	*2.14*
				330	**20**	**11**	**19**	**25**
932	Restaurants	KSF	16.0	*107.20*	*5.26*	*4.31*	*5.52*	*3.53*
				1715	**84**	**69**	**88**	**56**
Internal Trip Capture Reduction (13% AM) (19% PM)					**38**	**34**	**88**	**80**
Total Trips				**9717**	**257**	**229**	**373**	**342**

The average pass-by trip percentage is 56 percent per the ITE Trip Generation Manual, 11th Edition. The pass-by trips were taken at the intersections and on the mainline. Shown in Table 1 is the internal trip capture. These are trips that stay inside the development i.e., a trip from the residential area to the grocery store. The internal trip capture was determined by using the NCHRP 684 Internal Trip Capture Estimation Tool. It is attached for reference.

The PM peak hour is the heaviest time of traffic on the highway and the development. It is considered the design hour volume (DHV) for operations and geometric design purposes.

The distribution and assignment of the site generated trips is shown in the following graphic. The distribution is based on the current percent movement splits at CO-56/Meadowlark Dr. and CO-287/CO-56.



4. FUTURE CONDITIONS

The CDOT OTIS 20-year growth factor for US-287 is 1.44 and for SH-56 it is 1.13. The 5-year growth factor is 1.10 for US-287 and 1.03 for SH-56. Although likely inclusive of this development, the growth factors were applied as background growth and the site generated traffic was added on for the total growth conditions.

5. PROJECT IMPACTS

ATC uses Synchro v.11 for operations analyses. The Synchro v.11 methodologies are based on the **Highway Capacity Manual, 6th Edition** (HCM). The Synchro HCM reports in the appendix are for reference. LOS is letter rating from A to F. LOS A indicates free-flow traffic conditions and no delay at intersections. LOS F is heavy traffic congestion with significant delay. LOS is provided for the overall operations at signalized intersections. LOS D is generally the benchmark for acceptable signalized intersection operations during the weekday peak hours. The critical movement, not the overall, provides the LOS rating for unsignalized intersections. The critical movement is generally a left turn from the minor approach. Caution is advised when evaluating the LOS at unsignalized intersections particularly when LOS F shows. In cases of a LOS F, the HCM suggests that other evaluation measures should be considered such as the volume over capacity ratio and the 95th percentile queue length to make the most effective traffic control decision. LOS F at unsignalized intersections is considered normal for the weekday peak hour particularly when the v/c ratio and the 95th percentile queue length are acceptable.

The Synchro operations analysis revealed that the intersection at US-287 would operate at no worse than LOS D with little to no delay or queuing in the left turn storage bays. The 20-year growth factor of 1.44 when applied to the mainline volumes shows that the intersection will continue to operate at LOS B again with little to no delay or queuing in the left turn storage bays.

The intersection at Meadowlark Dr. and SH-56 currently operates at LOS C and would continue to do so in the background 2025 and 2040 AM and PM peak hour. The additional site generated traffic will cause significant delay and LOS F operations.

The right turn only entrance will operate at LOS B in all conditions. The Synchro graphics and reports are attached.

Traffic Signal Warrant Analysis

To determine the need for a traffic signal at CO-56/Meadowlark Dr. we have prepared a warrant analysis based on the procedures and methodology promulgated by the Manual on Uniform Traffic Control Devices (MUTCD) that has been adopted as Colorado Law. The analysis worksheets and an explanation summary are provided in the appendix.

Three scenarios were prepared. 1) Existing Conditions, 2) Future Conditions with Residential Only, and 3) Future Conditions with Residential and 50% Build Out of the Commercial Development. The Traffic Signal Analysis reports are provided in the appendix. In summary, the results show in Scenario 1 Existing Conditions that a traffic signal is not warranted. In Scenario 2 Future Conditions with Residential Only a traffic signal is not warranted but it is very close to meeting Warrant #2 - Four-Hour Warrant. As it is very close additional traffic generated by the commercial area will probably push it over the top. Thus, the reason for Scenario 3 Future Conditions with Residential and 50% Build Out of the Commercial Development. In fact, with Scenario 3 the three volume warrants Warrant 1 – Eight-Hour Warrant, Warrant, 2 – Four Hour Warrant and Warrant 3 – Peak Hour Warrant are met. Note that Warrant 8 – Roadway Network permits signal installation up to five years from a projected warrant. A more comprehensive analysis including warrant worksheets is provided in the appendix.

Street Traffic Volumes

Table 2 provides and summary of the ACF traffic volume requirements for the primary roadway, SH-56.

Table 2

Street Taffic Volume Summary Table									
	Street Segment	Existing Volume	Date of Existing Volume	Regional Traffic Growth	Traffic from Other Development	Site Generated Traffic	Total Traffic	ACF Traffic Threshold	ACF Compliance
1	SH-56 e/o US-287	447	10/15/2019	505	unk	115	620	920	YES

Peak Hour Link Volumes

Table 3 summarizes the AFC compliance for the individual roadway links in the peak hour.

Table 3

Peak Hour Link Volume Summary Table									
	Existing		AFC	2025		AFC	2040		AFC
Link	VPHPL	ACF Base	Compliant	VPHPL	ACF Base	Compliant	VPHPL	ACF Base	Compliant
SH-56 e/o B. Pkwy. (east link)	323	920	YES	490	920	YES	537	920	YES
SH-56 e/o B. Pkwy. (west link)	447	920	YES	537	920	YES	589	920	YES
ACF Base VPHPL adjusted per Attachments E & F									

Intersection Delay

The intersection operations were analyzed for the existing weekday AM and PM peak hour and the 2025 and 2040 scenarios with and without the site generated traffic. The signalized intersection analyses were performed with the current left turn phasing in the existing and 2025/2040scenarios. The Synchro graphics and reports for each condition are attached for reference.

Table 4 provides a summary of the Peak Hour intersection Level of Service characteristics. The major intersection threshold for any movement at a signalized intersection is LOS E. LOS F is recorded on the EB leg/movements and WB left on US-287 in 2040. This can be mitigated with opening the dual left turn lanes that are currently striped in and signal timing improvements. Note that the Synchro program is for fixed cycle times. The signal is fully actuated, and each movement is optimized.

The traffic signal at SH-56/Meadowlark Dr. is ACF compliant in all conditions.

LOS F on the critical movement at an unsignalized intersection acceptable in urban conditions. The right in/right out access will operate at a high LOS B in all scenarios.

Table 4

Peak Hour Intersection Level of Service Summary												
	Traffic	Existing		2025 Background		2025 Total		2040 Background		2040 Total		ACF
Intersection	Control	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	Compliant?
US-287/SH-56	Signalized											
EBL		E	E	E	E	E	E	E	E	E	F	NO
EBT		E	D	E	D	E	E	E	D	E	F	NO
WBL		E	D	E	D	E	E	E	E	F	F	NO
WBT		D	D	D	D	D	E	D	D	D	E	YES
NBL		B	A	B	A	B	B	C	A	C	B	YES
NBT		B	B	B	B	B	B	B	F	B	C	YES
SBL		A	B	B	B	B	B	B	B	B	C	YES
SBT		B	B	B	B	C	B	C	B	C	B	YES
Overall Intersection Delay		27.3	21.8	27.8	22.4	32.8	28.8	32.8	32.1	39.8	38.6	
Overall Intersection LOS		C	C	C	B	C	C	C	D	D	C	YES
SH-56/Meadowlark	TWSC											
NBLTR		C	C	C	C			C	D			YES
EBL		A	A	A	A			A	A			YES
WBL		A	A	A	A			A	A			YES
SBLTR		C	C	C	C			C	C			YES
Overall Intersection Delay		3.5	3.2	3.6	3.3			4.2	3.8	2.8	5.0	
SH-56/Meadowlark	Signalized											
EBL						D	D			D	E	YES
EBT						A	A			A	A	YES
EBR						D	D			D	D	YES
WBL						C	C			C	C	YES
WBT						A	A			A	A	YES
WBR						D	E			D	E	YES
NBL						C	C			C	C	YES
NBT						A	A			A	A	YES
NBR						C	C			C	C	YES
SBL						B	C			B	C	YES
SBT						B	B			B	C	YES
SBR						B	C			B	C	YES
Overall Intersection Delay						37.4	42.3			38.2	44.5	YES
Overall Intersection LOS						D	D			D	D	YES
SH-56/RIRO	TWSC											
SBR						B	B			B	B	YES
Overall Intersection Delay						0.3	0.3			0.3	0.3	

PEDESTRIAN and BICYCLE IMPACT EVALUATIONS
Presently there are no sidewalks or bike lanes on either side of SH-56 or US-287. Detached sidewalks are planned for frontage on US-287, SH-56, and Meadowlark Dr.

MITIGATION MEASURES
Based on the analysis herein, the primary improvement will be the reconstruction and signalization of the SH-56/Meadowlark intersection. The southbound approach should include exclusive left, through and right turn lanes. A right turn lane is needed for the right turn only access and this should be continuous to Meadowlark Dr. An acceleration lane is not required.

The non-compliance at the US-287/SH-56 intersection is on the eastbound leg/movement and the westbound left turn movement in the 2040 condition. The intersection, however, includes striped out areas for dual left turns on the eastbound, northbound, and southbound approaches which will improve the LOS and delay when put in use. Moreover, with real time adaptive signal control, the cycle time and phase splits will become considerably flexible. Note though that the current and future (with the current fixed timing) overall operation is acceptable.

CONCLUSIONS and RECOMMENDED IMPROVEMENTS SUMMARY
The study and operations analyses contained herein provides evidence that the recommended access locations and type will function within acceptable traffic engineering parameters promulgated by FHWA, AASHTO, MUTCD, CDOT, and LCUASS. The access locations and type are essential for safe and smooth transitions on and off the highway and to reduce to the greatest extent unnecessary on-site circulation.

ADEQUACY STATEMENT
In my professional opinion, the transportation facilities will be adequate and available to serve the proposed development within one year of the full build out of the project and that it meets or exceeds the applicable adopted level of service provided in Section 4.5 of the LCUASS standards.

APPENDIX

Traffic Signal Warrant Analysis

The need for a traffic signal can be projected using standard methodology and procedures recommended by the MUTCD, FHWA, and ITE. Of the nine warrants established in the MUTCD, three are what are known as volume warrants. Warrant 1 requires eight hours of traffic volume exceeding the threshold which is a combination of the intersection approaches on the major street and the approach volume on the minor street. Warrant 2 is the same combination but it is for four hours with a higher threshold requirement. Warrant 3 is the peak hour warrant where the same combination exceeds a threshold in just one hour during the peak hour. The peak hour warrant is designed to serve commercial developments that have a high discharge during a one-hour period. Warrants 1 and 2 are generally for residential applications and/or mixed-use developments. While it's easy to project the peak hour warrant, projecting the eight- and four-hour warrants requires an estimated daily volume (ADT) and time of day percentage of the ADT for the total of the major street approaches and the in and out movements of the minor street approach.

The warrant analysis herein is broken down into three scenarios; 1) Existing to test whether the current traffic entering the intersection satisfies a warrant. 2) Existing plus an increase in the background traffic and development of the residential section only. 3) Existing plus and increase in the background traffic, residential development and 50% of the commercial development. Note that the 50% commercial development was selected as the volume in the second scenario was close to meeting the four-hour warrant.

The ADT on the major street approaches is broken down into hourly volumes using Time of Day percentages published by the ITE Trip Generation Manual, 11th Edition. The ADT on the minor street approach likewise is determined using the same procedure. Note that on the minor street approach the right turn volume is typically reduced by 50% to account for right turn on red and ease of entering the major street stream particularly if an acceleration lane is present.

For the Existing scenario, the current volume of 8,000 ADT on CO-56 was input. The Meadowlark Dr. approach volume of 1,200 ADT was input. In this case, no warrant threshold was reached.

For the Existing plus the background and residential section only the volume on CO-56 was raised to 9,000 ADT and the Meadowlark Dr. ADT was raised to 2,000 ADT. In this case, three of the four hours needed to satisfy Warrant 2 were reached, but still fell short. Warrants 1 and 3 were not satisfied.

For the Existing plus the background, residential, and 50% of the commercial the volume on CO-56 was raised to 10,000 ADT, and the ADT on Meadowlark Dr. approach was raised to 5,000 ADT which included a 50% reduction of the right turn volume. In this case, all three volume warrants were satisfied.

Should 50% or more of the commercial development be anticipated within five years, then Warrant 8 - Roadway Network could warrant the traffic signal prior to meeting a warrant with actual traffic volumes. Note that CDOT generally requires actual traffic volumes to warrant a signal.

The following worksheets were developed by the Wisconsin DOT and conform to the MUTCD warrant analysis methodology and procedures. We use them as they are comprehensive and easy to use.

Wisconsin Department of Transportation Traffic Signal Warrant Summary Worksheet

70%

The Worksheet(s) attached are provided as an attachment to the Engineering Investigation Study for:

Intersection: CO-56 and Meadowlark
County: Larimer
Town: Berthoud

Major Street: CO-56
Critical Approach Speed: 45 mph
Lanes: 1 lane

Minor Street: Meadowlark
Critical Approach Speed: 25 mph
Lanes: 1 lane

% Right Turns Included
From North (SB) 0%
From East (WB) 100%
From South (NB) 100%
From West (EB) 100%

In built-up area of isolated community of < 10,000 population? No
Total number of approaches at intersection? 4 or more
If it is a "T" intersection, inflate minor threshold to 150%? No
Manually set volume level? 70%

Analysis based on PROJECTED volume data.

Forecast Year	Within 5 Years of Construction?	Time (HH:MM)			
		From	AM / PM	To	AM / PM
2040	No	6	AM	10	PM

Warrant Evaluation Summary	Warrant Met:
Warrant 1: Eight - Hour Vehicular Volume	**No**
Condition A: Minimum Vehicular Volume	No
Condition B: Interruption of Continuous Traffic	No
Condition C: Combination: 80% of A and B	No
Warrant 2: Four-Hour Volume	**No**
Warrant 3: Peak Hour Volume	**No**
Warrant 4: Pedestrian Volume	**N/A**
Criterion A: Four-Hour	
Criterion B: Peak-Hour	
Warrant 5: School Crossing	**N/A**
Warrant 6: Coordinated Signal System	**N/A**
Warrant 7: Crash Experience	**N/A**
Warrant 8: Roadway Network	**No**
Warrant 9: Intersection Near a Grade Crossing	**N/A**

Warrant Analysis Conducted By:

Name: John Aldridge
Agency: Aldridge Transportation Consultants
Date: 12/30/2022

Warrant 1: Eight - Hour Vehicular Volume 70%

Warrant Evaluated? Yes **Warrant Satisfied? No** **Manually Set To: No**

Condition A : Min. Veh. Volume		
Volume Level	70%	56%
Major Rd. Req	350	280
Minor Rd. Req	105	84
Number of Hours	0	1

Satisfied? No

Condition B: Interruption of Continuous Traffic		
Volume Level	70%	56%
Major Rd. Req	525	420
Minor Rd. Req	53	42
Number of Hours	2	7

Satisfied? No

Condition C: Combination of A & B at 56%

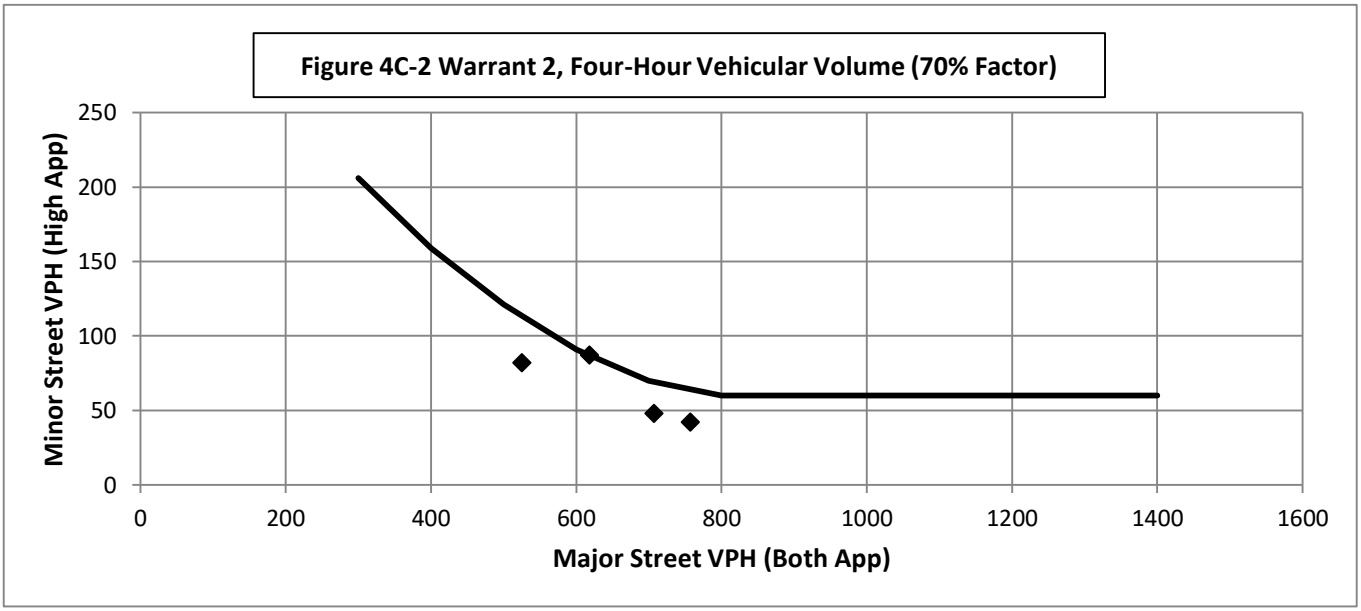
Satisfied? No

6:00 AM		Enter Start Time (Military Time) (HH:MM)			
Time Period	**From**	**To**	**Major Road: Both App. (VPH)**	**Minor Road: High App. (VPH)**	**Total**
1	6:00	7:00	254	40	294
2	7:00	8:00	525	82	607
3	8:00	9:00	618	87	705
4	9:00	10:00	436	53	489
5	10:00	11:00	373	38	411
6	11:00	12:00	449	48	497
7	12:00	13:00	482	37	519
8	13:00	14:00	387	33	420
9	14:00	15:00	449	41	490
10	15:00	16:00	436	32	468
11	16:00	17:00	595	44	639
12	17:00	18:00	757	42	799
13	18:00	19:00	707	48	755
14	19:00	20:00	436	24	460
15	20:00	21:00	347	24	371
16	21:00	22:00	235	10	245

Warrant 2: Four-Hour Volume 70%

Warrant Evaluated? Yes
Warrant Satisfied? No
Manually Set To: No

Hour Start	8:00	17:00	18:00	7:00
Major Road Vol.	618	757	707	525
Minor Road Vol.	87	42	48	82



Warrant 3: Peak Hour Volume 70%

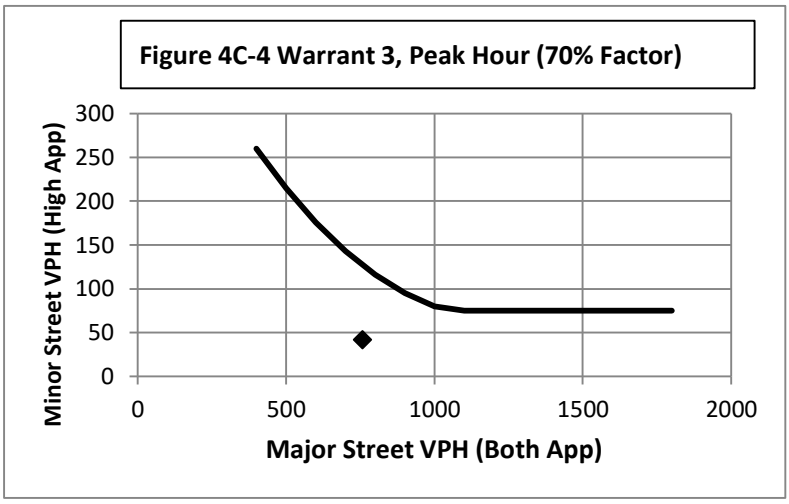
Warrant Evaluated? Yes **Warrant Satisfied? No** **Manually Set To: No**

Condition justifying use of warrant:

Criteria		Met?
Delay on Minor Approach	4	
Volume on Minor Approach	100	No
Total Entering Volume (veh/h)	800	

Manually Set Peak Hour? No

Peak Hour	Major Road Vol. (Both App.)	Minor Road Vol. (High App.)
17:00	757	42



Warrant 4: Pedestrian Volume 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

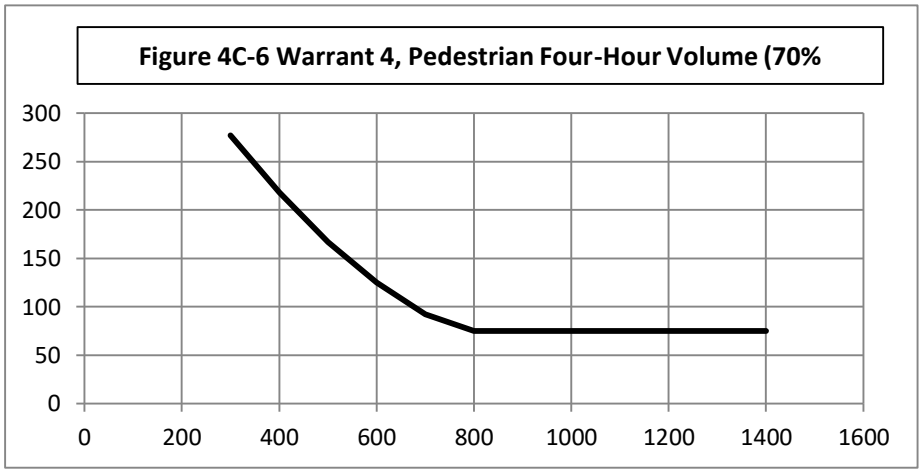
Criterion A: Four Hour

Hour (Start)	Pedestrian Volume	Major Road Vol.
0:00	0	#N/A
0:00	0	#N/A
0:00	0	#N/A
0:00	0	#N/A

Manually Set Major Rd Vol? No

Avg. walk speed less than 3.5 ft/s? No

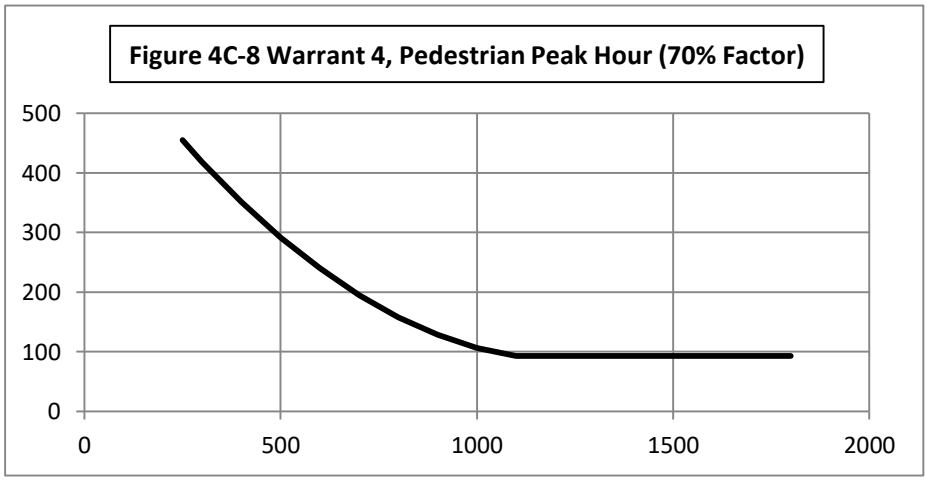
Criterion A Satisfied?



Criterion B: Peak Hour

Peak Hour	Pedestrian Vol.	Major Road Vol.
#N/A	#N/A	#N/A

Criterion B Satisfied?



Warrant 5: School Crossing 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

	Criteria	Fulfilled?
1	There are a MINIMUM of 20 school children during the highest crossing hour.	
2	There are fewer adequate gaps in the major road traffic stream during the period when the school children are using the crossing than the number of minutes in the same period.	
3	The nearest traffic signal along the major road is located more than 300 ft away. Or, the nearest traffic signal is within 300 ft but the proposed traffic signal will not restrict the progressive movement of traffic.	

Warrant 6: Coordinated Signal System 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

	Criteria	Fulfilled?
1	Signal spacing > 1000 ft	
2	On a one-way road or a road that has traffic predominantly in one direction, the adjacent signals are so far apart that they do not provide the necessary degree of vehicle platooning.	
3	On a two-way road, adjacent signals do not provide the necessary degree of platooning and the proposed and the adjacent signals will collectively provide a progressive operation.	

Warrant 7: Crash Experience 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

	Criteria		Met?	Fulfilled?
1	Adequate trial of other remedial measures has failed to reduce crash frequency.			
	Measures Tried:			
2	Five or more reported crashes, of types susceptible to correction by signal, have occurred within a 12 month period.	# of crashes per 12 months		
3	Warrant 1, Condition A (80%)		No	#N/A
	Warrant 1, Condition B (80%)		No	
	Warrant 4, Criterion A (80%)		#N/A	
	Warrant 4, Criterion B (80%)		#N/A	

Warrant 8: Roadway Network 70%

Warrant Evaluated? Yes **Warrant Satisfied? No** **Manually Set To:**

	Criteria			Met?	Fulfilled?
1	Total entering volume of at least 1,000 veh/h during typical weekday peak hour		799	No	No
	Five-year projected volumes that satisfy one or more of Warrants 1, 2, or 3.		2	Yes	
2	Total entering vol. of at least 1,000 veh/h for each of any 5 hrs of non-normal business day (Sat. or Sun.)				
	Hour				
	Volume				

	Characteristics of Major Routes - Select yes if all intersecting routes have characteristic	Fulfilled?
1	Part of the road or highway system that serves as the principal roadway network for through traffic flow	Yes
2	Rural or suburban highway outside of, entering, or traversing a city	Yes
3	Appears as a major route on an official plan	Yes

Warrant 9: Intersection Near a Grade Crossing 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

Adjustment Factors			Manually Set Peak Hour?				
Rail Traffic per Day	% High Occupancy Buses on Minor Road	% Tractor-Trailer Trucks on Minor Road	D	Peak Hour	Major Road Vol.	Minor Road Vol.	Adjusted Minor Vol.
1	0	0% to 2.5%	660	17:00	757	42	14.07

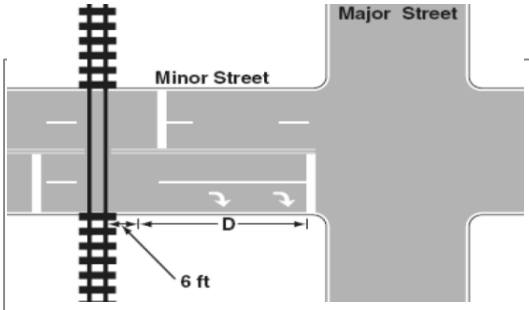
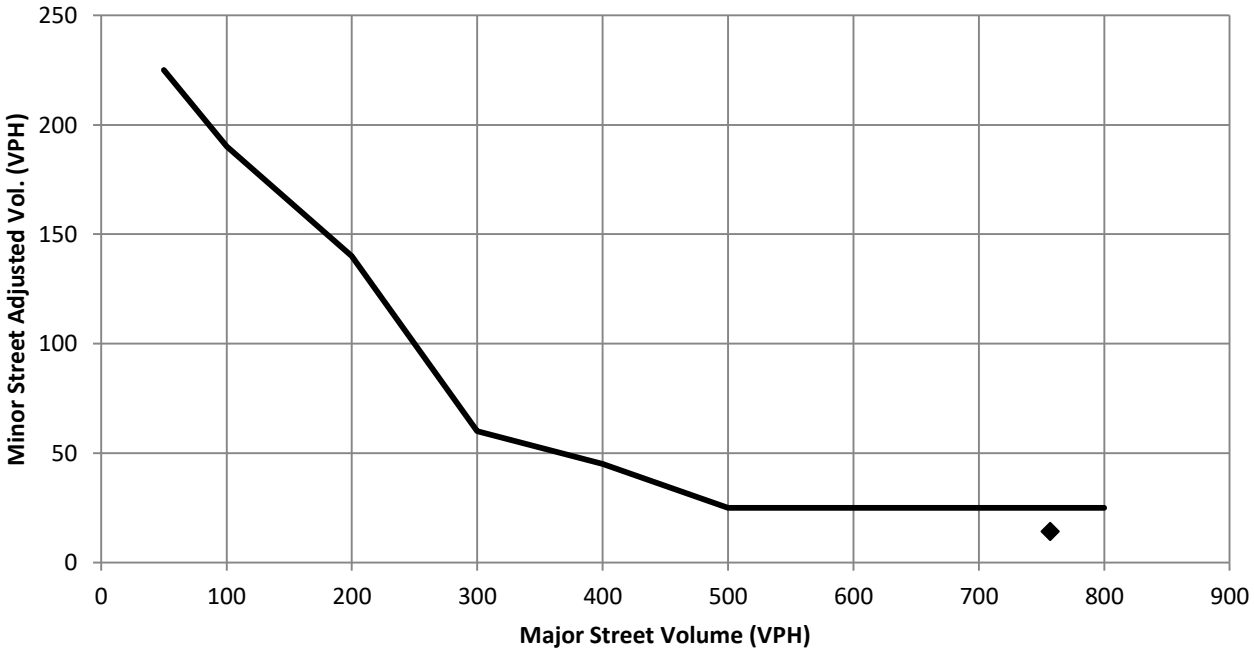


Figure 4C-9 Warrant9, Intersection Near a grade Crossing (One Approach Lane at the Track Crossing)



Conclusions/Comments:

Updated: 12/6/2017

Wisconsin Department of Transportation Traffic Signal Warrant Summary Worksheet

70%

The Worksheet(s) attached are provided as an attachment to the Engineering Investigation Study for:

Intersection: CO-56 and Meadowlark
County: Larimer
Town: Berthoud

Major Street: CO-56
Critical Approach Speed: 45 mph
Lanes: 1 lane

Minor Street: Meadowlark
Critical Approach Speed: 25 mph
Lanes: 1 lane

% Right Turns Included
From North (SB) 0%
From East (WB) 100%
From South (NB) 100%
From West (EB) 100%

In built-up area of isolated community of < 10,000 population? No
Total number of approaches at intersection? 4 or more
If it is a "T" intersection, inflate minor threshold to 150%? No
Manually set volume level? 70%

Analysis based on PROJECTED volume data.

Forecast Year	Within 5 Years of Construction?	Time (HH:MM)			
		From	AM / PM	To	AM / PM
2040	No	6	AM	10	PM

Warrant Evaluation Summary	Warrant Met:
Warrant 1: Eight - Hour Vehicular Volume	**No**
Condition A: Minimum Vehicular Volume	No
Condition B: Interruption of Continuous Traffic	No
Condition C: Combination: 80% of A and B	No
Warrant 2: Four-Hour Volume	**No**
Warrant 3: Peak Hour Volume	**No**
Warrant 4: Pedestrian Volume	**N/A**
Criterion A: Four-Hour	
Criterion B: Peak-Hour	
Warrant 5: School Crossing	**N/A**
Warrant 6: Coordinated Signal System	**N/A**
Warrant 7: Crash Experience	**N/A**
Warrant 8: Roadway Network	**No**
Warrant 9: Intersection Near a Grade Crossing	**N/A**

Warrant Analysis Conducted By:

Name: John Aldridge
Agency: Aldridge Transportation Consultants
Date: 12/30/2022

Warrant 1: Eight - Hour Vehicular Volume 70%

Warrant Evaluated? Yes **Warrant Satisfied? No** **Manually Set To: No**

Condition A : Min. Veh. Volume		
Volume Level	70%	56%
Major Rd. Req	350	280
Minor Rd. Req	105	84
Number of Hours	2	2

Satisfied? No

Condition B: Interruption of Continuous Traffic		
Volume Level	70%	56%
Major Rd. Req	525	420
Minor Rd. Req	53	42
Number of Hours	5	12

Satisfied? No

Condition C: Combination of A & B at 56%

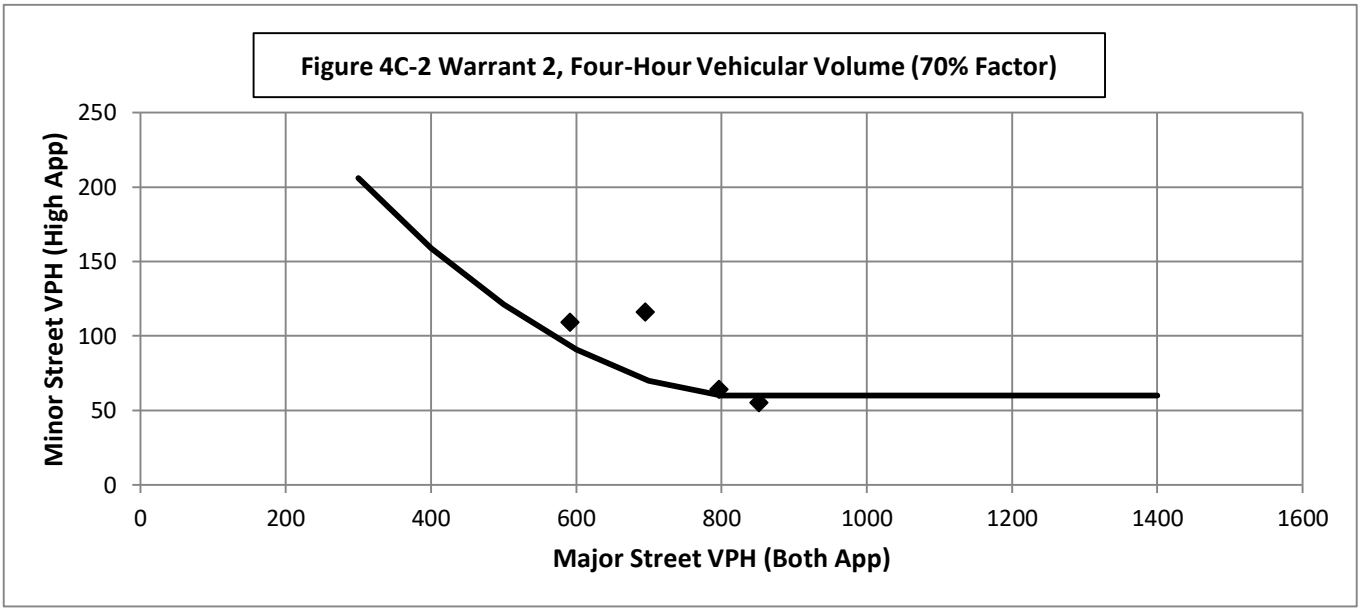
Satisfied? No

6:00 AM		Enter Start Time (Military Time) (HH:MM)			
Time Period	**From**	**To**	**Major Road: Both App. (VPH)**	**Minor Road: High App. (VPH)**	**Total**
1	6:00	7:00	286	54	340
2	7:00	8:00	591	109	700
3	8:00	9:00	695	116	811
4	9:00	10:00	491	71	562
5	10:00	11:00	420	51	471
6	11:00	12:00	506	64	570
7	12:00	13:00	543	50	593
8	13:00	14:00	435	45	480
9	14:00	15:00	506	55	561
10	15:00	16:00	491	42	533
11	16:00	17:00	669	59	728
12	17:00	18:00	851	55	906
13	18:00	19:00	796	64	860
14	19:00	20:00	491	32	523
15	20:00	21:00	390	32	422
16	21:00	22:00	264	13	277

Warrant 2: Four-Hour Volume 70%

Warrant Evaluated? Yes
Warrant Satisfied? No
Manually Set To: No

Hour Start	18:00	8:00	7:00	17:00
Major Road Vol.	796	695	591	851
Minor Road Vol.	64	116	109	55



Warrant 3: Peak Hour Volume 70%

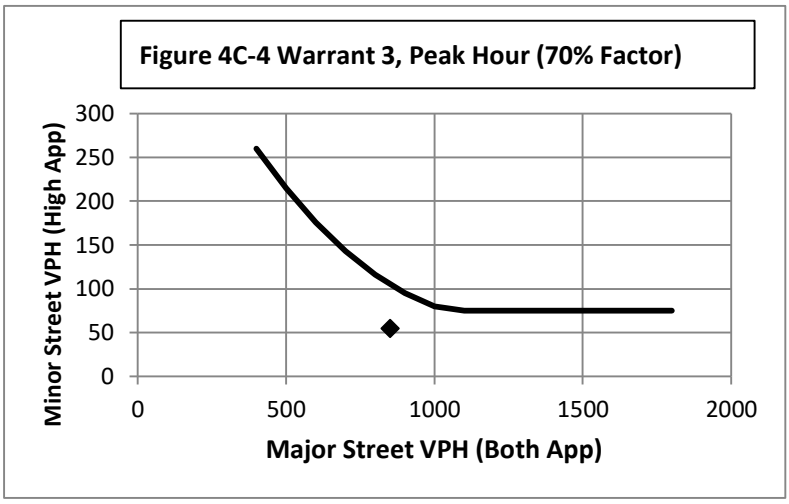
Warrant Evaluated? Yes **Warrant Satisfied? No** **Manually Set To: No**

Condition justifying use of warrant:

Criteria		Met?
Delay on Minor Approach	4	
Volume on Minor Approach	100	Yes
Total Entering Volume (veh/h)	800	

Manually Set Peak Hour? No

Peak Hour	Major Road Vol. (Both App.)	Minor Road Vol. (High App.)
17:00	851	55



Warrant 4: Pedestrian Volume 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

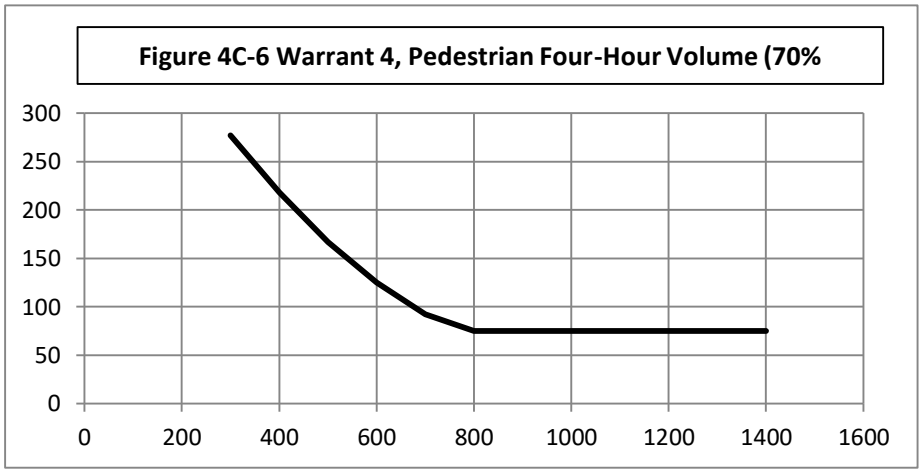
Criterion A: Four Hour

Hour (Start)	Pedestrian Volume	Major Road Vol.
0:00	0	#N/A
0:00	0	#N/A
0:00	0	#N/A
0:00	0	#N/A

Manually Set Major Rd Vol? No

Avg. walk speed less than 3.5 ft/s? No

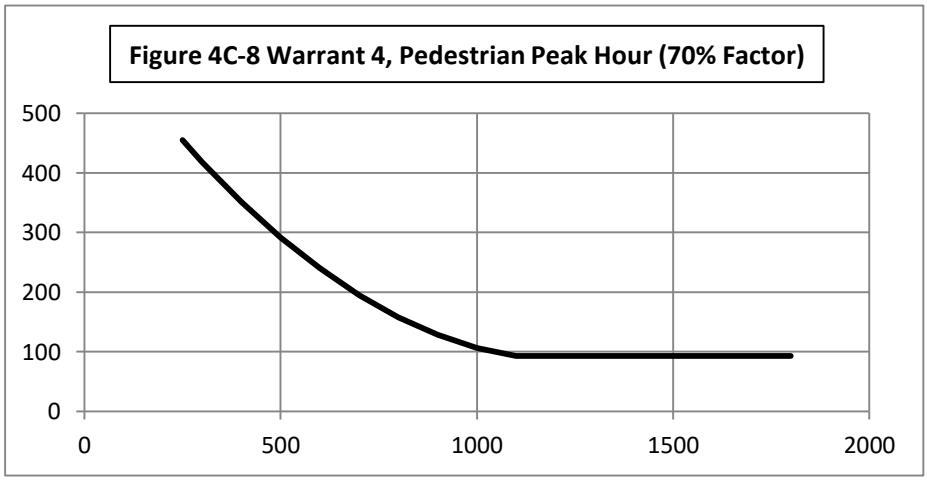
Criterion A Satisfied?



Criterion B: Peak Hour

Peak Hour	Pedestrian Vol.	Major Road Vol.
#N/A	#N/A	#N/A

Criterion B Satisfied?



Warrant 5: School Crossing 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

	Criteria	Fulfilled?
1	There are a MINIMUM of 20 school children during the highest crossing hour.	
2	There are fewer adequate gaps in the major road traffic stream during the period when the school children are using the crossing than the number of minutes in the same period.	
3	The nearest traffic signal along the major road is located more than 300 ft away. Or, the nearest traffic signal is within 300 ft but the proposed traffic signal will not restrict the progressive movement of traffic.	

Warrant 6: Coordinated Signal System 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

	Criteria	Fulfilled?
1	Signal spacing > 1000 ft	
2	On a one-way road or a road that has traffic predominantly in one direction, the adjacent signals are so far apart that they do not provide the necessary degree of vehicle platooning.	
3	On a two-way road, adjacent signals do not provide the necessary degree of platooning and the proposed and the adjacent signals will collectively provide a progressive operation.	

Warrant 7: Crash Experience 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

	Criteria		Met?	Fulfilled?
1	Adequate trial of other remedial measures has failed to reduce crash frequency.			
	Measures Tried:			
2	Five or more reported crashes, of types susceptible to correction by signal, have occurred within a 12 month period.	# of crashes per 12 months		
3	Warrant 1, Condition A (80%)		No	#N/A
	Warrant 1, Condition B (80%)		Yes	
	Warrant 4, Criterion A (80%)		#N/A	
	Warrant 4, Criterion B (80%)		#N/A	

Warrant 8: Roadway Network 70%

Warrant Evaluated? Yes **Warrant Satisfied? No** **Manually Set To:**

	Criteria			Met?	Fulfilled?
1	Total entering volume of at least 1,000 veh/h during typical weekday peak hour		906	No	No
	Five-year projected volumes that satisfy one or more of Warrants 1, 2, or 3.		2	Yes	
2	Total entering vol. of at least 1,000 veh/h for each of any 5 hrs of non-normal business day (Sat. or Sun.)				
	Hour				
	Volume				

	Characteristics of Major Routes - Select yes if all intersecting routes have characteristic	Fulfilled?
1	Part of the road or highway system that serves as the principal roadway network for through traffic flow	Yes
2	Rural or suburban highway outside of, entering, or traversing a city	Yes
3	Appears as a major route on an official plan	Yes

Warrant 9: Intersection Near a Grade Crossing 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

Adjustment Factors			Manually Set Peak Hour?				
Rail Traffic per Day	% High Occupancy Buses on Minor Road	% Tractor-Trailer Trucks on Minor Road	D	Peak Hour	Major Road Vol.	Minor Road Vol.	Adjusted Minor Vol.
1	0	0% to 2.5%	660	17:00	851	55	18.425

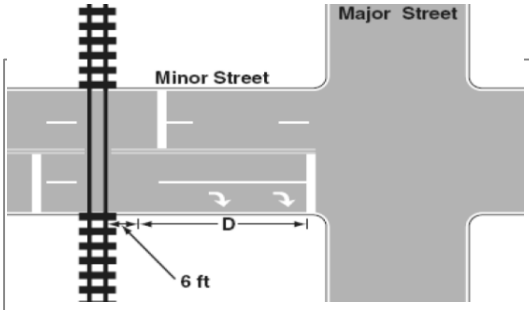
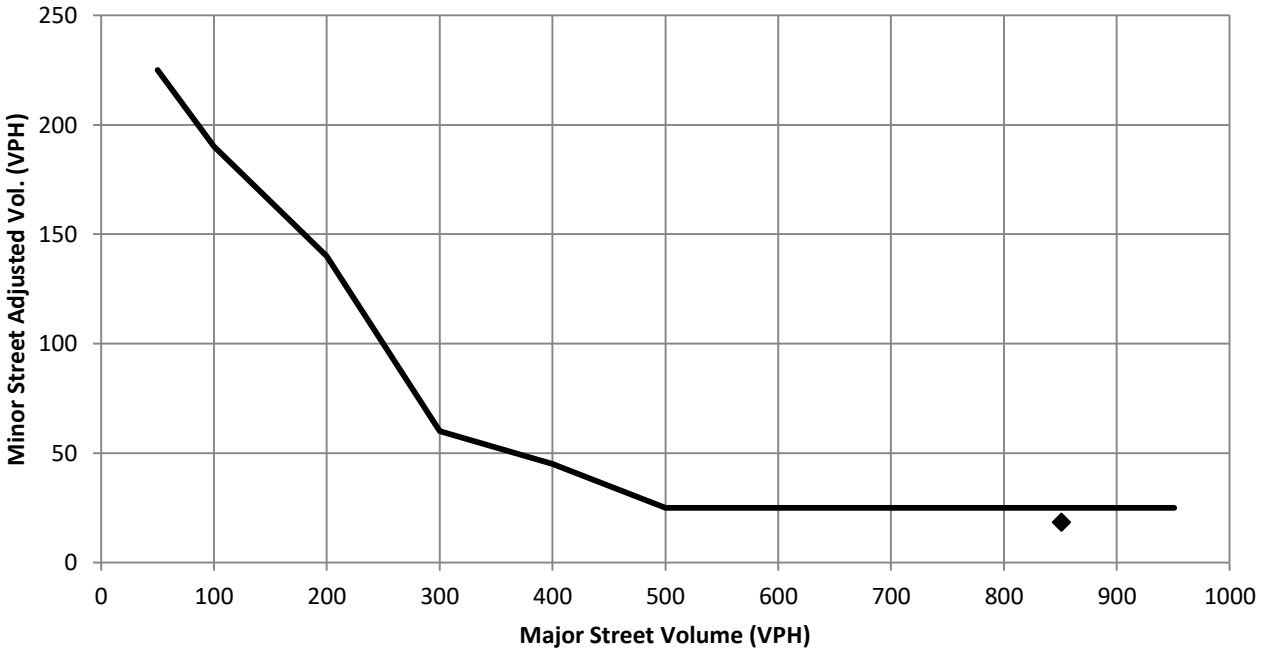


Figure 4C-9 Warrant9, Intersection Near a grade Crossing (One Approach Lane at the Track Crossing)



Conclusions/Comments:

Updated: 12/6/2017

Wisconsin Department of Transportation Traffic Signal Warrant Summary Worksheet

70%

The Worksheet(s) attached are provided as an attachment to the Engineering Investigation Study for:

Intersection: CO-56 and Meadowlark
County: Larimer
Town: Berthoud

Major Street: CO-56
Critical Approach Speed: 45 mph
Lanes: 1 lane

Minor Street: Meadowlark
Critical Approach Speed: 25 mph
Lanes: 2 or more lanes

% Right Turns Included
From North (SB) 0%
From East (WB) 100%
From South (NB) 50%
From West (EB) 100%

In built-up area of isolated community of < 10,000 population? No
Total number of approaches at intersection? 4 or more
If it is a "T" intersection, inflate minor threshold to 150%? No
Manually set volume level? 70%

Analysis based on PROJECTED volume data.

Forecast Year	Within 5 Years of Construction?	Time (HH:MM)			
		From	AM / PM	To	AM / PM
2040	No	6	AM	10	PM

Warrant Evaluation Summary	Warrant Met:
Warrant 1: Eight - Hour Vehicular Volume	**Yes**
Condition A: Minimum Vehicular Volume	No
Condition B: Interruption of Continuous Traffic	Yes
Condition C: Combination: 80% of A and B	Yes
Warrant 2: Four-Hour Volume	**Yes**
Warrant 3: Peak Hour Volume	**Yes**
Warrant 4: Pedestrian Volume	**N/A**
Criterion A: Four-Hour	
Criterion B: Peak-Hour	
Warrant 5: School Crossing	**N/A**
Warrant 6: Coordinated Signal System	**N/A**
Warrant 7: Crash Experience	**N/A**
Warrant 8: Roadway Network	**Yes**
Warrant 9: Intersection Near a Grade Crossing	**N/A**

Warrant Analysis Conducted By:

Name: John Aldridge
Agency: Aldridge Transportation Consultants
Date: 12/30/2022

Warrant 1: Eight - Hour Vehicular Volume 70%

Warrant Evaluated? Yes **Warrant Satisfied? Yes** **Manually Set To: Yes**

Condition A : Min. Veh. Volume		
Volume Level	70%	56%
Major Rd. Req	350	280
Minor Rd. Req	140	112
Number of Hours	6	12

Satisfied? No

Condition B: Interruption of Continuous Traffic		
Volume Level	70%	56%
Major Rd. Req	525	420
Minor Rd. Req	70	56
Number of Hours	11	14

Satisfied? Yes

Condition C: Combination of A & B at 56%

Satisfied? Yes

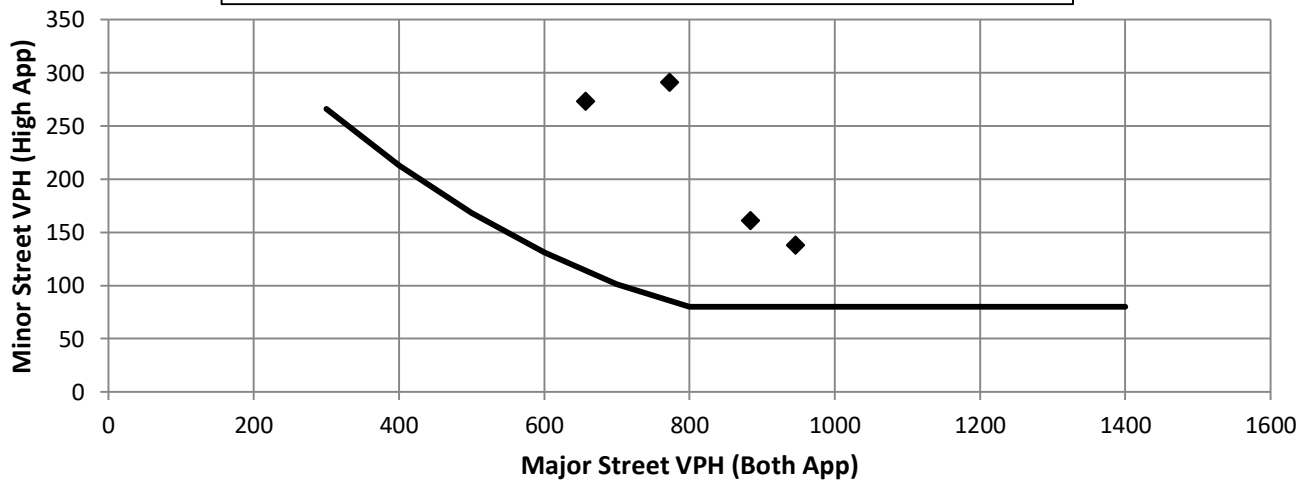
6:00 AM		Enter Start Time (Military Time) (HH:MM)			
Time Period	**From**	**To**	**Major Road: Both App. (VPH)**	**Minor Road: High App. (VPH)**	**Total**
1	6:00	7:00	318	134	452
2	7:00	8:00	657	273	930
3	8:00	9:00	772	291	1063
4	9:00	10:00	545	178	723
5	10:00	11:00	467	128	595
6	11:00	12:00	562	161	723
7	12:00	13:00	603	124	727
8	13:00	14:00	483	112	595
9	14:00	15:00	562	136	698
10	15:00	16:00	545	105	650
11	16:00	17:00	743	147	890
12	17:00	18:00	946	138	1084
13	18:00	19:00	884	161	1045
14	19:00	20:00	545	81	626
15	20:00	21:00	434	81	515
16	21:00	22:00	293	33	326

Warrant 2: Four-Hour Volume 70%

Warrant Evaluated? Yes
Warrant Satisfied? Yes
Manually Set To: Yes

Hour Start	17:00	8:00	18:00	7:00
Major Road Vol.	946	772	884	657
Minor Road Vol.	138	291	161	273

Figure 4C-2 Warrant 2, Four-Hour Vehicular Volume (70% Factor)



Warrant 3: Peak Hour Volume 70%

Warrant Evaluated? Yes **Warrant Satisfied? Yes** **Manually Set To: Yes**

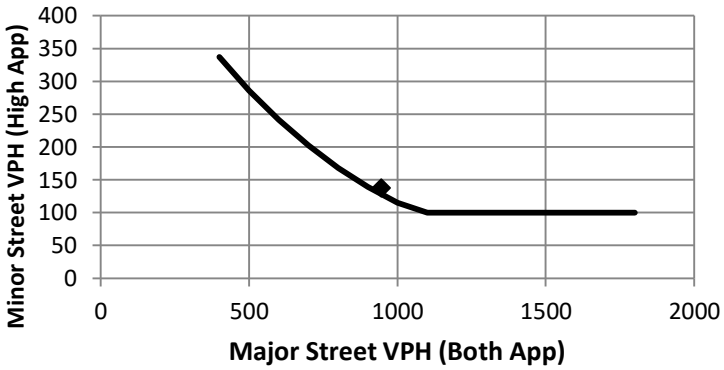
Condition justifying use of warrant:

Criteria		Met?
Delay on Minor Approach	5	
Volume on Minor Approach	150	Yes
Total Entering Volume (veh/h)	800	

Manually Set Peak Hour? No

Peak Hour	Major Road Vol. (Both App.)	Minor Road Vol. (High App.)
17:00	946	138

Figure 4C-4 Warrant 3, Peak Hour (70% Factor)



Warrant 4: Pedestrian Volume 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

Criterion A: Four Hour

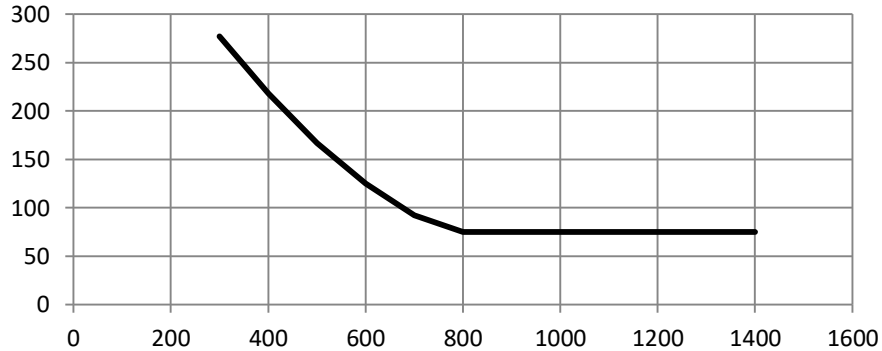
Hour (Start)	Pedestrian Volume	Major Road Vol.
0:00	0	#N/A
0:00	0	#N/A
0:00	0	#N/A
0:00	0	#N/A

Manually Set Major Rd Vol? No

Avg. walk speed less than 3.5 ft/s? No

Criterion A Satisfied?

Figure 4C-6 Warrant 4, Pedestrian Four-Hour Volume (70%

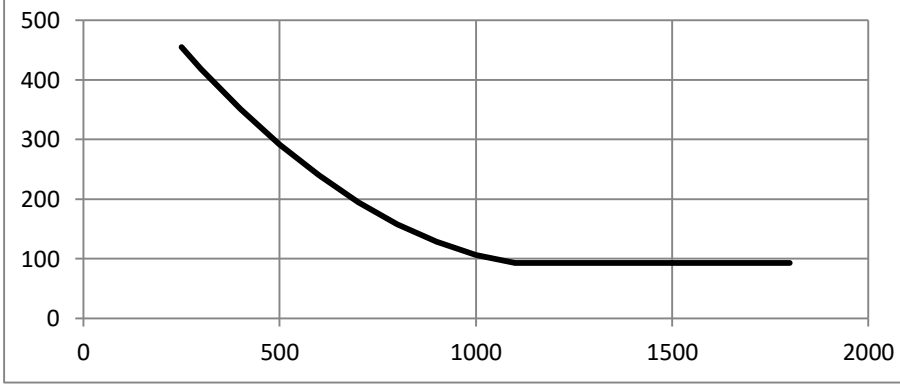


Criterion B: Peak Hour

Peak Hour	Pedestrian Vol.	Major Road Vol.
#N/A	#N/A	#N/A

Criterion B Satisfied?

Figure 4C-8 Warrant 4, Pedestrian Peak Hour (70% Factor)



Warrant 5: School Crossing 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

	Criteria	Fulfilled?
1	There are a MINIMUM of 20 school children during the highest crossing hour.	
2	There are fewer adequate gaps in the major road traffic stream during the period when the school children are using the crossing than the number of minutes in the same period.	
3	The nearest traffic signal along the major road is located more than 300 ft away. Or, the nearest traffic signal is within 300 ft but the proposed traffic signal will not restrict the progressive movement of traffic.	

Warrant 6: Coordinated Signal System 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

	Criteria	Fulfilled?
1	Signal spacing > 1000 ft	
2	On a one-way road or a road that has traffic predominantly in one direction, the adjacent signals are so far apart that they do not provide the necessary degree of vehicle platooning.	
3	On a two-way road, adjacent signals do not provide the necessary degree of platooning and the proposed and the adjacent signals will collectively provide a progressive operation.	

Warrant 7: Crash Experience 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

	Criteria		Met?	Fulfilled?
1	Adequate trial of other remedial measures has failed to reduce crash frequency.			
	Measures Tried:			
2	Five or more reported crashes, of types susceptible to correction by signal, have occurred within a 12 month period.	# of crashes per 12 months		
3	Warrant 1, Condition A (80%)		Yes	#N/A
	Warrant 1, Condition B (80%)		Yes	
	Warrant 4, Criterion A (80%)		#N/A	
	Warrant 4, Criterion B (80%)		#N/A	

Warrant 8: Roadway Network 70%

Warrant Evaluated? Yes **Warrant Satisfied? Yes** **Manually Set To: Yes**

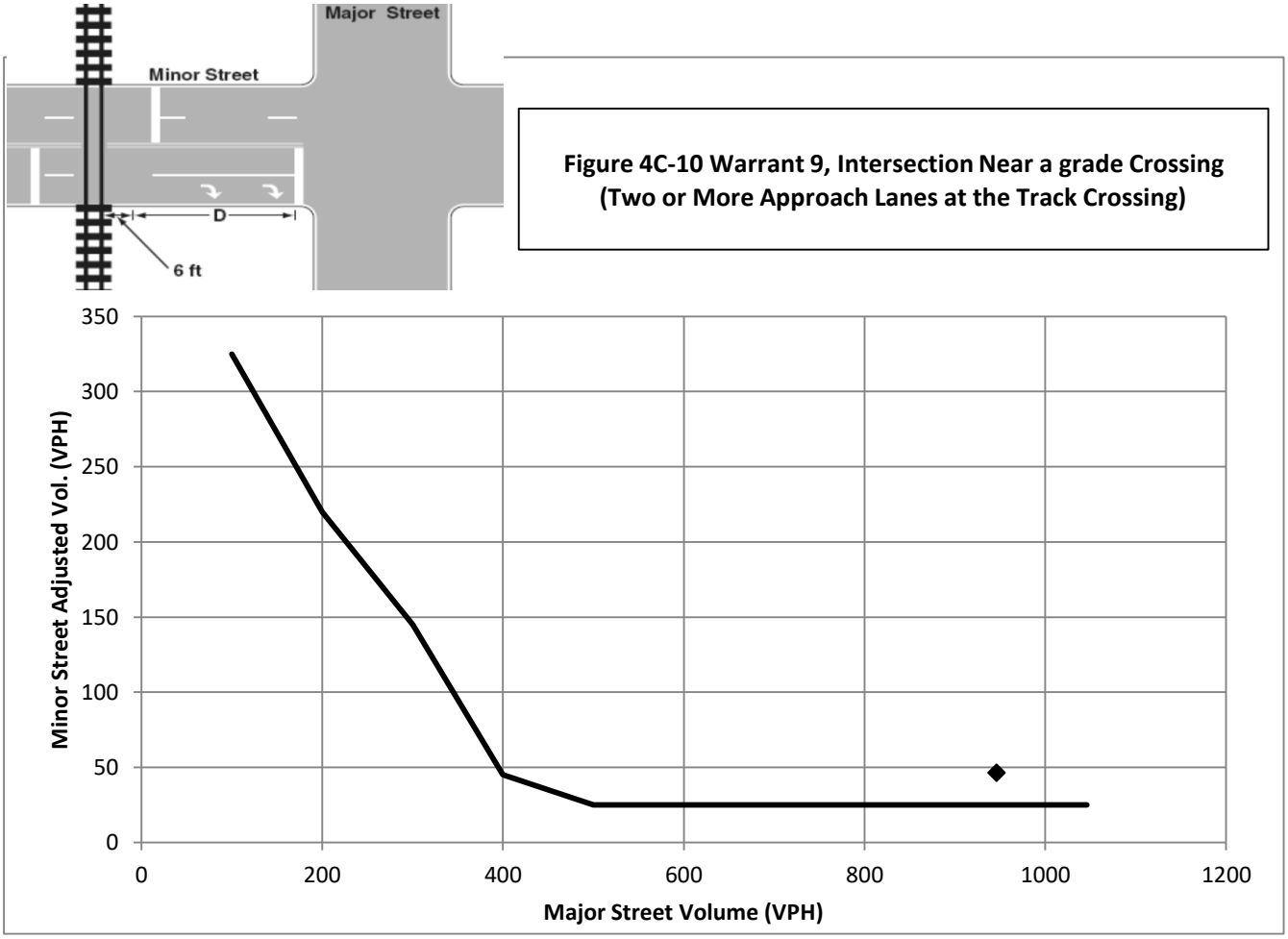
	Criteria			Met?	Fulfilled?
1	Total entering volume of at least 1,000 veh/h during typical weekday peak hour		1084	Yes	Yes
	Five-year projected volumes that satisfy one or more of Warrants 1, 2, or 3.		2	Yes	
2	Total entering vol. of at least 1,000 veh/h for each of any 5 hrs of non-normal business day (Sat. or Sun.)				
	Hour				
	Volume				

	Characteristics of Major Routes - Select yes if all intersecting routes have characteristic	Fulfilled?
1	Part of the road or highway system that serves as the principal roadway network for through traffic flow	Yes
2	Rural or suburban highway outside of, entering, or traversing a city	Yes
3	Appears as a major route on an official plan	Yes

Warrant 9: Intersection Near a Grade Crossing 70%

Warrant Evaluated? **Warrant Satisfied? N/A** **Manually Set To:**

Adjustment Factors			Manually Set Peak Hour?				
Rail Traffic per Day	% High Occupancy Buses on Minor Road	% Tractor-Trailer Trucks on Minor Road	D	Peak Hour	Major Road Vol.	Minor Road Vol.	Adjusted Minor Vol.
1	0	0% to 2.5%	660	17:00	946	138	46.23



Conclusions/Comments:

Updated: 12/6/2017

Aldridge Transportation Consultants, LLC

Advanced Transportation Planning and Traffic Engineering

John M.W. Aldridge, P.E.
Colorado Licensed Professional Engineer

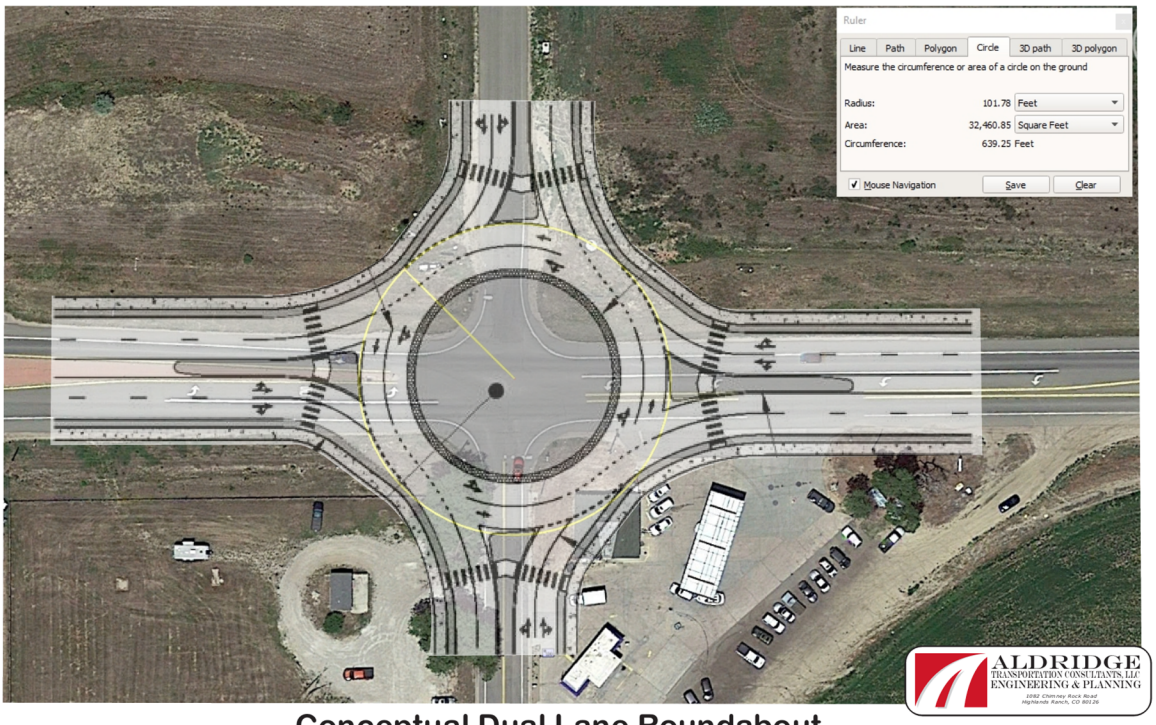
1082 Chimney Rock Road
Highlands Ranch, CO 80126
303-703-9112
Mobile: 303-594-4132

August 1, 2021

Technical Memorandum

Proposed Roundabout Alternative
SH-56/Meadowlark Dr.

At the behest of the Town of Berthoud this technical memorandum provides an engineering review of a roundabout in lieu of a traffic signal-controlled intersection at SH-56 and Meadowlark Dr. which is about 1,000 feet west of US-287. The traffic impact study (revised July 25, 2021) prepared for the Westside Crossing mixed-use development projected that traffic signal warrants would be met with build out or before of the project. The Town prefers a roundabout instead of a traffic signal and while there are many advantages to roundabouts including safety, less vehicle delay and queuing, signal progression, environmental factors, traffic calming, and aesthetics there are however some disadvantages primarily spatial requirements.



Conceptual Dual Lane Roundabout
CDOT will require a 200' diameter inscribed circle (the yellow circle in the background) to manage the turning radius of a WB-67 design vehicle.

The graphic shows a CDOT standard 200-foot diameter roundabout (the yellow circle shows the 200-foot inscribed circle) which is necessary to manage a WB-67 design vehicle. The center of the roundabout is shown on center of the intersection. Note though center placement is not required and can be offset but the entering roadways would have to be offset as well. The roundabout shown has a two-lane circulating ring. The entry/exit roads on SH-56 are two-lane as well assuming that SH-56 will be improved to four-lanes in the future. The Meadowlark Dr. entry/exit lanes will remain as single lanes. The graphic includes bike lanes, sidewalks, and pedestrian crossings with raised refuge islands.

The inscribed circle is approximately 75 percent of an acre. Adding the other features such as bike lanes, sidewalks, and traffic channelizing islands raises the total property needed easily over an acre. As shown, all four corners of the intersection would be impacted with right of way taking. The southeast corner currently developed with a gas station and convenience store would be taken in its entirety.

Roundabouts are generally more expensive to construct than a traffic signal. A ballpark estimate for a multi-lane roundabout is about $1.5 to $2 million dollars. A traffic signal is around $3-400,000.

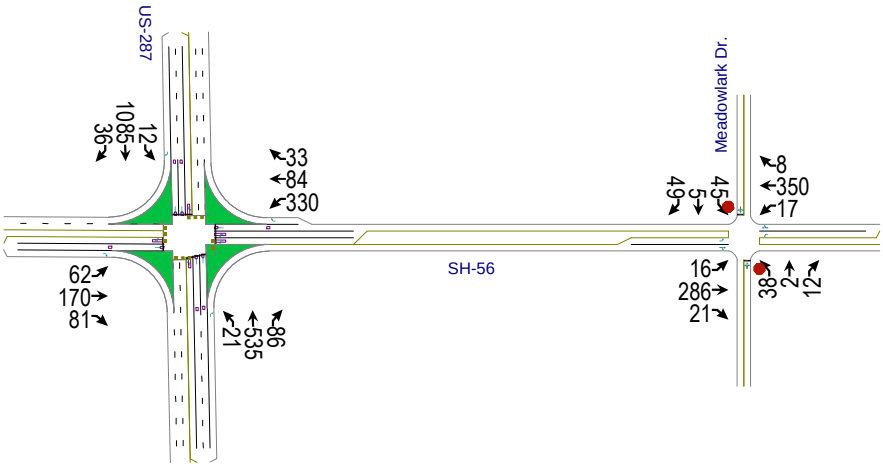
We trust that this technical memorandum provides the Town with the information required to make an enlightened decision on the choice of a traffic signal vs. a roundabout.

ATC appreciates the opportunity to be of service. Please call if you have any questions. We can be reached at 303-703-9112.

Respectfully submitted,
Aldridge Transportation Consultants, LLC

John M.W. Aldridge, P.E.
Principal

ATC is professional service firm specializing in traffic engineering and transportation planning. ATC's principal, John M.W. Aldridge, is a Colorado licensed professional engineer. In the past 20 years, ATC has prepared over 1,000 traffic impact studies, designed over 100 traffic signals, and has provided expert witness testimony on engineering design and access issues on multi-million-dollar interchange and highway projects in Kansas and Colorado.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SH-56
Meadowlark Dr.
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17

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	62	170	81	330	84	33	21	535	86	12	1085	36
Future Volume (veh/h)	62	170	81	330	84	33	21	535	86	12	1085	36
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	67	185	0	359	91	0	23	582	0	13	1179	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	86	220		428	361		281	2111		514	2084	
Arrive On Green	0.05	0.12	0.00	0.12	0.19	0.00	0.02	0.59	0.00	0.01	0.59	0.00
Sat Flow, veh/h	1781	1870	1585	3456	1870	1585	1781	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	67	185	0	359	91	0	23	582	0	13	1179	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1728	1870	1585	1781	1777	1585	1781	1777	1585
Q Serve(g_s), s	4.5	11.6	0.0	12.2	5.0	0.0	0.6	9.5	0.0	0.4	24.6	0.0
Cycle Q Clear(g_c), s	4.5	11.6	0.0	12.2	5.0	0.0	0.6	9.5	0.0	0.4	24.6	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	86	220		428	361		281	2111		514	2084	
V/C Ratio(X)	0.78	0.84		0.84	0.25		0.08	0.28		0.03	0.57	
Avail Cap(c_a), veh/h	156	335		590	491		315	2111		563	2084	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	56.5	51.9	0.0	51.4	41.1	0.0	12.0	11.8	0.0	9.9	15.4	0.0
Incr Delay (d2), s/veh	13.9	11.2	0.0	7.6	0.4	0.0	0.1	0.3	0.0	0.0	1.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.3	6.0	0.0	5.6	2.3	0.0	0.2	3.4	0.0	0.1	9.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	70.3	63.0	0.0	59.0	41.4	0.0	12.1	12.2	0.0	10.0	16.5	0.0
LnGrp LOS	E	E		E	D		B	B		A	B	
Approach Vol, veh/h		252	A		450	A		605	A		1192	A
Approach Delay, s/veh		65.0			55.5			12.2			16.4	
Approach LOS		E			E			B			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	6.3	75.8	19.4	18.6	7.2	74.9	10.3	27.7
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.0	55.0	20.5	21.5	5.0	55.0	10.5	31.5
Max Q Clear Time (g_c+I1), s	2.4	11.5	14.2	13.6	2.6	26.6	6.5	7.0
Green Ext Time (p_c), s	0.0	3.7	0.7	0.5	0.0	8.5	0.0	0.4

Intersection Summary	
HCM 6th Ctrl Delay	27.3
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

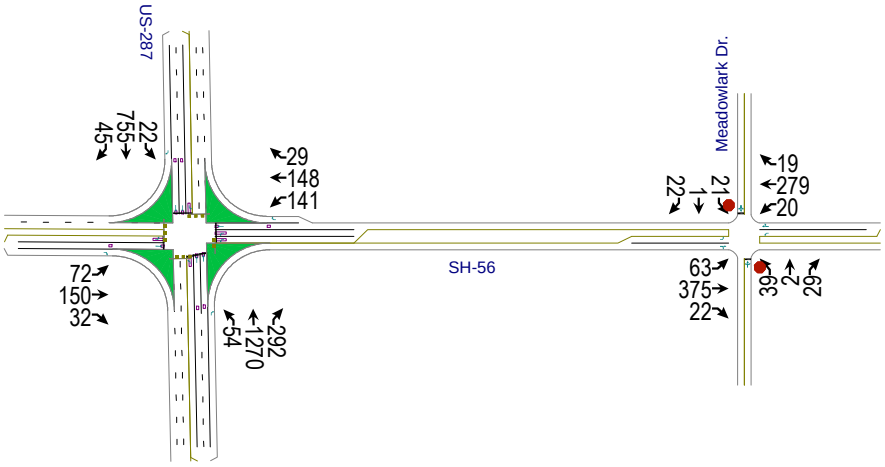
Intersection	
Int Delay, s/veh	3.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	16	286	21	17	350	8	38	2	12	45	5	49
Future Vol, veh/h	16	286	21	17	350	8	38	2	12	45	5	49
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	175	-	-	300	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	17	311	23	18	380	9	41	2	13	49	5	53

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	389	0	0	334	0	0	807	782	323	785	789	385
Stage 1	-	-	-	-	-	-	357	357	-	421	421	-
Stage 2	-	-	-	-	-	-	450	425	-	364	368	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
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	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1170	-	-	1225	-	-	300	326	718	310	323	663
Stage 1	-	-	-	-	-	-	661	628	-	610	589	-
Stage 2	-	-	-	-	-	-	589	586	-	655	621	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1170	-	-	1225	-	-	266	316	718	296	313	663
Mov Cap-2 Maneuver	-	-	-	-	-	-	266	316	-	296	313	-
Stage 1	-	-	-	-	-	-	651	619	-	601	580	-
Stage 2	-	-	-	-	-	-	529	577	-	632	612	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.4	0.4	19	16.9
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	313	1170	-	-	1225	-	-	409
HCM Lane V/C Ratio	0.181	0.015	-	-	0.015	-	-	0.263
HCM Control Delay (s)	19	8.1	-	-	8	-	-	16.9
HCM Lane LOS	C	A	-	-	A	-	-	C
HCM 95th %tile Q(veh)	0.6	0	-	-	0	-	-	1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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	72	150	32	141	148	29	54	1270	292	22	755	45
Future Volume (veh/h)	72	150	32	141	148	29	54	1270	292	22	755	45
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	78	163	0	153	161	0	59	1380	0	24	821	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	100	198		210	207		485	2347		276	2301	
Arrive On Green	0.06	0.11	0.00	0.06	0.11	0.00	0.04	0.66	0.00	0.02	0.65	0.00
Sat Flow, veh/h	1781	1870	1585	3456	1870	1585	1781	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	78	163	0	153	161	0	59	1380	0	24	821	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1728	1870	1585	1781	1777	1585	1781	1777	1585
Q Serve(g_s), s	5.2	10.2	0.0	5.2	10.1	0.0	1.3	25.9	0.0	0.5	12.7	0.0
Cycle Q Clear(g_c), s	5.2	10.2	0.0	5.2	10.1	0.0	1.3	25.9	0.0	0.5	12.7	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	100	198		210	207		485	2347		276	2301	
V/C Ratio(X)	0.78	0.82		0.73	0.78		0.12	0.59		0.09	0.36	
Avail Cap(c_a), veh/h	186	335		302	304		503	2347		316	2301	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	55.9	52.6	0.0	55.4	51.9	0.0	7.0	11.3	0.0	9.2	9.7	0.0
Incr Delay (d2), s/veh	12.5	8.3	0.0	5.0	7.4	0.0	0.1	1.1	0.0	0.1	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.6	5.1	0.0	2.4	5.0	0.0	0.4	8.6	0.0	0.2	4.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	68.5	60.9	0.0	60.3	59.3	0.0	7.1	12.4	0.0	9.4	10.1	0.0
LnGrp LOS	E	E		E	E		A	B		A	B	
Approach Vol, veh/h		241	A		314	A		1439	A		845	A
Approach Delay, s/veh		63.3			59.8			12.2			10.1	
Approach LOS		E			E			B			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	7.3	83.8	11.8	17.2	8.8	82.2	11.2	17.8
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.5	64.5	10.5	21.5	5.5	64.5	12.5	19.5
Max Q Clear Time (g_c+I1), s	2.5	27.9	7.2	12.2	3.3	14.7	7.2	12.1
Green Ext Time (p_c), s	0.0	11.5	0.1	0.5	0.0	5.6	0.1	0.4

Intersection Summary	
HCM 6th Ctrl Delay	21.2
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

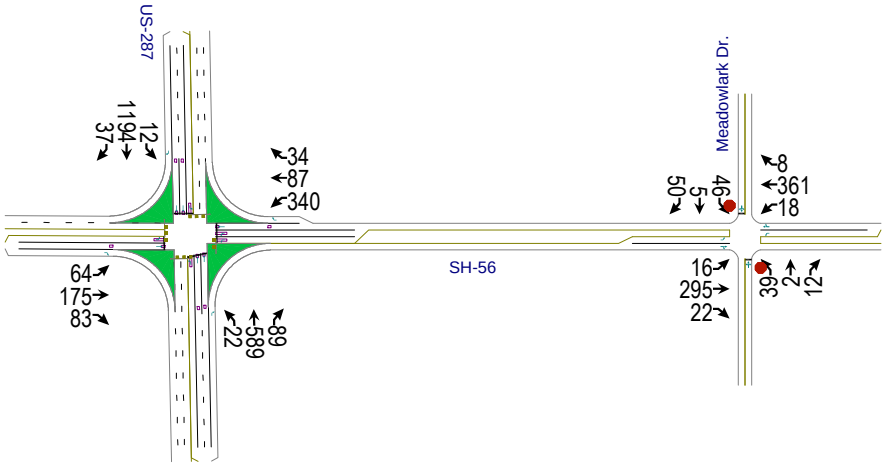
Intersection	
Int Delay, s/veh	3.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	63	375	22	20	279	19	39	2	29	21	1	22
Future Vol, veh/h	63	375	22	20	279	19	39	2	29	21	1	22
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	175	-	-	300	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	68	408	24	22	303	21	42	2	32	23	1	24

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	324	0	0	432	0	0	926	924	420	931	926	314
Stage 1	-	-	-	-	-	-	556	556	-	358	358	-
Stage 2	-	-	-	-	-	-	370	368	-	573	568	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
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	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1236	-	-	1128	-	-	249	269	633	247	269	726
Stage 1	-	-	-	-	-	-	515	513	-	660	628	-
Stage 2	-	-	-	-	-	-	650	621	-	505	506	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1236	-	-	1128	-	-	227	249	633	220	249	726
Mov Cap-2 Maneuver	-	-	-	-	-	-	227	249	-	220	249	-
Stage 1	-	-	-	-	-	-	487	485	-	624	615	-
Stage 2	-	-	-	-	-	-	615	609	-	451	478	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.1	0.5	20.3	17.4
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	310	1236	-	-	1128	-	-	339
HCM Lane V/C Ratio	0.245	0.055	-	-	0.019	-	-	0.141
HCM Control Delay (s)	20.3	8.1	-	-	8.3	-	-	17.4
HCM Lane LOS	C	A	-	-	A	-	-	C
HCM 95th %tile Q(veh)	0.9	0.2	-	-	0.1	-	-	0.5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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	62	170	81	330	84	33	21	535	86	12	1085	36
Future Volume (veh/h)	62	170	81	330	84	33	21	535	86	12	1085	36
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	69	190	0	369	94	0	24	640	0	13	1297	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	89	225		438	369		245	2091		479	2062	
Arrive On Green	0.05	0.12	0.00	0.13	0.20	0.00	0.02	0.59	0.00	0.01	0.58	0.00
Sat Flow, veh/h	1781	1870	1585	3456	1870	1585	1781	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	69	190	0	369	94	0	24	640	0	13	1297	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1728	1870	1585	1781	1777	1585	1781	1777	1585
Q Serve(g_s), s	4.6	11.9	0.0	12.5	5.1	0.0	0.7	10.8	0.0	0.4	29.0	0.0
Cycle Q Clear(g_c), s	4.6	11.9	0.0	12.5	5.1	0.0	0.7	10.8	0.0	0.4	29.0	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	89	225		438	369		245	2091		479	2062	
V/C Ratio(X)	0.78	0.85		0.84	0.25		0.10	0.31		0.03	0.63	
Avail Cap(c_a), veh/h	156	335		590	491		278	2091		527	2062	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	56.4	51.7	0.0	51.2	40.7	0.0	13.3	12.4	0.0	10.3	16.6	0.0
Incr Delay (d2), s/veh	13.6	12.0	0.0	8.2	0.4	0.0	0.2	0.4	0.0	0.0	1.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.4	6.2	0.0	5.8	2.3	0.0	0.2	3.9	0.0	0.1	10.6	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	70.0	63.7	0.0	59.4	41.1	0.0	13.5	12.8	0.0	10.4	18.1	0.0
LnGrp LOS	E	E		E	D		B	B		B	B	
Approach Vol, veh/h		259	A		463	A		664	A		1310	A
Approach Delay, s/veh		65.4			55.7			12.8			18.0	
Approach LOS		E			E			B			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	6.3	75.1	19.7	18.9	7.3	74.1	10.5	28.2
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.0	55.0	20.5	21.5	5.0	55.0	10.5	31.5
Max Q Clear Time (g_c+I1), s	2.4	12.8	14.5	13.9	2.7	31.0	6.6	7.1
Green Ext Time (p_c), s	0.0	4.1	0.7	0.5	0.0	9.2	0.0	0.4

Intersection Summary	
HCM 6th Ctrl Delay	27.8
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

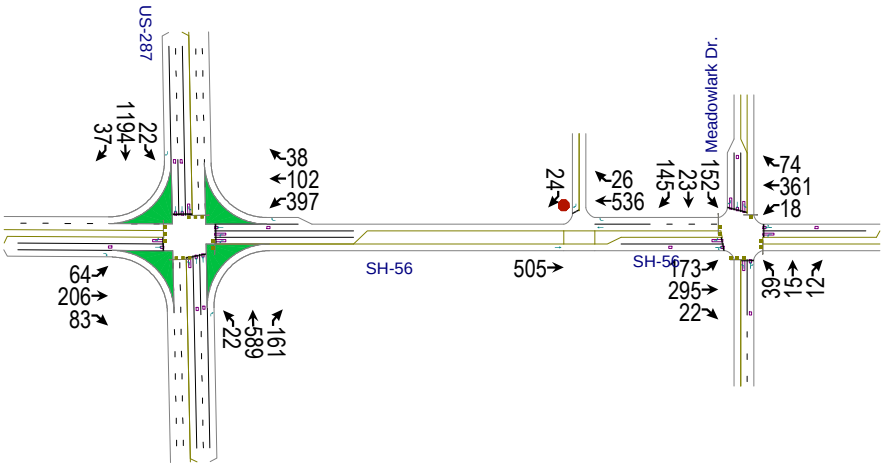
Intersection	
Int Delay, s/veh	3.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	16	286	21	17	350	8	38	2	12	45	5	49
Future Vol, veh/h	16	286	21	17	350	8	38	2	12	45	5	49
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	175	-	-	300	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	18	320	24	19	392	9	43	2	13	50	6	55

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	401	0	0	344	0	0	833	807	332	811	815	397
Stage 1	-	-	-	-	-	-	368	368	-	435	435	-
Stage 2	-	-	-	-	-	-	465	439	-	376	380	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
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	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1158	-	-	1215	-	-	288	315	710	298	312	652
Stage 1	-	-	-	-	-	-	652	621	-	600	580	-
Stage 2	-	-	-	-	-	-	578	578	-	645	614	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1158	-	-	1215	-	-	254	305	710	284	302	652
Mov Cap-2 Maneuver	-	-	-	-	-	-	254	305	-	284	302	-
Stage 1	-	-	-	-	-	-	642	611	-	590	571	-
Stage 2	-	-	-	-	-	-	516	569	-	621	604	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.4	0.4	19.9	17.6
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	300	1158	-	-	1215	-	-	396
HCM Lane V/C Ratio	0.194	0.015	-	-	0.016	-	-	0.28
HCM Control Delay (s)	19.9	8.2	-	-	8	-	-	17.6
HCM Lane LOS	C	A	-	-	A	-	-	C
HCM 95th %tile Q(veh)	0.7	0	-	-	0	-	-	1.1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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	62	200	81	385	99	37	21	535	156	21	1085	36
Future Volume (veh/h)	62	200	81	385	99	37	21	535	156	21	1085	36
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	69	224	0	431	111	0	24	640	0	24	1297	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	89	258		502	437		221	1933		451	1933	
Arrive On Green	0.05	0.14	0.00	0.05	0.08	0.00	0.02	0.54	0.00	0.02	0.54	0.00
Sat Flow, veh/h	1781	1870	1585	3456	1870	1585	1781	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	69	224	0	431	111	0	24	640	0	24	1297	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1728	1870	1585	1781	1777	1585	1781	1777	1585
Q Serve(g_s), s	4.6	14.1	0.0	14.9	6.7	0.0	0.7	12.0	0.0	0.7	31.5	0.0
Cycle Q Clear(g_c), s	4.6	14.1	0.0	14.9	6.7	0.0	0.7	12.0	0.0	0.7	31.5	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	89	258		502	437		221	1933		451	1933	
V/C Ratio(X)	0.78	0.87		0.86	0.25		0.11	0.33		0.05	0.67	
Avail Cap(c_a), veh/h	151	335		590	496		254	1933		484	1933	
HCM Platoon Ratio	1.00	1.00	1.00	0.33	0.33	0.33	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	56.4	50.7	0.0	55.9	45.5	0.0	15.8	15.2	0.0	12.0	19.7	0.0
Incr Delay (d2), s/veh	13.6	17.2	0.0	10.8	0.3	0.0	0.2	0.5	0.0	0.0	1.9	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.4	7.6	0.0	7.6	3.2	0.0	0.3	4.5	0.0	0.3	11.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	70.0	67.8	0.0	66.7	45.8	0.0	16.0	15.7	0.0	12.1	21.5	0.0
LnGrp LOS	E	E		E	D		B	B		B	C	
Approach Vol, veh/h		293	A		542	A		664	A		1321	A
Approach Delay, s/veh		68.3			62.4			15.7			21.4	
Approach LOS		E			E			B			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	7.3	69.8	21.9	21.0	7.3	69.8	10.5	32.5
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.0	55.0	20.5	21.5	5.0	55.0	10.2	31.8
Max Q Clear Time (g_c+I1), s	2.7	14.0	16.9	16.1	2.7	33.5	6.6	8.7
Green Ext Time (p_c), s	0.0	4.1	0.6	0.5	0.0	8.7	0.0	0.5

Intersection Summary	
HCM 6th Ctrl Delay	32.8
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	168	286	21	17	350	72	38	15	12	148	22	141
Future Volume (veh/h)	168	286	21	17	350	72	38	15	12	148	22	141
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	188	320	24	19	392	81	43	17	13	166	25	158
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	256	619	46	287	438	90	540	393	300	722	949	805
Arrive On Green	0.03	0.12	0.12	0.02	0.29	0.29	0.40	0.40	0.40	0.07	0.51	0.51
Sat Flow, veh/h	1781	1718	129	1781	1504	311	1201	983	752	1781	1870	1585
Grp Volume(v), veh/h	188	0	344	19	0	473	43	0	30	166	25	158
Grp Sat Flow(s),veh/h/ln	1781	0	1847	1781	0	1814	1201	0	1735	1781	1870	1585
Q Serve(g_s), s	8.4	0.0	21.0	0.9	0.0	30.0	2.7	0.0	1.3	6.3	0.8	6.5
Cycle Q Clear(g_c), s	8.4	0.0	21.0	0.9	0.0	30.0	2.7	0.0	1.3	6.3	0.8	6.5
Prop In Lane	1.00		0.07	1.00		0.17	1.00		0.43	1.00		1.00
Lane Grp Cap(c), veh/h	256	0	666	287	0	528	540	0	693	722	949	805
V/C Ratio(X)	0.73	0.00	0.52	0.07	0.00	0.90	0.08	0.00	0.04	0.23	0.03	0.20
Avail Cap(c_a), veh/h	343	0	947	334	0	764	540	0	693	782	949	805
HCM Platoon Ratio	0.33	0.33	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	31.5	0.0	43.1	29.5	0.0	40.8	22.4	0.0	22.0	17.5	14.7	16.2
Incr Delay (d2), s/veh	5.4	0.0	0.6	0.1	0.0	9.8	0.3	0.0	0.1	0.2	0.1	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.3	0.0	10.5	0.4	0.0	14.7	0.8	0.0	0.5	2.6	0.4	2.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	37.0	0.0	43.7	29.6	0.0	50.6	22.7	0.0	22.1	17.6	14.8	16.7
LnGrp LOS	D	A	D	C	A	D	C	A	C	B	B	B
Approach Vol, veh/h		532			492			73			349	
Approach Delay, s/veh		41.3			49.7			22.5			17.0	
Approach LOS		D			D			C			B	

Timer - Assigned Phs	1	2	3	4		6	7	8
Phs Duration (G+Y+Rc), s	13.0	52.5	6.8	47.7		65.4	15.2	39.4
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Max Green Setting (Gmax), s	12.5	22.5	5.5	61.5		39.5	16.5	50.5
Max Q Clear Time (g_c+I1), s	8.3	4.7	2.9	23.0		8.5	10.4	32.0
Green Ext Time (p_c), s	0.2	0.2	0.0	2.3		0.6	0.3	2.9

Intersection Summary	
HCM 6th Ctrl Delay	37.4
HCM 6th LOS	D

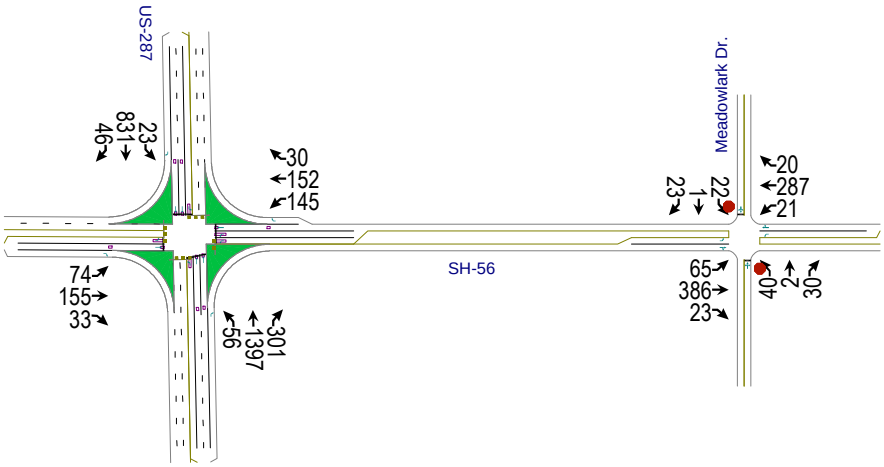
Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑	↱		↱
Traffic Vol, veh/h	0	490	520	25	0	23
Future Vol, veh/h	0	490	520	25	0	23
Conflicting Peds, #/hr	0	0	0	25	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	0	-	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	549	582	28	0	26

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	-	0	-	0	-	607
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	-	-	-	-	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	-	-	-	-	3.318
Pot Cap-1 Maneuver	0	-	-	-	0	496
Stage 1	0	-	-	-	0	-
Stage 2	0	-	-	-	0	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	-	-	-	-	-	484
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	12.9
HCM LOS			B

Minor Lane/Major Mvmt	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	-	-	-	484
HCM Lane V/C Ratio	-	-	-	0.053
HCM Control Delay (s)	-	-	-	12.9
HCM Lane LOS	-	-	-	B
HCM 95th %tile Q(veh)	-	-	-	0.2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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	72	150	32	141	148	29	54	1270	292	22	755	45
Future Volume (veh/h)	72	150	32	141	148	29	54	1270	292	22	755	45
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	81	168	0	158	166	0	60	1518	0	25	903	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	103	203		215	211		446	2331		239	2286	
Arrive On Green	0.06	0.11	0.00	0.06	0.11	0.00	0.04	0.66	0.00	0.02	0.64	0.00
Sat Flow, veh/h	1781	1870	1585	3456	1870	1585	1781	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	81	168	0	158	166	0	60	1518	0	25	903	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1728	1870	1585	1781	1777	1585	1781	1777	1585
Q Serve(g_s), s	5.4	10.6	0.0	5.4	10.4	0.0	1.3	30.8	0.0	0.6	14.6	0.0
Cycle Q Clear(g_c), s	5.4	10.6	0.0	5.4	10.4	0.0	1.3	30.8	0.0	0.6	14.6	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	103	203		215	211		446	2331		239	2286	
V/C Ratio(X)	0.79	0.83		0.73	0.79		0.13	0.65		0.10	0.39	
Avail Cap(c_a), veh/h	180	327		294	298		458	2331		272	2286	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	55.8	52.4	0.0	55.3	51.8	0.0	7.4	12.4	0.0	10.6	10.2	0.0
Incr Delay (d2), s/veh	12.3	9.1	0.0	6.1	8.9	0.0	0.1	1.4	0.0	0.2	0.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.7	5.3	0.0	2.5	5.3	0.0	0.4	10.4	0.0	0.2	4.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	68.1	61.5	0.0	61.4	60.7	0.0	7.5	13.8	0.0	10.8	10.7	0.0
LnGrp LOS	E	E		E	E		A	B		B	B	
Approach Vol, veh/h		249	A		324	A		1578	A		928	A
Approach Delay, s/veh		63.7			61.0			13.6			10.7	
Approach LOS		E			E			B			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	7.3	83.2	12.0	17.5	8.8	81.7	11.4	18.0
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.0	65.8	10.2	21.0	5.1	65.7	12.1	19.1
Max Q Clear Time (g_c+I1), s	2.6	32.8	7.4	12.6	3.3	16.6	7.4	12.4
Green Ext Time (p_c), s	0.0	12.9	0.1	0.4	0.0	6.4	0.1	0.4

Intersection Summary	
HCM 6th Ctrl Delay	21.8
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

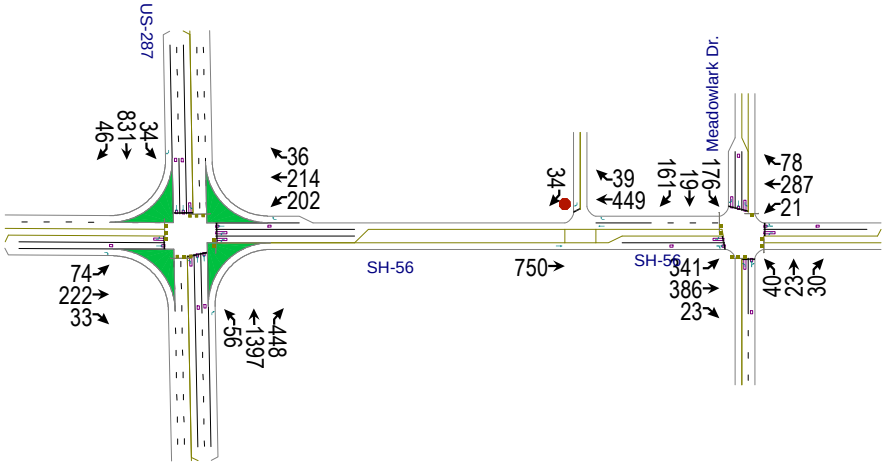
Intersection	
Int Delay, s/veh	3.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	63	375	22	20	279	19	39	2	29	21	1	22
Future Vol, veh/h	63	375	22	20	279	19	39	2	29	21	1	22
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	175	-	-	300	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	71	420	25	22	312	21	44	2	32	24	1	25

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	333	0	0	445	0	0	955	952	433	959	954	323
Stage 1	-	-	-	-	-	-	575	575	-	367	367	-
Stage 2	-	-	-	-	-	-	380	377	-	592	587	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
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	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1226	-	-	1115	-	-	238	259	623	237	259	718
Stage 1	-	-	-	-	-	-	503	503	-	653	622	-
Stage 2	-	-	-	-	-	-	642	616	-	493	497	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1226	-	-	1115	-	-	216	239	623	210	239	718
Mov Cap-2 Maneuver	-	-	-	-	-	-	216	239	-	210	239	-
Stage 1	-	-	-	-	-	-	474	474	-	615	610	-
Stage 2	-	-	-	-	-	-	607	604	-	438	468	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.1	0.5	21.4	18
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	297	1226	-	-	1115	-	-	326
HCM Lane V/C Ratio	0.264	0.058	-	-	0.02	-	-	0.151
HCM Control Delay (s)	21.4	8.1	-	-	8.3	-	-	18
HCM Lane LOS	C	A	-	-	A	-	-	C
HCM 95th %tile Q(veh)	1	0.2	-	-	0.1	-	-	0.5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74
222
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1397
56

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	72	216	32	196	208	35	54	1270	435	33	755	45
Future Volume (veh/h)	72	216	32	196	208	35	54	1270	435	33	755	45
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	81	242	0	219	233	0	60	1518	0	37	903	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	103	276		279	319		398	2104		212	2081	
Arrive On Green	0.06	0.15	0.00	0.03	0.06	0.00	0.04	0.59	0.00	0.03	0.59	0.00
Sat Flow, veh/h	1781	1870	1585	3456	1870	1585	1781	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	81	242	0	219	233	0	60	1518	0	37	903	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1728	1870	1585	1781	1777	1585	1781	1777	1585
Q Serve(g_s), s	5.4	15.2	0.0	7.6	14.7	0.0	1.6	36.5	0.0	1.0	16.9	0.0
Cycle Q Clear(g_c), s	5.4	15.2	0.0	7.6	14.7	0.0	1.6	36.5	0.0	1.0	16.9	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	103	276		279	319		398	2104		212	2081	
V/C Ratio(X)	0.79	0.88		0.79	0.73		0.15	0.72		0.17	0.43	
Avail Cap(c_a), veh/h	156	351		331	366		414	2104		233	2081	
HCM Platoon Ratio	1.00	1.00	1.00	0.33	0.33	0.33	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	55.8	50.1	0.0	57.4	53.9	0.0	10.2	17.4	0.0	15.0	13.8	0.0
Incr Delay (d2), s/veh	14.0	18.0	0.0	10.0	6.2	0.0	0.2	2.2	0.0	0.4	0.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.8	8.3	0.0	3.8	7.9	0.0	0.6	13.4	0.0	0.4	6.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	69.8	68.0	0.0	67.4	60.1	0.0	10.4	19.6	0.0	15.4	14.5	0.0
LnGrp LOS	E	E		E	E		B	B		B	B	
Approach Vol, veh/h		323	A		452	A		1578	A		940	A
Approach Delay, s/veh		68.5			63.6			19.3			14.5	
Approach LOS		E			E			B			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	8.0	75.6	14.2	22.2	8.8	74.8	11.4	25.0
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.0	63.0	11.5	22.5	5.4	62.6	10.5	23.5
Max Q Clear Time (g_c+I1), s	3.0	38.5	9.6	17.2	3.6	18.9	7.4	16.7
Green Ext Time (p_c), s	0.0	11.4	0.1	0.5	0.0	6.4	0.0	0.6

Intersection Summary	
HCM 6th Ctrl Delay	28.8
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	331	375	22	20	279	76	39	22	29	171	18	156
Future Volume (veh/h)	331	375	22	20	279	76	39	22	29	171	18	156
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	371	420	25	22	312	85	44	25	32	191	20	175
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	410	704	42	265	347	95	465	254	325	639	866	734
Arrive On Green	0.06	0.13	0.13	0.02	0.25	0.25	0.34	0.34	0.34	0.08	0.46	0.46
Sat Flow, veh/h	1781	1748	104	1781	1415	386	1188	745	954	1781	1870	1585
Grp Volume(v), veh/h	371	0	445	22	0	397	44	0	57	191	20	175
Grp Sat Flow(s),veh/h/ln	1781	0	1852	1781	0	1801	1188	0	1699	1781	1870	1585
Q Serve(g_s), s	18.6	0.0	27.2	1.1	0.0	25.6	3.0	0.0	2.7	8.0	0.7	8.0
Cycle Q Clear(g_c), s	18.6	0.0	27.2	1.1	0.0	25.6	3.0	0.0	2.7	8.0	0.7	8.0
Prop In Lane	1.00		0.06	1.00		0.21	1.00		0.56	1.00		1.00
Lane Grp Cap(c), veh/h	410	0	746	265	0	442	465	0	579	639	866	734
V/C Ratio(X)	0.90	0.00	0.60	0.08	0.00	0.90	0.09	0.00	0.10	0.30	0.02	0.24
Avail Cap(c_a), veh/h	544	0	986	302	0	578	465	0	579	681	866	734
HCM Platoon Ratio	0.33	0.33	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	36.1	0.0	42.9	32.9	0.0	43.8	27.1	0.0	27.0	21.0	17.5	19.4
Incr Delay (d2), s/veh	15.3	0.0	0.8	0.1	0.0	14.0	0.4	0.0	0.3	0.3	0.0	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	10.6	0.0	13.7	0.5	0.0	13.1	0.9	0.0	1.2	3.4	0.3	3.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	51.4	0.0	43.6	33.1	0.0	57.9	27.5	0.0	27.3	21.3	17.5	20.2
LnGrp LOS	D	A	D	C	A	E	C	A	C	C	B	C
Approach Vol, veh/h		816			419			101			386	
Approach Delay, s/veh		47.1			56.6			27.4			20.6	
Approach LOS		D			E			C			C	

Timer - Assigned Phs	1	2	3	4		6	7	8
Phs Duration (G+Y+Rc), s	14.7	45.4	7.1	52.8		60.1	26.0	33.9
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Max Green Setting (Gmax), s	13.0	20.0	5.1	63.9		37.5	30.5	38.5
Max Q Clear Time (g_c+I1), s	10.0	5.0	3.1	29.2		10.0	20.6	27.6
Green Ext Time (p_c), s	0.1	0.3	0.0	3.1		0.7	0.9	1.8

Intersection Summary	
HCM 6th Ctrl Delay	42.3
HCM 6th LOS	D

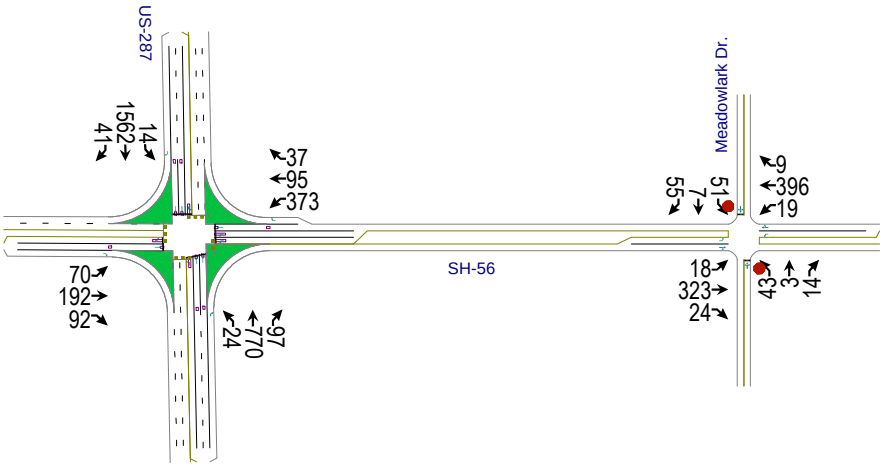
Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑	↱		↱
Traffic Vol, veh/h	0	728	436	38	0	33
Future Vol, veh/h	0	728	436	38	0	33
Conflicting Peds, #/hr	0	0	0	25	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	0	-	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	815	488	43	0	37

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	-	0	-	0	-	513
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	-	-	-	-	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	-	-	-	-	3.318
Pot Cap-1 Maneuver	0	-	-	-	0	561
Stage 1	0	-	-	-	0	-
Stage 2	0	-	-	-	0	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	-	-	-	-	-	548
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	12
HCM LOS			B

Minor Lane/Major Mvmt	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	-	-	-	548
HCM Lane V/C Ratio	-	-	-	0.067
HCM Control Delay (s)	-	-	-	12
HCM Lane LOS	-	-	-	B
HCM 95th %tile Q(veh)	-	-	-	0.2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92

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	62	170	81	330	84	33	21	535	86	12	1085	36
Future Volume (veh/h)	62	170	81	330	84	33	21	535	86	12	1085	36
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	76	209	0	405	103	0	26	837	0	15	1698	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	97	240		459	387		151	2034		379	2007	
Arrive On Green	0.05	0.13	0.00	0.13	0.21	0.00	0.02	0.57	0.00	0.02	0.56	0.00
Sat Flow, veh/h	1781	1870	1585	3456	1870	1585	1781	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	76	209	0	405	103	0	26	837	0	15	1698	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1728	1870	1585	1781	1777	1585	1781	1777	1585
Q Serve(g_s), s	5.1	13.2	0.0	13.8	5.5	0.0	0.7	15.8	0.0	0.4	47.8	0.0
Cycle Q Clear(g_c), s	5.1	13.2	0.0	13.8	5.5	0.0	0.7	15.8	0.0	0.4	47.8	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	97	240		459	387		151	2034		379	2007	
V/C Ratio(X)	0.78	0.87		0.88	0.27		0.17	0.41		0.04	0.85	
Avail Cap(c_a), veh/h	174	281		475	387		182	2034		424	2007	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	56.0	51.3	0.0	51.1	40.0	0.0	20.8	14.3	0.0	11.6	21.8	0.0
Incr Delay (d2), s/veh	12.8	21.9	0.0	17.1	0.4	0.0	0.5	0.6	0.0	0.0	4.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.6	7.5	0.0	6.9	2.5	0.0	0.3	5.8	0.0	0.2	18.4	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	68.8	73.3	0.0	68.2	40.3	0.0	21.3	15.0	0.0	11.6	26.4	0.0
LnGrp LOS	E	E		E	D		C	B		B	C	
Approach Vol, veh/h		285	A		508	A		863	A		1713	A
Approach Delay, s/veh		72.1			62.6			15.2			26.3	
Approach LOS		E			E			B			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	6.5	73.2	20.4	19.9	7.4	72.3	11.0	29.3
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.0	62.5	16.5	18.0	5.0	62.5	11.7	22.8
Max Q Clear Time (g_c+I1), s	2.4	17.8	15.8	15.2	2.7	49.8	7.1	7.5
Green Ext Time (p_c), s	0.0	5.8	0.1	0.2	0.0	8.5	0.0	0.3

Intersection Summary	
HCM 6th Ctrl Delay	32.8
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

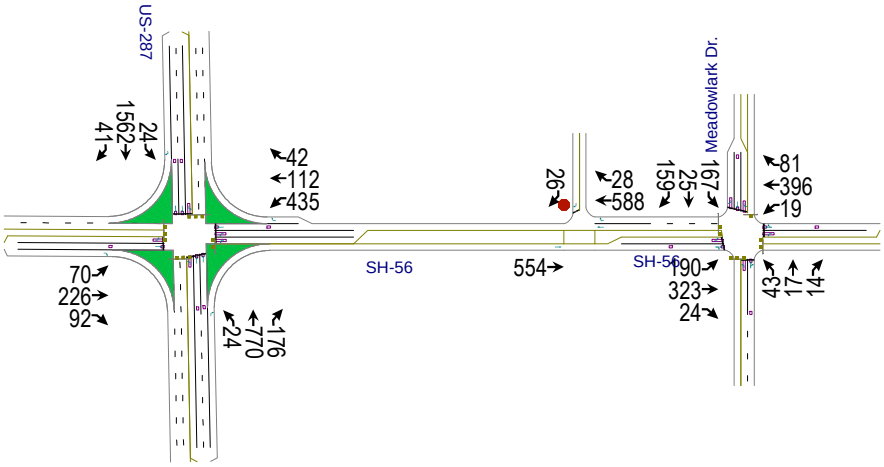
Intersection	
Int Delay, s/veh	4.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	16	286	21	17	350	8	38	2	12	45	5	49
Future Vol, veh/h	16	286	21	17	350	8	38	2	12	45	5	49
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	175	-	-	300	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	20	351	26	21	430	10	47	3	15	55	8	60

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	440	0	0	377	0	0	915	886	364	890	894	435
Stage 1	-	-	-	-	-	-	404	404	-	477	477	-
Stage 2	-	-	-	-	-	-	511	482	-	413	417	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
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	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1120	-	-	1181	-	-	253	284	681	264	280	621
Stage 1	-	-	-	-	-	-	623	599	-	569	556	-
Stage 2	-	-	-	-	-	-	545	553	-	616	591	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1120	-	-	1181	-	-	217	274	681	249	270	621
Mov Cap-2 Maneuver	-	-	-	-	-	-	217	274	-	249	270	-
Stage 1	-	-	-	-	-	-	612	588	-	559	546	-
Stage 2	-	-	-	-	-	-	476	543	-	589	580	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.4	0.4	23.4	20.5
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	260	1120	-	-	1181	-	-	354
HCM Lane V/C Ratio	0.248	0.018	-	-	0.018	-	-	0.348
HCM Control Delay (s)	23.4	8.3	-	-	8.1	-	-	20.5
HCM Lane LOS	C	A	-	-	A	-	-	C
HCM 95th %tile Q(veh)	1	0.1	-	-	0.1	-	-	1.5


Meadowlark Dr.
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US-287
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1562
41

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	62	200	81	385	99	37	21	535	156	21	1085	36
Future Volume (veh/h)	62	200	81	385	99	37	21	535	156	21	1085	36
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	76	246	0	473	122	0	26	837	0	26	1698	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	97	275		504	445		134	1895		359	1895	
Arrive On Green	0.05	0.15	0.00	0.05	0.08	0.00	0.02	0.53	0.00	0.02	0.53	0.00
Sat Flow, veh/h	1781	1870	1585	3456	1870	1585	1781	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	76	246	0	473	122	0	26	837	0	26	1698	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1728	1870	1585	1781	1777	1585	1781	1777	1585
Q Serve(g_s), s	5.1	15.5	0.0	16.4	7.4	0.0	0.8	17.3	0.0	0.8	51.3	0.0
Cycle Q Clear(g_c), s	5.1	15.5	0.0	16.4	7.4	0.0	0.8	17.3	0.0	0.8	51.3	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	97	275		504	445		134	1895		359	1895	
V/C Ratio(X)	0.78	0.90		0.94	0.27		0.19	0.44		0.07	0.90	
Avail Cap(c_a), veh/h	174	288		504	445		165	1895		390	1895	
HCM Platoon Ratio	1.00	1.00	1.00	0.33	0.33	0.33	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	56.0	50.3	0.0	56.6	45.5	0.0	24.0	17.1	0.0	13.2	25.0	0.0
Incr Delay (d2), s/veh	12.8	27.3	0.0	25.6	0.3	0.0	0.7	0.7	0.0	0.1	7.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.6	9.1	0.0	9.4	3.5	0.0	0.3	6.5	0.0	0.3	20.7	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	68.8	77.6	0.0	82.2	45.8	0.0	24.7	17.9	0.0	13.3	32.2	0.0
LnGrp LOS	E	E		F	D		C	B		B	C	
Approach Vol, veh/h		322	A		595	A		863	A		1724	A
Approach Delay, s/veh		75.5			74.7			18.1			31.9	
Approach LOS		E			E			B			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	7.4	68.5	22.0	22.1	7.4	68.5	11.0	33.1
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.0	61.0	17.5	18.5	5.0	61.0	11.7	24.3
Max Q Clear Time (g_c+I1), s	2.8	19.3	18.4	17.5	2.8	53.3	7.1	9.4
Green Ext Time (p_c), s	0.0	5.7	0.0	0.1	0.0	5.7	0.0	0.4

Intersection Summary	
HCM 6th Ctrl Delay	39.8
HCM 6th LOS	D

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	168	286	21	17	350	72	38	15	12	148	22	141
Future Volume (veh/h)	168	286	21	17	350	72	38	15	12	148	22	141
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	206	351	26	21	430	88	47	18	15	182	27	173
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	262	666	49	295	476	97	488	342	285	683	896	760
Arrive On Green	0.03	0.13	0.13	0.02	0.32	0.32	0.36	0.36	0.36	0.08	0.48	0.48
Sat Flow, veh/h	1781	1720	127	1781	1507	308	1182	943	786	1781	1870	1585
Grp Volume(v), veh/h	206	0	377	21	0	518	47	0	33	182	27	173
Grp Sat Flow(s),veh/h/ln	1781	0	1847	1781	0	1815	1182	0	1729	1781	1870	1585
Q Serve(g_s), s	8.9	0.0	22.9	0.9	0.0	32.8	3.2	0.0	1.5	7.4	0.9	7.7
Cycle Q Clear(g_c), s	8.9	0.0	22.9	0.9	0.0	32.8	3.2	0.0	1.5	7.4	0.9	7.7
Prop In Lane	1.00		0.07	1.00		0.17	1.00		0.45	1.00		1.00
Lane Grp Cap(c), veh/h	262	0	716	295	0	573	488	0	626	683	896	760
V/C Ratio(X)	0.78	0.00	0.53	0.07	0.00	0.90	0.10	0.00	0.05	0.27	0.03	0.23
Avail Cap(c_a), veh/h	342	0	947	339	0	764	488	0	626	731	896	760
HCM Platoon Ratio	0.33	0.33	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	30.5	0.0	42.0	27.6	0.0	39.3	25.4	0.0	24.9	19.7	16.5	18.3
Incr Delay (d2), s/veh	8.6	0.0	0.6	0.1	0.0	11.6	0.4	0.0	0.2	0.2	0.1	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.7	0.0	11.5	0.4	0.0	16.3	1.0	0.0	0.6	3.1	0.4	3.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.2	0.0	42.6	27.7	0.0	50.9	25.8	0.0	25.0	19.9	16.6	19.0
LnGrp LOS	D	A	D	C	A	D	C	A	C	B	B	B
Approach Vol, veh/h		583			539			80			382	
Approach Delay, s/veh		41.4			50.0			25.5			19.2	
Approach LOS		D			D			C			B	

Timer - Assigned Phs	1	2	3	4		6	7	8
Phs Duration (G+Y+Rc), s	14.0	48.0	7.0	51.0		62.0	15.6	42.4
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Max Green Setting (Gmax), s	12.8	22.2	5.5	61.5		39.5	16.5	50.5
Max Q Clear Time (g_c+I1), s	9.4	5.2	2.9	24.9		9.7	10.9	34.8
Green Ext Time (p_c), s	0.2	0.2	0.0	2.6		0.7	0.3	3.1

Intersection Summary	
HCM 6th Ctrl Delay	38.2
HCM 6th LOS	D

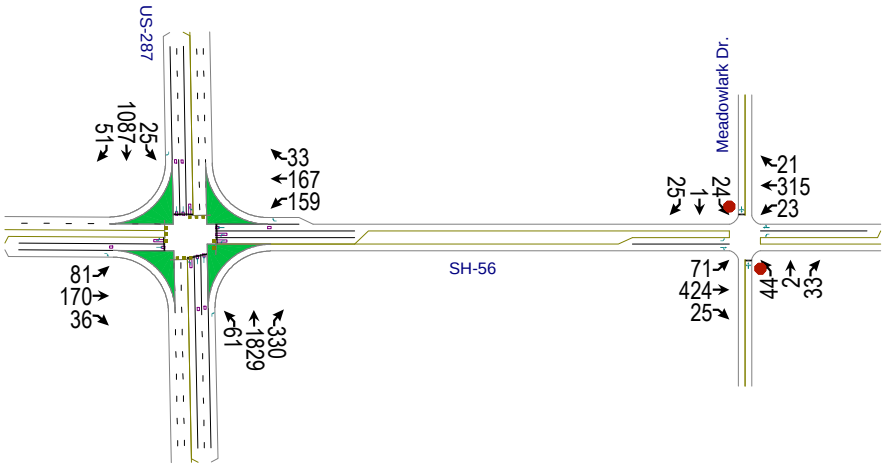
Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑	↱		↱
Traffic Vol, veh/h	0	490	520	25	0	23
Future Vol, veh/h	0	490	520	25	0	23
Conflicting Peds, #/hr	0	0	0	25	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	0	-	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	602	639	31	0	28

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	-	0	-	0	-	664
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	-	-	-	-	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	-	-	-	-	3.318
Pot Cap-1 Maneuver	0	-	-	-	0	461
Stage 1	0	-	-	-	0	-
Stage 2	0	-	-	-	0	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	-	-	-	-	-	450
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	13.5
HCM LOS			B

Minor Lane/Major Mvmt	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	-	-	-	450
HCM Lane V/C Ratio	-	-	-	0.063
HCM Control Delay (s)	-	-	-	13.5
HCM Lane LOS	-	-	-	B
HCM 95th %tile Q(veh)	-	-	-	0.2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81
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36

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	72	150	32	141	148	29	54	1270	292	22	755	45
Future Volume (veh/h)	72	150	32	141	148	29	54	1270	292	22	755	45
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	88	184	0	173	182	0	66	1988	0	27	1182	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	111	237		216	237		322	1982		140	1912	
Arrive On Green	0.06	0.13	0.00	0.06	0.13	0.00	0.05	0.56	0.00	0.03	0.54	0.00
Sat Flow, veh/h	1781	1870	1585	3456	1870	1585	1781	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	88	184	0	173	182	0	66	1988	0	27	1182	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1728	1870	1585	1781	1777	1585	1781	1777	1585
Q Serve(g_s), s	3.9	7.6	0.0	4.0	7.5	0.0	1.3	44.6	0.0	0.5	18.4	0.0
Cycle Q Clear(g_c), s	3.9	7.6	0.0	4.0	7.5	0.0	1.3	44.6	0.0	0.5	18.4	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	111	237		216	237		322	1982		140	1912	
V/C Ratio(X)	0.79	0.78		0.80	0.77		0.21	1.00		0.19	0.62	
Avail Cap(c_a), veh/h	111	421		216	421		347	1982		201	1912	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	37.0	33.8	0.0	37.0	33.8	0.0	9.6	17.7	0.0	19.2	12.8	0.0
Incr Delay (d2), s/veh	30.9	5.5	0.0	19.0	5.2	0.0	0.3	20.9	0.0	0.7	1.5	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.6	3.6	0.0	2.1	3.5	0.0	0.4	18.8	0.0	0.2	5.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	67.8	39.3	0.0	56.0	39.0	0.0	9.9	38.6	0.0	19.9	14.3	0.0
LnGrp LOS	E	D		E	D		A	F		B	B	
Approach Vol, veh/h		272	A		355	A		2054	A		1209	A
Approach Delay, s/veh		48.5			47.3			37.7			14.4	
Approach LOS		D			D			D			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	6.8	49.1	9.5	14.6	8.3	47.5	9.5	14.6
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.0	34.0	5.0	18.0	5.0	34.0	5.0	18.0
Max Q Clear Time (g_c+I1), s	2.5	46.6	6.0	9.6	3.3	20.4	5.9	9.5
Green Ext Time (p_c), s	0.0	0.0	0.0	0.5	0.0	6.2	0.0	0.5

Intersection Summary	
HCM 6th Ctrl Delay	32.1
HCM 6th LOS	C

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

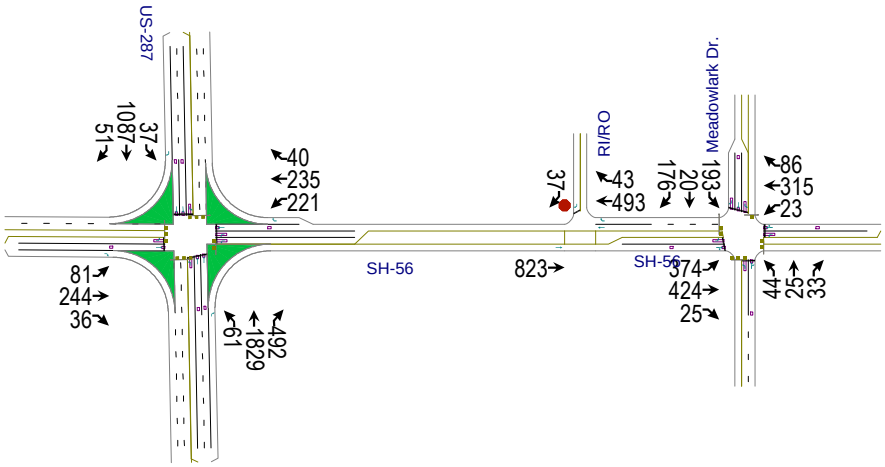
Intersection	
Int Delay, s/veh	3.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	63	375	22	20	279	19	39	2	29	21	1	22
Future Vol, veh/h	63	375	22	20	279	19	39	2	29	21	1	22
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	175	-	-	300	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	77	461	27	25	343	23	48	2	36	26	1	27

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	366	0	0	488	0	0	1048	1045	475	1053	1047	355
Stage 1	-	-	-	-	-	-	629	629	-	405	405	-
Stage 2	-	-	-	-	-	-	419	416	-	648	642	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
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	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1193	-	-	1075	-	-	206	229	590	204	228	689
Stage 1	-	-	-	-	-	-	470	475	-	622	598	-
Stage 2	-	-	-	-	-	-	612	592	-	459	469	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1193	-	-	1075	-	-	184	209	590	177	208	689
Mov Cap-2 Maneuver	-	-	-	-	-	-	184	209	-	177	208	-
Stage 1	-	-	-	-	-	-	439	444	-	582	584	-
Stage 2	-	-	-	-	-	-	573	578	-	401	439	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.1	0.5	25.7	20.7
HCM LOS			D	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	259	1193	-	-	1075	-	-	283
HCM Lane V/C Ratio	0.332	0.065	-	-	0.023	-	-	0.191
HCM Control Delay (s)	25.7	8.2	-	-	8.4	-	-	20.7
HCM Lane LOS	D	A	-	-	A	-	-	C
HCM 95th %tile Q(veh)	1.4	0.2	-	-	0.1	-	-	0.7


Meadowlark Dr.
86
315
23
193
20
176
RI/RO
43
493
37
40
235
221
SH-56
374
424
25
SH-56
823
44
25
33
US-287
37
1087
51
81
244
36
492
1829
19

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	72	216	32	196	208	35	54	1270	435	33	755	45
Future Volume (veh/h)	72	216	32	196	208	35	54	1270	435	33	755	45
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	88	265	0	241	255	0	66	1988	0	41	1182	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	104	282		274	321		304	2093		130	2072	
Arrive On Green	0.06	0.15	0.00	0.03	0.06	0.00	0.04	0.59	0.00	0.03	0.58	0.00
Sat Flow, veh/h	1781	1870	1585	3456	1870	1585	1781	3554	1585	1781	3554	1585
Grp Volume(v), veh/h	88	265	0	241	255	0	66	1988	0	41	1182	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1728	1870	1585	1781	1777	1585	1781	1777	1585
Q Serve(g_s), s	5.9	16.8	0.0	8.3	16.2	0.0	1.8	62.6	0.0	1.1	24.9	0.0
Cycle Q Clear(g_c), s	5.9	16.8	0.0	8.3	16.2	0.0	1.8	62.6	0.0	1.1	24.9	0.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	104	282		274	321		304	2093		130	2072	
V/C Ratio(X)	0.85	0.94		0.88	0.79		0.22	0.95		0.32	0.57	
Avail Cap(c_a), veh/h	104	282		274	321		324	2093		149	2072	
HCM Platoon Ratio	1.00	1.00	1.00	0.33	0.33	0.33	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	56.0	50.4	0.0	57.9	54.5	0.0	12.0	23.0	0.0	28.1	15.6	0.0
Incr Delay (d2), s/veh	44.3	37.6	0.0	26.5	12.9	0.0	0.4	11.0	0.0	1.4	1.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.9	10.6	0.0	4.7	9.2	0.0	0.6	25.1	0.0	0.7	9.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	100.3	88.0	0.0	84.4	67.4	0.0	12.4	34.0	0.0	29.5	16.8	0.0
LnGrp LOS	F	F		F	E		B	C		C	B	
Approach Vol, veh/h		353	A		496	A		2054	A		1223	A
Approach Delay, s/veh		91.1			75.6			33.3			17.2	
Approach LOS		F			E			C			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	8.2	75.2	14.0	22.6	8.9	74.5	11.5	25.1
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	5.0	69.4	9.5	18.1	5.8	68.6	7.0	20.6
Max Q Clear Time (g_c+I1), s	3.1	64.6	10.3	18.8	3.8	26.9	7.9	18.2
Green Ext Time (p_c), s	0.0	4.1	0.0	0.0	0.0	9.3	0.0	0.3

Intersection Summary	
HCM 6th Ctrl Delay	38.6
HCM 6th LOS	D

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	331	375	22	20	279	76	39	22	29	171	18	156
Future Volume (veh/h)	331	375	22	20	279	76	39	22	29	171	18	156
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	407	461	27	25	343	93	48	27	36	210	22	192
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	446	774	45	280	375	102	397	210	280	580	789	669
Arrive On Green	0.07	0.15	0.15	0.02	0.26	0.26	0.29	0.29	0.29	0.10	0.42	0.42
Sat Flow, veh/h	1781	1749	102	1781	1417	384	1167	727	969	1781	1870	1585
Grp Volume(v), veh/h	407	0	488	25	0	436	48	0	63	210	22	192
Grp Sat Flow(s),veh/h/ln	1781	0	1852	1781	0	1801	1167	0	1696	1781	1870	1585
Q Serve(g_s), s	21.2	0.0	29.6	1.2	0.0	28.2	3.7	0.0	3.3	9.6	0.8	9.6
Cycle Q Clear(g_c), s	21.2	0.0	29.6	1.2	0.0	28.2	3.7	0.0	3.3	9.6	0.8	9.6
Prop In Lane	1.00		0.06	1.00		0.21	1.00		0.57	1.00		1.00
Lane Grp Cap(c), veh/h	446	0	819	280	0	477	397	0	489	580	789	669
V/C Ratio(X)	0.91	0.00	0.60	0.09	0.00	0.91	0.12	0.00	0.13	0.36	0.03	0.29
Avail Cap(c_a), veh/h	556	0	986	313	0	563	397	0	489	580	789	669
HCM Platoon Ratio	0.33	0.33	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	38.7	0.0	41.2	31.1	0.0	42.8	31.7	0.0	31.5	24.5	20.3	22.8
Incr Delay (d2), s/veh	16.9	0.0	0.7	0.1	0.0	17.8	0.6	0.0	0.5	0.4	0.1	1.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	15.1	0.0	14.9	0.5	0.0	14.8	1.1	0.0	1.4	4.1	0.4	3.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	55.6	0.0	41.9	31.2	0.0	60.6	32.3	0.0	32.1	24.9	20.4	23.9
LnGrp LOS	E	A	D	C	A	E	C	A	C	C	C	C
Approach Vol, veh/h		895			461			111			424	
Approach Delay, s/veh		48.2			59.0			32.2			24.2	
Approach LOS		D			E			C			C	

Timer - Assigned Phs	1	2	3	4		6	7	8
Phs Duration (G+Y+Rc), s	16.0	39.1	7.3	57.6		55.1	28.6	36.3
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Max Green Setting (Gmax), s	11.5	21.5	5.1	63.9		37.5	31.5	37.5
Max Q Clear Time (g_c+I1), s	11.6	5.7	3.2	31.6		11.6	23.2	30.2
Green Ext Time (p_c), s	0.0	0.4	0.0	3.5		0.7	0.9	1.6

Intersection Summary	
HCM 6th Ctrl Delay	44.5
HCM 6th LOS	D

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑	↗		↗
Traffic Vol, veh/h	0	728	436	38	0	33
Future Vol, veh/h	0	728	436	38	0	33
Conflicting Peds, #/hr	0	0	0	25	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	0	-	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	894	536	47	0	41

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	-	0	-	0	-	561
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	-	-	-	-	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	-	-	-	-	3.318
Pot Cap-1 Maneuver	0	-	-	-	0	527
Stage 1	0	-	-	-	0	-
Stage 2	0	-	-	-	0	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	-	-	-	-	-	514
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	12.6
HCM LOS			B

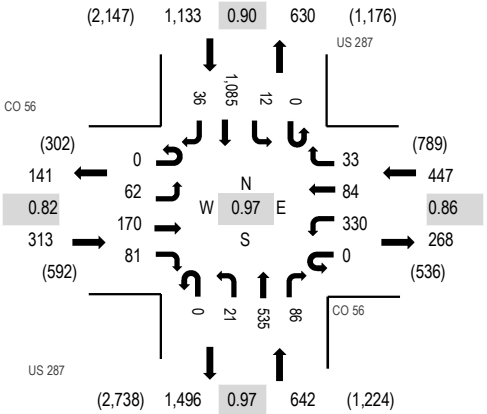
Minor Lane/Major Mvmt	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	-	-	-	514
HCM Lane V/C Ratio	-	-	-	0.079
HCM Control Delay (s)	-	-	-	12.6
HCM Lane LOS	-	-	-	B
HCM 95th %tile Q(veh)	-	-	-	0.3

All Traffic Data Services Inc.

(303) 216-2439
www.alltrafficdata.net

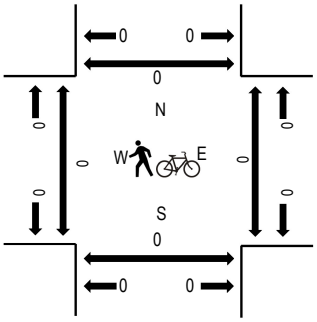
Location: 1 US 287 & CO 56 AM
Date: Tuesday, October 15, 2019
Peak Hour: 07:15 AM - 08:15 AM
Peak 15-Minutes: 08:00 AM - 08:15 AM

Peak Hour - All Vehicles



Note: Total study counts contained in parentheses.

Peak Hour - Pedestrians/Bicycles on Crosswalk



Traffic Counts

Interval Start Time	CO 56 Eastbound				CO 56 Westbound				US 287 Northbound				US 287 Southbound				Total	Rolling Hour	Pedestrian Crossings			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right			West	East	South	North
7:00 AM	0	11	24	11	0	64	8	5	0	5	102	11	0	1	297	5	544	2,424	0	0	0	0
7:15 AM	0	16	36	25	0	80	13	8	0	3	139	15	0	4	303	10	652	2,535	0	0	0	0
7:30 AM	0	21	36	19	0	84	11	10	0	7	133	16	0	1	269	6	613	2,505	0	0	0	0
7:45 AM	0	12	51	21	0	80	23	8	0	6	133	30	0	2	241	8	615	2,435	0	0	0	0
8:00 AM	0	13	47	16	0	86	37	7	0	5	130	25	0	5	272	12	655	2,328	0	0	0	0
8:15 AM	0	18	69	16	0	58	26	7	0	4	129	35	0	4	241	15	622		0	0	0	0
8:30 AM	0	15	20	19	0	61	38	6	0	8	119	22	1	5	216	13	543		0	0	0	0
8:45 AM	0	20	43	13	0	43	22	4	0	7	109	31	0	3	203	10	508		0	0	0	0
Count Total	0	126	326	140	0	556	178	55	0	45	994	185	1	25	2,042	79	4,752		0	0	0	0
Peak Hour	0	62	170	81	0	330	84	33	0	21	535	86	0	12	1,085	36	2,535		0	0	0	0

All Traffic Data Services Inc.

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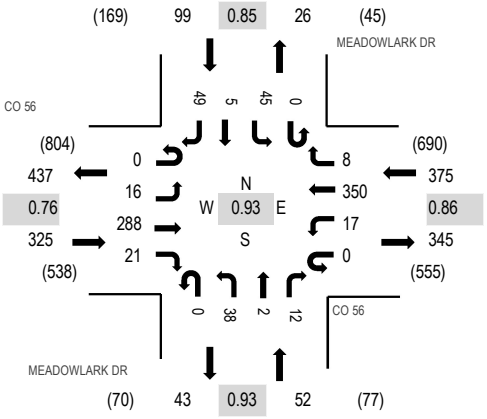
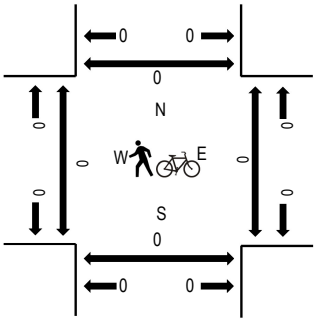
Location: 2 MEADOWLARK DR & CO 56 AM
Date: Tuesday, October 15, 2019
Peak Hour: 07:30 AM - 08:30 AM
Peak 15-Minutes: 08:15 AM - 08:30 AM

Peak Hour - All Vehicles



Note: Total study counts contained in parentheses.

Peak Hour - Pedestrians/Bicycles on Crosswalk



Traffic Counts

Interval Start Time	CO 56 Eastbound				CO 56 Westbound				MEADOWLARK DR Northbound				MEADOWLARK DR Southbound				Total	Rolling Hour	Pedestrian Crossings			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right			West	East	South	North
7:00 AM	0	0	34	1	0	1	67	1	0	3	0	1	0	4	1	11	124	697	0	0	0	0
7:15 AM	0	7	45	4	0	2	83	1	0	8	0	2	0	3	0	19	174	797	0	0	0	0
7:30 AM	0	3	48	4	0	5	73	1	0	10	0	2	0	7	1	21	175	851	0	0	0	0
7:45 AM	0	3	76	5	0	1	99	1	0	11	0	3	0	13	1	11	224	846	0	0	0	0
8:00 AM	0	8	67	4	0	5	107	3	0	8	2	3	0	7	2	8	224	777	0	0	0	0
8:15 AM	0	2	97	8	0	6	71	3	0	9	0	4	0	18	1	9	228		0	0	0	0
8:30 AM	0	2	43	3	1	5	88	5	0	6	0	1	0	5	0	11	170		0	0	0	0
8:45 AM	0	1	67	6	0	4	55	2	0	4	0	0	0	4	0	12	155		0	0	0	0
Count Total	0	26	477	35	1	29	643	17	0	59	2	16	0	61	6	102	1,474		0	0	0	0
Peak Hour	0	16	288	21	0	17	350	8	0	38	2	12	0	45	5	49	851		0	0	0	0

All Traffic Data Services Inc.

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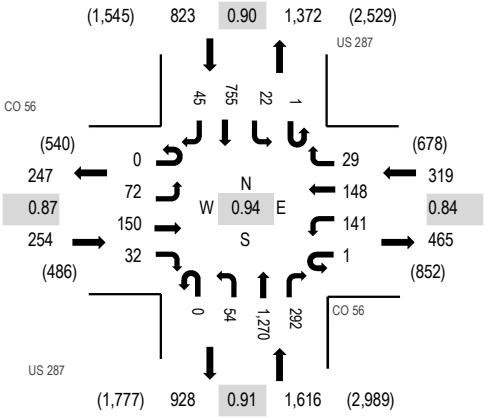
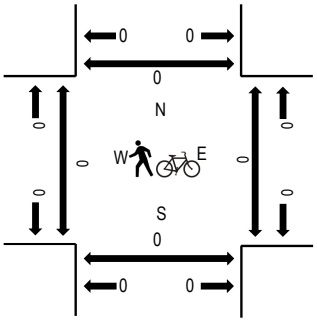
Location: 1 US 287 & CO 56 PM
Date: Tuesday, October 15, 2019
Peak Hour: 04:45 PM - 05:45 PM
Peak 15-Minutes: 05:15 PM - 05:30 PM

Peak Hour - All Vehicles



Note: Total study counts contained in parentheses.

Peak Hour - Pedestrians/Bicycles on Crosswalk



Traffic Counts

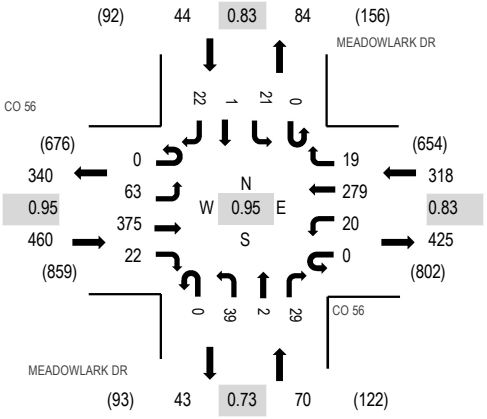
Interval Start Time	CO 56 Eastbound				CO 56 Westbound				US 287 Northbound				US 287 Southbound				Total	Rolling Hour	Pedestrian Crossings			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right			West	East	South	North
4:00 PM	0	11	33	5	0	44	56	8	0	18	262	54	0	5	140	8	644	2,709	0	0	0	0
4:15 PM	0	21	40	8	0	43	35	5	0	18	272	47	0	6	152	14	661	2,793	0	0	0	0
4:30 PM	0	12	26	8	0	47	44	5	0	17	274	59	0	4	187	13	696	2,930	0	0	0	0
4:45 PM	0	23	37	13	0	34	38	5	0	16	280	81	0	3	166	12	708	3,012	0	0	0	0
5:00 PM	0	15	42	7	0	33	36	9	0	13	295	65	0	11	190	12	728	2,989	0	0	0	0
5:15 PM	0	15	43	7	0	46	39	6	0	11	358	75	0	4	184	10	798		0	0	0	0
5:30 PM	0	19	28	5	1	28	35	9	0	14	337	71	1	4	215	11	778		0	0	0	0
5:45 PM	0	20	36	12	0	29	36	7	0	20	260	72	0	5	174	14	685		0	0	0	0
Count Total	0	136	285	65	1	304	319	54	0	127	2,338	524	1	42	1,408	94	5,698		0	0	0	0
Peak Hour	0	72	150	32	1	141	148	29	0	54	1,270	292	1	22	755	45	3,012		0	0	0	0

All Traffic Data Services Inc.

(303) 216-2439
www.alltrafficdata.net

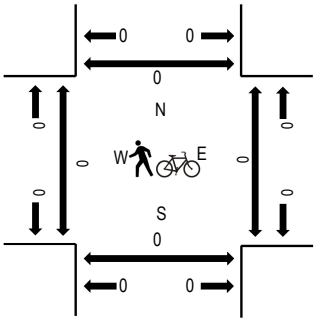
Location: 2 MEADOWLARK DR & CO 56 PM
Date: Tuesday, October 15, 2019
Peak Hour: 04:30 PM - 05:30 PM
Peak 15-Minutes: 05:00 PM - 05:15 PM

Peak Hour - All Vehicles



Note: Total study counts contained in parentheses.

Peak Hour - Pedestrians/Bicycles on Crosswalk



Traffic Counts

Interval Start Time	CO 56 Eastbound				CO 56 Westbound				MEADOWLARK DR Northbound				MEADOWLARK DR Southbound				Total	Rolling Hour	Pedestrian Crossings			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right			West	East	South	North
4:00 PM	1	10	77	6	0	4	94	6	0	5	0	7	0	10	0	4	224	847	0	0	0	0
4:15 PM	0	9	76	5	0	7	70	5	0	5	0	7	0	4	0	6	194	858	0	0	0	0
4:30 PM	0	10	78	4	0	5	83	4	0	9	0	5	0	5	0	4	207	892	0	0	0	0
4:45 PM	0	17	98	8	0	7	59	1	0	9	0	8	0	8	1	6	222	892	0	0	0	0
5:00 PM	0	20	97	6	0	5	67	8	0	15	0	9	0	3	0	5	235	880	0	0	0	0
5:15 PM	0	16	102	4	0	3	70	6	0	6	2	7	0	5	0	7	228		0	0	0	0
5:30 PM	0	9	83	7	0	6	70	4	0	4	4	5	0	6	1	8	207		0	0	0	0
5:45 PM	0	16	93	7	0	5	57	8	0	8	1	6	0	3	2	4	210		0	0	0	0
Count Total	1	107	704	47	0	42	570	42	0	61	7	54	0	44	4	44	1,727		0	0	0	0
Peak Hour	0	63	375	22	0	20	279	19	0	39	2	29	0	21	1	22	892		0	0	0	0

NCHRP 684 Internal Trip Capture Estimation Tool			
Project Name:	Gateway	**Organization:**	ATC
Project Location:	Berthoud	**Performed By:**	jmwa
Scenario Description:		**Date:**	10/14/2019
Analysis Year:	2024	**Checked By:**	
Analysis Period:	**AM Peak Hour**	**Date:**	

Table 1-A: Base Vehicle-Trip Generation Estimates (Single-Use Site Estimate)

Land Use	Development Data (*For Information Only*)			Estimated Vehicle-Trips[3]		
	ITE LUCs[1]	Quantity	Units	Total	Entering	Exiting
Office				0	0	0
Retail				337	190	148
Restaurant				159	87	72
Cinema/Entertainment				0	0	0
Residential				59	14	45
Hotel				0		
All Other Land Uses[2]				0	0	0
				555	291	265

Table 2-A: Mode Split and Vehicle Occupancy Estimates

Land Use	Entering Trips			Exiting Trips		
	Veh. Occ.[4]	% Transit	% Non-Motorized	Veh. Occ.[4]	% Transit	% Non-Motorized
Office	1.00	0%	5%	1.00	0%	5%
Retail	1.50	0%	5%	1.50	0%	5%
Restaurant	1.50	0%	5%	1.50	0%	5%
Cinema/Entertainment	1.50	0%	5%	1.50	0%	5%
Residential						
Hotel						
All Other Land Uses[2]	1.00			1.00		

Table 3-A: Average Land Use Interchange Distances (Feet Walking Distance)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						

Table 4-A: Internal Person-Trip Origin-Destination Matrix*

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	0		29	0	0	0
Restaurant	0	15		0	1	0
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	9	0		0
Hotel	0	0	0	0	0	

Table 5-A: Computations Summary

	Total	Entering	Exiting
All Person-Trips	805	430	375
Internal Capture Percentage	13%	13%	14%
External Vehicle-Trips[5]	459	243	216
External Transit-Trips[6]	0	0	0
External Non-Motorized Trips[6]	34	19	15

Table 6-A: Internal Trip Capture Percentages by Land Use

Land Use	Entering Trips	Exiting Trips
Office	N/A	N/A
Retail	5%	13%
Restaurant	29%	15%
Cinema/Entertainment	N/A	N/A
Residential	7%	20%
Hotel	N/A	N/A

[1]Land Use Codes (LUCs) from *Trip Generation Manual*, published by the Institute of Transportation Engineers.

[2]Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator.

[3]Enter trips assuming no transit or non-motorized trips (as assumed in ITE *Trip Generation Manual*).

[4]Enter vehicle occupancy assumed in Table 1-A vehicle trips. If vehicle occupancy changes for proposed mixed-use project, manual adjustments must be made to Tables 5-A, 9-A (O and D). Enter transit, non-motorized percentages that will result with proposed mixed-use project complete.

[5]Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-A.

[6]Person-Trips

*Indicates computation that has been rounded to the nearest whole number.

Estimation Tool Developed by the Texas A&M Transportation Institute - Version 2013.1

Project Name:	Gateway
Analysis Period:	**AM Street Peak Hour**

Table 7-A: Conversion of Vehicle-Trip Ends to Person-Trip Ends

Land Use	Table 7-A (D): Entering Trips			Table 7-A (O): Exiting Trips		
	Veh. Occ.	Vehicle-Trips	Person-Trips*	Veh. Occ.	Vehicle-Trips	Person-Trips*
Office	1.00	0	0	1.00	0	0
Retail	1.50	190	285	1.50	148	222
Restaurant	1.50	87	131	1.50	72	108
Cinema/Entertainment	1.50	0	0	1.50	0	0
Residential	1.00	14	14	1.00	45	45
Hotel	1.00	0	0	1.00	0	0

Table 8-A (O): Internal Person-Trip Origin-Destination Matrix (Computed at Origin)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	64		29	0	31	0
Restaurant	33	15		0	4	3
Cinema/Entertainment	0	0	0		0	0
Residential	1	0	9	0		0
Hotel	0	0	0	0	0	

Table 8-A (D): Internal Person-Trip Origin-Destination Matrix (Computed at Destination)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		91	30	0	0	0
Retail	0		66	0	0	0
Restaurant	0	23		0	1	0
Cinema/Entertainment	0	0	0		0	0
Residential	0	48	26	0		0
Hotel	0	11	8	0	0	

Table 9-A (D): Internal and External Trips Summary (Entering Trips)

Destination Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles[1]	Transit[2]	Non-Motorized[2]
Office	0	0	0	0	0	0
Retail	15	270	285	171	0	14
Restaurant	38	93	131	59	0	5
Cinema/Entertainment	0	0	0	0	0	0
Residential	1	13	14	13	0	0
Hotel	0	0	0	0	0	0
All Other Land Uses[3]	0	0	0	0	0	0

Table 9-A (O): Internal and External Trips Summary (Exiting Trips)

Origin Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles[1]	Transit[2]	Non-Motorized[2]
Office	0	0	0	0	0	0
Retail	29	193	222	122	0	10
Restaurant	16	92	108	58	0	5
Cinema/Entertainment	0	0	0	0	0	0
Residential	9	36	45	36	0	0
Hotel	0	0	0	0	0	0
All Other Land Uses[3]	0	0	0	0	0	0

[1]Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-A

[2]Person-Trips

[3]Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator

*Indicates computation that has been rounded to the nearest whole number.

NCHRP 684 Internal Trip Capture Estimation Tool			
Project Name:	Gateway	**Organization:**	ATC
Project Location:	Berthoud	**Performed By:**	JMWA
Scenario Description:		**Date:**	10/14/2019
Analysis Year:	2024	**Checked By:**	
Analysis Period:	**PM Street Peak Hour**	**Date:**	

Table 1-P: Base Vehicle-Trip Generation Estimates (Single-Use Site Estimate)

Land Use	Development Data (*For Information Only*)			Estimated Vehicle-Trips[3]		
	ITE LUCs[1]	Quantity	Units	Total	Entering	Exiting
Office				0	0	0
Retail				658	332	327
Restaurant				156	97	59
Cinema/Entertainment				0	0	0
Residential				72	45	27
Hotel				0		
All Other Land Uses[2]				0	0	0
				886	474	413

Table 2-P: Mode Split and Vehicle Occupancy Estimates

Land Use	Entering Trips			Exiting Trips		
	Veh. Occ.[4]	% Transit	% Non-Motorized	Veh. Occ.[4]	% Transit	% Non-Motorized
Office	1.00	0%	5%	1.00	0%	5%
Retail	1.50	0%	5%	1.50	0%	5%
Restaurant	1.50	0%	5%	1.50	0%	5%
Cinema/Entertainment	1.50	0%	0%	1.50	0%	0%
Residential						
Hotel						
All Other Land Uses[2]	1.00	1%	0%	1.00	1%	0%

Table 3-P: Average Land Use Interchange Distances (Feet Walking Distance)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		300	300		500	
Retail					500	
Restaurant					500	
Cinema/Entertainment					500	
Residential		500	500			
Hotel						

Table 4-P: Internal Person-Trip Origin-Destination Matrix*

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	0		42	0	21	0
Restaurant	0	36		0	7	0
Cinema/Entertainment	0	0	0		0	0
Residential	0	10	5	0		0
Hotel	0	0	0	0	0	

Table 5-P: Computations Summary

	Total	Entering	Exiting
All Person-Trips	1,296	689	607
Internal Capture Percentage	19%	18%	20%
External Vehicle-Trips[5]	678	366	312
External Transit-Trips[6]	0	0	0
External Non-Motorized Trips[6]	51	28	23

Table 6-P: Internal Trip Capture Percentages by Land Use

Land Use	Entering Trips	Exiting Trips
Office	N/A	N/A
Retail	9%	13%
Restaurant	32%	48%
Cinema/Entertainment	N/A	N/A
Residential	62%	56%
Hotel	N/A	N/A

[1]Land Use Codes (LUCs) from *Trip Generation Manual*, published by the Institute of Transportation Engineers.

[2]Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator.

[3]Enter trips assuming no transit or non-motorized trips (as assumed in ITE *Trip Generation Manual*).

[4]Enter vehicle occupancy assumed in Table 1-P vehicle trips. If vehicle occupancy changes for proposed mixed-use project, manual adjustments must be

[5]Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-P.

[6]Person-Trips

*Indicates computation that has been rounded to the nearest whole number.

Estimation Tool Developed by the Texas A&M Transportation Institute - Version 2013.1

Project Name:	Gateway
Analysis Period:	**PM Street Peak Hour**

Table 7-P: Conversion of Vehicle-Trip Ends to Person-Trip Ends

Land Use	Table 7-P (D): Entering Trips			Table 7-P (O): Exiting Trips		
	Veh. Occ.	Vehicle-Trips	Person-Trips*	Veh. Occ.	Vehicle-Trips	Person-Trips*
Office	1.00	0	0	1.00	0	0
Retail	1.50	332	498	1.50	327	491
Restaurant	1.50	97	146	1.50	59	89
Cinema/Entertainment	1.50	0	0	1.50	0	0
Residential	1.00	45	45	1.00	27	27
Hotel	1.00	0	0	1.00	0	0

Table 8-P (O): Internal Person-Trip Origin-Destination Matrix (Computed at Origin)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	10		142	20	128	25
Restaurant	3	36		7	16	6
Cinema/Entertainment	0	0	0		0	0
Residential	1	10	5	0		1
Hotel	0	0	0	0	0	

Table 8-P (D): Internal Person-Trip Origin-Destination Matrix (Computed at Destination)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		39	3	0	2	0
Retail	0		42	0	21	0
Restaurant	0	249		0	7	0
Cinema/Entertainment	0	20	4		2	0
Residential	0	45	19	0		0
Hotel	0	10	7	0	0	

Table 9-P (D): Internal and External Trips Summary (Entering Trips)

Destination Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles[1]	Transit[2]	Non-Motorized[2]
Office	0	0	0	0	0	0
Retail	46	452	498	286	0	23
Restaurant	47	99	146	63	0	5
Cinema/Entertainment	0	0	0	0	0	0
Residential	28	17	45	17	0	0
Hotel	0	0	0	0	0	0
All Other Land Uses[3]	0	0	0	0	0	0

Table 9-P (O): Internal and External Trips Summary (Exiting Trips)

Origin Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles[1]	Transit[2]	Non-Motorized[2]
Office	0	0	0	0	0	0
Retail	63	428	491	271	0	21
Restaurant	43	46	89	29	0	2
Cinema/Entertainment	0	0	0	0	0	0
Residential	15	12	27	12	0	0
Hotel	0	0	0	0	0	0
All Other Land Uses[3]	0	0	0	0	0	0

[1]Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-P

[2]Person-Trips

[3]Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator

*Indicates computation that has been rounded to the nearest whole number.

Table 7.1a Adjusted Internal Trip Capture Rates for Trip Origins within a Multi-Use Development			
Land Use Pairs		Weekday	
		AM Peak Hour	PM Peak Hour
From OFFICE	To Office	0.0%	0.0%
	To Retail	28.0%	19.4%
	To Restaurant	63.0%	3.9%
	To Cinema/Entertainment	0.0%	0.0%
	To Residential	1.0%	2.0%
	To Hotel	0.0%	0.0%
From RETAIL	To Office	29.0%	2.0%
	To Retail	0.0%	0.0%
	To Restaurant	13.0%	29.0%
	To Cinema/Entertainment	0.0%	4.0%
	To Residential	14.0%	26.0%
	To Hotel	0.0%	5.0%
From RESTAURANT	To Office	31.0%	3.0%
	To Retail	14.0%	41.0%
	To Restaurant	0.0%	0.0%
	To Cinema/Entertainment	0.0%	8.0%
	To Residential	4.0%	18.0%
	To Hotel	3.0%	7.0%
From CINEMA/ENTERTAINMENT	To Office	0.0%	2.0%
	To Retail	0.0%	21.0%
	To Restaurant	0.0%	31.0%
	To Cinema/Entertainment	0.0%	0.0%
	To Residential	0.0%	8.0%
	To Hotel	0.0%	2.0%
From RESIDENTIAL	To Office	2.0%	4.0%
	To Retail	1.0%	38.2%
	To Restaurant	20.0%	19.1%
	To Cinema/Entertainment	0.0%	0.0%
	To Residential	0.0%	0.0%
	To Hotel	0.0%	3.0%
From HOTEL	To Office	75.0%	0.0%
	To Retail	14.0%	16.0%
	To Restaurant	9.0%	68.0%
	To Cinema/Entertainment	0.0%	0.0%
	To Residential	0.0%	2.0%
	To Hotel	0.0%	0.0%

Table 7.2a Adjusted Internal Trip Capture Rates for Trip Destinations within a Multi-Use Development			
Land Use Pairs		Weekday	
		AM Peak Hour	PM Peak Hour
To OFFICE	From Office	0.0%	0.0%
	From Retail	4.0%	31.0%
	From Restaurant	14.0%	30.0%
	From Cinema/Entertainment	0.0%	6.0%
	From Residential	3.0%	57.0%
	From Hotel	3.0%	0.0%
To RETAIL	From Office	32.0%	7.8%
	From Retail	0.0%	0.0%
	From Restaurant	8.0%	50.0%
	From Cinema/Entertainment	0.0%	4.0%
	From Residential	17.0%	9.1%
	From Hotel	4.0%	2.0%
To RESTAURANT	From Office	23.0%	1.9%
	From Retail	50.0%	29.0%
	From Restaurant	0.0%	0.0%
	From Cinema/Entertainment	0.0%	3.0%
	From Residential	20.0%	12.7%
	From Hotel	6.0%	5.0%
To CINEMA/ENTERTAINMENT	From Office	0.0%	1.0%
	From Retail	0.0%	26.0%
	From Restaurant	0.0%	32.0%
	From Cinema/Entertainment	0.0%	0.0%
	From Residential	0.0%	0.0%
	From Hotel	0.0%	0.0%
To RESIDENTIAL	From Office	0.0%	4.0%
	From Retail	2.0%	46.0%
	From Restaurant	5.0%	16.0%
	From Cinema/Entertainment	0.0%	4.0%
	From Residential	0.0%	0.0%
	From Hotel	0.0%	0.0%
To HOTEL	From Office	0.0%	0.0%
	From Retail	0.0%	17.0%
	From Restaurant	4.0%	71.0%
	From Cinema/Entertainment	0.0%	1.0%
	From Residential	0.0%	12.0%
	From Hotel	0.0%	0.0%

TOWN OF BERTHOUD

NOTICE OF A PUBLIC HEARING BEFORE THE TOWN OF BERTHOUD PLANNING COMMISSION TO CONSIDER A FINAL PLAT FOR THE WESTSIDE CROSSING DEVELOPMENT.

NOTICE IS HEREBY GIVEN that the Town of Berthoud Planning Commission will conduct a Public Hearing on March 14, 2024 commencing at 6:00 p.m. or as soon thereafter as the matter may come on for hearing, at the Berthoud Town Hall, 807 Mountain Avenue, Berthoud, Colorado, for the purpose of considering a Final Plat. The property is located at the Northeast corner of Mountain Avenue and Highway 287. Copies of the proposed submittal documents can be provided by emailing lauren.richardson@baselinecorp.com. Any person may appear at such hearing and present evidence upon this matter.

Dated this day of February 12, 2024

By: Lauren Richardson, Associate Planner

Published in the Berthoud Surveyor:

February 14, 2024