# BASIN 4100 AND DFA 0056

## OUTFALL SYSTEMS PLAN

September 2020

1525 Raleigh St., Suite 400
Denver, Colorado 80204

olsson

MHFD
MILE HIGH FLOOD DISTRICT

City of Thornton

ADAMS COUNTY
COLORADO

September 30, 2020

Mr. Dave Skuodas, PE, CFM
Project Manager
Mile High Flood District
2480 W. 26th Avenue, Suite 156B
Denver, CO 80211

**Re: Basin 4100 and DFA 0056 OSP**
**Agreement No. 17-08.07**
**Olsson Project No. 017-2321**

Dear Mr. Skuodas:

Olsson is pleased to submit the draft conceptual design report for Basin 4100 and DFA 0056. This report documents the baseline hydrology development process, existing conditions evaluation, alternatives analysis, and conceptual design of the plan selected by the project sponsors for Basin 4100 and DFA 0056. The conceptual design report was prepared with the cooperation of MHFD, the City of Thornton, and Adams County.

We appreciate the opportunity to work with you and the sponsors on this project.

Sincerely,

Deb Ohlinger, PE, CFM
Project Manager

Amy M. Gabor, PE, CFM, LEED® AP
Project Engineer

Hannah Pring, EI
Assistant Engineer

CC: Shea Thomas, MHFD
Jim Kaiser, City of Thornton
Rachelle Plas, City of Thornton
Russell Nelson, Adams County
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**ABBREVIATIONS INDEX**

Ave – Avenue
Blvd – Boulevard
BMP – Best Management Practice
CDOT – Colorado Department of Transportation
CMP – corrugated metal pipe
CUHP– Colorado Urban Hydrograph Procedure
DFA – Direct Flow Area
D/S – downstream
E – East
EGL – energy grade line
EPA – Environmental Protection Agency
EURV – excess urban runoff volume
EX – existing
FEMA – Federal Emergency Management Agency
FHAD – Flood Hazard Area Delineation
FIRM – Flood Insurance Rate Map
FTR – future
FHWA – Federal Highway Administration
HSG – hydrologic soils group
I/Imp. – Imperviousness
LCC – Lower Clear Creek Canal
LiDAR – light detection and ranging
MDP – Major Drainageway Plan
MHFD – Mile High Flood District
N – North
NLCD – National Land Cover Database
No. – Number
NOAA – National Oceanic and Atmospheric Administration
NRCS – Natural Resources Conservation Service
O&M – operations and maintenance
OSP – Outfall Systems Plan
Rd – Road
RCBC – reinforced concrete box culvert
RCP – reinforced concrete pipe
ROW – right-of-way
RTD – Regional Transportation District
RTD NMRL – RTD North Metro Rail Line commuter railroad; formerly the Union Pacific Railroad
S – South
SEO – State Engineer's Office
SSP – smooth steel pipe
St – Street
SWMM – Storm Water Management Model
UDFCD – Urban Drainage and Flood Control District
U/S – upstream
USACE – United States Army Corps of Engineers
USDCM – Urban Storm Drainage Criteria Manual
Thornton – City of Thornton
W – West
WQCV – water quality capture volume
WSE – water surface elevation
% – percent
ac – acre
AF/ac-ft – acre-feet
cfs – cubic feet per second
ft or ' – foot/feet
in or " – inch/inches
mi – mile

## EXECUTIVE SUMMARY

### Purpose and Objective

This report presents the Outfall Systems Plan (OSP) for Basin 4100 and Direct Flow Area (DFA) 0056. The OSP was co-sponsored by the Mile High Flood District (MHFD), the City of Thornton (Thornton), and Adams County.

The purpose of this study was to update the hydrology, develop alternatives to alleviate potential flooding, and complete a conceptual design of the plan selected by the project sponsors. The information from this study provides a guide for project sponsors to use for future construction projects for the entirety of Basin 4100 and DFA 0056. The watershed is mostly developed and the OSP will be used to identify and rectify potential flooding, drainage, channel stability and ecological hazards within Basin 4100 and DFA 0056, as well as provide guidance to the project sponsors for future outfall systems construction as the watershed continues to develop or redevelop.

### Planning Process

The effective hydrology of the Basin 4100 and DFA 0056 watersheds was completed for the *Basin 4100 and Direct Flow Area 0056 Outfall Systems Planning Study Preliminary Design Report* prepared by Kiowa Engineering Corporation in July 2002 (2002 OSP).

The baseline hydrology developed for this study represents an updated analysis using CUHP 2005, version 2.0.0 and EPA SWMM, version 5.1.012. Detailed information regarding the hydrologic modeling process is included in Section 3.0.

A kickoff meeting was held to discuss the project goals, hydrologic analysis, areas of concern, and potential alternatives with MHFD, Adams County, and Thornton. The meeting was held on August 28, 2017. A meeting was held on November 15, 2017 to discuss the sensitivity analysis of the detention basin modeling. A progress meeting was held January 29, 2018 to discuss review comments on the hydrologic analysis and focus items for the alternative analysis. A progress meeting was held on July 20, 2020 to discuss the conceptual design comments. Minutes from these meetings are included in Appendix A. Additional alternatives analysis comments are included in Appendix A. A public meeting was held on December 12, 2018 and was an open house format. The sign in sheet and comment form that was received are included in Appendix A.

The MDP was prepared with the cooperation of MHFD, City of Thornton, and Adams County. The representatives who were involved with this study are listed in Table ES-1.

***Table ES-1 – Project Participants***

| Name | Representing | Assignment |
|---|---|---|
| Dave Skuodas | MHFD | Project Manager |
| Brooke Seymour | MHFD | Project Sponsor |
| Jim Kaiser | City of Thornton | Project Sponsor |
| Matt Eberly | City of Thornton | Project Sponsor |
| Rachelle Plas | City of Thornton | Project Sponsor |
| Russell T. Nelson | Adams County | Project Sponsor |
| Marc Pedrucci | Adams County | Project Sponsor |
| Deb Ohlinger | Olsson | Project Manager |
| Amy Gabor | Olsson | Project Engineer |
| Hannah Pring | Olsson | Assistant Engineer |

### Project Area Description

**Watershed and Drainageway Description**

The Basin 4100 watershed encompasses approximately 2.3 square miles, as shown in Figure ES-1. The watershed boundaries are generally 100th Avenue on the north, 88th Avenue on the south, Washington Street at its westernmost point, and the South Platte River at the southeast limit. Basin 4100 is approximately 2.1 miles long and 1.3 miles wide and is located completely in the city of Thornton, as shown in Figure 1.

DFA 0056 encompasses approximately 2.5 square miles and is bound by the South Platte River along the southeast boundary. The Basin 4100 boundary serves as the western boundary, and the northernmost portion of the watershed is bound by 104th Avenue. DFA 0056 is approximately 1.1 miles wide, 2.6 miles long, and extends through Adams County and Thornton as shown in Figure ES-1.

Both watersheds generally slope down to the east toward the South Platte River, with flow path slopes ranging from 0.1 to 4 percent (%). The lowest and highest watershed elevations are 5045 and 5428, respectively.

**Reservoirs**

Five reservoirs are located at the eastern edge of the study area adjacent to the South Platte River on its west bank, all of which are in DFA 0056. Approximately a third of the study area flows into these reservoirs, which overflow into the South Platte River. No infrastructure is located downstream of the reservoirs other than the spillways between the reservoirs and the river.

**Irrigation Ditches**

The Colorado Agricultural Ditch and Lower Clear Creek Canal both flow through the study area. The Colorado Agricultural Ditch enters the study area at 88th Avenue and extends northeast across the watershed until it reaches the northern watershed border. The School Tributary presently flows into the Colorado Agricultural Ditch near 88th Avenue. Tributary B also flows into the Colorado Agricultural Ditch north of Aspen Drive on the east side of Welby Road. The Lower Clear Creek Canal crosses the Basin 4100 drainageway between 88th Avenue and the northern watershed boundary.

**Planned Construction**

Two residential developments, "River Valley Village" and "Cherrylane," north and south, respectively, of Thornton Parkway between Colorado Boulevard and Riverdale Road, were under construction during the development of this study. River Valley Village drains to a detention basin northwest of Thornton Parkway and Riverdale Road, which becomes the beginning of Tributary J. Cherrylane has its own detention basin, which discharges to the storm drain system out of the River Valley Village basin. Construction of ballfields in Subbasin 51 as part of the Riverdale Ballfields project. Construction had not been completed at the time the hydrology was developed, however, the future percent imperviousness calculated for the Riverdale Ballfields project was used for the future conditions for Subbasin 51. Future land use and zoning were taken into account for potential future development, which is reflected in the future conditions' hydrology.

**Alternatives Analysis**

After completing a hydraulic analysis of the existing drainage systems and discussing the goals of the alternative analysis, the alternative development process began. The primary goals of the alternative analysis were to increase conveyance capacity to reduce road overtopping, protect habitable structures from flooding, reduce erosion potential, and enhance water quality. Each alternative was first evaluated based on site constraints, feasibility, and constructability. From the alternatives that passed this first screening process, the recommended alternative was determined based on benefits, cost, including land acquisition and maintenance costs, and environmental impacts.

The main alternatives that were considered for this analysis include: maintaining the status quo, floodplain preservation with channel stabilization, channel improvements, structure improvements to meet criteria, detention, and storm drain system improvements. Floodplain preservation is the preferred alternative; therefore, constructing a defined channel was only evaluated where there was substantial benefit.

**Recommended Plan**

The Recommended Plan was chosen based on a combination of quantitative and qualitative measurements. The Recommended Plan consists of:

**Drainageway 4100-1**

- Maintaining status quo outside of recommended improvement areas
- All channel stabilization improvements
- All structure improvements

**Drainageway 4100-2**

- Maintaining status quo outside of recommended improvement areas
- All channel stabilization improvements
- Structure improvements at Structures J and L
- Storm drain system improvements at Structure K
- All detention improvements

**School Tributary**

- Maintaining status quo outside of recommended improvement areas
- All storm drain system improvements (developer to construct open channels for local flow)
- All detention improvements

**B Tributary**

- Maintaining status quo outside of recommended improvement areas
- All storm drain system improvements

**D Tributary**

- Maintaining status quo outside of recommended improvement areas
- All storm drain system improvements

**West G Tributary**

- Maintaining status quo outside of recommended improvement areas
- All channel stabilization improvements
- All storm drain system improvements - a detailed analysis of the storm drain and street system should be completed in this area when the site south of Thornton Parkway is developed.

**North G Tributary**

- Maintaining status quo
- A detailed analysis of the storm drain and street system should be completed in this area when the site south of Thornton Parkway is developed.

**H Tributary**

- Maintaining status quo - the pipe-full capacity calculations for H Tributary show that the existing storm drain system under 96th Place does not have 100-year capacity, which would result in flows overtopping between the houses. However, the capacity is close to the future 100-year storm event and this section of the storm drain system serves as a detention basin outlet. The detention basin was not included in the model. There are no known reports of flooding in this area. This section of storm drain system may have adequate capacity for detained peak flows.

**J Tributary**

- Maintaining status quo outside of recommended improvement areas
- All structure improvements

**North K Tributary**
- Maintaining status quo outside of recommended improvement areas
- All channel conveyance improvements
- All storm drain system improvements

**South K Tributary**
- Maintaining status quo outside of recommended improvement areas

**Colorado Boulevard**
- Maintaining status quo outside of recommended improvement areas
- All channel conveyance improvements
- All structure improvements
- All storm drain system improvements

**Thornton Parkway Tributary**
- Maintaining status quo

The main themes in the recommended plan were to provide sufficient capacity at crossings to eliminate overtopping, to bring existing storm drain and street systems into compliance with 100- year criteria and to improve overall reach stability.

**Conceptual Design**

The Selected Plan letter was issued by MHFD, on behalf of Adams County and the City of Thornton, on November 27, 2019, and is included in Appendix A. The Recommended Plan from the Alternatives Analysis, outlined in Section 5, was accepted for the Selected Plan, with the inclusion of two deviations which are described herein. The Selected Plan is intended to provide adequate protection while adhering to Adams County's, Thornton's, and MHFD's drainage criteria. The Selected Plan consists of the major (future conditions 100-year) storm conveyance improvements, including floodplain preservation, crossing structure improvements, channel improvements, regional detention, and storm drain system improvements. Several changes to the recommended plan were implemented during the conceptual design phase. These changes included:

- Reduce the size of the Subbasin 316's emergency spillway for the RTD NMRL embankment crossing. Thornton retained Olsson under a separate contract to complete a final design of the overflow structure during the development of the conceptual design. Olsson's final design is shown in this conceptual design.

- The Drainageway 4100 old Riverdale Road crossing design was updated to include a non-levee feature berm to allow for smaller flows to maximize head at the existing crossing location, with higher flows engaging the spillway of the berm, and an additional crossing structure that outlets directly to the South Platte River that provides a combined 100-year storm event capacity. This change from the alternatives analysis was directed by the sponsors after the Selected Plan letter was issued.

- Thornton provided new survey of the trail crossing at the Colorado Agricultural Ditch that showed that the crossing consisted of two 24-inch RCPs, not the two 18-inch RCPs that were used in the previous analysis. All report sections except the alternatives analysis were updated with the updated pipe size.

- The Drainageway 4100 and West G Tributary recommended check structure were replaced with drop structures and channel grading.

- Along School Tributary, detention will be implemented on the east side of the RTD NMRL embankment due to cited utility conflicts on the west side of the embankment.

- Remove the J Tributary crossing structure recommendation where the trail was recently installed.

- During the conceptual design phase, adjustments were made based on progressing the design to a more detailed level than the alternatives analysis. The most significant changes are on North K Tributary, where the structure and channel design had to be modified based on the higher channel invert that would be needed to tie into the 2-year diversion storm drain system.

The Selected Plan is intended to provide adequate protection while adhering to City of Thornton's, Adams County's, and MHFD's drainage criteria. The Selected Plan consists of the major (future conditions 100-year) storm conveyance improvements, including floodplain preservation, crossing, and channel improvements. The total construction cost of the master plan improvements is $27.8 million, or $41.9 million including maintenance over 50 years. A summary of the Selected Plan improvements and their associated costs by reach and jurisdiction is shown in Table ES-2. The Selected Plan improvements are shown on Figure ES-1.

**Prioritization and Phasing**

In general, the conveyance improvements may be completed at any time. Ideally, structure and channel improvements would be implemented downstream to upstream. However. the reality of the phasing within Basin 4100 and DFA 0056 will be that Thornton and Adams County will construct improvements as funding permits and that will provide the greatest benefits to the citizens.

In general, it is suggested that the recommended plan be implemented from downstream to upstream within each tributary area. However, the improvements can be implemented in a different order, if desired. Following is a more detailed recommendation of phasing and prioritization:

- Crossing structures should be installed first to increase public safety and emergency access
- The Drainageway 4100-1 channel stabilization improvements are a higher priority to prevent the channel from threatening private properties.
- Once the full School Tributary basin is connected to Colorado Boulevard, the likelihood of overtopping the old roadway berm is significantly increased; therefore, the Basin 4100 outfall improvements at old Riverdale Road should be built prior to, or concurrently, with developer constructed School Tributary improvements.
- The drop structures in Drainageway 4100 and West G Tributary should be installed if the channels begin to show further signs of erosion. Low maintenance streams should be evaluated as an alternative to drop structures, if possible. In some areas, the available space for preferred low maintenance stream sections may be limited, due to some reaches being constrained by development.

- The improvements on North K Tributary should be implemented when funding is available to prevent flooding at 100th and McKay and to protect the reservoirs.
- Improvements along School Tributary should generally be implemented as development occurs.

The storm drain improvements are recommended to be installed as needed, based on flooding history and reports.

***Table ES-2 - Selected Plan Cost Summary***

| Reach | Jurisdiction | Description | Capital | Easement/ ROW | Engineering | Legal/ Admin | Contract Admin/CM | Contingency | Total Capital Cost | Annual O&M Cost | 50-Year O&M Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Drainageway 4100-1 | Thornton | Status Quo - Outside of recommended improvement areas<br>Channel Improvements - 9 drop structures, channel grading<br>Structure Improvements - Remove and replace culverts and old Riverdale Road (Structure A), construct berm (optional), remove and replace culverts at the Trail at Colorado Agricultural Ditch (Structure F) | $2,084,841 | $0 | $312,726 | $104,242 | $208,484 | $521,210 | $3,231,503 | $93,961 | $2,018,489 |
| Drainageway 4100-2 | Thornton | Status Quo - Outside of recommended improvement areas<br>Channel Improvements - 9 drop structures, replace failed drop structure, channel grading<br>Structure Improvements - Remove culvert and install Pedestrian Bridge at Community Park (Structure J), remove and replace culverts at Race Street (Structure L)<br>Storm Drain System Improvements - Install parallel pipe and manholes at Thornton Parkway (Structure K)<br>Detention - Install emergency overflow box at RTD NMRL | $3,857,430 | $0 | $578,614 | $192,872 | $385,743 | $964,358 | $5,979,017 | $252,146 | $5,416,656 |
| School Tributary | Thornton | Status Quo - Outside of recommended improvement areas<br>Structure Drain System Improvements - Remove existing structures at canal and old Welby Road, install pipe and manholes<br>Detention - Construct detention basin downstream of RTD NMRL | $2,634,769 | $0 | $395,215 | $131,738 | $263,477 | $658,692 | $4,083,891 | $28,050 | $602,571 |
| B Tributary | Thornton | Status Quo - Outside of recommended improvement areas<br>Storm Drain System Improvements - Install pipe and manholes | $891,573 | $0 | $133,736 | $44,579 | $89,157 | $222,893 | $1,381,938 | $4,978 | $106,936 |
| D Tributary | Thornton | Status Quo - Outside of recommended improvement areas<br>Storm Drain System Improvements - Remove and replace pipe (Pipe 3) | $86,228 | $0 | $12,934 | $4,311 | $8,623 | $21,557 | $133,653 | $7,224 | $155,187 |

***Table ES-2 - Selected Plan Cost Summary***

| Reach | Jurisdiction | Description | Capital | Easement/ ROW | Engineering | Legal/ Admin | Contract Admin/CM | Contingency | Total Capital Cost | Annual O&M Cost | 50-Year O&M Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| West G Tributary | Thornton | Status Quo - Outside of recommended improvement areas<br>Channel Improvements - 1 drop structure, channel grading<br>Storm Drain System Improvements - Remove and replace pipe and manholes (Pipes 5-8) | $1,471,813 | $0 | $220,772 | $73,591 | $147,181 | $367,953 | $2,281,310 | $72,603 | $1,559,666 |
| North G Tributary | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $63,980 | $1,374,436 |
| H Tributary | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,128 | $24,232 |
| J Tributary | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $32,145 | $690,545 |
| | Adams County | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $15,612 | $335,380 |
| North K Tributary | Thornton | Status Quo - Outside of recommended improvement areas | $3,390,111 | $0 | $508,517 | $169,506 | $339,011 | $847,528 | $5,254,673 | $36,380 | $781,511 |
| | Thornton | Channel Conveyance Improvements - Channel improvements, remove and replace crossings (Structures R and S, and Pipe 22) | | | | | | | | | |
| | Thornton | Storm Drain System Improvements - Install pipe and manholes | | | | | | | | | |
| South K Tributary | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $11,412 | $245,155 |
| Colorado Boulevard | Thornton | Status Quo - Outside of recommended improvement areas | $3,511,426 | $0 | $526,714 | $175,571 | $351,143 | $877,856 | $5,442,710 | $22,666 | $486,912 |
| | | Channel Conveyance Improvements - 1 drop structure, channel grading | | | | | | | | | |
| | | Structure Improvements - Remove and replace culvert at driveway (Structure T) | | | | | | | | | |
| | | Storm Drain System Improvements - Remove and replace pipe and manholes (Pipes 26-29) | | | | | | | | | |
| Thornton Parkway | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $12,604 | $270,763 |
| Total Thornton | Thornton | All Thornton Improvements | $17,928,191 | $0 | $2,689,228 | $896,410 | $1,792,819 | $4,482,047 | $27,788,695 | $639,277 | $13,733,059 |
| Total Adams County | Adams County | All Adams County Improvements | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $15,612 | $335,380 |
| Total | Thornton/ Adams County | All Improvements | $17,928,191 | $0 | $2,689,228 | $896,410 | $1,792,819 | $4,482,047 | $27,788,695 | $654,889 | $14,068,439 |

## Legend

- Existing Centerline
- Canals
- Roads
- Contours
- Basin Boundary
- Water Body
- Thornton City Boundary
- Special_Item_Area
- Adams County Boundary
- Sloping Drop Structure
- Manhole
- Modify Manhole
- DIVERSION STRUCTURE
- Emergency Overflow
- Pedestrian Bridge
- Wall
- Detention Facilities
- Channel Improvements

### Storm Drain/Culvert

- Box Culvert
- 30-Inch Diameter
- 36-Inch Diameter
- 42-Inch Diameter
- 48-Inch Diameter
- 60-Inch Diameter
- 66-Inch Diameter
- 72-Inch Diameter
- 84-Inch Diameter

N

0 300 600 1,200 Feet

INSTALL 48-INCH RCP

DIVERSION STRUCTURE

DRIVEWAY REPLACE EXISTING CULVERT WITH 12-FT X 4-FT RCBC

CHANNEL GRADING

DRIVEWAY REPLACE EXISTING CULVERT WITH 12-FT X 4-FT RCBC

CHANNEL GRADING

WALL

MCKAY ROAD REPLACE EXISTING 24-INCH CMP WITH 16-FT X 3-FT RCBC

CHANNEL GRADING

WEST SPRAT PLATTE LAKE

ADAMS COUNTY 88TH AVENUE OPEN SPACE

RACE STREET REPLACE EXISTING 24-INCH RCP WITH 60-INCH RCP

REPLACE 24-INCH RCP WITH 30-INCH RCP

CHANNEL GRADING

3.7-FT DROP STRUCTURE

3-FT DROP STRUCTURE

3-FT DROP STRUCTURE

3-FT DROP STRUCTURE

3-FT DROP STRUCTURE

3.1-FT DROP STRUCTURE

ADD PARALLEL 42-INCH RCP

1.2-FT DROP STRUCTURE

REPLACE 30-INCH RCP WITH 42-INCH RCP

MODIFY MANHOLE

REPLACE 36-INCH RCP WITH 42-INCH RCP

REMOVE AND REPLACE FAILED 6-FT DROP STRUCTURE

CHANNEL GRADING

TRAIL (1) 18-INCH CMP TO BE REMOVED AND REPLACED WITH 45-FT PEDESTRIAN BRIDGE

CHANNEL GRADING

3-FT DROP STRUCTURE

2.4-FT DROP STRUCTURE

TRAIL AT COLORADO AGRICULTURAL DITCH REMOVE (2) 24-INCH RCP AND REPLACE WITH (2) 36-INCH RCP, LOWERED

REPLACE 48-INCH RCP WITH 60-INCH RCP

REPLACE 48-INCH RCP WITH 66-INCH RCP

3-FT DROP STRUCTURE

CHANNEL GRADING

EMERGENCY OVERFLOW BOX

1-FT DROP STRUCTURE

CHANNEL GRADING

3-FT DROP STRUCTURE

3-FT DROP STRUCTURE

2.8-FT DROP STRUCTURE

3-FT DROP STRUCTURE

INSTALL 48-INCH RCP

CHANNEL GRADING

3.4-FT DROP STRUCTURE

REMOVE EXISTING (3) 38-INCH X 24-INCH HERCP
REMOVE EXISTING (2) 30-INCH HDPE

INSTALL 66-INCH RCP

INSTALL 84-INCH RCP

CONSTRUCT 3.7 AF DETENTION POND

INSTALL 84-INCH RCP CONNECT TO EXISTING STORM SYSTEM

REMOVE 18-INCH RCP

2-FT DROP STRUCTURE

2-FT DROP STRUCTURE

CHANNEL GRADING

REPLACE 42-INCH RCP WITH 42-INCH RCP, LOWERED 2-FT

INSTALL 30-INCH RCP PARALLEL TO EXISTING 42-INCH RCP

REPLACE 24-INCH RCP WITH 48-INCH RCP

REPLACE 30-INCH RCP WITH 60-INCH RCP

REPLACE 36-INCH RCP WITH 72-INCH RCP

OLD RIVERDALE ROAD REMOVE EXISTING (1) 84-INCH CMP REPLACE WITH (3) 8-FT X 6-FT RCBC

POTENTIAL BERM

INSTALL 48-INCH RCP SECONDARY CROSSING AT OLD RIVERDALE ROAD

(3) 2-FT DROP STRUCTURES

CHANNEL GRADING

CLICK TO TURN STREETS ON OR OFF

CLICK TO TURN AERIAL ON OR OFF

CLICK TO TURN TOPOGRAPHY ON OR OFF

| | | | |
|---|---|---|---|
| PROJECT: 017-2321<br>DRAWN BY: MD<br>DATE: 09/2020 | **MILE HIGH FLOOD DISTRICT**<br>**CITY OF THORNTON AND ADAMS COUNTY** | **BASIN 4100 AND DFA 0056**<br>**CONCEPTUAL DESIGN MAP** | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | FIGURE<br>ES-1 |

## 1.0 INTRODUCTION

### 1.1 Authorization

Olsson was retained to complete an Outfall Systems Plan (OSP) for Basin 4100 and Direct Flow Area (DFA) 0056. The OSP was co-sponsored by the Mile High Flood District (MHFD), the City of Thornton (Thornton), and Adams County. The Agreement Regarding Outfall Systems Planning of Basin 4100 and DFA 0056 (Agreement No. 17-08.07) was executed on August 4, 2017.

### 1.2 Purpose and Scope

The purpose of this study was to update the hydrology, develop alternatives to alleviate potential flooding, and complete a conceptual design of the plan selected by the project sponsors. The information from this study provides a guide for project sponsors to use for future construction projects for the entirety of Basin 4100 and DFA 0056. The watershed is mostly developed and the OSP will be used to identify and rectify potential flooding, drainage, channel stability and ecological hazards within Basin 4100 and DFA 0056, as well as provide guidance to the project sponsors for future outfall systems construction as the watershed continues to develop or redevelop. No modifications to the scope of this study were made by the project sponsors.

The following tasks were completed as part of the outfall systems plan:

- Collected existing outfall systems plan (OSP), development drainage studies, and drainage improvement as-built plans
- Solicited input from project sponsors
- Obtained base mapping, structure surveys, and GIS information from MHFD, Adams County, and Thornton.
- Obtained future land use mapping from Adams County and Thornton
- Determined subwatershed boundaries and parameters in accordance with MHFD criteria
- Developed existing and future (fully developed) conditions baseline hydrology using the Colorado Urban Hydrograph Procedure (CUHP) 2005, version 2.0.0 and the Environmental Protection Agency Stormwater Management Model (EPA SWMM) 5.1, version 5.1.012
- Conducted a sensitivity analysis of detention basins within the watershed
- Reconciled the hydrology with previous studies
- Identified problem areas
- Developed improvement alternatives and corresponding costs
- Completed a conceptual design of the alternatives selected by the project sponsors
- Mapped the master plan 100-year floodplain
- Completed this report

### 1.3 Planning Process

The effective hydrology of the Basin 4100 and DFA 0056 watersheds was completed for the *Basin 4100 and Direct Flow Area 0056 Outfall Systems Planning Study Preliminary Design Report* prepared by Kiowa Engineering Corporation in July 2002 (2002 OSP). The baseline hydrology developed for this study represents an updated analysis using CUHP 2005, version 2.0.0 and EPA SWMM, version 5.1.012. Detailed information regarding the hydrologic modeling process is included in Section 3.0.

A kickoff meeting was held to discuss the project goals, hydrologic analysis, areas of concern, and potential alternatives with MHFD, Adams County, and Thornton. The meeting was held on August 28, 2017. A meeting was held on November 15, 2017 to discuss the sensitivity analysis of the detention basin modeling. A progress meeting was held January 29, 2018 to discuss review comments on the hydrologic analysis and focus items for the alternative analysis. A progress meeting was held on July 20, 2020 to discuss the conceptual design comments. Minutes from these meetings are included in Appendix A. Additional alternatives analysis comments are included in Appendix A. A public meeting was held on December 12, 2018 and was an open house format. The sign in sheet and comment form that was received are included in Appendix A.

### 1.4 Mapping and Surveys

MHFD provided 1-foot (ft) interval 2014 LiDAR contour mapping, acquired by FEMA after the 2013 flood, for the entire Basin 4100 and DFA 0056 study limits. The LiDAR mapping was processed by DRCOG and published in 2014. The LiDAR mapping is referenced to the NAVD 88 vertical datum and the NAD 83 horizontal datum. Adams County and Thornton provided GIS files of parcels, street centerlines, zoning, storm drains, and sanitary sewer in the watershed. Select structure surveys were provided by Thornton for the alternative analysis.

### 1.5 Data Collection

Drainage studies, as-built plans and OSPs were collected from MHFD, Adams County, and Thornton. The Adams County, Colorado and Incorporated Areas Flood Insurance Rate Maps (FIRMs) were obtained from the Federal Emergency Management Agency (FEMA). The main studies and plans that were reviewed in the preparation of this report are shown in Table 1.

***Table 1 – Data Collected***

| Title | Date | Author |
|---|---|---|
| Basin 4100 and Direct Flow Area 0056: Outfall Systems Planning Study Preliminary Design Report | July 2002 | Kiowa Engineering Corporation |
| Basin 4100 Direct Flow Area 0056: Outfall Systems Planning | March 1986 | J.S. Griffith |
| 88th Avenue Open Space Master Plan | September 2016 | CDM Smith |
| North Metro Rail Line Project Area F- Drainage Report and Drainage Plans | April 2016 | Regional Rail Partners |
| Villages North Subdivision Filing No. 5 Pond 301 Construction Plans | September 2005 | Vision Land Consultants, Inc. |
| Final Drainage Report: Cherry Lane Subdivision | March 2012 | Jansen Strawn Consulting Engineers |
| As-Built Survey – River Valley Village | January 2003 | Acklam & Associates, Inc. |
| Railroad Crossing Analysis at 88th Avenue and Welby Road | February 2015 | Merrick & Company |
| Original Thornton at 88th Station Area Master Plan | January 2015 | Steer Davies Gleave |
| School Tributary from Colorado Boulevard to Welby Road | August 2017 | Merrick & Company |

### 1.6 Acknowledgements

The OSP was prepared with the cooperation of MHFD, Adams County, and Thornton. The representatives who were involved with this study are listed in Table 2.

***Table 2 – Project Participants***

| Name | Representing | Assignment |
|---|---|---|
| Dave Skuodas | MHFD | Project Manager |
| Brooke Seymour | MHFD | Project Sponsor |
| Jim Kaiser | City of Thornton | Project Sponsor |
| Matt Eberly | City of Thornton | Project Sponsor |
| Rachelle Plas | City of Thornton | Project Sponsor |
| Russell T. Nelson | Adams County | Project Sponsor |
| Marc Pedrucci | Adams County | Project Sponsor |
| Deb Ohlinger | Olsson | Project Manager |
| Amy Gabor | Olsson | Project Engineer |
| Hannah Pring | Olsson | Assistant Engineer |

## 2.0 STUDY AREA DESCRIPTION

### 2.1 Project Area

#### Watershed and Drainageway Description

The Basin 4100 watershed encompasses approximately 2.3 square miles, as shown in Figure 1. The watershed boundaries are generally 100th Avenue on the north, 88th Avenue on the south, Washington Street at its westernmost point, and the South Platte River at the southeast limit. Basin 4100 is approximately 2.1 miles long and 1.3 miles wide and is located completely in the city of Thornton, as shown in Figure 1.

DFA 0056 encompasses approximately 2.5 square miles and is bound by the South Platte River along the southeast boundary. The Basin 4100 boundary serves as the western boundary, and the northernmost portion of the watershed is bound by 104th Avenue. DFA 0056 is approximately 1.1 miles wide, 2.6 miles long, and extends through Adams County and Thornton as shown in Figure 1.

Both watersheds generally slope down to the east toward the South Platte River, with flow path slopes ranging from 0.1 to 4 percent (%). The lowest and highest watershed elevations are 5045 and 5428, respectively. The drainageway paths shown on Figure 1 represent the major storm event flow paths. In some areas, such as South K Tributary, minor storm events will flow along a different path. Additionally, Tributary B is intercepted by the Colorado Agricultural Canal. The flow path shown on Figure 1 represents the path flow would take in a major storm event, assuming the canal was full.

City of Thornton provided Olsson with *The EDR Aerial Photo Decade Package*, dated December 10, 2018, included in Appendix C. The package includes historic aerial imagery of the lower portion or Drainageway 4100.

#### Reservoirs

Five reservoirs are located at the eastern edge of the study area adjacent to the South Platte River on its west bank, all of which are in DFA 0056. Approximately a third of the study area flows into these reservoirs, which overflow into the South Platte River. No infrastructure is located downstream of the reservoirs other than the spillways between the reservoirs and the river.

#### Existing Regional Detention Basins

Seven regional detention basins located in the Basin 4100 watershed were included in the baseline hydrology. These detention basins are dispersed throughout the watershed and are labeled as detention basins 302, 316, 322, 326, 327, 329, and 331. No detention basins were included in the DFA 0056 baseline hydrology. More detailed hydrologic information is included in Section 3.4.

#### Irrigation Ditches

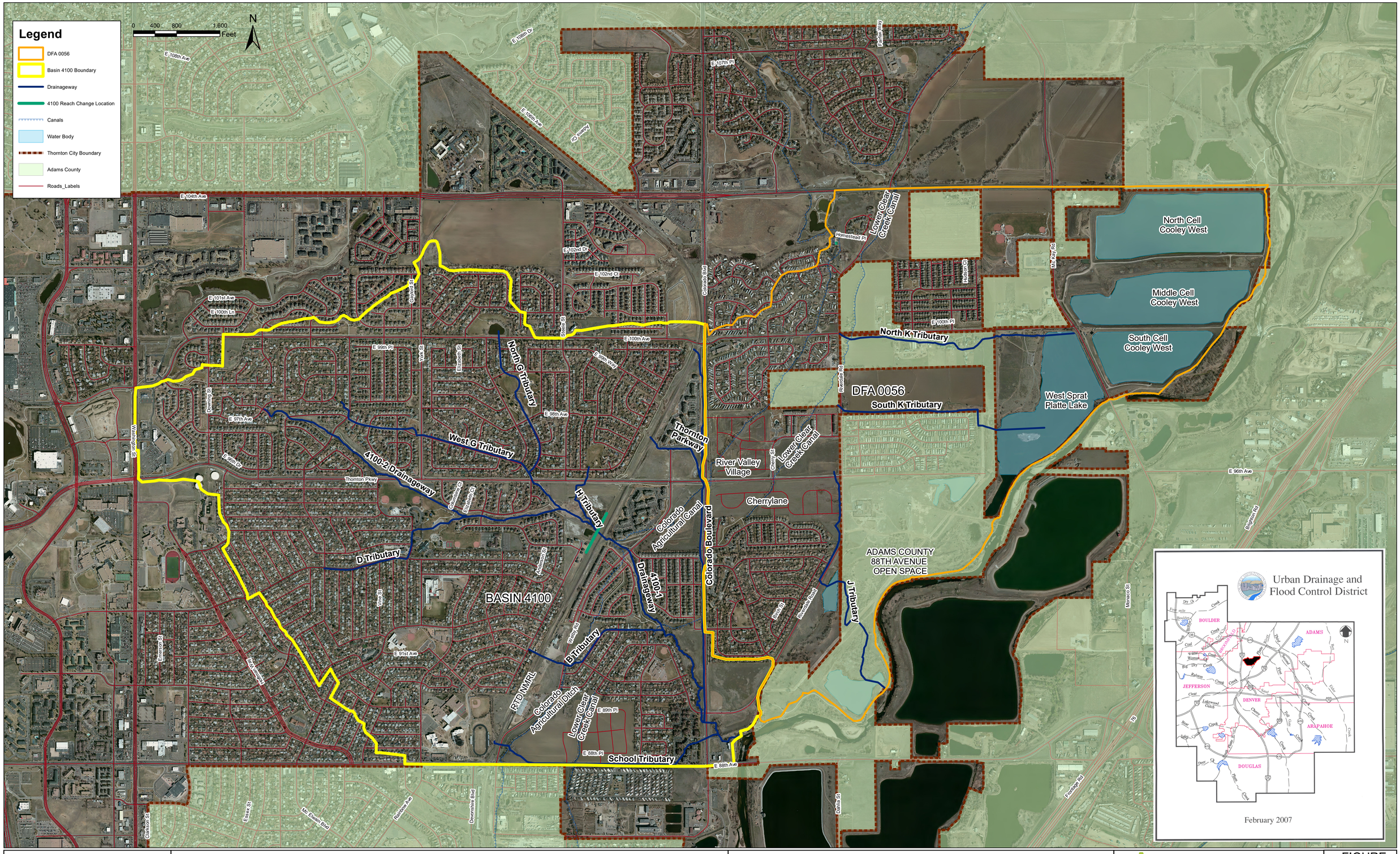
The Colorado Agricultural Ditch and Lower Clear Creek Canal both flow through the study area. The Colorado Agricultural Ditch enters the study area at 88th Avenue and extends northeast across the watershed until it reaches the northern watershed border. The School Tributary presently flows into the Colorado Agricultural Ditch near 88th Avenue. Tributary B also flows into the Colorado Agricultural Ditch north of Aspen Drive on the east side of Welby Road. The Lower Clear Creek Canal crosses the Basin 4100 drainageway between 88th Avenue and the northern watershed boundary.

#### Planned Construction

Two residential developments, “River Valley Village” and “Cherrylane,” north and south, respectively, of Thornton Parkway between Colorado Boulevard and Riverdale Road, were under construction during the development of this study. River Valley Village drains to a detention basin northwest of Thornton Parkway and Riverdale Road, which becomes the beginning of Tributary J. Cherrylane has its own detention basin, which discharges to the storm drain system out of the River Valley Village basin. Construction of ballfields in Subbasin 51 as part of the Riverdale Ballfields project. Construction had not been completed at the time the hydrology was developed, however, the future percent imperviousness calculated for the Riverdale Ballfields project was used for the future conditions for Subbasin 51. Future land use and zoning were taken into account for potential future development, which is reflected in the future conditions’ hydrology.

#### Soils

Soil types were determined using the Natural Resources Conservation Service (NRCS) Web Soil Survey. The soils in the watershed consist primarily of hydrologic soils groups (HSG) C and D, which are generally characterized by low infiltration rates, as defined by the NRCS. Significant areas of HSG A soils, which are generally characterized by high infiltration rates, are also present in the watershed. The soils map is included on Figure B-1 in Appendix B.




| | | | |
|---|---|---|---|
| PROJECT: 017-2321<br>DRAWN BY: HP<br>DATE: 09/2020 | **MILE HIGH FLOOD DISTRICT**<br>**ADAMS COUNTY AND CITY OF THORNTON** | **BASIN 4100 AND DFA 0056**<br>**STUDY AREA MAP** | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | FIGURE<br>1 |

## 2.2 Land Use

The watershed is mostly developed, with areas of land that remain undeveloped, primarily east of Riverdale Road. Existing development consists mostly of single-family residential, with some multi-family residential and mobile home developments. Pockets of industrial, commercial, and open space/recreational areas are also present. Existing land use was verified using aerial imagery and site visit observations.

Outside of the existing developed area, future land use will consist mostly of medium-density residential areas, low-density residential areas, urban reserve areas, and urban village areas, with pockets of commercial areas, institutional areas, and mixed-use areas. Future land use information was obtained from Thornton and Adams County zoning maps, included in Appendix B, and GIS information. Additional discussion of land uses and corresponding percent impervious values is included in Section 3.3.

## 2.3 Reach Descriptions

Basin 4100 and DFA 0056 were divided into 12 reaches, as shown in Figure 1. Table 3 summarizes the major crossing structure inventory for Basin 4100 and DFA 0056. The reaches also contain storm drain systems, which are summarized in Table 13. The existing channel conditions are described in more detail below. Tributary C previously flowed underneath the RTD NMRL near Yucca Way and continued along Welby Road. The crossing structure has since been abandoned, and what would have been Tributary C briefly flows along the west side of RTD NMRL and into Detention Basin 316.

***Table 3 – Major Structure Crossing Inventory***

| Reach | Juris-diction | Street Name | Street Class | Existing Structure | Width (ft) | Condition |
|---|---|---|---|---|---|---|
| **Drainageway 4100-1** | Thornton | Old Riverdale Road | n/a | (1) 84-inch CMP | 69 | Good |
| | Thornton | Colorado Boulevard | Principal Arterial | (2) 9-foot (S) x 5-foot (R) RCBC | 171 | Fair - 1 ft of sediment D/S, Dense vegetation U/S |
| | Thornton | Cypress Drive | Local | (2) 9-foot (S) x 5-foot (R) RCBC | 94 | Fair - Dense vegetation D/S, Partially blocked U/S with debris |
| | Thornton | Lower Clear Creek Canal | Agricultural Canal | (2) 84-inch RCP | 92 | Fair - 6 inches of sediment and signs of vegetation growth in bottom of culvert |
| | Thornton | Welby Road | Local | (2) 8-foot (S) x 6-foot (R) RCBC | 117 | Good - Clear with some vegetation encroachment |
| | Thornton | Trail at Colorado Agricultural Ditch | Trail | (2) 24-inch RCP | 78 | Good |
| **Drainageway 4100-2** | Thornton | RTD NML | Railroad | (2) 36-inch RCP | 189 | Good - Debris partially clogging trash rack. |
| | Thornton | Trail U/S of Pond 316 | Trail | (10) 18-inch HDPE | 25 | Fair - Dense Vegetation D/S and U/S |
| **School Tributary** | Thornton | Clayton Court | Local | (2) 8-foot (S) x 5-foot (R) RCBC | 107 | Fair - Dense Vegetation D/S and U/S |
| | Thornton | Trail to Community Park | Trail | (1) 18-inch CMP | 50 | Poor - Bottom of CMP Rusted out. Flows exiting out of holes in bottom of pipe. |
| | Thornton | Thornton Parkway | Minor Arterial | (1) 48-inch RCP | 1211 | Fair - Debris partially blocking D/S and U/S |
| | Thornton | Race Street | Local | (1) 24-inch RCP | 166 | Good |
| | Thornton | RTD NMRL | Railroad | (1) 84-inch RCP | 89 | Good |
| | Thornton | Old Welby Road | Local | (3) 38-inch x 24-inch HERCP | 43 | Unknown |
| | Thornton | Colorado Agricultural Ditch Trail | Trail | (2) 30-inch HDPE | 30 | Unknown |
| **B Tributary** | Thornton | Welby Road | Local | (1) 36-inch CMP | 58 | Unknown |
| | Thornton | Yucca Way to East of RTD NMRL | Easement and Railroad | (1) 36-inch RCP | 508 | Good |
| **D Tributary** | Thornton | Reach consists of storm drain and open channel. Storm drain information can be found in Table 13. | | | | |
| **West G Tributary** | Thornton | Reach consists of storm drain. Storm drain information can be found in Table 13 | | | | |
| **North G Tributary** | Thornton | Yorkborough Park Trail | Trail | (1) 24-inch RCP | 71 | Good |
| | Thornton | Reach consists of storm drain. Storm drain information can be found in Table 13. | | | | |
| **H Tributary** | Thornton | Reach consists of storm drain. Storm drain information can be found in Table 13. | | | | |
| **J Tributary** | Thornton | Reach consists of storm drain, detention basin outfalls, and open channel. Storm drain information can be found in Table 13. | | | | |
| **North K Tributary** | Thornton | Access Road | Unknown | Unknown (1) 36-inch RCP? | 79 | Unknown |
| | Thornton | Access Road | Unknown | Unknown (1) 36-inch RCP? | 61 | Unknown |
| **South K Tributary** | Thornton | Reach consists of storm drain and open channel. Storm drain information can be found in Table 13. | | | | |
| **Colorado Boulevard** | Thornton | Driveway | Driveway | (1) 42-inch RCP | 128 | Good |
| | Reach consists of storm drain. Storm drain information can be found in Table 13. | | | | | |
| **Thornton Parkway** | Thornton | Welby Road | Local | (1) 54-inch RCP | 92 | Good |

## Reach: 4100-1 (South Platte River to Downstream of RTD NMRL)

### Existing Conditions

From the confluence with the South Platte River to the downstream side of the Regional Transportation District North Metro Rail Line (RTD NMRL) crossing, Drainageway 4100 consists of a highly vegetated open channel with several crossings. Between the South Platte River confluence and the original Riverdale Road embankment is a short section of open channel with steep banks on one side and a wall on the other. A small detention area is located immediately upstream of the original Riverdale Road embankment at the confluence with School Tributary. Between Colorado Boulevard and Cypress Drive is a vegetated open channel that appears to be stable. Between Cypress Drive and the Lower Clear Creek Canal, the channel becomes more eroded, with areas of vertical banks. Upstream of the Lower Clear Creek Canal crossing, the channel appears to be mostly stable, despite the steep side slopes and a small, incised low flow channel.

Drainageway 4100 crosses under a pedestrian bridge right at the confluence with the South Platte River. Just upstream, an 84-inch corrugated metal pipe (CMP) outlets a small detention area, which was not included in the baseline hydrology, at the confluence of Drainageway 4100 and School Tributary. The 84-inch CMP outlet invert is several feet higher than the bottom of the channel, creating a waterfall-like effect for flows out of the detention basin. The invert cannot be lowered significantly without impacting a large water line as well as multiple other utilities. This crossing conveyed flows underneath the original Riverdale Road embankment, now a berm protecting a 36-inch water line. From the School Tributary confluence moving upstream, Drainageway 4100 crosses underneath Colorado Boulevard in two 9-foot span by 5-foot rise RCBCs, Cypress Drive in two 9-foot span by 5-foot rise RCBCs, Lower Clear Creek Canal and a pedestrian trail in two 84-inch RCPs, Welby Road in two 8-foot span by 6-foot RCBCs, and the trail at the Colorado Agricultural Ditch in two 24-inch RCPs. The Colorado Agricultural Ditch crosses Drainageway 4100 in a siphon upstream of the two 24-inch RCPs.

This reach is generally located in private property, with a large portion covered by easements. The large parcel between Colorado Blvd and just downstream of Lower Clear Creek Canal is on private property and has not yet been platted. When development of this parcel occurs, drainage easements and tracts for the floodplain will be dedicated to the City of Thornton. Near the Lower Clear Creek Canal crossing, the drainageway is on property owned by the Lower Clear Creek Canal. Upstream of Lower Clear Creek, tracts and easements are located along the drainageway corridor.

Photo 1: Reach 4100-1

### 2002 OSP Recommendations

The selected improvement plan for this reach included a grass-lined channel with select areas of bank stabilization and crossing structure improvements. A spillway was proposed downstream of the detention basin at the Drainageway 4100 and School Tributary confluence. Within the channel, several grouted-sloping boulder drop structures, and check structures were recommended, but have not been implemented. New crossing structures were recommended for Welby Road to provide 100-year capacity, as it is a minor arterial road. The Welby Road crossing was designed as two 8-foot wide by 5-foot high RCBCs. Two 8-foot wide by 6-foot high RCBCs have been constructed since the 2002 OSP. Crossings were recommended at both irrigation canals, the Lower Clear Creek Canal and the trail at the Colorado Agricultural Ditch, to prevent storm water from causing the ditches to spill. The crossings were recommended to be two 8-foot wide by 5-foot high RCBCs and three 7-foot wide by 5-foot high RCBCs, respectively, and have not been implemented.

## Reach: 4100–2 (Downstream of RTD NMRL to Upstream of Race Street)

### Existing Conditions

Drainageway 4100 crosses the RTD NMRL in two 36-inch RCPs, which serve as the Detention Basin 316 outlet. Upstream of Detention Basin 316, the drainageway continues as a vegetated open channel, crossing under a trail in ten 18-inch plastic pipes, Clayton Court in two 8-foot wide by 5-foot high RCBCs, and a pedestrian trail in one 18-inch CMP upstream of the confluence with D Tributary. The drainageway then continues upstream, passing underneath the Community Park and Thornton Parkway ballfields through a 48-inch RCP. Just upstream of the Thornton Parkway crossing, a large concrete and riprap drop structure exists. The existing drop structure has been undermined and water is flowing underneath the drop structure. Moving upstream, the channel continues as a densely vegetated channel, and crosses Race Street in a 24-inch RCP, which serves as the Detention Basin 331 outlet. Many areas along the drainageway in this reach contain an eroded low flow channel. This reach is generally located on City of Thornton property, with the floodplain encroaching slightly on private property in select areas.

Photo 2: Reach 4100-2

### 2002 OSP Recommendations

The improvements recommended for this reach were to maintain existing conditions, while constructing several check structures to stabilize the channel at an assumed 0.4% equilibrium. It was recommended that the crossing at Thornton Parkway have three 48-inch pipes. This recommendation has not been implemented. A monitoring program of this area would be needed to inspect embankment erosion after each large event. Race Street was recommended to have three 48-inch RCPs high in the embankment to carry high flows without overtopping the street, or to allow the overtopping. This recommendation has not been implemented. The plans for the RTD NMRL crossing were to formalize the detention and install a new outlet pipe. This recommendation has not been implemented as presented in the OSP, but the detention basin was formalized, and RTD reconstructed the culverts under the original railroad embankment as part of upgrading the line for NMRL service.

## Reach: School Tributary

### Existing Conditions

The School Tributary and Drainageway 4100 confluence is southeast of Riverdale Road and Colorado Boulevard. From downstream to upstream, flows are conveyed through an existing 84-inch storm drain system through the Catalina Apartments and a newly constructed line under 88th Avenue; daylighting west of Monroe Street. A temporary 72-inch flared end section was installed at the upstream end of the storm drain system. A temporary pipe extends under the Lower Clear Creek Canal and daylights into an ill-defined grass-lined channel that flows east along the north side of 88th Avenue. An 84-inch RCP has been placed under the relocated Welby Road for future use. Downstream of the railroad, the channel flows into the Colorado Agricultural Canal. When the capacity of the canal is exceeded, spills travel overland east to the relocated Welby Road. Any overflow from the relocated Welby Road would spill into the Lower Clear Creek Canal. Once the canal capacity is exceeded, flows will then continue east towards 88th Avenue, making this area susceptible to flooding. Detention Basin 302 represents inadvertent detention occurring upstream of the railroad. The flood storage area is located on Thornton property, while the outlet pipe is on RTD property. Upstream of the railroad, RTD will provide an adequate assurances letter that conveyance across the railroad will not be changed in the future. Near 88th avenue and York Street School Tributary consists of a vegetated swale at its upstream end and storm drain conveyance through the multiple school campus. This reach is generally located in right-of-way and private property. A lineal easement for storm sewer/open channel has been platted from the Colorado Agricultural Canal to the southeast corner of the undeveloped property, where the present stub out from 88th Avenue exists. An aerial easement from the canal to the RTD right-of-way was platted as a stormwater easement, in anticipation of constructing a detention basin upstream of the canal, as shown on the Welby Station plat.

Photo 3: School Tributary

### 2002 OSP Recommendations

Recommended improvements for School Tributary included creating a more defined, grass-lined channel, complete with grouted sloping boulder drop structures to achieve a 0.74% slope equilibrium. No grass-lined channels have been implemented according to the 2002 OSP, with the exception of the small channel to the west of the houses along Monroe Street. Crossing structures for Welby Road and the RTD NMRL were recommended to be two 66-inch RCPs and two 60-inch RCPs, respectively. An 84-inch RCP has been placed underneath Welby Road for future use. The RTD NMRL crossing was constructed as a single 84-inch RCP.

## Reach: B Tributary

### Existing Conditions

B Tributary discharges into the Colorado Agricultural Canal downstream of Welby Road. B Tributary crosses under Welby Road, a trucking company staging area, and the RTD NMRL to a custom inlet in Yucca Way southeast of the intersection of Roosevelt Avenue and Yucca Way, with a relatively short section of open channel between the crossings. The segment under the truck yard is CMP. The segment in the RTD NMRL right-of-way was replaced with a 36-inch RCP storm drain system. From the RTD right-of-way (ROW) to Yucca Way is 36-inch RCP. The design 100-year flows in the RTD NMRL plans match the 100-year peak flows in this study. The design plans are included in Appendix C. This reach is generally located in right-of-way.

Photo 4: Open Channel upstream of Welby Road

### 2002 OSP Recommendations

Recommendations included re-routing flows from the existing storm system that crosses under the RTD ROW to be completely within a storm drain system that would flow along Beachwood Drive and turning southeast to follow East 91st Avenue, until eventually outfalling into Drainageway 4100. These recommendations have not been implemented.

## Reach: D Tributary

### Existing Conditions

At D Tributary's confluence with Drainageway 4100, both channels are heavily vegetated with cattails. D Tributary exists as a densely vegetated open channel from the confluence to downstream of Community Park, where it outfalls from a 30-inch to 48-inch storm drain system. From downstream to upstream, the storm drain system is located underneath Community Park, along Gaylord Street, and along Eppinger Boulevard. This reach is located in right-of-way and City of Thornton property.

Photo 5: Reach 4100-2

### 2002 OSP Recommendations

According to the 2002 OSP, the existing storm drain does not carry the full 100-year event and the majority of the flow is carried overland. Recommendations included a flood berm along the northwest corner of 94th and Gaylord Street to protect existing houses from the overland flows. Channel stabilization in the form of check structures and protection for the existing storm drain outfall were also suggested. No improvements recommended in the 2002 OSP have been implemented.

## Reach: West G Tributary

### Existing Conditions

The West G Tributary and Drainageway 4100 confluence is located just upstream of Detention Basin 316. West G Tributary consists of an open, vegetated channel that crosses under a pedestrian trail downstream of Thornton Parkway. The channel is eroded and incised. Upstream of Thornton Parkway West G Tributary consists of a 24-inch to 48-inch storm drain system along 97th Avenue and then along York Street. Detention Basins 326, 327, and 329 are in the upper reaches of West G Tributary. The storm drain system is located in right-of-way, and the channel is located on City of Thornton property.

Photo 6: West G Tributary

### 2002 OSP Recommendations

No improvements were suggested to the existing storm drain system. The only improvements recommended were to implement low tailwater pipe protection at the outlet of the Thornton Parkway crossing, and to install several check structures to stabilize potential erosion. No improvements suggested in the 2002 OSP have been implemented.

## Reach: North G Tributary

### Existing Conditions

North G Tributary converges with West G Tributary at the downstream side of Thornton Parkway crossing. Both tributaries are within storm drain systems and flow parallel from the intersection of 97th Avenue and Fillmore Street until their confluence. North G Tributary is conveyed in a storm drain system along Fillmore Street downstream of Yorkborough Park. Through the southern portion of Yorkborough Park, flows are conveyed through Detention Basin 321S. The flows are conveyed underneath a pedestrian path in a 24-inch RCP to the northern portion of the park, Detention Basin 321N, which has flows conveyed through a low flow, concrete channel with grass overbanks. Upstream of Yorkborough Park, flows are conveyed in a storm drain system underneath Wigham Street and across 100th Avenue. Detention Basin 322 is located at the upstream reach limits of North G Tributary, upstream of 100th Avenue. This reach is located in right-of-way and City of Thornton property.

Photo 7: North G Tributary

### 2002 OSP Recommendations

No recommendations were made for this reach.

## Reach: H Tributary

### Existing Conditions

H Tributary consists of a storm drain system that crosses Thornton Parkway from an existing detention basin, which was not included in the baseline hydrology, to Detention Basin 316. This reach is located on City of Thornton property, with some pipe segments running through private property.

### 2002 OSP Recommendations

No recommendations were made for this reach.

## Reach: J Tributary

### Existing Conditions

J Tributary consists of detention basins, storm drain systems, and ill-defined channels. Flows are conveyed to the Adams County 88th Avenue Open Space. There are several areas along Riverdale Road where flows are intercepted and carried across the road in storm drain systems to the open space area. Flows in the Cherrylane and River Valley Village developments are detained and released to the south toward the open space. This reach is located in right-of-way and Adams County Open Space property.

Photo 8: J Tributary (Adams County 88th Avenue Open Space)

### 2002 OSP Recommendations

The previous recommendations for J Tributary included improving the Riverdale Road crossing to be three 48-inch RCPs. No improvements suggested in the 2002 OSP have been implemented.

## Reach: North K Tributary

### Existing Conditions

North K Tributary has historically been identified as flowing parallel to 100th Avenue. The channel is not defined along the whole reach, but some areas of vegetated roadside ditches exist. This reach is generally located in right-of-way and City of Thornton property.

Photo 9: North K Tributary

### 2002 OSP Recommendations

The recommendation for North K Tributary was to install a 100-year capacity storm drain of 42-inch RCP. The storm drain would extend from upstream of the RTD NMRL to a detention basin with a water quality pool adjacent to the West Sprat Platte Lake. No improvements suggested in the 2002 OSP have been implemented

## Reach: South K Tributary

### Existing Conditions

South K Tributary consists of a minor storm drain system and an undefined major event overflow path. The minor event flows will be conveyed to the South Platte River via a storm drain system along 96th Avenue, and then north along the east side of the North County Village mobile home development. Storm events that exceed the capacity of the storm drain system will flow to the east into West Sprat Platte Lake. Construction of ballfields recently occurred in Subbasin 51 as part of the Riverdale Ballfields project. This reach is located on City of Thornton property.

Photo 10: South K Tributary

### 2002 OSP Recommendations

South K Tributary was recommended to be a grass-lined channel, flowing adjacent to the North County Village, but flowing west to east along the south side of the mobile home development. Several drop structures were proposed within the channel before the channel transitioned into being a wetland channel. It was also proposed that a channel be constructed to convey stormwater from the detention basin to the South Platte River after crossing underneath the South Platte River Trail via three 54-inch culverts. No improvements suggested in the 2002 OSP have been implemented.

## Reach: Colorado Boulevard

### Existing Channel Conditions

Flows along Colorado Boulevard confluence with Drainageway 4100 near Cypress Road. South of Thornton Parkway, flows are conveyed along Colorado Boulevard via street flow and a storm drain system. Detention Basin 307 is located upstream of Thornton Parkway. Upstream of the detention basin, a 42-inch RCP is located under the driveway that leads to the Reserve at Thornton Apartments. Between the driveway and 100th Avenue, flows parallel Colorado Boulevard on the west and are conveyed in a combination of open, grass-lined channels and some storm drain pipes. The storm drain system is generally located in right-of-way and the crossing structures and channel are located on private property and are covered by easements.

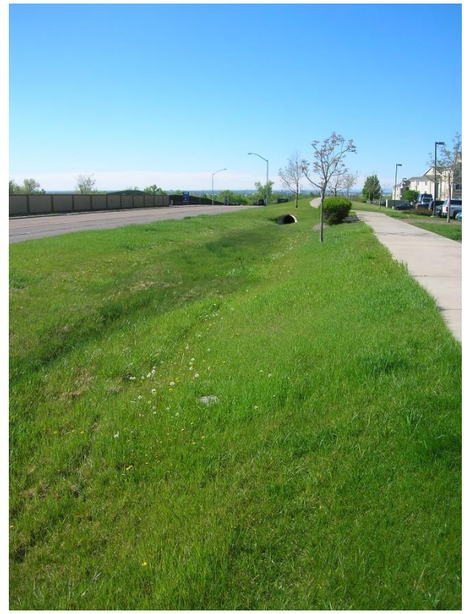


Photo 11: Channel west of Colorado Boulevard

### 2002 OSP Recommendations

No recommendations were made for this reach.

**Reach: Thornton Parkway**

**Existing Channel Conditions**

The Thornton Parkway and Colorado Boulevard drainageways converge at Detention Basin 307. Flows north of Thornton Parkway are conveyed in a vegetated open channel with several boulder drop structures. The channel has one 54-inch RCP crossing under Welby Road. This reach is located on private property.

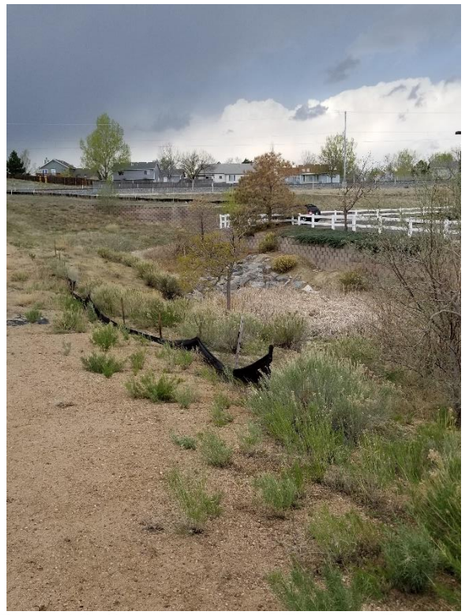


Photo 12: Channel north of Thornton Parkway

**2002 OSP Recommendations**

No recommendations were made for this reach.

## 2.4 Flood History

The FIRMs show three main FEMA-designated floodplains. Drainageway 4100 has a Zone AE floodplain from just upstream of Thornton Parkway to Colorado Boulevard and a Zone A floodplain between Colorado Boulevard and the South Platte River. The South Platte River floodplain extends into the study area with a Zone AE floodplain and a floodway. The FEMA FIRM panels are included in Appendix C. Two Letters of Map Revision (LOMRs) were completed along Basin 4100. In general, the FEMA floodplain is similar to the approximate 100-year floodplain in this study. Key differences are summarized below

- This study shows a 100-year spill onto 95th Avenue at the Community Park crossing, whereas the FEMA floodplain does not.

- This study shows the old Riverdale Road detention basin overtopping into the South Platte River, whereas the FEMA floodplain shows the Zone A floodplain contained in the detention basin.

The 2002 OSP estimated culvert capacities using FHWA methods, assuming entrance control, and identified undersized crossings. Channel improvements were also recommended along some reaches where conveyance was limited. In general, this study identified similar problem areas, included in Section 4, as those identified in the 2002 OSP, summarized in Section 2.3.

## 2.5 Environmental Assessment

Wetlands and riparian zones within the Basin 4100 and DFA 0056 watersheds primarily occur in areas of riverine, freshwater ponds, or lakes. Areas where there is increased urbanization, or a concrete channel will be less likely to have wetland qualities. The areas directly alongside the banks of Drainageway 4100 or any of its tributaries are likely to qualify as a wetland. This information was acquired through the U.S. Fish & Wildlife Service's National Wetlands Inventory. See Appendix D for the delineation of wetland areas for Basin 4100 and DFA 0056.

## 3.0 HYDROLOGIC ANALYSIS

### 3.1 Overview

Hydrology was developed for the baseline condition using existing infrastructure, for both existing and future (fully developed) land uses. Peak discharges for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year return period storms were analyzed using CUHP 2005, version 2.0.0, to generate hydrographs for each subwatershed. Hydrographs for the subwatersheds were routed using EPA SWMM, version 5.1.012, to determine peak discharge rates at select design points. The updated EPA SWMM results were compared to the 2002 OSP. The hydrology comparison is detailed in Section 3.6 and shown in Table 7.

### 3.2 Design Rainfall

One-hour rainfall depths from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 were input into CUHP 2005 to model the watershed hydrology for each storm event and are shown in Table 4. The watersheds are less than 5 square miles, so no area adjustment factors were necessary for any of the storm events. Tables of the unadjusted rainfall distributions for each storm event are included as Tables B-1, in Appendix B.

***Table 4 - One-Hour Point Rainfall (inches)***

| Duration | 2-Year | 5-Year | 10-Year | 25-Year | 50-Year | 100-Year | 500-Year |
|---|---|---|---|---|---|---|---|
| 1-Hour | 0.832 | 1.11 | 1.37 | 1.77 | 2.1 | 2.47 | 3.43 |

### 3.3 Subwatershed Characteristics

A summary of the CUHP 2005 model parameters can be found in Appendix B. LiDAR mapping, structure survey information, as-built drawings, and drainage studies were used to determine input parameters.

**Subwatershed Delineation**

The overall watershed boundary was delineated using LiDAR. The overall watershed boundary was checked for general agreement with the surrounding watershed boundaries.

The Basin 4100 and DFA 0056 watersheds were divided into 57 subwatersheds that were delineated based on the LiDAR mapping MHFD provided (Section 1.4), various drainage studies, and site observations. Subwatershed boundaries reflect the major storm event conditions and do not include minor storm drain systems. Major storm drain systems, including detention basin outlets, were included in the model. The subwatersheds range in size from 6.6 acres to 125.9 acres, with an average subwatershed size of 53.8 acres.

Pursuant to MHFD policy, Lower Clear Creek Canal and the Colorado Agricultural Ditch were assumed to be at full capacity for the baseline hydrology, meaning that stormwater runoff would flow over the canals. The path shown for Tributary B reflects this modeling approach, assuming the Colorado Agricultural Canal is full. The subwatersheds are shown on Figure B-1 in Appendix B.

**Length, Distance to Centroid, Slope**

The LiDAR data was used to determine subwatershed flow path lengths, distance to centroid values, and slopes. Flow paths were based on major drainage overland paths with some storm drain system detention basin outlets modeled. Private detention facilities and irrigation reservoirs were not included in the model. Where private detention basins and irrigation reservoirs were present, flow paths were determined based on the overflow path from the basins, assuming the outlets would be clogged.

Subwatersheds were generally delineated to avoid shapes with elongated tails and very narrow and long shapes, which can skew the results. To check these two scenarios, the following equations were used:

r = Length to Centroid / Total Length (if $0.1 \leq r < 0.3$, the subwatershed may have an elongated tail)
r = $Length^2$ / Area (if $r > 4$, the subwatershed may be very narrow and long)

If the r value of a subwatershed indicated that it may have an elongated tail, or be very narrow and long, it was checked. Many of the subwatersheds in question did not have an elongated tail and were not long and narrow in shape. The questionable r values were generally a result of the nature of the urbanized portion of the watershed. Flow paths were generally delineated following streets, which resulted in longer paths than a more direct, undeveloped path. The majority of subwatersheds with questionable r values had reasonable unit discharges, as compared to similar subwatersheds.

The Basin 4100 and DFA 0056 watersheds generally slope down toward the east and southeast. Subbasin flow path slopes ranged from 0.1 to 4 percent (%), averaging at 1.79%. The lowest and highest watershed elevations are 5045 and 5428, respectively. Slopes were estimated using the weighted slope equation from the CUHP manual.

$$((L_1S_1^{0.24}+\ldots+ L_nS_n^{0.24}) / (L_1 +\ldots+L_n))^{4.17}$$

All of the slopes were below 4%, and therefore no slope corrections were necessary.

**Watershed Imperviousness**

The existing and future land uses are discussed in Section 2.2. To determine the existing conditions percent imperviousness, the National Land Cover Database (NLCD) was used. Several changes to the NLCD information were made to determine the existing percent imperviousness:

- The NLCD 0% imperviousness value used for water was changed to 100%
- All 0% NLCD values that were not water were changed to 2%

After the aforementioned changes were made to the NLCD percent imperviousness values, the percent impervious values were spot checked for accuracy and were determined to be acceptable. The overall existing percent imperviousness of the watershed is 38.9%. The existing percent impervious values for each subbasin are shown on Figure B-1, in Appendix B.

To determine appropriate future land use percent imperviousness values in the undeveloped portions of the watershed, the zoning descriptions and MHFD's Urban Storm Drainage Criteria Manual (USDCM) Table 6-3 were used. The future land use areas are shown on Figure B-1, in Appendix B. The future land use designations and corresponding percent imperviousness values are shown in Table 5. The overall

future percent imperviousness of the watershed was estimated to be 46.4%. The future percent impervious values for each subbasin are shown on Figure B-1, in Appendix B.

***Table 5 – Land Uses and Corresponding Impervious Values***

| Land Use Plan | Land Use Designation from Corresponding Plan | Figure Destination | Percent Imperviousness |
|---|---|---|---|
| Thornton | Parks and Open Space | POS | 5 |
| Thornton | Residential Low | RL | 30 |
| N/A | Riverdale Ballfields[1] | RB | 32 |
| Thornton | Residential Medium | RM | 45 |
| Thornton | Institutional | I | 55 |
| Thornton | Urban Village | UV | 75 |
| Thornton | Mixed Use | MU | 75 |
| Thornton | Employment Center | EC | 75 |
| Thornton | Residential High | RH | 75 |
| Thornton | Urban Reserve | UR | 75 |
| Thornton | Commercial | C | 95 |

[1]The Riverdale Ballfields designed percent imperviousness was used for this study.

**Depression Losses**

Depression losses were determined using Table 6-6 in the USDCM. A weighted average was used for the depression losses in each subbasin, based on land use designation. A pervious depression loss of 0.35 inches, which represents lawns and grass, was used for the developed portions of the watershed, and a value of 0.4, which represents open fields, was used for the undeveloped portions of the watershed. An average of an impervious depression loss of 0.05, which represents sloped roofs, and 0.1, which represents large paved areas, was used for residential areas. A value of 0.1, which represents flat roofs and large paved areas, was used for commercial, office, and industrial areas.

**Infiltration**

Initial and final infiltration rates and Horton's decay rate were determined using Table 6-7 in the USDCM and are shown in Table 6. A weighted average of soil type was used to determine subwatershed rates. The hydrologic soil groups are shown on Figure B-1, in Appendix B.

***Table 6 - Horton's Equation Parameters***

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) | | Decay Coefficient |
|---|---|---|---|
| | Initial | Final | |
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

## 3.4 Detention

Pursuant to MHFD's policy to recognize only regional and publicly-owned facilities, all private detention basins, irrigation reservoirs, and inadvertent detention areas were generally not modeled, with some exceptions.

While some detention basins are privately owned, Thornton has maintenance easements over them, and several showed enough impact that they were accounted for in the baseline hydrology. A meeting on November 15, 2017 was held to discuss detention basin sensitivity in the watershed. Minutes for this meeting can be found in Appendix A. The sensitivity analysis consisted of several SWMM Models, adding in different combinations of detention basins that were included in the 2002 OSP to determine the impacts of each detention basin on the model. Detention Basins 302, 316, and 331 were the most influential, and were included in the final model. The area downstream of Detention Basin 331, between design points 130 to 120T, along 95th Avenue, 94th Drive and 94th Lane is prone to flooding. Detention Basins 326, 327, and 329 interact together and were determined to have a larger impact on peak flows and were included in the model. Detention Basin 307 is important in understanding the storm drain system capacities along Colorado Boulevard, and was therefore included in the model.

Detention Basin 302, recognized as an area of inadvertent detention, was modeled according to the stage-storage-discharge information that was provided by Merrick & Company McLaughlin Water Engineers in the memorandum: *Railroad Crossing Analysis at 88th Avenue and Welby Road* from February 20, 2015. The memorandum is included in Appendix B. The flood storage area is located on Thornton property, while the outlet pipe is on RTD property. RTD will provide an adequate assurances letter that conveyance across the railroad will not be changed in the future.

Detention Basin 316 was modeled according to the *Villages North Subdivision Filing No. 5 Pond 301 Construction Plans* by Vision Land Consulting, Inc. Stage-area-storage information was included in the plans and input into the model. Olsson developed stage-discharge using the MHFD Detention Basin spreadsheet, version 3.07, and the outlet structure details in these plans. The construction plans are included in Appendix B. RTD's plans for the North Metro Rail Line Project were also referenced to verify stage-discharge information.

The remaining detention basins that were included in the 2002 OSP, 307, 322, 326, 327, 329, and 331, were modeled using the storage-discharge information provided in the *Basin 4100 and Direct Flow Area 0056: Outfall Systems Planning Study Preliminary Design Report* from Kiowa Engineering Corporation, published in 2002. The storage information was checked using the MHFD Detention Basin Design Workbook, version 3.07, according to topography used in this study. It was found that the information from the OSP was reasonable; and therefore, the OSP values were used.

A total of five additional detention basins that were not included in the 2002 OSP were also incorporated into this study. Detention Basins 321N and 321S are located in series along North G Tributary in Yorkborough Park. Olsson developed stage-area information using LiDAR and stage-discharge using survey provided by the City of Thornton in the MHFD Detention Basin spreadsheet, version 3.07. Detention Basins 339 and 340 are located along J Tributary in the Cherrylane subdivision and the River Valley Village subdivision. Stage-area values for Detention Basin 339 were taken from the *Final Drainage Report: Cherry Lane Subdivision* and elevation 5090 added based on LiDAR area. Stage-area for Detention Basin 340 was developed using LiDAR. Stage-discharge for both detention basins was

calculated using as-built/design plans and UD-Detention, version 3.07. Excerpts from the plans and drainage reports are included in Appendix B.

A total of twelve detention basins were included in the baseline hydrology model. They were 302, 307, 316, 321N, 321S, 322, 326, 327, 329, 331, 339, and 340. The detention basin stage-storage-discharge information can be found in Table B-2 in Appendix B.

### 3.5 Hydrograph Routing

The parameters for the EPA SWMM model conveyance elements were determined using the LiDAR data, as-built drawings, and drainage reports. Some conveyance elements in the SWMM model contain multiple drop structures, steep culverts, and short, steep sections. The slope used for the conveyance element in the model reflects the actual slope of the ground between drop structures and not the calculated slope between two design points. To adjust the slope in the SWMM model, the drops were modeled in EPA SWMM as one large drop at the downstream end of the conveyance element.

Channel geometry was determined using the LiDAR mapping. For flows that are conveyed via streets, the street sections were models as trapezoidal sections with a 5-foot depth, 1-foot bottom width, and 20-foot horizontal to 1-foot vertical (20:1) side slopes. Overflow elements were added where they were needed to convey the full future 500-year storm event to ensure no inadvertent detention was being modeled at these locations. The locations that required overflow elements were downstream of Detention Basins 307, 326, 327, 329, and 339.

The Manning's n values for engineered conveyance elements, including pipe, street, and channels were increased 25 percent in accordance with the USDCM. Channel section Manning's n values were set at 0.045 in the model. Street section Manning's n values were set at 0.016, or 0.02 in the model. Concrete pipe Manning's n values were set at 0.015, or 0.01875 in the model. None of the streams provided more substantial attenuation, so USDCM Eq. 6-8 was not used to determine the Manning's n values.

The EPA SWMM 5.1 input parameters and 100-year future conditions output are included in Appendix B. EPA SWMM 5.1 model elements, including subwatersheds, design points and conveyance elements are shown on Figure B-1 and a schematic of the model is shown on Figures B-2 in Appendix B. Six flow diversions were included in analysis at nodes 106, 107O, 126O, 127O, 129O, and 139O, where the storm systems were modeled in addition to overland flows.

### 3.6 Previous Studies

Two previous studies of Basin 4100 and DFA 0056 have been completed: the 2002 OSP by Kiowa Engineering and the 1986 OSP by J.S. Griffith. A comparison of peak flows between this study and the 1986 OSP was not completed.

A comparison of 100-year peak flows from the 2002 OSP and this study is shown in Table 7. Differences and similarities between the 2002 OSP and this study are noted below.

- The 2002 OSP used CUHPF95 and UDSWM95, whereas this study used CUHP 2.0.0 and SWMM 5.1.012 for the baseline hydrology.
- The rainfall values used for the 2002 OSP were significantly higher than the NOAA Atlas 14 Point Precipitation Frequency Estimates used for this study. The 100-year 1-hour point rainfall depth in the 2002 OSP appears to be 2.7 inches, while the 100-year 1-hour point rainfall depth used in this study was 2.47 inches. Both studies used a 2-hour storm distribution.
- The 2002 OSP overall future percent imperviousness was 39.1%, which is lower than this study's future percent imperviousness of 46.4%. Percent impervious values for this study were developed using the National Land Cover Database, which could account for differences between the studies. Also, the previous study assigned an imperviousness of 2% to reservoirs with permanent pools within the watershed, whereas this study used 100%.
- The 2002 OSP overall watershed area of 3,008 acres is similar to the 3,065-acre watershed area in this study. The largest difference can be attributed to Subbasins 44 and 55 in this study, previously numbered as 38 and 42, respectively. Delineation was done using LiDAR data, and the differences in area were due to changes that have since been made in the watershed. A figure comparing the old study watershed and this study can be found in the January 29, 2018 meeting minutes, located in Appendix A.
- The 2002 OSP included 11 detention basins, whereas this study included 12, seven of which were included in the 2002 OSP and five which were not. Based on the detention basin sensitivity analysis, the detention basins that were in the previous study that were not included in this model did not have a significant impact on peak flows. Detention Basin 316, which was 2002 OSP Detention Basin 301, required supplemental stage-area-discharge information since it had been updated. Detention Basins 302, 321N, 321S, 339, and 340 were included in this model but were not included in the previous model.

The "EX Q100" and "FTR Q100" peak flows shown in Table 7 represent the baseline hydrology from this study, and include twelve detention basins, as discussed in section 3.4. See Table 7 for a comparison of results from the 2002 OSP to the updated hydrology.

***Table 7 – Previous Studies Hydrology Reconciliation***

| 2002 OSP | | | 2019 OSP | | | | | |
|---|---|---|---|---|---|---|---|---|
| Design Point | Reference Location | Peak Discharges (cfs) | Design Point | Peak Discharges (cfs) | | | % Diff (FTR Q100 to 2002 OSP Q100) | % Diff (2002 Rainfall FTR Q100 to 2002 OSP Q100) |
| | | QI00 | | EX Q100 | FTR Q100 | 2019 OSP with 2002 Rainfall FTR Q100 | | |
| 101T | Colorado Front Range Trail | 1540 | 100 | 1086 | 1288 | 1696 | -16% | 10% |
| 133 | School Tributary at Welby Road | 302 | 102 | 335 | 335 | 449 | 11% | 49% |
| 109 | Cypress Drive | 639 | 110T | 276 | 300 | 400 | -53% | -37% |
| 118 | Thornton Parkway and 97th Avenue | 755 | 120 | 390 | 391 | 610 | -48% | -19% |
| 117 | Southwest of Thornton Parkway and RTD NMRL Trail | 1387 | 120T | 987 | 1001 | 1511 | -28% | 9% |
| 125 | York Street and 100th Avenue | 87 | 124 | 68 | 68 | 90 | -22% | 4% |
| 121 | 97th Avenue and York Street | 216 | 124T | 148 | 151 | 297 | -30% | 38% |
| 126 | Russell Way and Eppinger Blvd. D Tributary | 149 | 136 | 30 | 30 | 40 | -80% | -73% |
| 147 | 93 1/2 Avenue and Riverdale Road | 658 | 138 | 90 | 129 | 239 | -80% | -64% |
| 149 | Thornton Parkway and Riverdale Road | 430 | 140 | 116 | 129 | 176 | -70% | -59% |
| 137 | Riverdale Road and 100th Avenue | 73 | 149 | 62 | 64 | 86 | -13% | 17% |

The updated hydrology generally resulted in lower peak discharges throughout the watershed. The differences are mostly due to the lower rainfall data that was used in the baseline hydrology. Design points on the western side of the watershed reflected different routing than what was portrayed in the 2002 OSP. The differences in model results are in line with trends of other watersheds and will need no calibration.

## 3.7 Results of Analysis

In general, the peak flows are lower than the 2002 OSP, as discussed in Section 3.6. The baseline peak discharges and volumes for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storm events for all the EPA SWMM 5.1 design points can be found in Tables B-3 and B-4, respectively, in Appendix B, and are also located in Tables 8 and 9. A summary of key peak flows and runoff volumes are listed in Tables B-5 through B-28, in Appendix B. The peak discharges versus channel station are shown in Figures B-3 through B-14. Select SWMM generated hydrographs are included as Figure B-15, in Appendix B.

***Table 8 – Baseline Peak Flows***

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| **Drainageway 4100** | | | | | | | | | | | | | | | | | | | | |
| 100 | --- | South Platte River | 1,691 | 2.6 | 0 | 0 | 128 | 218 | 332 | 634 | 827 | 1,086 | 1,666 | 213 | 330 | 462 | 805 | 1,016 | 1,288 | 1,881 |
| 104 | 204 | | 1,684 | 2.6 | 523 | 523 | 126 | 216 | 329 | 630 | 822 | 1,079 | 1,655 | 209 | 325 | 456 | 796 | 1,005 | 1,274 | 1,861 |
| 105 | 205 | | 1,333 | 2.1 | 514 | 1037 | 68 | 114 | 171 | 333 | 441 | 606 | 980 | 106 | 166 | 236 | 421 | 541 | 703 | 1,086 |
| 110T | 210T | | 1,077 | 1.7 | 2333 | 3370 | 43 | 69 | 100 | 170 | 218 | 276 | 415 | 52 | 81 | 114 | 188 | 239 | 300 | 448 |
| 114 | 214 | | 996 | 1.6 | 136 | 3506 | 17 | 38 | 72 | 135 | 151 | 167 | 218 | 22 | 40 | 75 | 137 | 153 | 168 | 216 |
| 115 | 215 | Welby Road | 988 | 1.5 | 1625 | 5131 | 19 | 37 | 71 | 134 | 149 | 163 | 209 | 24 | 40 | 74 | 135 | 150 | 165 | 206 |
| 116O | 216O | | 957 | 1.5 | 864 | 5995 | 13 | 37 | 71 | 134 | 147 | 162 | 187 | 14 | 40 | 74 | 135 | 147 | 162 | 187 |
| 116 | 216 | H Tributary Confluence | 957 | 1.5 | 0 | 5995 | 174 | 271 | 387 | 714 | 915 | 1,292 | 2,253 | 181 | 280 | 397 | 726 | 929 | 1,316 | 2,292 |
| 120T | 220T | | 733 | 1.1 | 636 | 6631 | 137 | 209 | 294 | 516 | 681 | 987 | 1,726 | 139 | 212 | 298 | 516 | 691 | 1,001 | 1,745 |
| 130T | 230T | D Tributary Confluence | 391 | 0.6 | 1799 | 8430 | 73 | 107 | 152 | 273 | 402 | 609 | 1,037 | 74 | 108 | 153 | 274 | 410 | 619 | 1,049 |
| 130 | 230 | | 269 | 0.4 | 0 | 8430 | 47 | 61 | 79 | 171 | 266 | 410 | 709 | 47 | 62 | 80 | 177 | 272 | 418 | 719 |
| 131O | 231O | | 149 | 0.2 | 3121 | 11551 | 31 | 38 | 40 | 108 | 170 | 275 | 476 | 32 | 39 | 40 | 112 | 175 | 283 | 486 |
| 131 | 231 | | 149 | 0.2 | 0 | 11551 | 56 | 81 | 114 | 200 | 259 | 332 | 504 | 59 | 86 | 119 | 206 | 265 | 340 | 514 |
| 132T | 232T | | 127 | 0.2 | 785 | 12336 | 52 | 76 | 106 | 183 | 235 | 299 | 450 | 55 | 80 | 112 | 189 | 241 | 307 | 459 |
| 132 | 232 | | 86 | 0.1 | 631 | 12967 | 35 | 52 | 76 | 129 | 166 | 210 | 317 | 39 | 57 | 81 | 135 | 173 | 219 | 330 |
| **School Tributary** | | | | | | | | | | | | | | | | | | | | |
| 101 | 201 | Colorado Boulevard | 317 | 0.5 | 0 | 0 | 57 | 98 | 151 | 280 | 358 | 453 | 617 | 99 | 149 | 203 | 344 | 425 | 523 | 717 |
| 102T | 202T | | 298 | 0.5 | 1337 | 1337 | 52 | 91 | 140 | 261 | 334 | 423 | 577 | 94 | 140 | 192 | 323 | 399 | 488 | 663 |
| 102O | 202O | RTD NMRL | 215 | 0.3 | 2852 | 4189 | 49 | 79 | 116 | 203 | 256 | 319 | 429 | 49 | 79 | 116 | 203 | 256 | 319 | 429 |
| 102 | 202 | | 215 | 0.3 | 0 | 4189 | 49 | 79 | 116 | 204 | 261 | 335 | 503 | 49 | 79 | 116 | 204 | 261 | 335 | 503 |
| **B Tributary** | | | | | | | | | | | | | | | | | | | | |
| 110T | 210T | Drainageway 4100 Confluence | 1077 | 1.7 | 0 | 0 | 43 | 69 | 100 | 170 | 218 | 276 | 415 | 52 | 81 | 114 | 188 | 239 | 300 | 448 |
| 110 | 210 | | 81 | 0.1 | 216 | 216 | 26 | 42 | 63 | 109 | 140 | 178 | 268 | 31 | 50 | 71 | 120 | 153 | 194 | 291 |
| 112T | 212T | | 40 | 0.1 | 450 | 666 | 14 | 23 | 34 | 59 | 77 | 97 | 147 | 15 | 24 | 35 | 61 | 78 | 100 | 150 |
| 113 | 213 | RTD NMRL | 33 | 0.1 | 2015 | 2681 | 14 | 22 | 33 | 54 | 70 | 89 | 134 | 14 | 22 | 33 | 54 | 70 | 89 | 134 |
| **D Tributary** | | | | | | | | | | | | | | | | | | | | |
| 130T | 230T | Drainageway 4100 Confluence | 391 | 0.6 | 0 | 0 | 73 | 107 | 152 | 273 | 402 | 609 | 1037 | 74 | 108 | 153 | 274 | 410 | 619 | 1049 |
| 134 | 234 | | 122 | 0.2 | 40 | 40 | 33 | 55 | 81 | 142 | 183 | 234 | 352 | 33 | 55 | 81 | 142 | 183 | 234 | 352 |
| 135T | 235T | | 63 | 0.1 | 1287 | 1327 | 21 | 33 | 48 | 81 | 103 | 131 | 196 | 21 | 33 | 48 | 81 | 103 | 131 | 196 |
| 136 | 236 | | 20 | 0.0 | 1834 | 3161 | 5 | 7 | 11 | 18 | 24 | 30 | 45 | 5 | 7 | 11 | 18 | 24 | 30 | 45 |
| **West G Tributary** | | | | | | | | | | | | | | | | | | | | |
| 120T | 220T | 4100 Drainageway Confluence | 733 | 1.1 | 0 | 0 | 137 | 209 | 294 | 516 | 681 | 987 | 1726 | 139 | 212 | 298 | 516 | 691 | 1001 | 1745 |
| 120 | 220 | | 343 | 0.5 | 0 | 0 | 73 | 110 | 146 | 249 | 308 | 390 | 706 | 74 | 112 | 148 | 249 | 308 | 391 | 713 |
| 123 | 223 | | 232 | 0.4 | 0 | 0 | 32 | 49 | 68 | 156 | 207 | 281 | 573 | 32 | 49 | 68 | 156 | 207 | 282 | 580 |
| 124T | 224T | | 135 | 0.2 | 2136 | 2136 | 11 | 17 | 24 | 74 | 100 | 148 | 354 | 11 | 17 | 25 | 74 | 101 | 151 | 361 |
| 126O | 226O | | 104 | 0.2 | 2226 | 4362 | 31 | 47 | 62 | 99 | 117 | 159 | 321 | 32 | 48 | 63 | 99 | 118 | 162 | 327 |
| 126 | 226 | York Street | 70 | 0.1 | 0 | 4362 | 22 | 34 | 47 | 78 | 110 | 152 | 303 | 23 | 36 | 48 | 78 | 111 | 159 | 312 |
| 128T | 228T | | 37 | 0.1 | 1446 | 5808 | 2 | 3 | 5 | 12 | 18 | 44 | 88 | 2 | 3 | 6 | 12 | 20 | 48 | 93 |
| 129O | 229O | | 30 | 0.0 | 1661 | 7469 | 8 | 14 | 20 | 25 | 30 | 52 | 90 | 9 | 15 | 21 | 26 | 32 | 56 | 94 |
| 129 | 229 | | 30 | 0.0 | 0 | 7469 | 9 | 14 | 21 | 37 | 48 | 61 | 92 | 10 | 16 | 23 | 40 | 51 | 64 | 96 |

***Table 8 – Baseline Peak Flows***

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| **North G Tributary** | | | | | | | | | | | | | | | | | | | | |
| 120 | 220 | West G Confluence | 343 | 0.5 | 0 | 0 | 73 | 110 | 146 | 249 | 308 | 390 | 706 | 74 | 112 | 148 | 249 | 308 | 391 | 713 |
| 121O | 221O | | 86 | 0.1 | 1215 | 1215 | 7 | 11 | 15 | 25 | 32 | 46 | 85 | 8 | 12 | 16 | 26 | 33 | 48 | 101 |
| 121 | 221 | Yorkborough Park | 86 | 0.1 | 0 | 1215 | 7 | 11 | 16 | 29 | 38 | 53 | 87 | 8 | 12 | 17 | 30 | 40 | 55 | 104 |
| 122O | 222O | | 58 | 0.1 | 1335 | 2550 | 5 | 8 | 12 | 20 | 26 | 32 | 64 | 6 | 9 | 13 | 22 | 27 | 33 | 75 |
| 122 | 226O | | 58 | 0.1 | 2226 | 4776 | 13 | 23 | 36 | 66 | 87 | 111 | 170 | 16 | 27 | 41 | 74 | 95 | 122 | 184 |
| **H Tributary** | | | | | | | | | | | | | | | | | | | | |
| 116 | 216 | 4100 Drainageway Confluence | 957 | 1.5 | 0 | 0 | 174 | 271 | 387 | 714 | 915 | 1292 | 2253 | 181 | 280 | 397 | 726 | 929 | 1316 | 2292 |
| 118T | 218T | | 56 | 0.1 | 583 | 583 | 12 | 18 | 23 | 47 | 64 | 88 | 143 | 12 | 18 | 23 | 47 | 64 | 88 | 143 |
| 118 | 218 | Thornton Parkway | 43 | 0.1 | 750 | 1333 | 9 | 14 | 19 | 39 | 53 | 72 | 117 | 9 | 14 | 19 | 39 | 53 | 72 | 117 |
| **J Tributary** | | | | | | | | | | | | | | | | | | | | |
| 137 | 237 | South Platte Confluence | 364 | 0.6 | 0 | 0 | 10 | 18 | 37 | 82 | 117 | 172 | 382 | 12 | 28 | 51 | 96 | 135 | 204 | 440 |
| 138T | 238T | | 252 | 0.4 | 1890 | 1890 | 13 | 23 | 37 | 85 | 114 | 149 | 331 | 14 | 31 | 54 | 96 | 127 | 194 | 386 |
| 138 | 238 | Riverdale Road | 215 | 0.3 | 1380 | 3270 | 9 | 16 | 24 | 44 | 57 | 90 | 259 | 9 | 16 | 24 | 45 | 68 | 129 | 299 |
| 139O | 239O | | 170 | 0.3 | 1916 | 5186 | 2 | 11 | 21 | 38 | 49 | 97 | 232 | 7 | 18 | 29 | 48 | 61 | 111 | 259 |
| 139 | 239 | | 170 | 0.3 | 0 | 5186 | 11 | 19 | 31 | 62 | 81 | 107 | 239 | 24 | 39 | 57 | 98 | 125 | 159 | 267 |
| 140O | 240O | Thornton Parkway | 93 | 0.1 | 1481 | 6667 | 9 | 13 | 15 | 18 | 30 | 83 | 167 | 11 | 13 | 16 | 19 | 45 | 98 | 184 |
| 140 | 240 | Thornton Parkway | 93 | 0.1 | 0 | 6667 | 11 | 20 | 34 | 67 | 88 | 116 | 179 | 13 | 24 | 39 | 75 | 99 | 129 | 199 |
| **North K Tributary** | | | | | | | | | | | | | | | | | | | | |
| 143 | 247 | Confluence with Reservoir | 263 | 0.4 | 0 | 0 | 13 | 29 | 58 | 134 | 187 | 263 | 428 | 56 | 92 | 137 | 251 | 328 | 433 | 668 |
| 143T | 248 | | 199 | 0.3 | 1725 | 1725 | 11 | 24 | 46 | 108 | 148 | 206 | 329 | 49 | 78 | 113 | 205 | 264 | 342 | 522 |
| 145 | 249 | | 109 | 0.2 | 2811 | 4536 | 14 | 26 | 44 | 87 | 115 | 152 | 235 | 48 | 73 | 101 | 164 | 206 | 258 | 381 |
| **South K Tributary** | | | | | | | | | | | | | | | | | | | | |
| 150T | 250T | Confluence with Reservoir | 293 | 0.5 | 0 | 0 | 20 | 34 | 58 | 125 | 178 | 258 | 441 | 36 | 58 | 87 | 167 | 226 | 315 | 514 |
| 150 | 250 | | 191 | 0.3 | 1231 | 1231 | 29 | 47 | 77 | 155 | 205 | 271 | 422 | 55 | 83 | 121 | 215 | 276 | 354 | 535 |
| 151 | 251 | | 119 | 0.2 | 296 | 1527 | 13 | 23 | 41 | 90 | 120 | 160 | 252 | 33 | 51 | 76 | 136 | 176 | 227 | 345 |
| 152 | 252 | Riverdale Road | 65 | 0.1 | 2626 | 4153 | 14 | 25 | 40 | 72 | 94 | 120 | 184 | 28 | 44 | 62 | 101 | 127 | 160 | 237 |
| **Colorado Boulevard** | | | | | | | | | | | | | | | | | | | | |
| 105 | 205 | Confluence with Drainageway 4100 | 1333 | 2.1 | 0 | 0 | 68 | 114 | 171 | 333 | 441 | 606 | 980 | 106 | 166 | 236 | 421 | 541 | 703 | 1086 |
| 106 | 206 | | 173 | 0.3 | 1274 | 1274 | 15 | 39 | 78 | 141 | 189 | 257 | 406 | 41 | 75 | 106 | 183 | 238 | 313 | 480 |
| 107O | 207O | Thornton Parkway | 107 | 0.2 | 2603 | 3877 | 7 | 27 | 50 | 107 | 141 | 185 | 282 | 22 | 46 | 72 | 132 | 168 | 215 | 321 |
| 107 | 207 | | 107 | 0.2 | 0 | 3877 | 23 | 39 | 60 | 111 | 144 | 187 | 286 | 37 | 57 | 80 | 135 | 171 | 218 | 326 |
| 109 | 209 | | 30 | 0.0 | 2407 | 6284 | 8 | 13 | 19 | 35 | 45 | 57 | 87 | 11 | 17 | 24 | 41 | 52 | 65 | 98 |
| **Thornton Parkway** | | | | | | | | | | | | | | | | | | | | |
| 107 | 207 | Thornton Parkway | 107 | 0.2 | 0 | 0 | 23 | 39 | 60 | 111 | 144 | 187 | 286 | 37 | 57 | 80 | 135 | 171 | 218 | 326 |
| 108 | 208 | | 42 | 0.1 | 1396 | 1396 | 8 | 13 | 21 | 40 | 53 | 69 | 106 | 8 | 13 | 21 | 40 | 53 | 69 | 106 |

***Table 9 – Baseline Runoff Volumes***

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| **Drainageway 4100** | | | | | | | | | | | | | | | | | | | | |
| 100 | --- | South Platte River | 1,691 | 2.6 | 0 | 0 | 20 | 36 | 59 | 110 | 140 | 174 | 247 | 29 | 48 | 72 | 122 | 153 | 186 | 260 |
| 104 | 204 | | 1,684 | 2.6 | 523 | 523 | 20 | 36 | 59 | 109 | 140 | 173 | 246 | 28 | 47 | 72 | 122 | 152 | 185 | 258 |
| 105 | 205 | | 1,333 | 2.1 | 514 | 1037 | 13 | 24 | 41 | 79 | 100 | 120 | 164 | 17 | 30 | 48 | 85 | 106 | 126 | 170 |
| 110T | 210T | | 1,077 | 1.7 | 2333 | 3370 | 8 | 16 | 28 | 56 | 70 | 82 | 104 | 9 | 17 | 30 | 58 | 71 | 83 | 105 |
| 114 | 214 | | 996 | 1.6 | 136 | 3506 | 6 | 12 | 23 | 48 | 60 | 69 | 84 | 6 | 13 | 24 | 49 | 61 | 69 | 85 |
| 115 | 215 | Welby Road | 988 | 1.5 | 1625 | 5131 | 6 | 12 | 23 | 48 | 60 | 69 | 84 | 6 | 13 | 24 | 49 | 61 | 69 | 84 |
| 116O | 216O | | 957 | 1.5 | 864 | 5995 | 5 | 11 | 21 | 45 | 56 | 64 | 76 | 5 | 12 | 22 | 46 | 57 | 64 | 77 |
| 116 | 216 | H Tributary Confluence | 957 | 1.5 | 0 | 5995 | 24 | 36 | 50 | 83 | 108 | 141 | 219 | 24 | 37 | 51 | 84 | 109 | 142 | 221 |
| 120T | 220T | | 733 | 1.1 | 636 | 6631 | 19 | 28 | 40 | 65 | 84 | 110 | 169 | 19 | 29 | 40 | 65 | 85 | 110 | 170 |
| 130T | 230T | D Tributary Confluence | 391 | 0.6 | 1799 | 8430 | 10 | 15 | 22 | 36 | 46 | 60 | 92 | 11 | 16 | 22 | 36 | 46 | 60 | 93 |
| 130 | 230 | | 269 | 0.4 | 0 | 8430 | 7 | 10 | 14 | 24 | 31 | 40 | 62 | 7 | 10 | 14 | 24 | 31 | 41 | 63 |
| 131O | 231O | | 149 | 0.2 | 3121 | 11551 | 4 | 6 | 9 | 14 | 18 | 23 | 35 | 4 | 6 | 9 | 14 | 18 | 23 | 35 |
| 131 | 231 | | 149 | 0.2 | 0 | 11551 | 4 | 6 | 9 | 14 | 18 | 23 | 35 | 4 | 6 | 9 | 14 | 18 | 23 | 35 |
| 132T | 232T | | 127 | 0.2 | 785 | 12336 | 4 | 6 | 8 | 12 | 16 | 20 | 31 | 4 | 6 | 8 | 13 | 16 | 20 | 31 |
| 132 | 232 | | 86 | 0.1 | 631 | 12967 | 3 | 4 | 5 | 8 | 11 | 14 | 21 | 3 | 4 | 5 | 9 | 11 | 14 | 21 |
| **School Tributary** | | | | | | | | | | | | | | | | | | | | |
| 101 | 201 | Colorado Boulevard | 317 | 0.5 | 0 | 0 | 7 | 11 | 17 | 29 | 37 | 49 | 75 | 10 | 16 | 22 | 34 | 43 | 54 | 81 |
| 102T | 202T | 0 | 298 | 0.5 | 1337 | 1337 | 6 | 10 | 16 | 27 | 35 | 46 | 71 | 10 | 15 | 21 | 32 | 41 | 51 | 76 |
| 102O | 202O | Old Welby Road | 215 | 0.3 | 2852 | 4189 | 6 | 9 | 13 | 21 | 27 | 35 | 53 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |
| 102 | 202 | 0 | 215 | 0.3 | 0 | 4189 | 6 | 9 | 13 | 21 | 27 | 35 | 53 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |
| **B Tributary** | | | | | | | | | | | | | | | | | | | | |
| 110T | 210T | Drainageway 4100 Confluence | 1077 | 1.7 | 0 | 0 | 8 | 16 | 28 | 56 | 70 | 82 | 104 | 9 | 17 | 30 | 58 | 71 | 83 | 105 |
| 110 | 210 | | 81 | 0.1 | 216 | 216 | 2 | 3 | 5 | 8 | 10 | 13 | 20 | 3 | 4 | 5 | 8 | 11 | 13 | 20 |
| 112T | 212T | | 40 | 0.1 | 450 | 666 | 1 | 2 | 2 | 4 | 5 | 6 | 10 | 1 | 2 | 2 | 4 | 5 | 6 | 10 |
| 113 | 213 | RTD NMRL | 33 | 0.1 | 2015 | 2681 | 1 | 1 | 2 | 3 | 4 | 5 | 8 | 1 | 1 | 2 | 3 | 4 | 5 | 8 |
| **D Tributary** | | | | | | | | | | | | | | | | | | | | |
| 130T | 230T | Drainageway 4100 Confluence | 391 | 0.6 | 0 | 0 | 10 | 15 | 22 | 36 | 46 | 60 | 92 | 11 | 16 | 22 | 36 | 46 | 60 | 93 |
| 134 | 234 | | 122 | 0.2 | 40 | 40 | 3 | 5 | 7 | 12 | 15 | 20 | 30 | 3 | 5 | 7 | 12 | 15 | 20 | 30 |
| 135T | 235T | | 63 | 0.1 | 1287 | 1327 | 2 | 3 | 4 | 6 | 8 | 10 | 16 | 2 | 3 | 4 | 6 | 8 | 10 | 16 |
| 136 | 236 | | 20 | 0.0 | 1834 | 3161 | 1 | 1 | 1 | 2 | 3 | 3 | 5 | 1 | 1 | 1 | 2 | 3 | 3 | 5 |
| **West G Tributary** | | | | | | | | | | | | | | | | | | | | |
| 120T | 220T | 4100 Drainageway Confluence | 733 | 1.1 | 0 | 0 | 19 | 28 | 40 | 65 | 84 | 110 | 169 | 19 | 29 | 40 | 65 | 85 | 110 | 170 |
| 120 | 220 | | 343 | 0.5 | 0 | 0 | 9 | 13 | 18 | 29 | 38 | 50 | 77 | 9 | 13 | 18 | 30 | 38 | 50 | 77 |
| 123 | 223 | | 232 | 0.4 | 0 | 0 | 3 | 5 | 7 | 13 | 19 | 26 | 44 | 3 | 5 | 7 | 13 | 19 | 26 | 44 |
| 124T | 224T | | 135 | 0.2 | 2136 | 2136 | 1 | 1 | 2 | 5 | 8 | 12 | 22 | 1 | 1 | 2 | 5 | 8 | 12 | 22 |
| 126O | 226O | | 104 | 0.2 | 2226 | 4362 | 3 | 5 | 6 | 10 | 13 | 17 | 25 | 3 | 5 | 6 | 10 | 13 | 17 | 25 |
| 126 | 226 | York Street | 70 | 0.1 | 0 | 4362 | 2 | 3 | 4 | 7 | 9 | 13 | 21 | 2 | 3 | 4 | 7 | 9 | 13 | 21 |
| 128T | 228T | | 37 | 0.1 | 1446 | 5808 | 0 | 0 | 0 | 1 | 2 | 3 | 6 | 0 | 0 | 1 | 1 | 2 | 3 | 6 |
| 129O | 229O | | 30 | 0.0 | 1661 | 7469 | 1 | 1 | 2 | 3 | 4 | 5 | 7 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |
| 129 | 229 | | 30 | 0.0 | 0 | 7469 | 1 | 1 | 2 | 3 | 4 | 5 | 7 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |

***Table 9 – Baseline Runoff Volumes***

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| **North G Tributary** | | | | | | | | | | | | | | | | | | | | |
| 120 | 220 | West G Confluence | 343 | 0.5 | 0 | 0 | 9 | 13 | 18 | 29 | 38 | 50 | 77 | 9 | 13 | 18 | 30 | 38 | 50 | 77 |
| 121O | 221O | | 86 | 0.1 | 1215 | 1215 | 1 | 2 | 4 | 6 | 8 | 11 | 18 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 121 | 221 | Yorkborough Park | 86 | 0.1 | 0 | 1215 | 1 | 2 | 4 | 6 | 8 | 11 | 18 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 122O | 222O | | 58 | 0.1 | 1335 | 2550 | 1 | 2 | 3 | 5 | 6 | 8 | 13 | 1 | 2 | 3 | 5 | 7 | 9 | 13 |
| 122 | 226O | | 58 | 0.1 | 2226 | 4776 | 1 | 2 | 3 | 5 | 7 | 9 | 14 | 1 | 2 | 3 | 5 | 7 | 9 | 14 |
| **H Tributary** | | | | | | | | | | | | | | | | | | | | |
| 116 | 216 | 4100 Drainageway Confluence | 957 | 1.5 | 0 | 0 | 24 | 36 | 50 | 83 | 108 | 141 | 219 | 24 | 37 | 51 | 84 | 109 | 142 | 221 |
| 118T | 218T | | 56 | 0.1 | 583 | 583 | 1 | 2 | 2 | 4 | 5 | 7 | 11 | 1 | 2 | 2 | 4 | 5 | 7 | 11 |
| 118 | 218 | Thornton Parkway | 43 | 0.1 | 750 | 1333 | 1 | 1 | 2 | 3 | 4 | 5 | 9 | 1 | 1 | 2 | 3 | 4 | 5 | 9 |
| **J Tributary** | | | | | | | | | | | | | | | | | | | | |
| 137 | 237 | South Platte Confluence | 364 | 0.6 | 0 | 0 | 3 | 6 | 11 | 21 | 29 | 42 | 73 | 4 | 8 | 12 | 23 | 32 | 45 | 76 |
| 138T | 238T | | 252 | 0.4 | 1890 | 1890 | 3 | 6 | 10 | 18 | 23 | 32 | 53 | 4 | 7 | 12 | 19 | 25 | 34 | 56 |
| 138 | 238 | Riverdale Road | 215 | 0.3 | 1380 | 3270 | 1 | 2 | 2 | 5 | 8 | 15 | 33 | 1 | 2 | 2 | 6 | 10 | 17 | 36 |
| 139O | 239O | | 170 | 0.3 | 1916 | 5186 | 1 | 2 | 5 | 10 | 13 | 19 | 33 | 2 | 4 | 7 | 11 | 15 | 21 | 36 |
| 139 | 239 | | 170 | 0.3 | 0 | 5186 | 2 | 5 | 8 | 13 | 16 | 22 | 37 | 4 | 6 | 9 | 14 | 18 | 24 | 39 |
| 140O | 240O | Thornton Parkway | 93 | 0.1 | 1481 | 6667 | 1 | 2 | 4 | 7 | 9 | 12 | 19 | 2 | 3 | 5 | 8 | 9 | 12 | 20 |
| 140 | 240 | Thornton Parkway | 93 | 0.1 | 0 | 6667 | 1 | 2 | 4 | 8 | 10 | 14 | 21 | 2 | 3 | 5 | 8 | 11 | 14 | 22 |
| **North K Tributary** | | | | | | | | | | | | | | | | | | | | |
| 143 | 247 | Confluence with Reservoir | 263 | 0.4 | 0 | 0 | 3 | 6 | 10 | 21 | 28 | 37 | 60 | 9 | 13 | 19 | 29 | 36 | 45 | 68 |
| 143T | 248 | | 199 | 0.3 | 1725 | 1725 | 2 | 4 | 8 | 15 | 21 | 28 | 45 | 7 | 10 | 14 | 22 | 27 | 34 | 52 |
| 145 | 249 | | 109 | 0.2 | 2811 | 4536 | 2 | 3 | 5 | 9 | 12 | 16 | 25 | 4 | 6 | 8 | 12 | 15 | 19 | 28 |
| **South K Tributary** | | | | | | | | | | | | | | | | | | | | |
| 150T | 250T | Confluence with Reservoir | 293 | 0.5 | 0 | 0 | 5 | 7 | 11 | 20 | 28 | 38 | 62 | 7 | 11 | 15 | 24 | 32 | 42 | 66 |
| 150 | 250 | | 191 | 0.3 | 1231 | 1231 | 4 | 6 | 9 | 16 | 21 | 28 | 44 | 6 | 9 | 12 | 19 | 24 | 31 | 47 |
| 151 | 251 | | 119 | 0.2 | 296 | 1527 | 2 | 3 | 4 | 9 | 12 | 16 | 26 | 3 | 5 | 7 | 12 | 15 | 19 | 29 |
| 152 | 252 | Riverdale Road | 65 | 0.1 | 2626 | 4153 | 1 | 2 | 3 | 6 | 8 | 10 | 15 | 2 | 3 | 4 | 7 | 9 | 11 | 17 |
| **Colorado Boulevard** | | | | | | | | | | | | | | | | | | | | |
| 105 | 205 | Confluence with Drainageway 4100 | 1333 | 2.1 | 0 | 0 | 13 | 24 | 41 | 79 | 100 | 120 | 164 | 17 | 30 | 48 | 85 | 106 | 126 | 170 |
| 106 | 206 | | 173 | 0.3 | 1274 | 1274 | 4 | 6 | 9 | 16 | 21 | 27 | 42 | 6 | 9 | 13 | 20 | 25 | 31 | 46 |
| 107O | 207O | Thornton Parkway | 107 | 0.2 | 2603 | 3877 | 2 | 4 | 6 | 10 | 13 | 16 | 25 | 3 | 5 | 7 | 11 | 14 | 18 | 27 |
| 107 | 207 | | 107 | 0.2 | 0 | 3877 | 3 | 4 | 6 | 10 | 13 | 17 | 26 | 4 | 5 | 7 | 11 | 14 | 18 | 27 |
| 109 | 209 | | 30 | 0.0 | 2407 | 6284 | 1 | 1 | 2 | 3 | 4 | 5 | 7 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |
| **Thornton Parkway** | | | | | | | | | | | | | | | | | | | | |
| 107 | 207 | Thornton Parkway | 107 | 0.2 | 0 | 0 | 3 | 4 | 6 | 10 | 13 | 17 | 26 | 4 | 5 | 7 | 11 | 14 | 18 | 27 |
| 108 | 208 | | 42 | 0.1 | 1396 | 1396 | 1 | 1 | 2 | 4 | 5 | 6 | 10 | 1 | 1 | 2 | 4 | 5 | 6 | 10 |

## 4.0 HYDRAULIC ANALYSIS

### 4.1 Evaluation of Existing Conditions

Adams County, City of Thornton, and CDOT criteria were used to determine the crossing structure capacities. A summary of the criteria used to evaluate alternatives is included in Table 10.

A limited HEC-RAS model was developed for this study, as described in Section 4.2. It was used to determine structure capacities based on the criteria listed in Table 10. Many of the crossings do not have capacity for the 100-year storm event. Detailed structure capacity summary tables for the existing infrastructure, existing and future land use flows are included in Tables 11 and 12, respectively. These tables include only reaches with crossing structures. Some reaches contain only storm drain systems, which are included in Table 13.

***Table 10 – Crossing Structure Criteria***

| Jurisdiction | Max. Culvert Headwater:Depth | Bridge Freeboard | Street Overtopping |
|---|---|---|---|
| CDOT | Rise/Diameter:<br><36” – 2<br>36”-60” – 1.7<br>>60”-<84” – 1.5<br>84”-120” – 1.2<br>≥120” – 1.0 | 4’ (high debris),<br>$0.1Q^{0.3} + 0.008V^2$<br>(low-moderate debris) | No overtopping |
| Adams County | ≤1.5 | References MHFD, which then References CDOT | No overtopping |
| City of Thornton | ≤1.5 | See CDOT | No overtopping |

Select storm drain system mains were evaluated using a pipe-full capacity Manning’s equation:

$$Q = \frac{1.49}{n} A R^{2/3} S_f^{1/2}$$

The pipe analysis was completed based on the pipe sizes and materials shown in the GIS shapefiles provided by City of Thornton and supplemental survey provided by the City of Thornton. Invert elevations were not included in the GIS information. The overland slopes based on LiDAR were used to determine pipe slopes where survey was not provided. Inlet capacities were not evaluated. A summary of the pipe capacities and overland capacities is shown in Table 13.

***Table 11 – Crossing Structure Capacities (Existing Infrastructure, Existing Land Use Flows)***

| Reach | Station | Juris-diction | Street Name | Existing Structure | Str. ID | $Q_2$ (cfs) | $Q_2$ Overtop Depth (ft) | $Q_5$ (cfs) | $Q_5$ Overtop Depth (ft) | $Q_{10}$ (cfs) | $Q_{10}$ Overtop Depth (ft) | $Q_{25}$ (cfs) | $Q_{25}$ Overtop Depth (ft) | $Q_{50}$ (cfs) | $Q_{50}$ Overtop Depth (ft) | $Q_{100}$ (cfs) | $Q_{100}$ Overtop Depth (ft) | HW/D Criteria | HW:D Criteria Elev | Overtop Elev[1] | Controlling Criteria | Controlling Elevation | Capacity (cfs) | Criteria Met? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Drainageway 4100-1** | 10512 | Thornton | Old Riverdale Road | (1) 84-inch CMP | A | 128 | --- | 218 | 0.1 | 332 | 1.1 | 634 | 1.5 | 827 | 1.7 | 1,086 | 1.9 | 1.50 | 5,089.76 | 5,086.00 | Overtopping | 5,086.00 | 215 | NO |
| | 11039 | Thornton | Colorado Boulevard | (2) 9-foot (S) x 5-foot (R) RCBC | B | 68 | --- | 114 | --- | 171 | --- | 333 | --- | 441 | --- | 606 | --- | 1.50 | 5,091.85 | 5,096.89 | HW:D | 5,091.85 | 820 | YES |
| | 11260 | Thornton | Cypress Drive | (2) 9-foot (S) x 5-foot (R) RCBC | C | 68 | --- | 114 | --- | 171 | --- | 333 | --- | 441 | --- | 606 | --- | 1.50 | 5,094.78 | 5,099.00 | HW:D | 5,094.78 | 725 | YES |
| | 13472 | Thornton | Lower Clear Creek Canal | (2) 84-inch RCP | D | 43 | --- | 69 | --- | 100 | --- | 170 | --- | 218 | --- | 276 | --- | 1.50 | 5,116.26 | 5,117.00 | HW:D | 5,116.26 | 940 | YES |
| | 15091 | Thornton | Welby Road | (2) 8-foot (S) x 6-foot (R) RCBC | E | 17 | --- | 38 | --- | 72 | --- | 135 | --- | 151 | --- | 167 | --- | 1.50 | 5,140.02 | 5,140.97 | HW:D | 5,140.02 | 1040 | YES |
| | 15376 | Thornton | Trail at Colorado Agricultural Ditch | (2) 24-inch RCP | F | 17 | --- | 38 | --- | 72 | 0.3 | 135 | 0.8 | 151 | 0.9 | 167 | 0.9 | 1.50 | 5,142.17 | 5,142.63 | HW:D | 5,142.17 | 50 | NO |
| **Drainageway 4100-2** | 15787 | Thornton | RTD NMRL | (2) 36-inch RCP | G | 17 | --- | 38 | --- | 72 | --- | 135 | --- | 151 | --- | 167 | --- | ---[2] | ---[2] | 5,176.32 | ---[2] | 5,176.32 | ---[2] | YES |
| | 16777 | Thornton | Trail Upstream of Pond 316 | (10) 18-inch HDPE | H | 73 | --- | 107 | 0.1 | 152 | 0.3 | 273 | 0.6 | 402 | 0.8 | 609 | 1.2 | 1.50 | 5,162.25 | 5,162.63 | HW:D | 5,162.25 | 90 | NO |
| | 18210 | Thornton | Clayton Court | (2) 8-foot (S) x 5-foot (R) RCBC | I | 73 | --- | 107 | --- | 152 | --- | 273 | --- | 402 | --- | 609 | --- | 1.50 | 5,186.05 | 5,186.39 | HW:D | 5,186.05 | 795 | YES |
| | 18716 | Thornton | Trail to Community Park | (1) 18-inch CMP | J | 47 | 0.5 | 61 | 0.6 | 79 | 0.8 | 171 | 1.2 | 266 | 1.4 | 410 | 1.7 | 1.50 | 5,189.25 | 5,191.00 | HW:D | 5,189.25 | 5 | NO |
| | 20176 | Thornton | Thornton Parkway | (1) 48-inch RCP | K | 31 | --- | 38 | --- | 40 | --- | 108 | --- | 170 | --- | 275 | 1.5 | 1.5 | 5217.28 | 5,223.00 | HW:D | 5,217.28 | 115 | NO |
| | 21579 | Thornton | Race Street | (1) 24-inch RCP | L | 31 | --- | 38 | --- | 40 | --- | 108 | 0.4 | 170 | 0.5 | 275 | 0.8 | ---[2] | ---[2] | 5,261.16 | ---[2] | 5,261.16 | ---[2] | NO |
| **School Tributary** | 34223 | Thornton | Colorado Agricultural Ditch Trail | (2) 30-inch HDPE | M | 49 | --- | 79 | 0.6 | 116 | 0.6 | 203 | 1.0 | 256 | 1.1 | 319 | 1.1 | 1.50 | 5,149.75 | 5,149.04 | Overtopping | 5,149.04 | 60 | NO |
| | 34313 | Thornton | Old Welby Road | (3) 38-inch x 24-inch HERCP | N | 49 | --- | 79 | --- | 116 | --- | 203 | 0.4 | 256 | 0.6 | 319 | 0.7 | 1.50 | 5,150.00 | 5,152.00 | HW:D | 5,150.00 | 60 | NO |
| | 34389 | Thornton | RTD NMRL | (1) 84-Inch CMP | O | 49 | --- | 79 | --- | 116 | --- | 203 | --- | 256 | --- | 319 | --- | 1.50 | ---[2] | 5,158.00 | Overtopping | 5,158.00 | ---[2] | YES |
| **B Tributary** | n/a | Thornton | Welby Road | (1) 36-inch CMP | P | 14 | --- | 22 | --- | 33 | --- | 54 | --- | 70 | 1.1 | 89 | 3.0 | 1.50 | 5,152.50 | 5,152.00 | Overtopping | 5,152.00 | 63 | NO |
| | n/a | Thornton | RTD NMRL | (1) 36-inch RCP | Q | 14 | --- | 22 | --- | 33 | --- | 54 | --- | 70 | --- | 89 | --- | ---[3] | ---[3] | 5,173.00 | ---[3] | 5,173.00 | 90[3] | YES |
| **North G Tributary** | 40524 | Thornton | Yorkborough Park Trail | (1) 24-inch RCP | R | 7 | --- | 11 | --- | 16 | --- | 29 | --- | 38 | --- | 53 | 0.0 | ---[2] | ---[2] | 5,222.65 | ---[2] | 5,222.65 | ---[2] | NO |
| **North K Tributary** | 70140 | Thornton | Access Road | Unknown | S | 13 | ? | 29 | ? | 58 | ? | 134 | ? | 187 | ? | 263 | ? | ? | ? | 5,059.00 | ? | ? | ? | ? |
| | 71208 | Adams County | Access Road | Unknown | T | 13 | ? | 29 | ? | 58 | ? | 134 | ? | 187 | ? | 263 | ? | ? | ? | 5,061.00 | ? | ? | ? | ? |
| **Colorado Boulevard** | 60149 | Thornton | Driveway | (1) 42-inch RCP | U | 8 | --- | 13 | --- | 19 | --- | 35 | --- | 45 | --- | 57 | 0.0 | 1.5 | 5153.37 | 5,152.00 | Overtopping | 5,152.00 | 55 | NO |
| **Thornton Parkway** | 50978 | Thornton | Welby Road | (1) 54-inch RCP | V | 8 | --- | 13 | --- | 21 | --- | 40 | --- | 53 | --- | 69 | --- | 1.50 | 5,168.75 | 5,172.00 | HW:D | 5,168.75 | 155 | YES |

[1]Overtopping elevation based on lowest road elevation where water could overtop.
[2] Structure capacity in the detention basin is based on the stage storage discharge relationship for the detention basin and EPA SWMM output.
[3] Structure capacity based on RTD NMRL plans - Q100=90 cfs.

*Table 12 – Crossing Structure Capacities (Existing Infrastructure, Future Land Use Flows)*

| Reach | Station | Juris-diction | Street Name | Existing Structure | Str. ID | $Q_2$ (cfs) | $Q_2$ Overtop Depth (ft) | $Q_5$ (cfs) | $Q_5$ Overtop Depth (ft) | $Q_{10}$ (cfs) | $Q_{10}$ Overtop Depth (ft) | $Q_{25}$ (cfs) | $Q_{25}$ Overtop Depth (ft) | $Q_{50}$ (cfs) | $Q_{50}$ Overtop Depth (ft) | $Q_{100}$ (cfs) | $Q_{100}$ Overtop Depth (ft) | HW/D Criteria | HW:D Criteria Elev | Overtop Elev[1] | Controlling Criteria | Controlling Elevation | Capacity (cfs) | Criteria Met? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drainageway 4100-1 | 10512 | Thornton | Old Riverdale Road | (1) 84-inch CMP | A | 213 | --- | 330 | 1.1 | 462 | 1.3 | 805 | 1.7 | 1,016 | 1.9 | 1,288 | 2.1 | 1.50 | 5,089.76 | 5,086.00 | Overtopping | 5,086.00 | 215 | NO |
| | 11039 | Thornton | Colorado Boulevard | (2) 9-foot (S) x 5-foot (R) RCBC | B | 106 | --- | 166 | --- | 236 | --- | 421 | --- | 541 | --- | 703 | --- | 1.50 | 5,091.85 | 5,096.89 | HW:D | 5,091.85 | 820 | YES |
| | 11260 | Thornton | Cypress Drive | (2) 9-foot (S) x 5-foot (R) RCBC | C | 106 | --- | 166 | --- | 236 | --- | 421 | --- | 541 | --- | 703 | --- | 1.50 | 5,094.78 | 5,099.00 | HW:D | 5,094.78 | 725 | YES |
| | 13472 | Thornton | Lower Clear Creek Canal | (2) 84-inch RCP | D | 52 | --- | 81 | --- | 114 | --- | 188 | --- | 239 | --- | 300 | --- | 1.50 | 5,116.26 | 5,117.00 | HW:D | 5,116.26 | 940 | YES |
| | 15091 | Thornton | Welby Road | (2) 8-foot (S) x 6-foot (R) RCBC | E | 22 | --- | 40 | --- | 75 | --- | 137 | --- | 153 | --- | 168 | --- | 1.50 | 5,140.02 | 5,140.97 | HW:D | 5,140.02 | 1040 | YES |
| | 15376 | Thornton | rail at Colorado Agricultural Ditch | (2) 24-inch RCP | F | 22 | --- | 40 | --- | 75 | 0.4 | 137 | 0.8 | 153 | 0.9 | 168 | 0.9 | 1.50 | 5,142.17 | 5,142.63 | HW:D | 5,142.17 | 50 | NO |
| Drainageway 4100-2 | 15787 | Thornton | RTD NMRL | (2) 36-inch RCP | G | 22 | --- | 40 | --- | 75 | --- | 137 | --- | 153 | --- | 168 | --- | ---[2] | ---[2] | 5,176.32 | ---[2] | 5,176.32 | ---[2] | YES |
| | 16777 | Thornton | Trail Upstream of Pond 316 | (10) 18-inch HDPE | H | 74 | --- | 108 | 0.1 | 153 | 0.3 | 274 | 0.6 | 410 | 0.9 | 619 | 1.2 | 1.50 | 5,162.25 | 5,162.63 | HW:D | 5,162.25 | 90 | NO |
| | 18210 | Thornton | Clayton Court | (2) 8-foot (S) x 5-foot (R) RCBC | I | 74 | --- | 108 | --- | 153 | --- | 274 | --- | 410 | --- | 619 | --- | 1.50 | 5,186.05 | 5,186.39 | HW:D | 5,186.05 | 795 | YES |
| | 18716 | Thornton | Trail to Community Park | (1) 18-inch CMP | J | 47 | 0.5 | 62 | 0.6 | 80 | 0.8 | 177 | 1.2 | 272 | 1.5 | 418 | 1.7 | 1.50 | 5,189.25 | 5,191.00 | HW:D | 5,189.25 | 5 | NO |
| | 20176 | Thornton | Thornton Parkway | (1) 48-inch RCP | K | 32 | --- | 39 | --- | 40 | --- | 112 | --- | 175 | --- | 283 | 1.6 | 1.50 | 5,217.28 | 5,223.00 | HW:D | 5,217.28 | 115 | NO |
| | 21579 | Thornton | Race Street | (1) 24-inch RCP | L | 32 | --- | 39 | --- | 40 | --- | 112 | 0.4 | 175 | 0.5 | 283 | 0.8 | ---[2] | ---[2] | 5,261.16 | ---[2] | 5,261.16 | ---[2] | NO |
| School Tributary | 34223 | Thornton | Colorado Agricultural Ditch Trail | (2) 30-inch HDPE | M | 49 | --- | 79 | 0.6 | 116 | 0.7 | 203 | 1.0 | 256 | 1.1 | 319 | 1.1 | 1.50 | 5,149.75 | 5,149.04 | Overtopping | 5,149.04 | 60 | NO |
| | 34313 | Thornton | Old Welby Road | (3) 38-inch x 24-inch HERCP | N | 49 | --- | 79 | --- | 116 | --- | 203 | 0.4 | 256 | 0.6 | 319 | 0.7 | 1.50 | 5,150.00 | 5,152.00 | HW:D | 5,150.00 | 60 | NO |
| | 34839 | Thornton | RTD NMRL | (1) 84-Inch CMP | O | 49 | --- | 79 | --- | 116 | --- | 203 | --- | 256 | --- | 319 | --- | 1.50 | ---[2] | 5,158.00 | Overtopping | 5,158.00 | ---[2] | YES |
| B Tributary | n/a | Thornton | Welby Road | (1) 36-inch CMP | P | 14 | --- | 22 | --- | 33 | --- | 54 | --- | 70 | 1.1 | 89 | 3.0 | 1.50 | 5,152.50 | 5,152.00 | Overtopping | 5,152.00 | 57 | NO |
| | n/a | Thornton | RTD NMRL | (1) 36-inch RCP | Q | 14 | --- | 22 | --- | 33 | --- | 54 | --- | 70 | --- | 89 | --- | ---[3] | ---[3] | 5,173.00 | ---[3] | 5,173.00 | 90[3] | YES |
| North G Tributary | 40524 | Thornton | Yorkborough Park Trail | (1) 24-inch RCP | R | 8 | --- | 12 | --- | 17 | --- | 30 | --- | 40 | --- | 55 | 0.1 | ---[2] | ---[2] | 5,222.65 | ---[2] | 5,222.65 | ---[2] | NO |
| North K Tributary | 70140 | Thornton | Access Road | Unknown | S | 56 | ? | 92 | ? | 137 | ? | 251 | ? | 328 | ? | 433 | ? | ? | ? | 5,059.00 | ? | ? | ? | ? |
| | 71208 | Thornton | Access Road | Unknown | T | 56 | ? | 92 | ? | 137 | ? | 251 | ? | 328 | ? | 433 | ? | ? | ? | 5,061.00 | ? | ? | ? | ? |
| Colorado Boulevard | 60149 | Thornton | Driveway | (1) 42-inch RCP | U | 11 | --- | 17 | --- | 24 | --- | 41 | --- | 52 | --- | 65 | 0.2 | 1.50 | 5,153.37 | 5,152.00 | Overtopping | 5,152.00 | 55 | NO |
| Thornton Parkway | 50978 | Thornton | Welby Road | (1) 54-inch RCP | V | 8 | --- | 13 | --- | 21 | --- | 40 | --- | 53 | --- | 69 | --- | 1.50 | 5,168.75 | 5,172.00 | HW:D | 5,168.75 | 155 | YES |

[1]Overtopping elevation based on lowest road elevation where water could overtop.
[2] Structure capacity in the detention basin is based on the stage storage discharge relationship for the detention basin and EPA SWMM output.
[3] Structure capacity based on RTD NMRL plans - Q100=90 cfs.

***Table 13 – Existing System Pipe Capacities***

| Pipe ID | Reach | Description | Design Point | Future $Q_2$ (cfs) | Future $Q_5$ (cfs) | Future $Q_{10}$ (cfs) | Future $Q_{25}$ (cfs) | Future $Q_{50}$ (cfs) | Future $Q_{100}$ (cfs) | Type | No. of Barrels | Dia. (in) | n | Slope (ft/ft) | Pipe Capacity (cfs) | Pipe Storm Event Capacity | Velocity (fps) | Overland Capacity (cfs) | Total Capacity | Total Storm Event Capacity | Meet Criteria? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | School Tributary | Flows from open channel just west of Monroe Street | 101 | 99 | 149 | 203 | 344 | 425 | 523 | RCP | 1 | 84 | 21 | 0.015 | 0.011 | 460 | 50 | 12.0 | ** | ** | 50 |
| 2 | D Tributary | Gaylord Street to open channel | 134 | 33 | 55 | 81 | 142 | 183 | 234 | RCP | 1 | 48 | 0.015 | 0.070 | 331 | 100 | 26.3 | --- | 331 | 100 | YES |
| 3 | D Tributary | Gaylord Street | 135T | 21 | 33 | 48 | 81 | 103 | 131 | RCP | 1 | 30 | 0.015 | 0.023 | 54 | 10 | 11.0 | 31 | 85 | 25 | NO |
| 4 | D Tributary | Travels along E Eppinger Blvd | 136 | 5 | 7 | 11 | 18 | 24 | 30 | RCP | 1 | 30 | 0.015 | 0.020 | 50 | 100 | 10.2 | --- | 50 | 100 | YES |
| 5 | West G Tributary | Crosses under Thornton Parkway from 97th Ave | 123 | 32 | 49 | 68 | 156 | 207 | 282 | RCP | 1 | 48 | 0.015 | 0.010 | 126 | 10 | 10.1 | 20 | 147 | 10 | NO |
| 6 | West G Tributary | Crosses under Thornton Parkway from 97th Ave | 123 | 32 | 49 | 68 | 156 | 207 | 282 | RCP | 1 | 48 | 0.015 | 0.014 | 146 | 10 | 11.6 | 20 | 166 | 25 | NO |
| 7 | West G Tributary | Travels along 97th Avenue | 124T | 11 | 17 | 25 | 74 | 101 | 151 | RCP | 1 | 36 | 0.015 | 0.024 | 89 | 25 | 12.6 | 31 | 120 | 50 | NO |
| 8 | West G Tributary | From Pond 327 | 127O | 10 | 16 | 21 | 46 | 61 | 79 | RCP | 1 | 24 | 0.015 | 0.026 | 32 | 10 | 10.1 | 21 | 53 | 25 | NO |
| 9 | North G Tributary | Travels along 97th Avenue, south of Fillmore Street | 121O/120 | 10 | 15 | 21 | 32 | 41 | 60 | RCP | 1 | 36 | 0.015 | 0.011 | 61 | 100 | 8.6 | 20 | 81 | 100 | YES |
| 10 | North G Tributary | Under Fillmore Street, South of Yorkborough Park | 121O | 8 | 12 | 16 | 26 | 33 | 48 | RCP | 1 | 24 | 0.015 | 0.007 | 17 | 10 | 5.4 | 41 | 58 | 100 | YES |
| 11 | North G Tributary | Crosses under 100th Avenue and along Wigham St | 122O | 6 | 9 | 13 | 22 | 27 | 33 | RCP | 1 | 36 | 0.015 | 0.035 | 108 | 100 | 15.3 | --- | 108 | 100 | YES |
| 12 | North G Tributary | From Pond 322 and crosses under 100th Avenue | 122O | 6 | 9 | 13 | 22 | 27 | 33 | RCP | 1 | 30 | 0.015 | 0.035 | 66 | 100 | 13.5 | --- | 66 | 100 | YES |
| 13 | H Tributary | Crosses under Thornton Parkway | 118 | 9 | 14 | 19 | 39 | 53 | 72 | RCP | 1 | 36 | 0.015 | 0.023 | 88 | 100 | 12.5 | --- | 88 | 100 | YES |
| 14 | H Tributary | Crosses under 96th Place | 118 | 9 | 14 | 19 | 39 | 53 | 72 | RCP | 1 | 30 | 0.015 | 0.012 | 39 | 25 | 8.0 | 22 | 61 | 50 | NO |
| 15 | J Tributary | 94th Ave and Riverdale Road | 139O | 7 | 18 | 29 | 48 | 61 | 111 | RCP | 1 | 36 | 0.015 | **** | 94 | 50 | 13.3 | 20 | 114 | 100 | YES |
| 16 | J Tributary - 2 | Flows Under Riverdale Road | 138 | 9 | 16 | 24 | 45 | 68 | 129 | RCP | 1 | 24 | 0.015 | 0.010 | 20 | 100 | 6.3 | *** | 151 | 100 | YES |
| 17 | J Tributary - 2 | Flows Under Riverdale Road | 141 | | | | | | | RCP | 1 | 24 | 0.015 | 0.030 | 34 | | 10.8 | | | | |
| 18 | J Tributary - 2 | Flows Under Riverdale Road | 141 | | | | | | | RCP | 1 | 36 | 0.015 | 0.028 | 97 | | 13.7 | | | | |
| 19 | J Tributary - 1 | Crosses under Riverdale Road to channel | 141 | 8 | 14 | 22 | 38 | 50 | 64 | RCP | 1 | 36 | 0.015 | 0.014 | 68 | 100 | 9.6 | --- | 68 | 100 | YES |
| 20 | J Tributary - 1 | Bellaire Street south of 91st Drive | 141 | 8 | 14 | 22 | 38 | 50 | 64 | RCP | 1 | 30 | 0.015 | 0.014 | 42 | 25 | 8.5 | 21 | 63 | 50 | NO |
| 21 | J Tributary - 1 | Bellaire Street south of Ash Street | 141 | 8 | 14 | 22 | 38 | 50 | 64 | RCP | 1 | 24 | 0.015 | 0.014 | 23 | 10 | 7.4 | 30 | 53 | 50 | NO |
| 22 | North K Tributary | 100th Avenue and McKay Road | 145 | 48 | 73 | 101 | 164 | 206 | 258 | RCP | 2 | 24 | 0.015 | 0.011 | 41 | <2 | 13.0 | *** | 41 | <2 | NO |
| 23 | North K Tributary | 100th Avenue and McKay Road | 145 | 48 | 73 | 101 | 164 | 206 | 258 | RCP | 1 | 24 | 0.015 | 0.006 | 15 | <2 | 4.8 | *** | 15 | <2 | NO |
| 24 | North K Tributary | Outflow from pond flows under 100th Avenue | 145 | 48 | 73 | 101 | 164 | 206 | 258 | CMP | 1 | 54 | 0.024 | 0.010 | 106 | 10 | 6.7 | *** | 106 | 10 | NO |
| 25 | South K Tributary | Surface Water to Sprat Platte Lake | 150 | 55 | 83 | 121 | 215 | 276 | 354 | RCP | 1 | 36 | 0.015 | 0.001 | 14 | <2 | 2.0 | *** | 14 | <2 | NO |
| 26 | Colorado Boulevard | Parallel to Colorado Boulevard | 106 | 41 | 75 | 106 | 183 | 238 | 313 | RCP | 1 | 36 | 0.015 | 0.007 | 48 | 2 | 6.8 | 28 | 76 | 5 | NO |
| 27 | Colorado Boulevard | Parallel to Colorado Boulevard | 107O | 22 | 46 | 72 | 132 | 168 | 215 | RCP | 1 | 30 | 0.015 | 0.011 | 38 | 2 | 7.7 | 27 | 65 | 5 | NO |
| 28 | Colorado Boulevard | Parallel to Colorado Boulevard | 107O | 22 | 46 | 72 | 132 | 168 | 215 | RCP | 1 | 24 | 0.015 | 0.027 | 32 | 2 | 10.3 | 39 | 71 | 5 | NO |
| 29 | Colorado Boulevard | Parallel to Colorado Boulevard | 109 | 11 | 17 | 24 | 41 | 52 | 65 | RCP | 1 | 42 | 0.015 | 0.005 | 65***** | 50 | 6.7 | 39 | 104 | 100 | YES |

** Open channel - no overland flow capacity

*** No curb and gutter along roadway - no overland flow capacity
****Capacity based on Cherry Lane Final Drainage Report
*****Water will begin to overtop the channel to the east onto Colorado Boulevard with flows in excess of 35 cfs

### 4.2 Flood Hazards

**Hydraulic Modeling General Approach**

The OSP study limits of Drainageway 4100 and DFA 0056 encompass 4.8 miles, which generally slope to the east and southeast with flow path slopes ranging from 0.1 to 4 percent.

The U.S. Army Corps of Engineers' HEC-RAS River Analysis System, version 5.0.3 was used to evaluate the infrastructure crossing structure capacities and the approximate floodplains. Cross sections for HEC-RAS were developed electronically using 1-foot interval LiDAR data acquired by FEMA after the 2013 Flood and provided to Olsson by MHFD. Land survey data was not collected for the study. Crossing structure size, material, and length information were collected from the GIS provided by the City of Thornton. Inverts for these crossing structures were taken from LiDAR data. Cross section locations were set upstream and downstream of crossings and drop structures, spaced on average, around 200 feet apart. Cross section topography was based on the LiDAR. Bank stations were typically set at the low flow channel.

Manning's "n" values were determined based on observations made during site visits and supplemented with aerial photography. The channel and bank roughness values ranged from 0.016 to 0.16. Concrete lined channels, trails, and streets were set to 0.016. Areas that appeared to have short grasses were set to 0.04. Areas with longer grass and scattered trees were set to 0.05 to 0.07. Areas with dense areas of cattails were set to 0.1. Areas with thick trees and brush were set to 0.16. Developed areas with privacy fence were set to 0.1. Photos illustrating the Manning's "n" values for sample reaches are shown below.

Channel Manning's "n" = 0.016
Overbank Manning's "n" = 0.04

Channel Manning's "n" = 0.04
Overbank Manning's "n" = 0.05

Channel Manning's "n" = 0.16
Overbank Manning's "n" = 0.04

Channel Manning's "n" = 0.1
Overbank Manning's "n" = 0.1 and 0.05

Channel Manning's "n" = 0.1
Overbank Manning's "n" = 0.05

Channel Manning's "n" = 0.04
Overbank Manning's "n" = 0.07

A rain-on-grid FLO-2D model was developed to better understand flow paths in DFA 0056. The results showed that the majority of the watershed has shallow overland flows, with deeper flows near the reservoirs.

**Structure Modeling Approach**

Survey of select structures was provided by Thornton and incorporated into the hydraulic analysis. The general modeling techniques used at the structures are summarized below.

- Cross section orientation – At the road crossing structures, cross sections were oriented perpendicular to the channel.
- Ineffective flow area contraction and expansion ratio ranges – In general, a 1:1 contraction ratio and a 1:3 expansion ratio were used to determine ineffective areas upstream and downstream of crossings, respectively. The skewed crossings required special consideration to determine reasonable ineffective areas.
- Contraction and Expansion coefficients – The contraction coefficient was changed from the default value of 0.1 to 0.3 and the expansion coefficient was changed from the default value of 0.3 to 0.5 at the upstream and downstream bounding cross section of all major crossing structures.
- Ineffective flow areas – Ineffective flow area elevations at crossing structures were typically set 0.1 foot below the roadway top on the upstream and downstream side. Downstream ineffective areas were set to 0.1 foot below the roadway top for structures to more accurately model roads that overtop. Some ineffective areas were modified to increase model stability or better represent the crossing.
- HEC-RAS "Bridge Modeling Approach" – HEC-RAS contains numerous options to model each crossing within the "Bridge Modeling Approach" form. Pressure and/or weir flow was selected as the default modeling approach.

### Set Internal Water Surface Elevations
Set water surface elevations were used in the model in Detention Basin 316, along Drainageway 4100, and in Detention Basins 321N and 321S, along G Tributary to represent the detention basin stage-storage-discharge relationship.

### Spills
The HEC-RAS modeling showed several areas where flows would spill out of the channel. The spill locations are noted on Figure 2. The spills were not modeled in detail for this study.

### Boundary Conditions
The South Platte River 10-year water surface elevation at the Drainageway 4100 confluence was not available; therefore, the normal depth boundary condition with a 0.19 percent slope was used for Drainageway 4100. The preliminary South Platte River FHAD showed a 10-year water surface elevation that results in a lower starting water surface elevation than the normal depth boundary condition.

### Drainage Problems
Problem areas as determined by the hydraulic model are shown in Figure 2, included at the end of this section. Crossing structure and storm drain capacities are summarized in Tables 11 through 13. The following flood hazards are described as they relate to the future peak flows (future land use, existing infrastructure).

### Reach: Drainageway 4100-1
Old Riverdale Road will be overtopped during the 5-year storm event and spill into DFA 0056 and the trail at the Colorado Agricultural Ditch will be overtopped during the 10-year storm event, which will also spill into the Colorado Agricultural Ditch. There is no reported flooding of the old Riverdale Road. The low point is located on the east side of old Riverdale Road, and overflows will be directed toward private property. A 24-inch pipe captures flows north of Riverdale Road and conveys them to the south side. Stormwater will backflow into this pipe and could overtop Riverdale Road to the east which is at a lower elevation (approximately 5084) than the old Riverdale Road low point (5086). Backflow into the pipe that allows overtopping at a lower elevation was not considered in the analysis, and an overtopping depth of 5086 was used. It is possible that overtopping has not been observed due to the developed area of the upper School Tributary basin not reaching the outfall system, and much of the remaining School Tributary basin not reaching the outfall system, and much of the remaining School Tributary basin being undeveloped at the time of this study, and not connected to the outfall. When this area is fully built out, Old Riverdale Road may be more susceptible to overtopping. The basis of this report is a fully built out and connected School Tributary basin. The crown of the 84-inch CMP under old Riverdale Road is higher than the low point in old Riverdale Road, which limits the culvert capacity before overtopping occurs.

The drainageway upstream of Cypress Drive is eroded with vertical banks. A housing development is being constructed with homes near the channel that could become threatened if the channel is not stabilized.

### Reach: Drainageway 4100-2
The trail crossing upstream of Detention Basin 316 is overtopped in the 5-year storm event. The trail crossing consists of a series of ten 18-inch culverts, which could be prone to clogging. Houses are located near the floodplain upstream of the trail, making the maintenance of the trail crossing a high priority. The trail to Community Park is overtopped during the 2-year storm event. This undersized crossing contributes to flooding along 95th Avenue. The crossings at Thornton Parkway and Race Street are undersized and will be overtopped during the 100-year and 25-year storm event, respectively.

A large drop structure upstream of Thornton Parkway has been undermined, causing the upstream low flow channel to erode.

Detention Basin 316 does not have an emergency spillway. If the outlet structure were to clog, the water in the basin would continue to rise. If it reached elevation 5166, it would flood the low point at the intersection of Eppinger Boulevard and Yucca Way. At elevation 5168, homes near this intersection and several homes that back up to the detention basin would begin to flood. The basin has no overflow until it reaches an elevation of nearly 5172, where it would begin to flow south in the west vee ditch adjacent to the RTD NMRL.

### Reach: School Tributary
The existing 84-inch storm drain system has capacity for the 50-year storm event. Existing conditions upstream of the storm drain system consist of shallow overland flows across the open space north of 88th Avenue. The Lower Clear Creek Canal and new Welby Road alignment near 88th Avenue included 18-inch RCP and 84-inch RCP crossings, respectively. It appears that the 18-inch RCP under Lower Clear Creek Canal is intended as a temporary structure for the storm drain system that was constructed with the new Welby Road alignment. The immediate upstream 84-inch RCP under Welby Road is buried on the upstream side; ready for the construction of future development. The Colorado Agricultural Ditch Trail will be overtopped in the 5-year storm event, which it does not have capacity for in dry conditions, or the 2-year event if the canal is flowing, and old Welby Road will be overtopped during the 25-year storm event. Flows in excess of the canal capacity would then continue southeast to the relocated Welby Road. Overflows at the relocated Welyb Road would spill into the Lower Clear Creek Canal, and then continue spilling southeast when the canal capacity is reached, making the entire area susceptible to flooding.

### Reach: B Tributary
Welby Road is overtopped in the 50-year storm event. B Tributary currently discharges all flows into the Colorado Agricultural Canal. The upper end of B Tributary is limited by the capacity of a single grated inlet, with no curb opening. Flooding has been documented when the curb opening is blocked with debris.

### Reach: D Tributary
The majority of the D Tributary storm drain system appears to have adequate capacity, with only a small stretch with limited capacity.

### Reach: West G Tributary
The storm drain system and overland street capacities do not meet 100-year criteria, which could cause local flooding. It appears that Detention Basins 326, 327, and 329 may overtop the spillway during the future 100-year storm event. Flows that exceed the capacity of the storm drain system in West G Tributary and North G Tributary will flow down Fillmore Street and 97th Avenue, respectively, to the intersection and into a sump on Thornton Parkway. The sump in Thornton Parkway is located north of an undeveloped area. The total future 100-year peak flow that reaches 97th Avenue and

Thornton Parkway (Design Point 120) is 391 cfs. Based on the estimated pipe capacities, a total of 187 cfs will be conveyed in the pipes, and 204 cfs will flow overland to the sump. This analysis is based on pipe-full capacities based on street slopes and supplemental survey and does not include an evaluation of inlets. A detailed analysis of the storm drain and street system should be completed in this area when the site south of Thornton Parkway is developed.

The channel downstream of the West G Tributary and North G Tributary confluence and upstream of Detention Basin 316 is eroded with vertical banks in some areas.

**Reach: North G Tributary**
Yorkborough Park Trail crossing will be overtopped during the 25-year storm event.

**Reach: H Tributary**
The pipe-full capacity calculations show that the existing storm drain system under 96th Place does not have 100-year capacity, which would result in flows overtopping between the houses. However, the capacity is close to the future 100-year storm event and this section of the storm drain system serves as a detention basin outlet. The detention basin was not included in the model. There are no known reports of flooding in this area. This section of storm drain system may have adequate capacity for detained peak flows.

**Reach: J Tributary**
The J Tributary system appears to have adequate capacity for the future 100-year storm event. The 100-year design outflow from the Cherry Lane Final Drainage Report was used as the capacity of the pipe along Riverdale Road (Pipe 15). The calculated future 100-year flow in this report is slightly higher (111 cfs versus 94 cfs) than what was calculated in the Cherry Lane report. Based on the stage-discharge calculations completed for this report, using the information from the Cherry Lane construction documents, the future 100-year storm event would flow over the spillway and into the swale along Riverdale Road. The swale appears to have adequate capacity to convey the overflow, but the road could potentially be overtopped at the intersection of Riverdale Road and 94th Avenue.

**Reach: North K Tributary**
The 100th and McKay Street intersection is reported to flood yearly. Another concern is separating as much of the storm flows as possible from the reservoirs, since the only outlet from this intersection is to the northeast into the reservoirs.

**Reach: South K Tributary**
The main concern with South K Tributary is separating as much of the storm flows as possible from the reservoirs.

**Reach: Colorado Boulevard**
The storm drain system that parallels the road and the overland street appear to have inadequate capacity. The driveway crossing into the Reserve at Thornton development northwest of Colorado Boulevard and Thornton Parkway (Structure U) would be overtopped during the 100-year storm event. Although the upstream pipe (Pipe 29) under the grass section has adequate capacity for the 100-year storm event, the pipe is inlet controlled, which will cause water to overtop onto Colorado Boulevard with flows in excess of 35 cfs. Although Colorado Boulevard has capacity for the overflow at this location, the downstream street and storm drain system do not have capacity, and any overtopping at this location will contribute to flooding along the street downstream. There are no known reports of flooding in this area. In reality, inadvertent detention is likely occurring upstream of the RTD NMRL, which would result in lower flows reaching the Colorado Boulevard system than what is shown in this analysis. However, if larger pipes across the RTD NMRL are installed in the future, more frequent flooding, as shown in this analysis, could occur.

**Reach: Thornton Parkway**
No drainage problems were identified in this reach.

**Erosion Analysis**
Maximum allowable shear stresses for various types of channel materials were taken from the USDA Agricultural Handbook No. 667 and are shown in Table 14.

***Table 14 - Maximum Permissible Shear Stress (USDA's AG HBK 667)***

| Class | Veg. Height | Max. Permissible Shear (lb/ft$^2$) | |
|---|---|---|---|
| | | Short Duration | Long Duration |
| A | >24" | 7.5 | 7.5 |
| B | 12"-24" | 5.73 | 5.73 |
| C | 6"-12" | 4.2 | 4.2 |
| D | 2"-6" | 3.33 | 3.33 |
| E | <2" | 2.16 | 2.16 |
| Riprap | --- | (4xD50) | (4xD50) |
| Concrete | --- | 100 | 100 |

The short and long duration values are the same. The HEC-RAS data was used to determine the shear stresses at each cross section for the future land use 100-year storm event. High shear stresses are present at several locations. Typically, the highest shear stresses are located at drop structures and at road crossings, where the water backs up as a result of the road embankment. Steeper reaches will also have higher shear stresses. The shear stresses for the major storm are high in many areas, due to sections with steep longitudinal slopes of the channels. The channel is more stable during the minor storm events, with the high shear stresses located at drop structures.

**Water Quality Analysis**
Detention Basin 316 was developed as a regional water quality/detention basin treating Reach 4100-2. No other regional water quality facilities are located in the watershed, although on-site water quality and detention basins are located throughout the watershed.

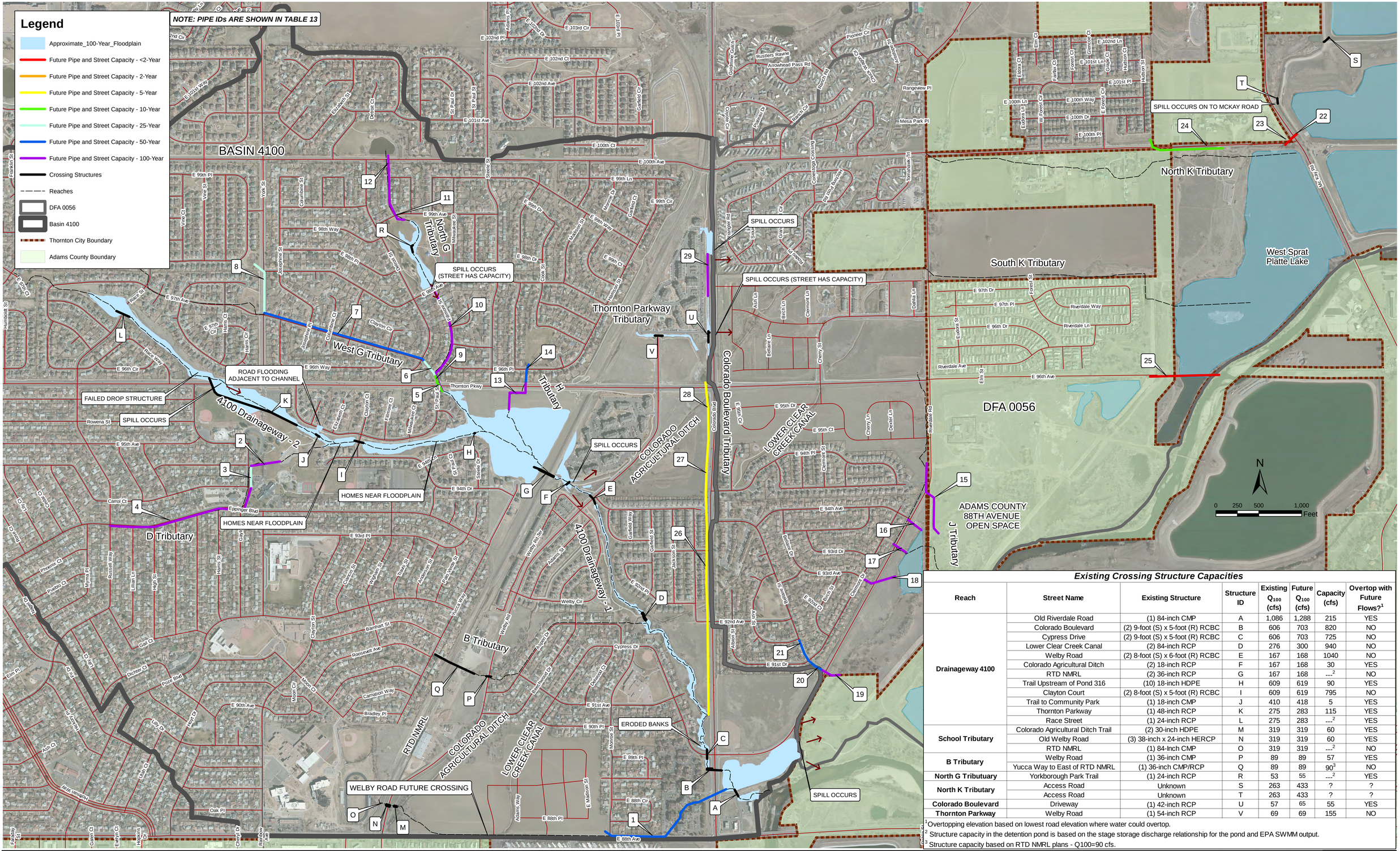
## 4.3 Previous Analysis

The FIRMs show three main FEMA-designated floodplains. Drainageway 4100 has a Zone AE floodplain from just upstream of Thornton Parkway to Colorado Boulevard and Zone A between Colorado Boulevard and the South Platte River. The South Platte River floodplain extends into the study area with a Zone AE floodplain and a floodway. The FEMA FIRM panels are included in Appendix C. Two Letters of Map Revision (LOMRs) were completed along Basin 4100. In general, the FEMA floodplain is similar to the approximate 100-year floodplain in this study. Key differences are summarized below

- This study shows a 100-year spill onto 95th Avenue at the Community Park crossing, whereas the FEMA floodplain does not.

- This study shows the old Riverdale Road detention basin overtopping into the South Platte river, whereas the FEMA floodplain shows the Zone A floodplain contained in the detention basin.

The 2002 OSP estimated culvert capacities using FHWA methods, assuming entrance control, and identified undersized crossings. Channel improvements were also recommended along some reaches where conveyance was limited. In general, this study identified similar problem areas, included in Section 4, as those identified in the 2002 OSP, summarized in Section 2.3.




## Existing Crossing Structure Capacities

| Reach | Street Name | Existing Structure | Structure ID | Existing $Q_{100}$ (cfs) | Future $Q_{100}$ (cfs) | Capacity (cfs) | Overtop with Future Flows?[1] |
|---|---|---|---|---|---|---|---|
| Drainageway 4100 | Old Riverdale Road | (1) 84-inch CMP | A | 1,086 | 1,288 | 215 | YES |
| | Colorado Boulevard | (2) 9-foot (S) x 5-foot (R) RCBC | B | 606 | 703 | 820 | NO |
| | Cypress Drive | (2) 9-foot (S) x 5-foot (R) RCBC | C | 606 | 703 | 725 | NO |
| | Lower Clear Creek Canal | (2) 84-inch RCP | D | 276 | 300 | 940 | NO |
| | Welby Road | (2) 8-foot (S) x 6-foot (R) RCBC | E | 167 | 168 | 1040 | NO |
| | Colorado Agricultural Ditch | (2) 18-inch RCP | F | 167 | 168 | 30 | YES |
| | RTD NMRL | (2) 36-inch RCP | G | 167 | 168 | ---[2] | NO |
| | Trail Upstream of Pond 316 | (10) 18-inch HDPE | H | 609 | 619 | 90 | YES |
| | Clayton Court | (2) 8-foot (S) x 5-foot (R) RCBC | I | 609 | 619 | 795 | NO |
| | Trail to Community Park | (1) 18-inch CMP | J | 410 | 418 | 5 | YES |
| | Thornton Parkway | (1) 48-inch RCP | K | 275 | 283 | 115 | YES |
| | Race Street | (1) 24-inch RCP | L | 275 | 283 | ---[2] | YES |
| School Tributary | Colorado Agricultural Ditch Trail | (2) 30-inch HDPE | M | 319 | 319 | 60 | YES |
| | Old Welby Road | (3) 38-inch x 24-inch HERCP | N | 319 | 319 | 60 | YES |
| | RTD NMRL | (1) 84-Inch CMP | O | 319 | 319 | ---[2] | NO |
| B Tributary | Welby Road | (1) 36-inch CMP | P | 89 | 89 | 57 | YES |
| | Yucca Way to East of RTD NMRL | (1) 36-inch CMP/RCP | Q | 89 | 89 | 90[3] | NO |
| North G Tributuary | Yorkborough Park Trail | (1) 24-inch RCP | R | 53 | 55 | ---[2] | YES |
| North K Tributary | Access Road | Unknown | S | 263 | 433 | ? | ? |
| | Access Road | Unknown | T | 263 | 433 | ? | ? |
| Colorado Boulevard | Driveway | (1) 42-inch RCP | U | 57 | 65 | 55 | YES |
| Thornton Parkway | Welby Road | (1) 54-inch RCP | V | 69 | 69 | 155 | NO |

[1] Overtopping elevation based on lowest road elevation where water could overtop.
[2] Structure capacity in the detention pond is based on the stage storage discharge relationship for the pond and EPA SWMM output.
[3] Structure capacity based on RTD NMRL plans - Q100=90 cfs.

| | | | |
|---|---|---|---|
| PROJECT: 017-2321<br>DRAWN BY: HP<br>DATE: 10/2018 | **MILE HIGH FLOOD DISTRICT**<br>**ADAMS COUNTY AND CITY OF THORNTON** | **BASIN 4100 AND DFA 0056**<br>**DRAINAGE PROBLEM AREAS** | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | FIGURE<br>2 |

## 5.0 ALTERNATIVE ANALYSIS

### 5.1 Alternative Development Process

After completing a hydraulic analysis of the existing drainage systems and discussing the goals of the alternative analysis, the alternative development process began. The primary goals of the alternative analysis were to increase conveyance capacity to reduce road overtopping, protect habitable structures from flooding, reduce erosion potential, and enhance water quality.

Each alternative was first evaluated based on site constraints, feasibility, and constructability. From the alternatives that passed this first screening process, the recommended alternative was determined based on benefits, cost, including land acquisition and maintenance costs, and environmental impacts.

### 5.2 Criteria and Constraints

**Channel Stabilization**
For the alternative analysis, channel stabilization was evaluated in two different ways. For areas where the majority of the channel appeared to be stable, but the low flow was eroded, check structures were evaluated so as to minimize disturbance. For areas where the entire channel, including the banks, appeared unstable, full channel improvements were evaluated. During conceptual design, low maintenance streams will be evaluated. In some areas, the space available for preferred low maintenance stream sections may be limited, due to some reaches being constrained by development.

For areas where check structures were evaluated, the number of 3-foot high check structures was calculated based on the overall elevation difference in each reach, minus existing drop structures. Exact check structure locations were not determined. The median future 10-year floodplain width and the main channel width were used to determine the length of the check structures in Drainageway 4100 and West G Tributary, respectively, for the cost estimate.

For areas where full channel improvements were evaluated, excavation and a maximum drop height of 3 feet were analyzed to achieve a stable slope and achieve the channel improvement goals. Channel sections were based on a bankfull section to convey 70% of the future 2-year peak flows and bankfull depths, widths, and floodplain terrace widths in Table 8-2 in the USDCM, Volume 1, Chapter 8.

The stable slope was determined by comparing the shear stresses at different slopes using the HEC-RAS model output from the existing infrastructure, future land use model. Using the HEC-RAS depth for the existing conditions model and changing the slope to calculate shear stresses gives a general idea of future shear stresses, even though the water would typically be deeper at a flatter slope, which would result in higher shear stresses than this analysis shows. Only areas that appeared to be unstable were evaluated. A full equilibrium slope evaluation was not completed as part of this study. The stable slope of West G Tributary was estimated to be 0.4%. The stable slope for Drainageway 4100 was estimated to be 0.7%. Some areas of Drainageway 4100 appear to be stable, even though the slopes are greater than 0.7%. The estimated stable slope values will be checked during conceptual design by calculating velocities and Froude numbers for typical channel sections in each reach.

**Channel Conveyance Improvements**
Channel improvements were analyzed in areas where the existing flow paths are ill-defined, or habitable structures are near the floodplain. Areas where the channel is eroded and in need of repair were evaluated in the channel stabilization alternative. For the alternatives-level analysis, excavation and a maximum drop height of 3 feet were analyzed to achieve a stable slope and to achieve the channel improvement goals. In some areas, area available for the preferred low maintenance stream sections may be limited, due to some reaches being constrained by development.

**Structure Improvements**
All alternatives were developed using CDOT, Adams County, City of Thornton, and MHFD design criteria. A summary of the criteria used to evaluate the alternatives for the structure crossings is included in Table 10, Section 4.1. Private and pedestrian crossings were not included in the alternatives analysis, unless there was a benefit to replacing them, other than reducing overtopping at the structures themselves.

**Detention**
Detention was investigated for J Tributary, North K Tributary, South K Tributary, School Tributary, and at the confluence of Drainageway 4100 and School Tributary. Initial detention basins were evaluated using the MHFD detention worksheet (UD Detention version 3.07) to determine stage-storage using the LiDAR topography to determine the maximum detention basin depth. The SWMM model was updated to include the detention basin at School Tributary to ensure the detention basin would reduce the 100-year future peak flow rate down to the existing storm drain system capacity. The detention basin and outlet configuration were not designed in detail for the alternatives analysis.

**Water Quality**
Water quality detention basins were investigated for J Tributary, North K Tributary, South K Tributary, and at the confluence of Drainageway 4100 at School Tributary. Initial detention basins were evaluated using the MHFD detention worksheet (UD Detention version 3.07) to determine stage-storage using the LiDAR topography to determine the maximum detention basin depth.

### 5.3 Alternative Categories

The main alternatives that were considered for this analysis include: maintaining the status quo, channel stabilization, channel conveyance improvements, structure improvements to meet criteria, storm drain system improvements, detention, and water quality. Constructing a defined channel was evaluated only where there was substantial benefit. An alternatives pre-screening matrix is shown in Table 15.

***Table 15 – Alternatives Pre-Screening Matrix***

| Reach | Status Quo | Channel Stabilization | Channel Impvmts | Structure Impvmts | Storm Drain System Impvmts | Detention | Water Quality |
|---|---|---|---|---|---|---|---|
| Drainageway 4100-1 | X | X | | X | | X | X |
| Drainageway 4100-2 | X | X | | X | X | X | |
| School Tributary | X | | X | X | X | X | |
| B Tributary | X | | | | X | | |
| D Tributary | X | | | | X | | |
| West G Tributary | X | X | | | X | | |
| North G Tributary | X | | | | | | |
| H Tributary | X | | | | X | | |
| J Tributary | X | | | X | | X | X |
| North K Tributary | X | | X | | X | X | X |
| South K Tributary | X | | | | X | X | X |
| Colorado Boulevard | X | | X | X | X | | |
| Thornton Parkway | X | | | | | | |

### 5.4 Alternative Hydraulics

The hydraulic analysis of the alternatives was performed in accordance with MHFD, Adams County, and City of Thornton criteria. The existing HEC-RAS model was modified for each alternative to determine appropriate structure improvements and select channel improvements to look at the system as a whole. Other channel improvements were evaluated using Bentley FlowMaster v8i. Proposed storm drain system improvements were evaluated using a pipe-full Manning's equation calculation.

### 5.5 Alternative Costs

The construction costs of the evaluated improvements were estimated using unit costs obtained from the MHFD SWIFT tool, which utilizes UD-MP Cost 2009 and adjusts unit costs based upon the most recent Colorado Construction Cost Index (CCI). The unit costs are summarized in Table 16. Costs for contingencies, engineering, legal and administration, and construction management were included as a percentage of capital improvement costs as follows: 25%, 15%, 5%, and 10%, respectively.

Check structure costs include structure, revegetation, riprap, and the actual structure costs. In all jurisdictions check structures were assumed to consist of a 1-foot wide by 6-foot tall concrete wall with a 27-inch thick soil riprap bed extending 10 feet upstream and downstream of the structure.

The unit costs for structure installations include structure excavation and backfill, minor channel grading near the structure, pavement removal and replacement, outlet protection, abutments, and the actual structures. Although the costs for culvert flared end sections, headwalls/toewalls, and wingwalls were determined separately, the cost estimates in Appendix E lump all structure costs together in a linear foot cost, including multiple cells. The major channel grading and drop structures were identified separately. The existing roadway sections were used to determine the length of the structure. If the roadways are widened in the future, the structure replacement cost would increase.

Revegetation and landscaping costs were assumed to be included in the detention and water quality costs. Revegetation is assumed to be broadcast, upland and wetland seed for the disturbed land area. The cost estimates do not include tilling, establishment irrigation, soil amendments, mulching, weed control, shrubs, or trees. A lump sum indirect cost line item of 5% of the hard construction costs was added for erosion control and stormwater management.

***Table 16 - Unit Costs***

| Item | Unit | 2018 Unit Cost |
|---|---|---|
| 30-inch | LF | $112 |
| 36-inch | LF | $135 |
| 42-inch | LF | $158 |
| 48-inch | LF | $180 |
| 60-inch | LF | $300 |
| 66-inch | LF | $330 |
| 72-inch | LF | $450 |
| 84-inch | LF | $525 |
| 30-inch FES | EA | $1,962 |
| 36-inch FES | EA | $2,012 |
| 42-inch FES | EA | $2,125 |
| Concrete | CY | $750 |
| Steel | LB | $1 |
| Manhole, 5' Dia. (Pipe Dia. 36" - 42"), Depth > 15-feet) | EA | $4,875 |
| Manhole, 6' Dia. | EA | $5,375 |
| Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees | EA | $15,000 |
| Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees | EA | $18,750 |
| Modify Manhole | EA | $1,500 |
| Remove Manhole | EA | $1,000 |
| Removal of Culvert Pipe (D<48"") | LF | $25 |
| Removal of Culvert Pipe (48"<D<84") | LF | $62 |
| Flume | LF | $1,220 |
| 40-ft x 10-ft Emergency Spillway Box | EA | $50,000 |
| 7.5-ft SSP, Jack and Bore | LF | $3,000 |
| Pedestrian Bridge | EA | $150,000 |
| Grouted Boulders, 36-inch | SY | 238 |
| Check Structure, Concrete | LF | $338 |
| Excavation, Mid Range | CY | $30 |
| Detention (Complete-in-Place) | AC-FT | $57,000 |
| Install Outlet Structure | EA | $15,000 |
| Cutoff Wall | LF | $333 |
| Spillway | LF | $124 |
| Soil Riprap, Type M | CY | 88 |
| Reclamation & Seeding (Native Grasses) | AC | $1,250 |
| Remove Failed Drop | EA | $30,000 |
| Culvert Maintenance | LF | $1 |
| Manhole and Inlet Maintenance | EA | $62 |
| Hydraulic Structure Maintenance | EA | $625 |
| Channel Maintenance | LF | $2 |
| Detention/WQ Maintenance | ACRE | $1,875 |

### 5.6 Alternative Plans

Maps of the alternatives are shown on Figure 3, included at the end of this section. All alternatives were evaluated based on existing infrastructure, future land use flows. The existing conditions for the status quo alternative are shown on Figure 2. Summaries of the structure and storm drain alternatives are included in Table 17 and 18, respectively. A summary of the costs for each alternative is included in Table 19. The operations and maintenance cost for the alternatives represents maintenance for the entire reach with the alternative improvements in place. The summary of costs includes contingencies, engineering design services, legal and administrative services, construction observation and materials testing, easements, and operations and maintenance completed three times per year over a course of 50 years. Costs associated with each reach and alternative are included in Appendix E.

#### Reach: Drainageway 4100-1

##### Reach Goals

The main concerns with this reach of Drainageway 4100 are that a large portion of the channel is severely eroded and that stormwater will enter the Colorado Agricultural Ditch. The goal of improvements for Drainageway 4100-1 is to stabilize the degrading channel, enhance water quality, and separate stormwater from the ditch. Channel stabilization improvements are intended to stabilize the system, preventing erosion from threatening properties, and create a healthier channel system, resulting in an enhanced ecosystem and water quality. Crossing improvements are intended to convey the 100-year storm event and prevent stormwater from entering the Colorado Agricultural Ditch. The old Riverdale Road crossing is also undersized. The goal in this area is to control outflows to prevent channel erosion downstream.

##### Status Quo

If the existing structures were left in place, several crossings would be overtopped. The old Riverdale Road crossing would be overtopped with a depth of 2.1 feet for the future 100-year event, and a portion of the overflows would be directed toward private property. The low points along the old road alignment are located in Riverdale Road and also on the east side, south of Riverdale Road. When stormwater overtops this area, stormwater will pool in the low point of Riverdale Road and spill into the open area in DFA 0056. The trail at the Colorado Agricultural Ditch overtops with 0.9 foot of depth in the future 100-year event. If no channel improvements are completed, the channel could continue to erode, threatening private properties. The total construction cost for this alternative in this reach would be $0.

##### Channel Stabilization

A defined 100-year channel could be constructed downstream of old Riverdale Road. This reach of channel has vertical walls on one side and steep banks on the other. The proposed channel would have a geometry that would reflect a bankfull section with a 6-foot bottom width, 2.5 feet in depth and 4:1 side slopes. The bankfull section would meander through a section with floodplain benches on each side with an average width of 16 feet and tie into existing ground with 4:1 side slopes. Three 2.5-foot high drop structures would be installed to achieve a stable slope of 0.7%. The channel downstream of the old Riverdale Road culvert would be raised to match the culvert invert elevation.

A defined 100-year channel could be constructed between Cypress Drive and the Lower Clear Creek Canal. This stretch of Drainageway 4100 shows signs of severe degradation. The channel would have a geometry that would reflect a bankfull section with a 6-foot bottom width, varying from 1.5 feet to 2 feet in depth and 4:1 side slopes. The bankfull section would meander through a section with floodplain benches on each side with an average width of 10 to 12 feet and tie into existing ground with 4:1 side slopes. A 3-foot high drop structure would be installed to achieve a stable slope of 0.7%.

In order to achieve the stable channel slope of 0.7% within the reach between Lower Clear Creek Canal and RTD NMRL, six 3-foot high check structures, assumed to be 55 feet wide, would be installed. Check structures were evaluated only in areas that show signs of an eroded low flow channel in this reach. The channel between the Colorado Agricultural Ditch and the railroad has steep side slopes and an incised low flow channel. However, the channel appears to be in good condition and the corridor is too tight to significantly flatten the side slopes. No channel improvements are recommended in this portion of the reach.

The total construction cost for this alternative in this reach would be $926,000.

##### Structure Improvements

To provide major storm conveyance, several structures require improvements:

- At the old Riverdale Road embankment (Structure A), near the downstream limit, three 8-foot wide by 6-foot high RCBCs would be installed in addition to the existing 84-inch CMP. The invert of the RCBCs was set to match the existing pipe to avoid conflicts with the water line crossing. However, the walls of an RCBC are thicker than that of the CMP. Potential conflicts should be investigated further to determine whether this alternative is feasible. Additionally, the downstream channel would need to be improved, as described in the channel stabilization section, to avoid further degradation with the higher peak flows that would be discharged from the RCBCs. It may be possible to install the culverts on the east side to directly discharge into the South Platte River.
- To avoid storm water flowing into the Colorado Agricultural Ditch, the existing two 18-inch RCPs (Structure F) would be replaced with two 42-inch RCPs. The invert of the culverts would be 2 feet lower than the existing culverts to avoid the canal crossing. The channel would require modifications in the vicinity of the structure to match the lowered invert elevations. A sanitary sewer line is located in this vicinity and could restrict this alternative.

The total construction cost for this alternative would be $511,000.

##### Detention

Increasing the detention basin at the confluence of Drainageway 4100 and School Tributary was evaluated to reduce the peak flows low enough to utilize the existing 84-inch CMP under the berm comprising the south and east sides of the basin. The existing detention basin was not included in the baseline hydrology because it had minimal impact on peak flows. The required volume to decrease flows to the 84-inch CMP was too large to be feasible and this alternative was not investigated further.

As an alternative to the structure improvements at the old Riverdale Road crossing, a spillway could be constructed in the southeast portion of the berm that would allow overflows to flow directly into the South Platte River. The spillway would not only allow the existing culvert to remain in place, but would also result in less stormwater reaching the eroded channel downstream of the culvert. The spillway should be designed to keep the 100-year water surface elevation below elevation 5086 to prevent water from pooling in Riverdale Road. The depth of the spillway would be minimized, to make as much use of the existing culvert as possible. It would have a crest elevation of 5084.5, a crest length of 240 feet, 20:1 side slopes to allow a drivable longitudinal slope for maintenance access, a design water depth of 1.5 feet, and a total

depth of 3.5 feet. A 6-foot deep cutoff wall would be located along the spillway and the downstream side would be armored to prevent erosion. The total construction cost for this alternative in this reach would be $857,000.

### Water Quality

Water quality was evaluated at the confluence of Drainageway 4100 and School Tributary. On-line WQCV is generally not recommended, since stormwater treatment should occur prior to entering the drainageway. If on-line WQCV is used, it should be sized for the entire tributary area. The scenarios that were evaluated do not meet these goals but do provide some water quality benefit before stormwater reaches the South Platte River.

Three different scenarios were evaluated:

1. Provide water quality capture volume (WQCV) sized for the Drainageway 4100 tributary area downstream of the railroad (7.3 acre-feet)

2. Provide WQCV sized for the entire Drainageway 4100 tributary area (22.0 acre-feet)

3. Provide WQCV for the Drainageway 4100 tributary area downstream of the railroad and School Tributary (12.8 acre-feet)

Adequate space was not available for scenarios 2 or 3 and they were not investigated further. Detention Basin 316 provides water quality upstream and greatly reduces the peak flows. Scenario 1, providing the WQCV of 7.3 acre-feet that can be achieved in the available space, is recommended. The total construction cost for this alternative in this reach would be $760,000. Although the volumes of scenarios 2 or 3 could not be achieved, it may be possible to provide more volume than scenario 1. If this alternative is selected, it is recommended that the volume of WQCV that can be achieved in this area be maximized with more detailed grading, rather than targeting the volume of scenario 1. This alternative may not be feasible if other alternatives at the old Riverdale Road are selected.

## Reach: Drainageway 4100-2

### Reach Goals

The main concerns with this reach of Drainageway 4100 are undersized road crossings and select areas where the low flow channel is eroding. The goals of improvements for Drainageway 4100-2 are to convey the 100-year storm event and to stabilize portions of the channel that show signs of erosion, including a failed drop structure. Crossing improvements are intended to convey the 100-year storm event and prevent road overtopping. Improvements to the existing Detention Basin 316 are meant to protect private properties in the event that the outlet structure clogs, since there is currently no emergency outlet.

### Status Quo

If the existing structures were left in place, several crossings would be overtopped. The following crossings would be overtopped with their respective approximate future 100-year depth: pedestrian trail upstream of Detention Basin 316, 1.2 feet; pedestrian trail to Community Park, 1.7 feet; Thornton Parkway, 1.6 feet; Race Street, 0.8 foot. The channel could continue to degrade upstream of Thornton Parkway if the existing drop structure that has been undermined is not replaced. Detention Basin 316 does not have an emergency spillway. If the outlet structure were to clog, storm water would flow to the south to the low point at the intersection of Eppinger Boulevard and Yucca Way, where it would begin to flood the houses along Yucca Way. The total construction cost for this alternative in this reach would be $0.

### Channel Stabilization

In order to achieve the stable channel slope of 0.7% within the reach, ten 3-foot high check structures, assumed to be 55 feet wide, would be installed. Check structures were evaluated only in areas that show signs of an eroded low flow channel, between Clayton Court and Race Street. The existing drop structure upstream of Thornton Parkway has been undermined and could be removed and replaced to protect the upstream channel from further erosion. The total construction cost for this alternative would be $490,000.

### Structure Improvements

To provide major storm conveyance, several structures require improvements:

- The pedestrian trail upstream of Detention Basin 316 (Structure H) consists of ten 18-inch culverts. This area should be monitored due to the proximity of the floodplain to private properties immediately upstream of the crossing. If maintenance becomes an issue, a pedestrian bridge could be installed, although it was not included in the alternative analysis.

- The future 100-year floodplain spills onto 95$^{th}$ Avenue at the trail to Community Park (Structure J). Although this crossing is a trail, removing and replacing the structure would eliminate the upstream future 100-year spill on 95$^{th}$ Avenue. The existing 18-inch CMP would be removed and replaced with a 45-foot long pedestrian bridge. The goal of replacing this structure was to eliminate the 95$^{th}$ Avenue spill. As such, the freeboard criteria would not be met with this alternative. The bridge would be less prone to clogging as compared to the existing structure. Allowable trail slopes would dictate how much higher the bridge could be raised to meet freeboard requirements.

- To prevent Thornton Parkway (Structure K) from being overtopped, a parallel 6-foot wide by 4-foot high RCBC could be installed adjacent to the existing storm drain system at a higher elevation, discharging to the park in the low area south of the parking lot. Flows in excess of the 25-year future storm event would begin to flow through the overflow RCBC. The storm drain lateral elevations would need to be investigated to determine if they would need to be connected to the RCBC.

- The single 24-inch RCP at Race Street (Structure L) would be replaced with a 60-inch RCP. The 24-inch RCP serves as the existing Detention Basin 331 outlet. This alternative would likely require a formal outlet structure to ensure that the detention basin discharge does not change downstream of Race Street.

The total construction cost for this alternative would be $974,000.

### Storm Drain System Improvements

As an alternative to the Thornton Parkway (Structure K) parallel 6-foot by 4-foot RCBC in the structure improvements, a 42-inch RCP would be installed adjacent to the existing 48-inch RCP under Thornton Parkway and the northeast corner of Community Park. The storm drain lateral elevations would need to be investigated to determine if they would need to be connected to the new RCP. It is likely that the pipe invert elevations could be adjusted to connect to the storm drain laterals. The headwater to depth ratio of the existing pipe exceeds 1.5. However, the existing system consists of over 1,200 feet of pipe, and hydrostatic pressures will not exceed the weight of the pipe. The total construction cost for this alternative would be $511,000, as compared to the overflow structure option cost of $555,000.

### Detention

An emergency overflow could be constructed for Detention Basin 316, upstream of the RTD NMRL. The surrounding area is fully developed, and an overland spillway is not feasible. The emergency overflow would consist of a 10-foot by 40-foot inlet structure, set at the water surface elevation for the future 100-year storm event. The spillway opening was sized to convey the undetained future 100-year flows of 1,316 cfs, per criteria. The allowable headwater depth was set to an elevation that would result in some street flooding at the low point at the intersection of Eppinger Boulevard and Yucca Way, but no insurable structures would be impacted. The opening was sized 25% larger to account for a trash rack/safety guard. The box would connect to two 7.5-foot smooth steel pipes under the railroad that would discharge to Drainageway 4100 downstream of the railroad tracks. The pipes would be jack and bored under the railroad. The existing culvert outlets have capacity for only 250 cfs at the required headwater elevation and do not significantly reduce the required pipe capacity for the emergency spillway. The total construction cost for this alternative in this reach would be $2,100,000.

## Reach: School Tributary

### Reach Goals

The primary goal for School Tributary is providing guidance for stormwater infrastructure with future development. To accomplish this goal, improvements to convey the future 100-year storm event and match the capacity of the existing storm drain system were evaluated.

Alternatives focus on ways to utilize this existing storm drain system, as the Project Sponsors do not want to investigate a replacement alternative. The 100-year future peak flows at Monroe Street (Design Point 102T) would need to be below 425 cfs, in order to not exceed the 460 cfs capacity of the storm drain system at the downstream end at Colorado Boulevard (Design Point 101). Meeting this target discharge should be verified with any future development drainage reports and construction projects.

Upstream of the storm drain system, School Tributary does not have a defined conveyance channel. The goals of improvements for School Tributary are to convey the 100-year storm event and to enhance water quality. Channel conveyance improvements are meant to increase capacity for the future developed condition, while providing a healthy channel system. Structure improvements will prevent overtopping and stormwater from entering the Colorado Agricultural Ditch. Storm drain improvements are meant to provide 100-year conveyance and are intended to be used in conjunction with channels conveying local flows. Detention improvements are meant to reduce the future 100-year peak flow down to the capacity of the existing storm drain system.

### Status Quo

If the existing structures were left in place, several crossings would be overtopped during the future 100-year storm event. The Colorado Agricultural Ditch Trail and old Welby Road crossings would be overtopped with 1.1- and 0.7-foot depths, respectively. Since the School Tributary discharges directly into the Colorado Agricultural Ditch downstream of the trail crossing, shallow overland flows would continue across the open space area north of 88$^{th}$ avenue to the new Welby Road, then overtop the new road and the Lower Clear Creek Canal, as there are no connected structures in place. When new Welby Road was constructed, an 84-inch culvert was installed for future connections.

If no improvements, or flood attenuation were built with future development, the existing storm drain system between Monroe Street and Colorado Boulevard would not have capacity for the future 100-year storm event. The total construction cost for this alternative in this reach would be $0.

### Channel Conveyance Improvements

The channel conveyance improvements include canal and road crossing structures, since both would need to be constructed and they are not independent of each other. The alternatives were evaluated in conjunction with the *Original Thornton at 88$^{th}$ Station Area Master Plan.* The preferred channel location and future road crossings were based on the schematics in the master plan. An 84-inch RCP was installed under Welby Road for future use. The alternatives evaluated would utilize this existing crossing.

School Tributary would cross under the future Adams Street crossing in a 10-foot wide by 5-foot high RCBC, to be completed by the developer. The existing temporary 18-inch RCP that was constructed with the Welby Road realignment under Lower Clear Creek Canal would be removed and replaced with a 10-foot wide by 5-foot high RCBC, which would allow for clearance from the bottom of the canal to the top of the crossing structure. As an alternative, the existing 84-inch RCP at Welby Road could be extended across the canal. A drop manhole would be installed to maintain clearance below the canal. This option was not investigated further because it would result in a deeper channel downstream, which is not desirable. If this option is investigated in the future, the ditch company should be contacted to determine whether less clearance would be allowed to limit the depth of the 84-inch RCP and downstream channel improvements. The existing 84-inch RCP under Welby Road would be connected to the proposed channel improvements. This structure does not meet the headwater to depth requirements, although it is close at 1.6:1, as compared to the required 1.5:1. A flume would be installed at the Colorado Agricultural Ditch to minimize channel depths in this area. It was assumed that the existing old Welby Road crossing would remain in-place and would be overtopped.

A defined 100-year channel could be excavated from the existing storm drain system west of the intersection of Monroe Street and 88$^{th}$ Avenue to the RTD NMRL crossing in order to contain 100-year flows. The channel would have a 4-foot wide channel bottom, with 4:1 low flow channel side slopes, a 12-foot wide low bench at a slope of 2.0% and 4:1 upper side slopes that tie into existing ground. The depth of the proposed channel generally varies between 5 and 8 feet. Upstream of Welby Road, the channel depth would be approximately 15 feet, in order to utilize the existing 84-inch RCP that was installed for future use. The channel would continue to become shallower until it reached grade downstream with depths between 5 and 8 feet. A total of twelve 3-foot drop structures would be installed to maintain a stable slope of 0.5%. During the conceptual design, alternative drop structure heights will be evaluated to minimize the depth. A larger drop structure immediately west of Welby Road, or a drop inlet could be utilized to reduce the channel depths.

This alternative does not reduce the future 100-year flows down to the existing storm drain system capacity. Additionally, the property west of Monroe Street, east of the Lower Clear Creek Canal has already been platted, and will limit the corridor width available to implement these improvements.

The total construction cost for this alternative in this reach is $3,240,000.

### Storm Drain System Improvements

As an alternative to the channel conveyance improvements, a storm drain system could be installed for major storm conveyance, and channels for local drainage could be constructed with development and connected to the storm drain system. To provide major storm conveyance in the storm drain system, an 84-inch RCP would be installed between the existing end of system west of Monroe Street and Welby Road existing 84-inch RCPs. An 84-inch RCP would be installed between Welby Road and the existing RTD NMRL 84-inch RCP. Although a 72-inch RCP would have capacity between Welby Road and the RTD NMRL, it is recommended to match the larger upstream pipe size of 84 inches at the RTD NMRL. To provide flexibility for the future storm drain connections from the undeveloped parcels, the full downstream developed peak flows from Design Point 102T were used for the analysis. The Colorado Agricultural Ditch Trail and old Welby Road crossings would be removed.

Channel conveyance improvements would be constructed to convey only the development peak flows in Subbasin 2T. The channel section and drop structures would be similar to the improvements described in the channel conveyance alternative, except that the depths would generally range from 4-feet to 7-feet. The channel depths would need to be further minimized if the channel was located in the same alignment as the storm drain system to avoid a vertical conflict with the proposed RCP. The future 100-year peak flow for Subbasin 2T is estimated to be 284 cfs. The channel improvements were not included in the cost estimate, since they serve only the development and would be constructed by the developer.

Similar to the channel conveyance improvements, this alternative does not reduce the future 100-year flows down to the existing storm drain system capacity.

The total construction cost for this alternative in this reach is $3,194,000.

### Detention

The detention alternative would be constructed in conjunction with either the downstream channel conveyance improvements and crossing structures or the alternative storm drain system improvements. The reduction in peak flow is not significant enough to reduce the sizes of the improvements in those sections.

The 100-year detention upstream of the RTD NMRL could be enlarged to provide approximately 3.5 acre-feet of storage, or an additional 1.1 acre-feet. The detention area would be expanded within the existing detention area footprint, under elevation 5158. Several water mains are located in the detention area and may limit the depth of excavation. The alternative was evaluated using the existing outlet and corresponding stage-discharge. The proposed detention area would detain flows down to 288 cfs at the RTD NMRL, 425 cfs at the existing 84-inch storm drain at Monroe Street, and 460 cfs at the downstream end of the existing storm drain system at Colorado Boulevard.

The detention basin would reduce the future 100-year peak flows to 460 cfs at the downstream end of the existing storm drain system and no additional on-site detention would be required. Future development should still implement best management practices to provide the water quality capture volume.

The total future 100-year peak flow tributary to the existing storm drain system between Monroe Street and Colorado Boulevard, at Design Point 101, is 523 cfs, greater than the as-built capacity of 460 cfs for the existing storm drain system. If off-line detention facilities are constructed with new development to reduce the future peak flows down to existing conditions, regional detention basins may not be necessary to meet the existing pipe capacity. The 100-year future peak flow at Monroe Street, Design Point 102T, would need to be below 425 cfs, in order to not exceed the 460 cfs capacity of the storm drain system at the downstream end. Meeting this target discharge should be verified with any future development drainage reports and construction projects.

The total construction cost for this alternative in this reach is $115,000.

### Alternate Detention Location

Instead of expanding the storage on the west side of the RTD NMRL, a 100-year, 3.16 acre-foot detention basin could be constructed immediately downstream, or east, of the RTD NMRL. A shallow sanitary sewer exists in old Welby Road and should be investigated further if this alternative is selected. Storm flows would outlet from the detention basin in a 66-inch RCP.

The detention basin would reduce the future 100-year peak flows to 460 cfs at the existing storm drain system and no additional on-site detention would be required. If off-line detention facilities are constructed with new development to reduce the future peak flows down to existing, no detention basins would be required to meet the existing pipe capacity. The total construction cost for this alternative in this reach is $329,000.

### Water Quality

The WQCV for the tributary area upstream of the railroad tracks would be 3.3 acre-feet. The required volume would encompass almost all of the volume shown in the detention alternative upstream of the RTD NMRL or result in a footprint that encompasses the majority of the area shown on the *Original Thornton at 88th Station Area Master Plan* downstream of the RTD NMRL. Upstream of the RTD NMRL, the existing detention area would need to be enlarged to accommodate the WQCV; therefore, this alternative was evaluated only in conjunction with the detention alternative. A total of 5.2 acre-feet would be required to provide water quality and detention. An outlet structure would be installed upstream of the RTD NMRL crossing to restrict flows for the WQCV. This alternative would likely require additional storage volume from within the existing detention area footprint. Additionally, the volume in the conceptual analysis assumes the pipes would control the flow above the WQCV elevation, which would likely require too large of an outlet structure to be feasible. To reduce the size of the outlet structure, additional volume would be required in an already maximized area. Based on the required volume and outlet structure sizing, this alternative was not evaluated further.

On-line, regional water quality is not recommended downstream of the RTD NMRL and was not evaluated. If on-line water quality were considered, it would need to be sized for the entire tributary area. Downstream of the RTD NMRL, the proposed grass-lined channels will provide water quality, and all future developments should also implement best management practices to provide water quality capture volume.

### Reach: B Tributary

#### Reach Goals
The goals of improvements for B Tributary are to separate storm flows from the Colorado Agricultural Ditch and to convey the 100-year storm event.

#### Status Quo
If the existing system along B Tributary is left in place, stormwater flows will continue to combine with the Colorado Agricultural Ditch. Flooding along the ditch could happen if it were full when a storm occurred. Welby Road would be overtopped by 3.0 feet of water in the future 100-year storm event. The total construction cost for this alternative in this reach would be $0.

#### Storm Drain System Improvements
The construction of storm drain system improvements in B Tributary would help separate stormwater from the Colorado Agricultural Ditch. Several potential alignments were considered, including the alignment in the 2002 OSP, routing flows north in Welby Road and then east in Welby Circle, and routing the flows in Welby Road. The local roads contain storm drain systems, sanitary sewer systems, and water mains. The proposed storm drain system would consist of 48-inch RCP with manholes and would travel in Welby Road to Drainageway 4100. The proposed alignment contains fewer potential utility conflicts with existing storm drain, sanitary sewer, and water systems. A portion of the storm drain system might need to be installed under the sidewalk to maintain clearance from sanitary sewer and water mains. The proposed storm drain system would cross several existing storm drain laterals, water mains, a canal crossing, and a sanitary sewer main. These potential utility conflicts will need evaluated further in final design of any improvements. The existing storm drain laterals may need to be connected to the new storm drain system. Other utilities, including gas, electric, fiber optic, cable, and telephone were not investigated at this time, but will need to be considered for final design. The total construction cost for this alternative in this reach would be $933,000.

### Reach: D Tributary

#### Reach Goals
The goal of improvements for D Tributary is to safely convey the future 100-year storm event in the streets and storm drain system.

#### Status Quo
If the existing structures were left in place, the combined existing storm system and street capacities for Gaylord Street north of Carrol Court do not contain the 100-year event and could put properties at risk of flooding. The total construction cost for this alternative in this reach would be $0.

#### Storm Drain System Improvements
To provide major storm conveyance in both the storm drain system and the street, the existing 30-inch RCP in Gaylord Street between Carrol Court and East 94th Avenue (Pipe 3) should be removed and replaced with a 42-inch RCP. The total construction cost for this alternative in this reach is $95,000.

### Reach: West G Tributary

#### Reach Goals
The goal of improvements for West G Tributary is to provide future 100-year conveyance in the street and storm drain system.

#### Status Quo
If the existing structures were left in place, the combined existing storm system and street capacities for 97th Avenue and the system southeast of Detroit Court that goes underneath Thornton Parkway from 97th Avenue do not contain the 100-year event and could put properties at risk of flooding or inhibit emergency access. Allowable street spread generally controlled street capacities in this area, which would result in a higher risk of inhibiting emergency access, as opposed to property flooding.

Flows that exceed the capacity of the storm drain system in West G Tributary and North G Tributary will flow down Fillmore Street and 97th Avenue, respectively, to the intersection and into a sump on Thornton Parkway. The sump in Thornton Parkway is located north of an undeveloped area. Fire Station #1 may be relocated to this undeveloped site in the future. The total future 100-year peak flow that reaches 97th Avenue and Thornton Parkway (Design Point 120) is 391 cfs., which accounts for the upstream detention basins included in the baseline hydrology. Based on the estimated pipe capacities, a total of 187 cfs will be conveyed in the pipes, and 204 cfs will flow overland to the sump. This analysis is based on pipe-full capacities based on street slopes and supplemental survey and does not include an evaluation of inlets. A detailed analysis of the storm drain and street system should be completed in this area when the site south of Thornton Parkway is developed.

If no channel improvements are completed, the channel could continue to erode, threatening private properties. The total construction cost for this alternative in this reach would be $0.

#### Channel Stabilization
In order to achieve the stable channel slope of 0.4% within the reach, one 3-foot high check structure, assumed to be 15 feet wide, would be installed. The total construction cost for this alternative in this reach would be $9,000.

#### Storm Drain System Improvements
To provide major storm conveyance in both the storm drain system and the street, the 97th Avenue and York Street existing 48-inch, 36-inch, and 24-inch storm drain systems (Pipes 5 through 8) would be removed and replaced with 66-inch, 60-inch, 42-inch, and 30-inch RCPs. A detailed analysis of the storm drain and street system should be completed in this area when the site south of Thornton Parkway is developed. The total construction cost for this alternative in this reach is $1,348,000.

### Reach: North G Tributary

#### Reach Goals
The goal of improvements for North G Tributary is to provide future 100-year conveyance.

#### Status Quo
If the existing structures were left in place, the trail crossing structure in Yorkborough Park would be overtopped during the 100-year event by a depth of 0.1 foot. Because this structure is located in the park, no alternative structures were evaluated. If the existing storm drain system were left in place, flows from the park will spill over 98th Avenue and travel south along Fillmore Street. The storm drain system and street appear to have adequate capacity to convey the 100-year storm event. Based on Manning's equation, the storm drain system has capacity for 17 cfs, or a future 10-year storm event. However, the detention basin stage-discharge information shows that 28.8 cfs will be released through the storm drain system before overtopping of the detention basin occurs, which is approximately a future 25-year storm event. Although the storm drain system and street have capacity for the future 100-year storm event, street flows may contribute to flooding in Thornton Parkway, as detailed in the West G tributary Status

Quo description. A detailed analysis of the storm drain and street system should be completed in this area when the site south of Thornton Parkway is developed. There could be a potential benefit to raising the detention basin berms if street flooding in Fillmore Street and in Thornton Parkway is considered/observed too frequently, or is too severe. The total construction cost for this alternative in this reach would be $0.

## Reach: H Tributary

### Reach Goals
The goal of improvements for H Tributary is to provide future 100-year conveyance in the street and storm drain system. This section of storm drain system may have adequate capacity for detained peak flows.

### Status Quo
If the existing storm drain system were left in place, the houses on the south side of 96th Place adjacent to the pipe on either side could be at risk for flooding. The capacity is close to the future 100-year storm event and this section of the storm drain system serves as a detention basin outlet. The detention basin was not included in the model. There are no known reports of flooding in this area. This section of storm drain system may have adequate capacity for detained peak flows. The total construction cost for this alternative in this reach would be $0.

### Storm Drain System Improvements
To provide major storm conveyance in both the storm drain system and the street (Pipe 14), the existing 30-inch RCP should be removed and replaced with a 36-inch RCP. The total construction cost for this alternative in this reach is $108,000. It should be noted that the storm drain pipe is located in a confined area, between houses. The total construction cost could be higher due to working in a confined space. This will be investigated further, and the costs refined if this alternative is selected for conceptual design.

## Reach: J Tributary

### Reach Goals
The goal of improvements for J Tributary is to provide guidance for future 100-year stormwater infrastructure to be incorporated with the Adams County 88th Avenue Open Space future improvements. An excerpt from the open space master plan is included in Appendix E. The selected improvements will be overlaid on the master plan excerpt for the conceptual design. This tributary does not have any identified problem areas, and improvements are only intended to protect future park infrastructure. Water quality improvements are intended to reduce the amount of sediment and pollutants conveyed to the South Platte River.

### Status Quo
If the existing system in J Tributary is left in place, flows from the tributary will be conveyed to the Adams County 88th Avenue Open Space and could affect future park infrastructure. The system generally has capacity for the future 100-year storm event upstream of Riverdale Road. From the Riverdale Road crossing to the South Platte River, storm events will flow in existing channels and wide open areas. Part of the stormwater will flow into the Middle Pond and South Pond. This area will be modified with the future park improvements, and it is important to incorporate stormwater improvements into the overall open space master plan. The total construction cost for this alternative in this reach would be $0.

### Structure Improvements
The existing channel from Pipe 19 to Middle Pond could be left in place. This channel is shown adjacent to the future trail system in the Adams County Open Space, on the outer edge of the future natural play area. An existing channel confluences with J Tributary in the Middle Pond. The channel crosses under the future trail location in an unknown structure. For this analysis, it was assumed that the existing structure will be removed and replaced with a 36-inch RCP. The 36-inch RCP would have a headwater to depth ratio slightly higher than 1.5. The total construction cost for this alternative in this reach would be $15,000.

### Storm Drain System Improvements
Storm drain system improvements are included in the detention alternative.

### Detention
Stormwater from upstream of Riverdale Road could be collected in Middle Pond and then discharged to the South Platte River. The downstream end of Pipe 15 would be abandoned and a new 36-inch RCP that discharges into Middle Pond could be installed. The existing pond would be utilized for 3.6 acre-feet of WQCV and could also provide detention to reduce the size of the downstream infrastructure. An outlet structure would be installed and would discharge into a 48-inch RCP to the South Platte River. The outlet pipe would cross the Xcel powerline easement and two water lines, which may be in conflict and would need to be investigated for final design. An open channel from the Middle Pond outlet to the South Platte River was not investigated because it would bisect an open area with many trees, which would likely result in the loss of trees and other vegetation. This alternative would provide a hydraulic connection between Middle Pond and the South Platte River, and may result in the transfer of flows between the South Platte River and the Middle Pond during higher storm events.

This alternative would provide future 100-year conveyance through the open space area and provide formalized water quality. However, as stated in the water quality alternative below, water quality is already informally being provided for the subdivisions that do not have WQCV. Additionally, discharge from the Cherrylane subdivision detention basin, which already has WQCV, (Pipe 15) outlets east of the Middle Pond into an area with many trees. Redirecting the stormwater flows to Middle Pond may result in a loss of trees and other vegetation.
The total construction cost for this alternative in this reach would be $360,000.

### Water Quality
The Cherrylane and River Valley Village subdivisions have implemented water quality into their detention basins. The older subdivision south of 94th Avenue does not have water quality. Regional on-line water quality is generally not desirable, and if it is used, it should be based on the full upstream area, regardless of whether other water quality basins are present. To provide water quality benefits to the basin and to reduce the amount of sediment conveyed to the South Platte River, the WQCV could be captured in either of the two existing detention basins east of Riverdale Road. The WQCV for the tributary area upstream of Riverdale Road and for the entire tributary area would be 3.6 acre-feet, and 4.6 acre-feet, respectively. The area downstream of Riverdale Road is within the Adams County 88th Avenue Open Space. Stormwater flows from the developments that do not currently provide WQCV will enter the Middle Pond and South Pond, which provide informal water quality. Formalizing the water quality in the Middle Pond (3.6 acre-feet) was incorporated into the detention alternative and was not evaluated separately, since that alternative routes stormwater through the Middle Pond and incorporating WQCV into that alternative can easily be accomplished with those improvements.

## Reach: North K Tributary

### Reach Goals
The primary goal of improvements for North K Tributary is to prevent the minor flows from entering the reservoirs adjacent to the South Platte River. A second goal is to alleviate the frequent flooding at the intersection of 100th Avenue and McKay Road.

### Status Quo
If the existing system in North K Tributary is left in place, all flow in the tributary would be conveyed to the West Sprat Platte Lake and existing Thornton reservoirs east of 100th Avenue and McKay Road. Flooding at McKay Road has frequently been reported. The total construction cost for this alternative in this reach would be $0.

### Channel Conveyance Improvements
To convey the future 100-year storm event and prevent McKay Road from being overtopped, the open channel and structures downstream of 100th Avenue and McKay Road, McKay Road crossing, and 100th Avenue roadside ditches would need enlargement. The structure improvements and storm drain system improvements that would be needed to implement the channel conveyance improvements were included in this alternative. The improvements were sized using the tributary area north of 100th Avenue and west of McKay Road (Design Point 143). The area south of 100th Avenue would continue to flow into the West Sprat Platte Lake. The proposed roadside ditches would have a 10-foot bottom width, 4:1 side slopes, 1-foot of freeboard, and 100-year water surface depths of 4- and 3-feet for the ditches along McKay Road and north of 100th Avenue, respectively. The ditch on the south side of 100th Avenue carries minimal flow and Pipe 23 would remain in-place. The existing culverts and pipe (Structures S and T, and Pipe 22) would be removed and replaced with a 12-foot wide by 4-foot high RCBC at the driveways (Structures S and T), and a 7-foot wide by 4-foot high RCBC on the north side of 100th Avenue crossing McKay Road (Pipe 22). Although ponding in the intersection would be eliminated with this alternative, all storm flow would be conveyed to Thornton reservoirs, which would not protect the water quality of the reservoirs. It was assumed that the existing outfall to the Thornton reservoir could be lowered to allow for the enlarged channel upstream. The total construction cost for this alternative in this reach would be $755,000.

### Storm Drain System Improvements
The elevation of the intersection of 100th Avenue and McKay Road as it relates to the South Platte River results in a shallow, nearly flat storm drain system. A 48-inch RCP storm drain system could be installed from the downstream end of the channel conveyance improvements, north to 104th Avenue and into the South Platte River. This system would capture the future 2-year event from the tributary area north of 100th Avenue and west of McKay Road (Design Point 143) and prevent it from entering the reservoirs. The area south of 100th Avenue would continue to flow into the West Sprat Platte Lake and the south cell of the West Cooley Reservoirs. To capture part of the area south of 100th Avenue (Design Point 148), additional conveyance and structure improvements would need to be implemented and the pipe size increased to a 54-inch diameter RCP. Areas of limited cover would occur over the pipe along 104th Avenue. It may be possible to construct an open channel parallel to and south of 104th Avenue. If this alternative is selected, the cover over the pipe on the downstream end will be further investigated. An open channel on the upstream end of the alignment is not feasible, since it would need to be too deep and require too much space to maintain positive drainage. The total construction cost for this alternative in this reach would be $1,699,000.

An alternative alignment was investigated. A 42-inch storm drain system could be installed directly east, from 100th Avenue and McKay to the South Platte River. The storm drain system would be located in the berm between reservoirs and would be at a 0.2% slope, which could be difficult to construct. Additionally, the storm drain system would cross an existing storm drain pipe that may be in conflict. The storm drain system would convey nearly the future 2-year event for storm flows north of 100th Avenue and west of Hudson Court. The channel conveyance improvements alternative could be constructed for flows in excess of the 2-year storm event. A larger storm drain system would not be feasible in this location. This alignment was, therefore, not further investigated.

### Detention
Providing 100-year full spectrum detention for North K Tributary west of West Sprat Platte Lake was evaluated. The required detention basin size and small flow reduction makes this option cost prohibitive and is not recommended. A 2-year detention and WQCV basin could be constructed and is detailed in the water quality alternative.

### Water Quality
Water quality improvements for this reach were combined with South K Tributary and are included in that reach description.

## Reach: South K Tributary

### Reach Goals
The primary goal of improvements for South K Tributary is to prevent the minor flows from entering the reservoirs adjacent to the South Platte River.

### Status Quo
If the existing system in South K Tributary is left in place, minor flows from the tributary will be conveyed in an earthen swale and a 36-inch culvert, installed with the West Sprat Platte Reservoir Improvement Project, to the South Platte River. Storm events exceeding the capacity of the earthen swale will be diverted into the West Sprat Platte Lake and will spill to the Adams County 88th Avenue Open Space. Although the pipe capacity of the existing 36-inch pipe is shown to be less than a 2-year storm event, a detention basin and retention basin are located upstream of the pipe were not included in the baseline model. The pipe most likely has capacity for a detained 2-year storm event. This project met the goals of separating minor flows from the reservoirs. The total construction cost for this alternative in this reach would be $0.

### Storm Drain System Improvements
A storm drain system to capture the 2-year flows from the western part of North K Tributary (Design Points 145 and 148) and redirect them to South K Tributary was evaluated. The storm drain pipe would consist of a 60-inch RCP and would also convey 2-year flows from South K Tributary. The pipe would cross a 36-inch raw water line and a 42-inch potable water line. The existing grades would allow only a 0.3% slope along the pipe alignment, which would be in conflict with both water lines, based on the design plans for the water lines. Due to these major utility conflicts, this alternative was not investigated further.

### Detention
Providing 100-year full spectrum detention for South K Tributary west of West Sprat Platte Lake was evaluated. The required detention basin size and small flow reduction makes this option cost prohibitive and is not recommended. A 2-year detention and WQCV basin could be constructed and is detailed in the water quality alternative.

### Water Quality
Water quality could be combined for North and South K Tributaries. To provide water quality benefits to the basin and to reduce the amount of sediment conveyed to the Thornton reservoirs, a 2-year detention and water quality detention basin was evaluated at the same location described in the detention alternative above. Sufficient area is available to capture the 2-year storm from North K Tributary, in addition to flow from the South K Tributary. The combined 2-year detention/water quality basin volume is 11.7 acre-feet, with a depth of 5 feet plus 1-foot of freeboard. The 2-year release would be 5.4 cfs. The outfall would be a combination of an 18-inch RCP and open channel to the South Platte River. The 18-inch RCP outlet would extend from the detention basin to the existing open channel south of 97th Place. A single 42-inch RCP would convey the North K Tributary 2-year storm flow from 100th Avenue to the proposed detention basin. A 36-inch RCP would convey flow from South K Tributary to the detention basin. The water line crossings and sanitary sewer crossing would need to be further evaluated if this alternative were selected. The total construction cost for this alternative in this reach would be $1,520,000.

## Reach: Colorado Boulevard

### Reach Goals
The goal of improvements for Colorado Boulevard is to convey the 100-year storm event. A storm drain system would need to be installed to convey the 100-year storm event and crossings updated to prevent overtopping of Colorado Boulevard. There are no known reports of flooding in this area. Inadvertent detention is likely occurring upstream of the RTD NMRL, which would result in lower flows reaching the Colorado Boulevard system than what is shown in this analysis. However, if larger pipes across the RTD NMRL are installed in the future, more frequent flooding, as shown in this analysis, could occur.

### Status Quo
If the existing system along Colorado Boulevard is left in place, the existing 42-inch RCP that conveys flows under the driveway into the Reserve at Thornton Apartments would be overtopped by 0.2 foot. The 42-inch RCP that conveys flows parallel Colorado Boulevard underneath a grass bank, between the Reserve at Thornton Apartments driveway and 100th Avenue, would also be overtopped and allow flows to spill into Colorado Boulevard. The storm drain system and overland street cannot convey the future 100-year storm event and could put structures at risk of flooding and inhibit emergency access. The total construction cost for this alternative in this reach would be $0.

### Channel Conveyance Improvements
The upstream channel along Colorado Boulevard, between the Reserve at Thornton Apartments driveway and 100th Avenue, is undersized, allowing flows to overtop into Colorado Boulevard. The channel could be lowered to increase capacity for the future 100-year storm event. A two-foot drop structure would be installed at the upstream end of the improvements. This alternative assumes the 42-inch RCP under the grass would be lowered 2 feet, as detailed in the storm drain system improvements alternative. Channel improvements alone will not prevent the 100-year from spilling onto Colorado Boulevard. The total construction cost for this alternative would be $101,000.

### Structure Improvements
In order to provide major storm conveyance, the existing 42-inch RCP under the driveway into the Reserve at Thornton Apartments (Structure U) would need to be supplemented with an additional 30-inch RCP. Total construction cost for this alternative in this reach would be $34,000.

### Storm Drain System Improvements
To provide major storm conveyance, the existing 36-inch, 30-inch, and 24-inch RCPs (Pipes 26 through 28) should be removed and replaced with 72-inch, 60-inch, and 48-inch RCPs, respectively. The 42-inch RCP at the upstream end of the reach under the grass (Pipe 29) would be lowered 2 feet to prevent stormwater from spilling onto Colorado Boulevard. The existing pipe has capacity, but is inlet controlled. It may be possible to do a modified inlet instead of a full replacement. The total construction cost for this alternative in this reach is $3,319,000.

## Reach: Thornton Parkway

### Status Quo
If the existing system along Thornton Parkway is left in place, no 100-year flooding is predicted within the current system. The total construction cost for this alternative in this reach would be $0. No improvements were evaluated or are recommended for this reach.

***Table 17 – Alternatives Proposed Crossing Structures***

| Reach | Station | Jurisdiction | Street Name | Existing Structure | Proposed Structure | Str. ID | $Q_{100}$ (cfs) | $Q_{100}$ Overtop Depth (ft) | Bridge LC Elev | Bridge Freeboard Elevation | HW/D Criteria | HW:D Criteria Elev | Overtop Elev[1] | Controlling Criteria | Controlling Elevation | Criteria Met? | Overtop? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Drainageway 4100-1** | 10512 | Thornton | Old Riverdale Road | (1) 84-inch CMP | Existing and (3) 8-foot (S) x 6-foot (R) RCBC | A | 1,288 | --- | --- | --- | 1.50 | 5,086.76 | 5,086.00 | Overtopping | 5,086.00 | YES | NO |
| | 11039 | Thornton | Colorado Boulevard | (2) 9-foot (S) x 5-foot (R) RCBC | --- | B | 703 | --- | --- | --- | 1.50 | 5,091.85 | 5,096.89 | HW:D | 5,091.85 | YES | NO |
| | 11260 | Thornton | Cypress Drive | (2) 9-foot (S) x 5-foot (R) RCBC | --- | C | 703 | --- | --- | --- | 1.50 | 5,094.78 | 5,099.00 | HW:D | 5,094.78 | YES | NO |
| | 13472 | Thornton | Lower Clear Creek Canal | (2) 84-inch RCP | --- | D | 300 | --- | --- | --- | 1.50 | 5,116.26 | 5,117.00 | HW:D | 5,116.26 | YES | NO |
| | 15091 | Thornton | Welby Road | (2) 8-foot (S) x 6-foot (R) RCBC | --- | E | 168 | --- | --- | --- | 1.50 | 5,140.02 | 5,140.97 | HW:D | 5,140.02 | YES | NO |
| | 15379 | Thornton | Trail at Colorado Agricultural Ditch | (2) 18-inch RCP | (2) 42-inch RCP (lowered) | F | 168 | --- | --- | --- | 1.50 | 5,144.36 | 5,142.87 | Overtopping | 5,142.87 | YES | NO |
| **Drainageway 4100-2** | 15787 | Thornton | RTD NMRL | (2) 36-inch RCP | --- | G | 168 | --- | --- | --- | ---[2] | ---[2] | 5,176.32 | ---[2] | 5,176.32 | YES | NO |
| | 16777 | Thornton | Trail Upstream of Pond 316 | (10) 18-inch HDPE | --- | H | 619 | 1.2 | --- | --- | 1.50 | 5,162.25 | 5,162.63 | HW:D | 5,162.25 | NO | YES |
| | 18210 | Thornton | Clayton Court | (2) 8-foot (S) x 5-foot (R) RCBC | --- | I | 619 | --- | --- | --- | 1.50 | 5,186.05 | 5,186.39 | HW:D | 5,186.05 | YES | NO |
| | 18716 | Thornton | Trail to Community Park | (1) 18-inch CMP | Pedestrian Bridge (45-foot long) | J | 418 | --- | 5190.5 | 5,189.83 | --- | --- | 5,191.00 | Bridge FB | 5,189.83 | NO | NO |
| | 20176 | Thornton | Thornton Parkway | (1) 48-inch RCP | Existing and (1) 6-foot (S) x 4-foot (R) RCBC | K | 283 | --- | --- | --- | 1.50 | 5,217.28 | 5,223.00 | HW:D | 5,217.28 | NO | NO |
| | 21579 | Thornton | Race Street | (1) 24-inch RCP | (1) 60-inch RCP | L | 283 | --- | --- | --- | ---[2] | ---[2] | 5,261.16 | ---[2] | 5,261.16 | ---[2] | NO |
| **School Tributary** | n/a | Thornton | Proposed Adams Street | n/a | (1) 10-foot (S) x 5-foot (R) RCBC | --- | 488 | --- | --- | --- | 1.50 | --- | --- | --- | --- | YES | NO |
| | n/a | Thornton | Lower Clear Creek Canal | (1) 18-inch RCP | (1) 10-foot (S) x 5-foot (R) RCBC | --- | 488 | --- | --- | --- | 1.50 | 5,118.03 | 5,124.00 | HW:D | 5,118.03 | YES | NO |
| | n/a | Thornton | Welby Road | (1) 84-inch RCP (buried) | Connect to existing | --- | 488 | --- | --- | --- | 1.50 | 5,123.02 | 5,127.00 | HW:D | 5,123.02 | NO | NO |
| | 34223 | Thornton | Colorado Agri. Ditch Trail | (2) 30-inch HDPE | --- | M | 319 | 1.1 | --- | --- | 1.50 | 5,149.75 | 5,149.04 | Overtopping | 5,149.04 | NO | NO |
| | 34313 | Thornton | Old Welby Road | (3) 38-inch x 24-inch HERCP | --- | N | 319 | 0.7 | --- | --- | 1.50 | 5,150.00 | 5,152.00 | HW:D | 5,150.00 | NO | NO |
| | 34389 | Thornton | RTD NMRL | (1) 84-inch RCP | --- | O | 319 | --- | --- | --- | ---[2] | ---[2] | 5,158.00 | Overtopping | 5,158.00 | ---[2] | YES |
| **B Tributary** | n/a | Thornton | Welby Road | (1) 36-inch CMP | Remove existing | P | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | n/a | Thornton | RTD NMRL | (1) 36-inch RCP/CMP | --- | Q | 89 | --- | --- | --- | ---[3] | ---[3] | 5,173.00 | ---[3] | 5,173.00 | NO | NO |
| **North G Tributary** | 40524 | Thornton | Yorkborough Park Trail | (1) 24-inch RCP | --- | R | 55 | 0.1 | --- | --- | ---[2] | ---[2] | 5,222.65 | ---[2] | 5,222.65 | NO | YES |
| **J Tributary** | n/a | Thornton | Future Trail | Unknown | (1) 36-inch RCP | --- | 64 | --- | --- | --- | 1.5 | 5,075.80 | 5076.01 | HW:D | 5,075.80 | NO | NO |
| **North K Tributary** | 70140 | Thornton | Access Road | Unknown | (1) 12-foot (S) x 4-foot (R) RCBC | S | 433 | --- | --- | --- | 1.50 | 5,055.50 | 5,061.10 | HW:D | 5,055.50 | YES | NO |
| | 71208 | Thornton | Access Road | Unknown | (1) 12-foot (S) x 4-foot (R) RCBC | T | 433 | --- | --- | --- | 1.50 | 5,056.50 | 5,063.0 | HW:D | 5,056.50 | YES | NO |
| | 71630 | Thornton | 100th Avenue and Mckay Road | (1) 24-inch RCP | (1) 7-foot (S) x 4-foot (R) RCBC | 22 | 258 | --- | --- | --- | 1.50 | 5,058.00 | 5,058.0 | HW:D | 5,058.00 | YES | NO |
| **Colorado Boulevard** | 60149 | Thornton | Driveway | (1) 42-inch RCP | Existing and (1) 30-inch RCP | U | 65 | --- | --- | --- | 1.50 | 5,151.87 | 5,152.00 | HW:D | 5,151.87 | YES | NO |
| **Thornton Parkway** | 50978 | Thornton | Welby Road | (1) 54-inch RCP | --- | V | 69 | --- | --- | --- | 1.50 | 5,168.75 | 5,172.00 | HW:D | 5,168.75 | YES | NO |

[1]Overtopping elevation based on lowest road elevation where water could overtop.
[2] Structure capacity in the detention pond is based on the stage storage discharge relationship for the pond and EPA SWMM output.
[3] Structure capacity based on RTD NMRL plans - Q100=90 cfs.

***Table 18 – Alternatives Proposed System Pipe Capacities***

| Pipe ID | Reach | Description | Design Point | Future $Q_2$ (cfs) | Future $Q_{100}$ (cfs) | Type | No. of Barrels | Existing Diameter (in) | Proposed Diameter (in) | Hyd. Radius R (in) | n | Slope (ft/ft) | Pipe Capacity[1] (cfs) | Storm Event | Velocity (fps) | Overland Capacity (cfs) | Total Capacity (cfs) | Total Storm Event |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| K | Drainageway 4100-2 | Thornton Parkway and Community Park | 131O | 32 | 283 | RCP | 1 | 48 | 48 | 12.00 | 0.015 | 0.018 | 169 | 100 | 13.5 | --- | 288 | 100 |
| | | | | | | RCP | 1 | --- | 42 | 10.50 | 0.015 | 0.018 | 119 | | 12.3 | | | |
| 3 | D Tributary | Gaylord Street | 135T | 21 | 131 | RCP | 1 | 30 | 42 | 10.50 | 0.015 | 0.023 | 133 | 100 | 13.8 | 31 | 163 | 100 |
| 5 | West G Tributary | Crosses under Thornton Parkway from 97th Ave | 123 | 32 | 282 | RCP | 1 | 48 | 66 | 16.50 | 0.015 | 0.010 | 295 | 100 | 12.4 | 20 | 315 | 100 |
| 6 | West G Tributary | Crosses under Thornton Parkway from 97th Ave | 123 | 32 | 282 | RCP | 1 | 48 | 60 | 15.00 | 0.015 | 0.014 | 264 | 50 | 13.5 | 20 | 284 | 100 |
| 7 | West G Tributary | Travels along 97th Avenue | 124T | 11 | 151 | RCP | 1 | 36 | 42 | 10.50 | 0.015 | 0.024 | 134 | 50 | 14.0 | 31 | 166 | 100 |
| 8 | West G Tributary | From Pond 327 | 127O | 10 | 79 | RCP | 1 | 24 | 30 | 7.5 | 0.015 | 0.027 | 59 | 25 | 12 | 21 | 80 | 100 |
| 14 | H Tributary | Crosses under 96th Place | 118 | 9 | 72 | RCP | 1 | 30 | 36 | 9.00 | 0.015 | 0.012 | 64 | 50 | 9.0 | 22 | 86 | 100 |
| 22 | North K Tributary | 100th Avenue and McKay Road | 145 | 48 | 258 | RCBC | 1 | 24 | 84x48 | 15.27 | 0.015 | 0.016 | ---[2] | ---[2] | ---[2] | ---[2] | ---[2] | ---[2] |
| 26 | Colorado Boulevard | Parallel to Colorado Boulevard | 106 | 41 | 313 | RCP | 1 | 36 | 72 | 18.00 | 0.015 | 0.007 | 307 | 50 | 10.9 | 28 | 335 | 100 |
| 27 | Colorado Boulevard | Parallel to Colorado Boulevard | 107O | 22 | 215 | RCP | 1 | 30 | 60 | 15.00 | 0.015 | 0.011 | 239 | 100 | 12.2 | 27 | 267 | 100 |
| 28 | Colorado Boulevard | Parallel to Colorado Boulevard | 107O | 22 | 215 | RCP | 1 | 24 | 48 | 12.00 | 0.015 | 0.027 | 205 | 50 | 16.3 | 39 | 244 | 100 |
| 29 | Colorado Boulevard | Parallel to Colorado Boulevard | 109 | 11 | 65 | RCP | 1 | 42 | 42 | 10.50 | 0.015 | 0.005 | 65 | 50 | 6.7 | 39 | 104 | 100 |
| --- | School Tributary | From Monroe Street to Welby Road | 102T | 94 | 488 | RCP | 1 | --- | 84 | 21.00 | 0.015 | 0.011 | 582 | 100 | 15.1 | --- | 582 | 100 |
| --- | School Tributary | From Welby Road to RTD NMRL | 102T | 94 | 488 | RCP | 1 | --- | 84 | 21.00 | 0.015 | 0.015 | 680 | 100 | 17.7 | --- | 680 | 100 |
| --- | B Tributary | From RTD NMRL | 113 | 14 | 89 | RCP | 1 | --- | 48 | 12.00 | 0.015 | 0.007 | 101 | 100 | 8.1 | --- | 101 | 100 |
| --- | J Tributary (Detention Alternative) | Pipe 15 to Middle Pond | 139O | 7 | 111 | RCP | 1 | --- | 36 | 9.00 | 0.015 | 0.038 | 113 | 100 | 16.0 | --- | 113 | 100 |
| --- | J Tributary (Detention Alternative) | Middle Pond to South Platte River | 138T | --- | 116 | RCP | 1 | --- | 48 | 12.00 | 0.015 | 0.010 | 125 | 100 | 9.9 | --- | 125 | 100 |
| --- | North K Tributary | From channel, north to 104th Avenue, to South Platte River | 143 | 56 | --- | RCP | 1 | --- | 48 | 12.00 | 0.015 | 0.003 | 66 | 2 | 5.3 | --- | 66 | 2 |
| --- | North K Tributary (Water Quality Alternative) | From E 100th Ave into Detention Basin | 145/148 | 70 | --- | RCP | 1 | --- | 42 | 10.50 | 0.015 | 0.010 | 87 | 2 | 9.1 | --- | 87 | 2 |
| --- | South K Tributary (Water Quality Alternative) | E 97th Place to Detention Basin | 150 | 55 | --- | RCP | 1 | --- | 36 | 9.00 | 0.015 | 0.010 | 58 | 2 | 8.2 | --- | 58 | 2 |

[1]Mannings Eqn, USDCM vol1 Eqn 7-45: $Q = \frac{1.49}{n} A R^{2/3} S_f^{1/2}$

[2]Refer to Table 17 – Proposed Crossing Structures

***Table 19 - Alternatives Cost Summary***

| Reach | Alternative | Jurisdiction | Description | Capital | Easement/ ROW | Engineering | Legal/ Admin | Contract Admin/CM | Contingency | Total Capital Cost | Annual O&M Cost | 50-Year O&M Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4100-1 | Status Quo | Thornton | Maintain existing structures/channel | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $33,383 | $717,141 |
| | Channel Stabilization | | 6 check structures, 4 drop structures, channel improvements | $597,257 | $0 | $89,589 | $29,863 | $59,726 | $149,314 | $925,749 | $52,133 | $1,119,932 |
| | Structure Improvements | | Install additional culverts and old Riverdale Road (Structure A), remove and replace culverts at the trail at the Colorado Agricultural Ditch (Structure F) | $329,640 | $0 | $49,446 | $16,482 | $32,964 | $82,410 | $510,942 | $34,004 | $730,481 |
| | Detention | | Emergency spillway at old Riverdale Road | $552,811 | $0 | $82,922 | $27,641 | $55,281 | $138,203 | $856,857 | $33,383 | $717,141 |
| | Water Quality | | Water quality pond at old Riverdale Road | $490,568 | $0 | $73,585 | $24,528 | $49,057 | $122,642 | $760,381 | $52,824 | $1,134,770 |
| 4100-2 | Status Quo | Thornton | Maintain existing structures/channel/detention basins | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $137,563 | $2,955,157 |
| | Channel Stabilization | | 10 check structures, replace failed drop structure | $316,346 | $0 | $47,452 | $15,817 | $31,635 | $79,086 | $490,336 | $156,313 | $3,357,948 |
| | Structure Improvements | | Install Pedestrian Bridge at Community Park (Structure J), install parallel overflow culvert at Thornton Parkway (Structure K), remove and replace culverts at Race Street (Structure L) | $628,310 | $0 | $94,246 | $31,416 | $62,831 | $157,078 | $973,881 | $138,928 | $2,984,480 |
| | Storm Drain System Improvements | | Install parallel pipe and manholes at Thornton Parkway (Structure K) | $329,992 | $0 | $49,499 | $16,500 | $32,999 | $82,498 | $511,488 | $138,307 | $2,971,140 |
| | Detention | | Install emergency overflow structure and pipes at RTD NMRL | $1,354,700 | $0 | $203,205 | $67,735 | $135,470 | $338,675 | $2,099,785 | $138,877 | $2,983,385 |
| School Tributary | Status Quo | Thornton | Maintain existing storm drain system/structures/channel/detention basin | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $28,230 | $606,438 |
| | Channel Conveyance Improvements | | Remove existing structure at canal, install new crossing structure at future Adams Street and Lower Clear Creek Canal, install flume at Colorado Agricultural Ditch Trail, construct channel improvements and 12 drop structures | $2,090,448 | $0 | $313,567 | $104,522 | $209,045 | $522,612 | $3,240,194 | $51,531 | $1,106,994 |
| | Storm Drain System Improvements | | Remove existing structures at canal and old Welby Road, install pipe and manholes | $2,060,873 | $0 | $309,131 | $103,044 | $206,087 | $515,218 | $3,194,353 | $29,553 | $634,859 |
| | Detention | | Expand detention area upstream of RTD NMRL | $73,986 | $0 | $11,098 | $3,699 | $7,399 | $18,496 | $114,678 | $28,230 | $606,438 |
| B Tributary | Status Quo | Thornton | Maintain existing structures/channel | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $2,477 | $53,210 |
| | Storm Drain System Improvements | | Install pipe and manholes | $601,795 | $0 | $90,269 | $30,090 | $60,180 | $150,449 | $932,783 | $3,779 | $81,180 |
| D Tributary | Status Quo | Thornton | Maintain existing storm drain system/channel | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $3,972 | $85,327 |
| | Storm Drain System Improvements | | Remove and replace pipe (Pipe 3) | $61,045 | $0 | $9,157 | $3,052 | $6,104 | $15,261 | $94,619 | $3,972 | $85,327 |
| West G Tributary | Status Quo | Thornton | Maintain existing storm drain system/channel/detention basins | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $37,142 | $797,889 |
| | Channel Stabilization | | 1 check structure | $6,086 | $0 | $913 | $304 | $609 | $1,522 | $9,434 | $39,017 | $838,168 |
| | Storm Drain System Improvements | | Remove and replace pipe and manholes (Pipes 5-8) | $869,434 | $0 | $130,415 | $43,472 | $86,943 | $217,358 | $1,347,622 | $37,142 | $797,889 |

***Table 19 - Alternatives Cost Summary***

| Reach | Alternative | Jurisdiction | Description | Capital | Easement/ ROW | Engineering | Legal/ Admin | Contract Admin/CM | Contingency | Total Capital Cost | Annual O&M Cost | 50-Year O&M Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North G Tributary | Status Quo | Thornton | Maintain existing storm drain system/detention basin | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $36,234 | $778,387 |
| H Tributary | Status Quo | Thornton | Maintain existing storm drain system/detention basin | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $744 | $15,983 |
| | Storm Drain System Improvements | | Remove and replace pipe and manholes (Pipe 14) | $69,380 | $0 | $10,407 | $3,469 | $6,938 | $17,345 | $107,539 | $744 | $15,983 |
| J Tributary | Status Quo | Adams County | Maintain existing overland flowpaths | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $7,806 | $167,690 |
| | Status Quo | Thornton | Maintain existing storm drain system/detention basins | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $21,256 | $456,622 |
| | Structure Improvements | Adams County | Remove existing structure and install new crossing structure at future trail | $9,788 | $0 | $1,468 | $489 | $979 | $2,447 | $15,171 | $7,806 | $167,690 |
| | Water Quality | Adams County | Install inlet pipe, outlet structure, and outlet pipe | $231,987 | $0 | $34,798 | $11,599 | $23,199 | $57,997 | $359,580 | $18,582 | $399,186 |
| North K Tributary | Status Quo | Thornton | Maintain existing storm drain system/structures/channel | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $15,893 | $341,411 |
| | Channel Conveyance Improvements | Thornton | Channel improvements, remove and replace crossings (Structures S and T, and Pipe 22) | $487,331 | $0 | $73,100 | $24,367 | $48,733 | $121,833 | $755,364 | $15,893 | $341,411 |
| | Storm Drain System Improvements | Thornton | Install pipe and manholes | $1,096,152 | $0 | $164,423 | $54,808 | $109,615 | $274,038 | $1,699,036 | $18,125 | $389,359 |
| North K and South K Tributaries | Detention and Water Quality | Adams County | Combined detention/water quality basin and outfall | $49,979 | $0 | $7,497 | $2,499 | $4,998 | $12,495 | $77,468 | $15,893 | $341,411 |
| | Detention and Water Quality | Thornton | | $930,724 | $0 | $139,609 | $46,536 | $93,072 | $232,681 | $1,442,621 | $73,872 | $1,586,930 |
| South K Tributary | Status Quo | Thornton | Maintain existing storm drain system | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $5,706 | $122,577 |
| Colorado Boulevard | Status Quo | Thornton | Maintain existing storm drain system/structures/channel/detention basin | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $11,850 | $254,563 |
| | Channel Conveyance Improvements | | 1 drop structure, channel improvements | $65,352 | $0 | $9,803 | $3,268 | $6,535 | $16,338 | $101,296 | $13,725 | $294,842 |
| | Structure Improvements | | Remove and replace culvert at driveway (Structure U) | $21,912 | $0 | $3,287 | $1,096 | $2,191 | $5,478 | $33,964 | $12,234 | $262,812 |
| | Storm Drain System Improvements | | Remove and replace pipe and manholes (Pipes 26-29) | $2,141,256 | $0 | $321,188 | $107,063 | $214,126 | $535,314 | $3,318,947 | $11,850 | $254,563 |
| Thornton Parkway | Status Quo | Thornton | Maintain existing structures/channel | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $6,027 | $129,482 |

### 5.7 Evaluation of Alternatives

In evaluating the alternatives, the improvements were evaluated not only on costs, but also on the following qualitative aspects:

- Meeting Thornton's and Adams County's policies
- Flood protection
- Constructability
- Maintenance feasibility
- Public safety
- Public and property owner acceptance
- Water quality and environmental impacts
- Aesthetics

When the hydraulic analysis of future conditions 100-year improvements was complete, the feasibility of each alternative with respect to qualitative aspects was evaluated. The recommended alternative provides the highest benefit when considering quantitative and qualitative aspects of the project.

An alternatives evaluation matrix was then completed to help determine the Recommended Plan. Each component of the matrix was assigned a percentage weight and each alternative was evaluated on a scale of one to five, with five being the most beneficial rating. The alternatives evaluation matrix is shown in Table 20.

***Table 20 – Alternatives Evaluation Matrix***

| Alternative Description | Category | Public Safety | Cost | Meets Policy | Prevent Flooding | Operations and Maintenance | Prevent Stream Degradation | ROW Acquisition/ Easements | Public Acceptance | Environmental Impacts | Aesthetics | Weighted Average | Recommended? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Weight:** | **15%** | **15%** | **15%** | **15%** | **10%** | **10%** | **5%** | **5%** | **5%** | **5%** | **100%** | |
| Drainageway 4100-1 | Status Quo | 1 | 5 | 2 | 2 | 2 | 1 | 5 | 3 | 5 | 2 | 2.6 | NO |
| | Channel Stabilization | 3 | 3 | 5 | 2 | 4 | 5 | 4 | 4 | 4 | 4 | 3.7 | YES |
| | Structure Improvements | 4 | 3 | 5 | 5 | 4 | 3 | 4 | 4 | 4 | 4 | 4.1 | YES |
| | Detention | 3 | 1 | 5 | 5 | 3 | 3 | 4 | 3 | 4 | 3 | 3.4 | NO |
| | Water Quality | 3 | 2 | 3 | 2 | 2 | 3 | 4 | 3 | 5 | 4 | 2.8 | YES |
| Drainageway 4100-2 | Status Quo | 1 | 5 | 2 | 2 | 2 | 1 | 5 | 3 | 5 | 2 | 2.6 | NO |
| | Channel Stabilization | 3 | 4 | 5 | 2 | 4 | 5 | 4 | 4 | 4 | 4 | 3.8 | YES |
| | Structure Improvements | 4 | 3 | 5 | 5 | 4 | 3 | 4 | 4 | 4 | 4 | 4.1 | YES |
| | Storm Drain System Improvements | 4 | 4 | 4 | 5 | 4 | 3 | 4 | 4 | 5 | 2 | 4.0 | YES |
| | Detention | 3 | 1 | 5 | 5 | 3 | 1 | 4 | 3 | 3 | 2 | 3.1 | YES |
| School Tributary | Status Quo | 1 | 5 | 1 | 1 | 2 | 1 | 5 | 3 | 5 | 2 | 2.3 | NO |
| | Channel Conveyance Improvements | 3 | 1 | 3 | 4 | 4 | 5 | 2 | 4 | 3 | 4 | 3.2 | NO |
| | Storm Drain System Improvements | 4 | 2 | 2 | 4 | 4 | 5 | 4 | 4 | 3 | 3 | 3.4 | YES |
| | Detention | 4 | 3 | 4 | 5 | 3 | 5 | 4 | 4 | 3 | 3 | 3.9 | YES |
| B Tributary | Status Quo | 1 | 5 | 1 | 1 | 2 | 1 | 5 | 3 | 3 | 2 | 2.2 | NO |
| | Storm Drain System Improvements | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 3 | 3.6 | YES |
| D Tributary | Status Quo | 1 | 5 | 1 | 1 | 2 | 1 | 5 | 3 | 3 | 2 | 2.2 | NO |
| | Storm Drain System Improvements | 4 | 3 | 4 | 4 | 3 | 1 | 4 | 3 | 3 | 3 | 3.3 | YES |
| West G Tributary | Status Quo | 1 | 5 | 1 | 1 | 2 | 1 | 5 | 3 | 3 | 2 | 2.2 | NO |
| | Channel Stabilization | 3 | 4 | 5 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 3.9 | YES |
| | Storm Drain System Improvements | 4 | 2 | 4 | 5 | 3 | 1 | 4 | 3 | 3 | 3 | 3.3 | YES |

*Table 20 – Alternatives Evaluation Matrix*

| Alternative Description | Category | Public Safety | Cost | Meets Policy | Prevent Flooding | Operations and Maintenance | Prevent Stream Degradation | ROW Acquisition/ Easements | Public Acceptance | Environmental Impacts | Aesthetics | Weighted Average | Recommended? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Weight:** | **15%** | **15%** | **15%** | **15%** | **10%** | **10%** | **5%** | **5%** | **5%** | **5%** | **100%** | |
| North G Tributary | Status Quo | 1 | 5 | 1 | 5 | 2 | 1 | 5 | 3 | 3 | 2 | 2.8 | YES |
| H Tributary | Status Quo | 3 | 5 | 3 | 4 | 3 | 1 | 5 | 3 | 3 | 2 | 3.3 | YES |
| | Storm Drain System Improvements | 4 | 1 | 4 | 5 | 3 | 1 | 3 | 3 | 3 | 2 | 3.1 | NO |
| J Tributary | Status Quo | 3 | 5 | 5 | 3 | 3 | 3 | 5 | 4 | 5 | 4 | 3.9 | YES |
| | Structure Improvements | 4 | 4 | 5 | 4 | 3 | 4 | 4 | 4 | 4 | 5 | 4.1 | YES |
| | Detention with Water Quality | 4 | 3 | 4 | 4 | 2 | 4 | 4 | 4 | 3 | 4 | 3.6 | NO |
| North K Tributary | Status Quo | 1 | 5 | 1 | 2 | 2 | 1 | 5 | 3 | 5 | 2 | 2.4 | NO |
| | Channel Conveyance Improvements | 3 | 3 | 4 | 3 | 3 | 3 | 2 | 3 | 4 | 4 | 3.2 | YES |
| | Storm Drain System Improvements | 3 | 1 | 4 | 4 | 3 | 3 | 2 | 3 | 4 | 4 | 3.1 | YES |
| North K and South K Tributaries | Detention and Water Quality | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 4 | 2.6 | NO |
| South K Tributary | Status Quo | 3 | 5 | 4 | 3 | 2 | 2 | 5 | 3 | 5 | 3 | 3.5 | YES |
| Colorado Boulevard | Status Quo | 1 | 5 | 1 | 1 | 2 | 1 | 5 | 3 | 5 | 2 | 2.3 | NO |
| | Channel Conveyance Improvements | 4 | 3 | 4 | 5 | 4 | 5 | 4 | 3 | 4 | 4 | 4.1 | YES |
| | Structure Improvements | 4 | 3 | 5 | 5 | 4 | 2 | 4 | 3 | 4 | 4 | 3.9 | YES |
| | Storm Drain System Improvements | 4 | 3 | 4 | 5 | 3 | 2 | 4 | 3 | 5 | 3 | 3.7 | YES |
| Thornton Parkway | Status Quo | 1 | 5 | 1 | 1 | 2 | 1 | 5 | 3 | 5 | 2 | 2.3 | YES |
| Recommended Alternative | Recommended | 3.3 | 3.3 | 4.0 | 3.9 | 3.2 | 2.9 | 4.0 | 3.4 | 3.9 | 3.3 | 3.5 | --- |

[1]Alternative ranking is on a scale of 1 to 5, with 5 being the most beneficial. The alternative with the highest score would be the preferred alternative.

### 5.8 Recommended Plan

This section provides a summary of the recommended plan. See Section 5.6 for a full description of each alternative. The Recommended Plan was chosen based on a combination of quantitative and qualitative measurements. A legal opinion regarding the recommendation was provided by MHFD and is included in Appendix A. The recommended improvements are shown in Figure 3, improvement costs are summarized in Table 21, and detailed costs are shown in the SWIFT output in Appendix E. The Recommended Plan consists of:

**Drainageway 4100-1**

- Maintaining status quo outside of recommended improvement areas
- All channel stabilization improvements
- All structure improvements

**Drainageway 4100-2**

- Maintaining status quo outside of recommended improvement areas
- All channel stabilization improvements
- Structure improvements at Structures J and L
- Storm drain system improvements at Structure K
- All detention improvements

**School Tributary**

- Maintaining status quo outside of recommended improvement areas
- All storm drain system improvements (developer to construct open channels for local flow)
- All detention improvements

**B Tributary**
- Maintaining status quo outside of recommended improvement areas
- All storm drain system improvements

**D Tributary**
- Maintaining status quo outside of recommended improvement areas
- All storm drain system improvements

**West G Tributary**
- Maintaining status quo outside of recommended improvement areas
- All channel stabilization improvements
- All storm drain system improvements - a detailed analysis of the storm drain and street system should be completed in this area when the site south of Thornton Parkway is developed.

**North G Tributary**
- Maintaining status quo
- A detailed analysis of the storm drain and street system should be completed in this area when the site south of Thornton Parkway is developed.

**H Tributary**
- Maintaining status quo - the pipe-full capacity calculations for H Tributary show that the existing storm drain system under 96th Place does not have 100-year capacity, which would result in flows overtopping between the houses. However, the capacity is close to the future 100-year storm event and this section of the storm drain system serves as a detention basin outlet. The detention basin was not included in the model. There are no known reports of flooding in this area. This section of storm drain system may have adequate capacity for detained peak flows.

**J Tributary**
- Maintaining status quo outside of recommended improvement areas
- All structure improvements

**North K Tributary**
- Maintaining status quo outside of recommended improvement areas
- All channel conveyance improvements
- All storm drain system improvements

**South K Tributary**
- Maintaining status quo outside of recommended improvement areas

**Colorado Boulevard**
- Maintaining status quo outside of recommended improvement areas
- All channel conveyance improvements
- All structure improvements
- All storm drain system improvements

**Thornton Parkway Tributary**
- Maintaining status quo

The main themes in the recommended plan were to provide sufficient capacity at crossings to eliminate overtopping, to bring existing storm drain and street systems into compliance with 100- year criteria and to improve overall reach stability. In general, it is suggested that the recommended plan be implemented from downstream to upstream within each tributary area. However, the improvements can be implemented in a different order, if desired. Following is a more detailed recommendation of phasing and prioritization:

- Crossing structures should be installed first to increase public safety and emergency access
- The Drainageway 4100-1 channel stabilization improvements are a higher priority to prevent the channel from threatening private properties
- The check structures in Drainageway 4100 and West G Tributary should be installed if the channels begin to show further signs of erosion. Low maintenance streams should be evaluated as an alternative to check structures, if possible. In some areas, the available space for preferred low maintenance stream sections may be limited, due to some reaches being constrained by development.
- The improvements on North K Tributary should be implemented when funding is available to prevent flooding at 100th and McKay and to protect the reservoirs.
- Improvements along School Tributary and J Tributary should generally be implemented as development occurs.
- The storm drain improvements are recommended to be installed as needed, based on flooding history and reports.

The recommended plan costs are summarized by reach and jurisdiction in Table 21. The individual reach costs from the SWIFT tool are included in Appendix E.

***Table 21 - Recommended Plan Cost Summary***

| Reach | Jurisdiction | Description | Capital | Easement/ ROW | Engineering | Legal/ Admin | Contract Admin/CM | Contingency | Total Capital Cost | Annual O&M Cost | 50-Year O&M Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Drainageway 4100-1 | Thornton | Status Quo - outside of recommended improvement areas<br>Channel Stabilization - 6 check structures, 4 drop structures, channel improvements<br>Structure Improvements - Install additional culverts and old Riverdale Road (Structure A), remove and replace culverts at the trail at the Colorado Agricultural Ditch (Structure F) | $926,894 | $0 | $139,034 | $46,345 | $92,689 | $231,724 | $1,436,686 | $52,754 | $1,133,272 |
| Drainageway 4100-2 | Thornton | Status Quo - outside of recommended improvement areas<br>Channel Stabilization - 10 check structures, replace failed drop structure<br>Structure Improvements - Install Pedestrian Bridge at Community Park (Structure J), remove and replace culverts at Race Street (Structure L)<br>Storm Drain System Improvements - Install parallel pipe and manholes at Thornton Parkway (Structure K)<br>Detention - Install emergency overflow structure and pipes at RTD NMRL | $2,271,124 | $0 | $340,669 | $113,556 | $227,112 | $567,781 | $3,520,242 | $158,521 | $3,405,381 |
| School Tributary | Thornton | Status Quo - outside of recommended improvement areas<br>Structure Drain System Improvements - Remove existing structures at canal and old Welby Road, install pipe and manholes<br>Detention - Expand detention area upstream of RTD NMRL | $2,134,859 | $0 | $320,229 | $106,743 | $213,486 | $533,715 | $3,309,032 | $29,553 | $634,859 |
| B Tributary | Thornton | Status Quo - outside of recommended improvement areas<br>Storm Drain System Improvements - Install pipe and manholes | $601,795 | $0 | $90,269 | $30,090 | $60,180 | $150,449 | $932,783 | $3,779 | $81,180 |
| D Tributary | Thornton | Status Quo - outside of recommended improvement areas<br>Storm Drain System Improvements - Remove and replace pipe (Pipe 3) | $61,045 | $0 | $9,157 | $3,052 | $6,104 | $15,261 | $94,619 | $3,972 | $85,327 |
| West G Tributary | Thornton | Status Quo - outside of recommended improvement areas<br>Channel Stabilization - 1 check structure<br>Storm Drain System Improvements - Remove and replace pipe and manholes (Pipes 5-8) | $875,519 | $0 | $131,328 | $43,776 | $87,552 | $218,880 | $1,357,055 | $39,017 | $838,168 |
| North G Tributary | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $36,234 | $778,387 |
| H Tributary | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $744 | $15,983 |
| J Tributary | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $21,256 | $456,622 |
| | Adams County | Status Quo - outside of recommended improvement areas | $9,788 | $0 | $1,468 | $489 | $979 | $2,447 | $15,171 | $7,806 | $167,690 |

***Table 21 - Recommended Plan Cost Summary***

| Reach | Jurisdiction | Description | Capital | Easement/ ROW | Engineering | Legal/ Admin | Contract Admin/CM | Contingency | Total Capital Cost | Annual O&M Cost | 50-Year O&M Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Adams County | Structure Improvements - Remove existing structure and install new crossing structure at future trail | | | | | | | | | |
| North K Tributary | Thornton | Status Quo - outside of recommended improvement areas | $1,583,483 | $0 | $237,522 | $79,174 | $158,348 | $395,871 | $2,454,398 | $18,125 | $389,359 |
| | Thornton | Channel Conveyance Improvements - Channel improvements, remove and replace crossings (Structures S and T and Pipe 22) | | | | | | | | | |
| | Thornton | Storm Drain System Improvements - Install pipe and manholes | | | | | | | | | |
| South K Tributary | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $5,706 | $122,577 |
| Colorado Boulevard | Thornton | Status Quo - outside of recommended improvement areas | $2,228,517 | $0 | $334,278 | $111,426 | $222,852 | $557,129 | $3,454,202 | $13,725 | $294,842 |
| | | Channel Conveyance Improvements - 1 drop structure, channel improvements | | | | | | | | | |
| | | Structure Improvements - Remove and replace culvert at driveway (Structure U) | | | | | | | | | |
| | | Storm Drain System Improvements - Remove and replace pipe and manholes (Pipes 26-29) | | | | | | | | | |
| Thornton Parkway | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $6,027 | $129,482 |
| Total Thornton | Thornton | All Thornton Improvements | $10,683,236 | $0 | $1,602,486 | $534,162 | $1,068,323 | $2,670,810 | $15,122,331 | $388,442 | $8,344,589 |
| Total Adams County | Adams County | All Adams County Improvements | $9,788 | $0 | $1,468 | $489 | $979 | $2,447 | $15,171 | $7,806 | $167,690 |
| Total | Thornton/ Adams County | All Improvements | $10,693,024 | $0 | $1,603,954 | $534,651 | $1,069,302 | $2,673,257 | $15,137,502 | $396,248 | $8,512,279 |

## Legend

- Detention_Facilities
- Flume
- 40-ft x 10-ft Emergency Spillway Box
- 7.5-FT SSP, Jack and Bore
- Cutoff Wall
- Spillway
- Storm Drain
- Culvert
- Bridge
- Install Outlet Structure
- Modify Manhole
- Manhole
- Check Structure (Concrete)
- Sloping Drop Structure
- Channel Improvements
- Soil Riprap, Type M
- CL
- Canals
- Roads
- Contours
- Basin Boundary
- Water Body
- Thornton City Boundary
- Adams County Boundary

N

0 300 600 1,200 Feet

REPLACE 24-INCH RCP WITH 30-INCH RCP

REPLACE 36-INCH RCP WITH 42-INCH RCP

REPLACE 48-INCH RCP WITH 60-INCH RCP

RACE STREET REPLACE EXISTING (1) 24-INCH RCP WITH (1) 60-INCH RCP

(6) 3-FT CHECK STRUCTURES

(1) 3-FT CHECK STRUCTURE

REPLACE 48-INCH RCP WITH 66-INCH RCP

REMOVE AND REPLACE FAILED 6-FT DROP STRUCTURE

(3) 3-FT CHECK STRUCTURES

THORNTON PARKWAY EXISTING 48-INCH RCP ADD PARALLEL 42-INCH RCP

REPLACE 30-INCH WITH 42-INCH RCP

TRAIL AT COMMUNITY PARK REPLACE EXISTING (1) 18-INCH CMP WITH PEDESTRIAN BRIDGE 45-FT SPAN

CHANNEL IMPROVEMENTS

2-FT DROP STRUCTURE (TO BE COMPLETED IN CONJUNCTION WITH STORM DRAIN IMPROVEMENTS)

GRASS REPLACE EXISTING (1) 42-INCH RCP WITH (1) 42-INCH RCP, LOWERED 2-FT

DRIVEWAY EXISTING (1) 42-INCH RCP ADD (1) 30-INCH RCP

REPLACE 24-INCH RCP WITH 48-INCH RCP

(1) 3-FT CHECK STRUCTURE

(2) 7.5-FT SSP, JACK AND BORE

(1) 3-FT CHECK STRUCTURE

40-FT X 10-FT EMERGENCY SPILLWAY BOX

(1) 3-FT CHECK STRUCTURE

REPLACE 30-INCH RCP WITH 60-INCH RCP

COLORADO AGRICULTURAL DITCH REPLACE EXISTING (2) 18-INCH RCP WITH (2) 42-INCH RCP, LOWERED

(4) 3-FT CHECK STRUCTURES

REPLACE 36-INCH RCP WITH 72-INCH RCP

REPLACE EXISTING CULVERT WITH (1) 36-INCH RCP

INSTALL 48-INCH RCP

CHANNEL IMPROVEMENTS

3-FT DROP STRUCTURE

EXPAND DETENTION AN ADDITIONAL 1.1 ACRE-FT UPSTREAM OF RTD NMRL (TOTAL DETENTION = 3.5 ACRE-FT)

CHANNEL IMPROVEMENTS

REMOVE EXISTING 18-INCH RCP

INSTALL 84-INCH RCP

INSTALL 84-INCH RCP

OLD RIVERDALE ROAD EXISTING (1) 84-INCH CMP ADD (3) 8-FT X 6-FT RCBC

CHANNEL IMPROVEMENTS

(3) 2.5-FT DROP STRUCTURES

REMOVE EXISTING (3) 38-INCH X 24-INCH HERCP

CONNECT TO EXISTING 84-INCH RCP

INSTALL 48-INCH RCP

DRIVEWAY REPLACE EXISTING CULVERT WITH 12-FT X 4-FT RCBC

CHANNEL IMPROVEMENTS

DRIVEWAY REPLACE EXISTING CULVERT WITH 12-FT X 4-FT RCBC

MCKAY ROAD REPLACE EXISTING 24-INCH CMP WITH 7-FT X 4-FT RCBC

WEST SPRAT PLATTE LAKE

ADAMS COUNTY 88TH AVENUE OPEN SPACE

**INTERACTIVE FIGURES**

STUDY AREA
CHANNEL STABILIZATION
CHANNEL CONVEYANCE IMPROVEMENTS
STRUCTURE IMPROVEMENTS
STORM DRAIN SYSTEM IMPROVEMENTS
DETENTION/WATER QUALITY
RECOMMENDED PLAN

CLICK TO TURN STREETS ON OR OFF

CLICK TO TURN AERIAL ON OR OFF

CLICK TO TURN TOPOGRAPHY ON OR OFF

| | | | |
|---|---|---|---|
| PROJECT: 017-2321<br>DRAWN BY: MD<br>DATE: 05/2019 | **MILE HIGH FLOOD DISTRICT**<br>**CITY OF THORNTON AND ADAMS COUNTY** | **BASIN 4100 AND DFA 0056**<br>**ALTERNATIVES MAP** | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | FIGURE<br>3 |

## 6.0 CONCEPTUAL DESIGN

### 6.1 Plan Development Overview

The Selected Plan letter was issued by MHFD, on behalf of Adams County and the City of Thornton, on November 27, 2019, and is included in Appendix A. The Recommended Plan from the Alternatives Analysis, outlined in Section 5, was accepted for the Selected Plan, with the inclusion of two deviations which are described herein. The Selected Plan is intended to provide adequate protection while adhering to Adams County's, Thornton's, and MHFD's drainage criteria. The Selected Plan consists of the major (future conditions 100-year) storm conveyance improvements, including floodplain preservation, crossing structure improvements, channel improvements, regional detention, and storm drain system improvements. Several changes to the recommended plan were implemented during the conceptual design phase. These changes included:

- Reduce the size of the Subbasin 316's emergency spillway for the RTD NMRL embankment crossing. Thornton retained Olsson under a separate contract to complete a final design of the overflow structure during the development of the conceptual design. Olsson's final design is shown in this conceptual design.

- The Drainageway 4100 old Riverdale Road crossing design was updated to include a non-levee feature berm to allow for smaller flows to maximize head at the existing crossing location, with higher flows engaging the spillway of the berm, and an additional crossing structure that outlets directly to the South Platte River that provides a combined 100-year storm event capacity. This change from the alternatives analysis was directed by the sponsors after the Selected Plan letter was issued.

- Thornton provided new survey of the trail crossing at the Colorado Agricultural Ditch which showed that the crossing consisted of two 24-inch RCPs, not the two 18-inch RCPs that were used in the previous analysis. All report sections except the alternatives analysis were updated with the updated pipe size.

- The Drainageway 4100 and West G Tributary recommended check structure channel stabilization improvements were replaced with drop structures and channel grading.

- Along School Tributary, detention will be implemented on the west side of the RTD NMRL embankment due to cited utility conflicts on the east side of the embankment.

- Remove the J Tributary crossing structure recommendation where the trail was recently installed.

- During the conceptual design phase, adjustments were made based on progressing the design to a more detailed level than the alternatives analysis. The most significant changes are on North K Tributary, where the structure and channel design had to be modified based on the higher channel invert that would be needed to tie into the 2-year diversion storm drain system.

Summaries of the proposed crossing structures and the proposed storm drain pipes are shown in Table 22 and Table 23, respectively. A summary of the selected plan costs is included in Table 24.

Conceptual level plan and profile sheets are included in Appendix G. Typical cross sections for channel improvements are shown on the master plan in Appendix G.

The approximate future land use 100-year floodplains with and without improvements are shown on the plan sheet. The floodplains were delineated using the HEC-RAS information at each cross section location and the LiDAR data between cross sections. The future land use 100-year water surface elevations with and without improvements shown on the profile sheet were exported directly from HEC-RAS, with the exception of North K Tributary, where the water surface elevations were estimated using FlowMaster and UD_Culvert calculations. The master plan HEC-RAS cross sections and FlowMaster calculations are included in Appendix F.

#### Selected Plan Hydrology

The baseline hydrology was updated to include the proposed detention basin on School Tributary and outlet pipe. No other changes to the model were made. The conceptual design detention basin calculations, SWMM routing schematic, CUHP input (which matches the baseline model), SWMM input and output, and peak flows and volumes, are included in Appendix F.

#### Costs

A summary of the quantity methods and unit costs used for the master plan improvements is included in Section 5.5 – Alternative Costs. The unit costs shown in Table 16 were updated to reflect 2020 costs and are included in Table 22. After adjusting to 2020 costs using a factor of 1.26, many of the unit costs appeared to be low when compared to recent bid data. The unit cost factor was increased 50%, to 1.89 to better represent 2020 bid data. The channel improvement earthwork quantities were updated to reflect the proposed grading shown on the plan. A mid-range excavation cost was used to account for uncertainties in grading, riprap, and vegetation, which is the same as was done in the alternatives.

The total estimated construction cost of the master plan improvements is $27.8 million, or $41.9 million including maintenance over 50 years. The total cost of the improvements in each jurisdiction is included at the end of this section, in Table 25.

#### Hydraulics

The selected plan improvements were input into the existing conditions HEC-RAS 5.0.3 model to determine the approximate conceptual design floodplain and profiles. The approximate conceptual design floodplains and profile on North K Tributary were based on the UD-Culvert and channel FlowMaster calculations.

#### General Recommendations

In general it is recommended that:

1. The controlling jurisdictions take steps to stabilize all major waterways when their watershed urbanizes, rehabilitate existing degraded reaches of the waterways and their tributaries, and aggressively control erosion and sediment transport during construction activities.

2. The Sponsors and any other jurisdiction having land use control powers in this watershed require new land development, significant redevelopment, and publicly funded projects to provide to the maximum extent practicable runoff volume control practices (i.e., minimize

directly connected impervious areas and employ infiltrating BMPs) whenever site conditions permit.

3. The controlling jurisdictions take steps to require that all BMPs for all new development, redevelopment, and publicly funded projects provide to the maximum extent practicable a Water Quality Capture Volume (WQCV) as recommended in the Urban Storm Drainage Criteria Manual – Volume 3, after accounting for volume reductions achieved using volume control practices as recommended under Item 2 above.

4. All jurisdictions having land use control powers in this watershed continue to implement their floodplain management regulations, including regulation of the 100-year floodway and floodplain.

5. All jurisdictions having land use control powers in this watershed continue to participate in FEMA's flood insurance Community Rating System and public education programs.

6. All jurisdictions having land use control powers in these watersheds shall monitor land-use changes and whenever the land-use changes result in imperviousness ratios that exceed the projections identified in the *Final Report*, these jurisdictions shall take steps to further limit increases in stormwater runoff through the use of additional on-site detention, infiltrating BMPs and WQCV BMPs, thereby reducing the runoff rates, volumes, and future damage potentials to the *Final Report* levels.

***Table 22 - Selected Plan Unit Costs***

| Item | Unit | 2020 Unit Cost |
|---|---|---|
| 30-inch | LF | $170 |
| 36-inch | LF | $204 |
| 42-inch | LF | $238 |
| 48-inch | LF | $272 |
| 60-inch | LF | $454 |
| 66-inch | LF | $499 |
| 72-inch | LF | $680 |
| 84-inch | LF | $794 |
| 30-inch FES | EA | $2,967 |
| 36-inch FES | EA | $3,043 |
| 42-inch FES | EA | $3,213 |
| 48-inch FES | EA | $3,893 |
| Concrete | CY | $1,134 |
| Steel | LB | $2 |
| Manhole, 5' Dia. (Pipe Dia. 36" - 42"), Depth > 15-feet) | EA | $7,371 |

***Table 22 - Selected Plan Unit Costs***

| Item | Unit | 2020 Unit Cost |
|---|---|---|
| Manhole, 6' Dia. | EA | $8,127 |
| Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees | EA | $22,680 |
| Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees | EA | $28,350 |
| Modify Manhole | EA | $2,250 |
| Removal of Culvert Pipe (D<48") | LF | $38 |
| Removal of Culvert Pipe (48"<D<84") | LF | $94 |
| Removal of Culvert Pipe (D>84") | LF | $142 |
| Emergency Overflow Box | EA | $127,500 |
| Pedestrian Bridge | EA | $225,000 |
| Grouted Boulders, 36-inch | SY | $359 |
| Excavation, Mid-Range | CY | $45 |
| Detention (Complete-in-Place) | AC-FT | $86,184 |
| Wall | LF | $150 |
| Diversion Structure | EA | $30,000 |
| Soil Riprap, Type M | CY | $132 |
| Reclamation & Seeding (Native Grasses) | AC | $1,890 |
| Remove Failed Drop Structure | EA | $45,000 |
| Culvert Maintenance | LF | $2 |
| Manhole and Inlet Maintenance | EA | $94 |
| Hydraulic Structure Maintenance | EA | $945 |
| Channel Maintenance | LF | $4 |
| Detention/WQ Maintenance | ACRE | $2,835 |

***Table 23 – Proposed Crossing Structures***

| Reach | Station | Juris. | Street Name | Existing Structure | Proposed Structure | Str. ID | Design Point | $Q_2$ (cfs) | $Q_5$ (cfs) | $Q_{10}$ (cfs) | $Q_{25}$ (cfs) | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) | $WSE_{100}$ | $Q_{500}$ (cfs) | Bridge LC Elev | Bridge Freeboard Elevation | HW/D Criteria | HW:D Criteria Elev | Overtop Elev[1] | Controlling Criteria | Controlling Elevation | Criteria Met? | Overtop? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drainageway 4100-1 | 10512 | Thornton | Old Riverdale Road | (1) 84-inch CMP | (3) 8-foot (S) x 6-foot (R) RCBC and (1) 48-inch RCP[2] | A | 100 | 210 | 323 | 445 | 783 | 977 | 1,117 | 5,085.76 | 1860 | --- | --- | 1.50 | 5,088.26 | 5,086.00 | Overtopping | 5,086.00 | YES | NO |
| | | | | | (3) 8-foot (S) x 6-foot (R) RCBC[2] | | | | | | | | 1,227 | 5,086.49 | | --- | --- | 1.50 | 5,088.26 | 5,087.00 | Overtopping | 5,087.00 | YES | NO |
| | 11039 | Thornton | Colorado Boulevard | (2) 9-foot (S) x 5-foot (R) RCBC | --- | B | 105 | 106 | 167 | 236 | 421 | 541 | 703 | 5,089.39 | 1104 | --- | --- | 1.50 | 5,091.85 | 5,096.89 | HW:D | 5,091.85 | YES | NO |
| | 11260 | Thornton | Cypress Drive | (2) 9-foot (S) x 5-foot (R) RCBC | --- | C | 105 | 106 | 167 | 236 | 421 | 541 | 703 | 5,094.33 | 1104 | --- | --- | 1.50 | 5,094.78 | 5,099.00 | HW:D | 5,094.78 | YES | NO |
| | 13472 | Thornton | Lower Clear Creek Canal | (2) 84-inch RCP | --- | D | 110T | 53 | 82 | 115 | 189 | 240 | 302 | 5,110.65 | 446 | --- | --- | 1.50 | 5,116.26 | 5,117.00 | HW:D | 5,116.26 | YES | NO |
| | 15091 | Thornton | Welby Road | (2) 8-foot (S) x 6-foot (R) RCBC | --- | E | 115 | 24 | 40 | 74 | 135 | 150 | 165 | 5,133.08 | 206 | --- | --- | 1.50 | 5,140.02 | 5,140.97 | HW:D | 5,140.02 | YES | NO |
| | 15376 | Thornton | Trail at Colorado Agricultural Ditch | (2) 24-inch RCP | (2) 36-inch RCP (lowered) | F | 115 | 24 | 40 | 74 | 135 | 150 | 165 | 5,142.88 | 206 | --- | --- | 1.50 | 5,142.67 | 5,142.63 | Overtopping | 5,142.63 | NO[5] | YES |
| Drainageway 4100-2 | 15787 | Thornton | RTD NMRL | (2) 36-inch RCP | --- | G | 115 | 24 | 40 | 74 | 135 | 150 | 165 | 5,163.24 | 206 | --- | --- | ---[2] | ---[2] | 5,176.32 | ---[2] | 5,176.32 | YES | NO |
| | 16777 | Thornton | Trail Upstream of Pond 316 | (10) 18-inch HDPE | --- | H | 130T | 74 | 108 | 153 | 274 | 410 | 619 | 5,163.87 | 1049 | --- | --- | 1.50 | 5,162.25 | 5,162.63 | HW:D | 5,162.25 | NO[5] | YES |
| | 18210 | Thornton | Clayton Court | (2) 8-foot (S) x 5-foot (R) RCBC | --- | I | 130T | 74 | 108 | 153 | 274 | 410 | 619 | 5,184.09 | 1049 | --- | --- | 1.50 | 5,186.05 | 5,186.39 | HW:D | 5,186.05 | YES | NO |
| | 18716 | Thornton | Trail to Community Park | (1) 18-inch CMP | Pedestrian Bridge (45-foot long) | J | 130 | 47 | 62 | 80 | 177 | 272 | 418 | 5,190.84 | 719 | 5190.5 | 5,189.81 | --- | --- | 5,191.00 | Bridge FB | 5,189.81 | NO[5] | NO |
| | 20176 | Thornton | Thornton Parkway | (1) 48-inch RCP | Existing and (1) 42-inch RCP | K | 131O | 32 | 39 | 40 | 112 | 175 | 283 | 5,219.23 | 486 | --- | --- | 1.50 | 5,217.28 | 5,223.00 | HW:D | 5,217.28 | NO[6] | NO |
| | 21579 | Thornton | Race Street | (1) 24-inch RCP | (1) 60-inch RCP | L | 131O | 32 | 39 | 40 | 112 | 175 | 283 | 5,260.28 | 486 | --- | --- | ---[2] | ---[3] | 5,261.16 | ---[3] | 5,261.16 | ---[3] | NO |
| B Tributary | n/a | Thornton | Welby Road | (1) 36-inch CMP | Remove existing | P | 113 | 14 | 22 | 33 | 54 | 70 | 89 | --- | 134 | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | n/a | Thornton | Yucca Way to East of RTD NMRL | (1) 36-inch RCP | --- | Q | 113 | 14 | 22 | 33 | 54 | 70 | 89 | --- | 134 | --- | --- | ---[3] | ---[4] | 5,173.00 | ---[4] | 5,173.00 | YES | NO |
| North K Tributary | 70140 | Thornton | Access Road | Unknown | (1) 12-foot (S) x 4-foot (R) RCBC | S | 143 | 56 | 36 | 80 | 195 | 271 | 377 | 5,054.50 | 668 | --- | --- | 1.50 | 5,055.40 | 5,061.10 | HW:D | 5,055.40 | YES | NO |
| | 71208 | Thornton | Access Road | Unknown | (1) 12-foot (S) x 6-foot (R) RCBC | T | 145 | 48 | 73 | 101 | 164 | 206 | 258 | 5,056.80 | 381 | --- | --- | 1.50 | 5,057.56 | 5,063.0 | HW:D | 5,057.56 | YES | NO |
| | 71630 | Thornton | McKay Road | (1) 24-inch RCP | (1) 16-foot (S) x 3-foot (R) RCBC | 22 | 145 | 48 | 73 | 101 | 164 | 206 | 258 | 5,057.95 | 381 | --- | --- | 1.50 | 5,058.95 | 5,058.0 | Overtopping | 5,058.00 | YES | NO |
| Colorado Boulevard | 60149 | Adams County | Driveway | (1) 42-inch RCP | Existing and (1) 30-inch RCP | U | 109 | 11 | 17 | 24 | 41 | 52 | 65 | 5,151.10 | 98 | --- | --- | 1.50 | 5,151.87 | 5,152.00 | HW:D | 5,151.87 | YES | NO |

[1]Overtopping elevation based on lowest road elevation where water could overtop.

[2]Old Riverdale Road crossing was evaluated for two scenarios: 1) berm failure, future WQ outlet pipe utilized and 2) berm remains in place and full flow goes through RCBCs. The overtopping elevation for Scenario 1 was set to the lowest point water could overtop, which is located in the future WQ detention basin area, and Scenario 2 was set to the berm crest elevation.

[3]Detention Basin outlet, Headwater:depth ratio does not apply.

[4]Structure capacity based on RTD NMRL plans - Q100=90 cfs.

[5]Criteria not met is okay, since this is a trail crossing.

[6]Structure is a long storm drain pipe, so it is ok to not meet HW:D ratio.

***Table 24 – Proposed Storm Drain System Pipes***

| Pipe ID | Reach | Description | Design Point | Future $Q_2$ (cfs) | Future $Q_{100}$ (cfs) | Existing Diameter (in) | Proposed Diameter (in) | Hyd. Radius R (in) | n | Slope (ft/ft) | Pipe Capacity[1] (cfs) | Storm Event | Velocity (fps) | Future 100-Year Minus Capacity (cfs) | Overland Capacity (cfs) | Total Capacity (cfs) | Total Storm Event Capacity | Meet Criteria? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| K | Drainageway 4100-2 | Thornton Parkway and Community Park | 131O | 32 | 283 | 48 | 48 | 12.00 | 0.015 | 0.018 | 169 | 100 | 13.5 | --- | --- | 287 | 100 | YES |
| | | | | | | --- | 42 | 10.50 | 0.015 | 0.018 | 118 | | 12.2 | | | | | |
| 3 | D Tributary | Gaylord Street | 135T | 21 | 131 | 30 | 42 | 10.50 | 0.015 | 0.023 | 133 | 100 | 13.8 | --- | 31 | 163 | 100 | YES |
| 5 | West G Tributary | Crosses under Thornton Parkway from 97th Ave | 123 | 32 | 282 | 48 | 66 | 16.50 | 0.015 | 0.010 | 295 | 100 | 12.4 | --- | 20 | 315 | 100 | YES |
| 6 | West G Tributary | Crosses under Thornton Parkway from 97th Ave | 123 | 32 | 282 | 48 | 60 | 15.00 | 0.015 | 0.014 | 264 | 50 | 13.5 | 18 | 20 | 284 | 100 | YES |
| 7 | West G Tributary | Travels along 97th Avenue | 124T | 11 | 151 | 36 | 42 | 10.50 | 0.015 | 0.024 | 134 | 50 | 14.0 | 17 | 31 | 166 | 100 | YES |
| 8 | West G Tributary | From Pond 327 | 127O | 10 | 79 | 24 | 30 | 7.5 | 0.015 | 0.027 | 59 | 25 | 12 | 21 | 21 | 80 | 100 | YES |
| 26 | Colorado Boulevard | Parallel to Colorado Boulevard | 106 | 41 | 313 | 36 | 72 | 18.00 | 0.015 | 0.007 | 307 | 50 | 10.9 | 6 | 28 | 335 | 100 | YES |
| 27 | Colorado Boulevard | Parallel to Colorado Boulevard | 107O | 22 | 215 | 30 | 60 | 15.00 | 0.015 | 0.011 | 239 | 100 | 12.2 | --- | 27 | 267 | 100 | YES |
| 28 | Colorado Boulevard | Parallel to Colorado Boulevard | 107O | 22 | 215 | 24 | 48 | 12.00 | 0.015 | 0.027 | 205 | 50 | 16.3 | 10 | 39 | 244 | 100 | YES |
| 29 | Colorado Boulevard | Parallel to Colorado Boulevard | 109 | 11 | 65 | 42 | 42 | 10.50 | 0.015 | 0.005 | 65 | 50 | 6.7 | 1 | 39 | 104 | 100 | YES |
| --- | School Tributary | From Monroe Street to Welby Road | 102T | 89 | 426 | --- | 84 | 21.00 | 0.015 | 0.009 | 527 | 100 | 13.7 | --- | --- | 527 | 100 | YES |
| --- | School Tributary | From Welby Road to RTD NMRL | 102O | 46 | 288 | --- | 66 | 16.50 | 0.015 | 0.015 | 357 | 100 | 15.0 | --- | --- | 357 | 100 | YES |
| --- | B Tributary | From RTD NMRL | 112 | 16 | 104 | --- | 48 | 12.00 | 0.015 | 0.007 | 104 | 100 | 8.1 | --- | --- | 104 | 100 | YES |
| --- | North K Tributary | From channel, north to 104th Avenue, to South Platte River | 143 | 56 | 433 | --- | 48 | 12.00 | 0.015 | 0.002 | 56 | 2 | 4.5 | 377 | 377 | 433 | 50 | YES |

[1]Mannings Eqn, USDCM vol1 Eqn 7-45:

$$Q = \frac{1.49}{n} A R^{2/3} S_f^{1/2}$$

***Table 25 - Selected Plan Cost Summary***

| Reach | Jurisdiction | Description | Capital | Easement/ ROW | Engineering | Legal/ Admin | Contract Admin/CM | Contingency | Total Capital Cost | Annual O&M Cost | 50-Year O&M Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Drainageway 4100-1 | Thornton | Status Quo - Outside of recommended improvement areas<br>Channel Improvements - 9 drop structures, channel grading<br>Structure Improvements - Remove and replace culverts and old Riverdale Road (Structure A), construct berm (optional), remove and replace culverts at the Trail at Colorado Agricultural Ditch (Structure F) | $2,084,841 | $0 | $312,726 | $104,242 | $208,484 | $521,210 | $3,231,503 | $93,961 | $2,018,489 |
| Drainageway 4100-2 | Thornton | Status Quo - Outside of recommended improvement areas<br>Channel Improvements - 9 drop structures, replace failed drop structure, channel grading<br>Structure Improvements - Remove culvert and install Pedestrian Bridge at Community Park (Structure J), remove and replace culverts at Race Street (Structure L)<br>Storm Drain System Improvements - Install parallel pipe and manholes at Thornton Parkway (Structure K)<br>Detention - Install emergency overflow box at RTD NMRL | $3,857,430 | $0 | $578,614 | $192,872 | $385,743 | $964,358 | $5,979,017 | $252,146 | $5,416,656 |
| School Tributary | Thornton | Status Quo - Outside of recommended improvement areas<br>Structure Drain System Improvements - Remove existing structures at canal and old Welby Road, install pipe and manholes<br>Detention - Construct detention basin downstream of RTD NMRL | $2,634,769 | $0 | $395,215 | $131,738 | $263,477 | $658,692 | $4,083,891 | $28,050 | $602,571 |
| B Tributary | Thornton | Status Quo - Outside of recommended improvement areas<br>Storm Drain System Improvements - Install pipe and manholes | $891,573 | $0 | $133,736 | $44,579 | $89,157 | $222,893 | $1,381,938 | $4,978 | $106,936 |
| D Tributary | Thornton | Status Quo - Outside of recommended improvement areas<br>Storm Drain System Improvements - Remove and replace pipe (Pipe 3) | $86,228 | $0 | $12,934 | $4,311 | $8,623 | $21,557 | $133,653 | $7,224 | $155,187 |
| West G Tributary | Thornton | Status Quo - Outside of recommended improvement areas<br>Channel Improvements - 1 drop structure, channel grading<br>Storm Drain System Improvements - Remove and replace pipe and manholes (Pipes 5-8) | $1,471,813 | $0 | $220,772 | $73,591 | $147,181 | $367,953 | $2,281,310 | $72,603 | $1,559,666 |
| North G Tributary | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $63,980 | $1,374,436 |
| H Tributary | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $1,128 | $24,232 |

***Table 25 - Selected Plan Cost Summary***

| Reach | Jurisdiction | Description | Capital | Easement/ ROW | Engineering | Legal/ Admin | Contract Admin/CM | Contingency | Total Capital Cost | Annual O&M Cost | 50-Year O&M Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| J Tributary | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $32,145 | $690,545 |
| | Adams County | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $15,612 | $335,380 |
| North K Tributary | Thornton | Status Quo - Outside of recommended improvement areas | $3,390,111 | $0 | $508,517 | $169,506 | $339,011 | $847,528 | $5,254,673 | $36,380 | $781,511 |
| | Thornton | Channel Conveyance Improvements - Channel improvements, remove and replace crossings (Structures R and S, and Pipe 22) | | | | | | | | | |
| | Thornton | Storm Drain System Improvements - Install pipe and manholes | | | | | | | | | |
| South K Tributary | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $11,412 | $245,155 |
| Colorado Boulevard | Thornton | Status Quo - Outside of recommended improvement areas | $3,511,426 | $0 | $526,714 | $175,571 | $351,143 | $877,856 | $5,442,710 | $22,666 | $486,912 |
| | | Channel Conveyance Improvements - 1 drop structure, channel grading | | | | | | | | | |
| | | Structure Improvements - Remove and replace culvert at driveway (Structure T) | | | | | | | | | |
| | | Storm Drain System Improvements - Remove and replace pipe and manholes (Pipes 26-29) | | | | | | | | | |
| Thornton Parkway | Thornton | Status Quo | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $12,604 | $270,763 |
| Total Thornton | Thornton | All Thornton Improvements | $17,928,191 | $0 | $2,689,228 | $896,410 | $1,792,819 | $4,482,047 | $27,788,695 | $639,277 | $13,733,059 |
| Total Adams County | Adams County | All Adams County Improvements | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $15,612 | $335,380 |
| Total | Thornton/ Adams County | All Improvements | $17,928,191 | $0 | $2,689,228 | $896,410 | $1,792,819 | $4,482,047 | $27,788,695 | $654,889 | $14,068,439 |

### 6.2 Master Plan Description

Maps of the alternatives are shown on Figure 4, included at the end of this section. All master plan improvements were evaluated based on the future infrastructure, future land use flows. The existing conditions for existing infrastructure to remain are shown on Figure 2. Summaries of the structure and storm drain improvements are included in Table 23 and 24, respectively. A summary of the costs for each reach is included in Table 25. The operations and maintenance cost for the improvements represent maintenance for the entire reach with the master plan improvements in place. The summary of costs includes contingencies, engineering design services, legal and administrative services, construction observation and materials testing, easements, and operations and maintenance completed three times per year over a course of 50 years.

## Reach: Drainageway 4100-1 (Thornton)

### Channel Improvements

A defined 100-year channel would be constructed downstream of old Riverdale Road. This reach of channel has vertical walls on one side and steep banks on the other. The proposed channel would have a geometry that would reflect a bankfull section with a 6-foot bottom width, 3 feet in depth and 4:1 side slopes. The bankfull section would meander through a section with floodplain benches on each side with an average width of 16 feet and tie into existing ground with 4:1 side slopes. Three 2-foot high drop structures would be constructed to achieve a stable slope of 0.7%. The channel downstream of the old Riverdale Road culvert would be raised to match the culvert invert elevation.

A defined 100-year channel could be constructed between Cypress Drive and the Lower Clear Creek Canal. This stretch of Drainageway 4100 shows signs of severe degradation. The channel would have a geometry that would reflect a bankfull section with a 6-foot bottom width, 2.5 feet in depth and 4:1 side slopes. The bankfull section would meander through a section with floodplain benches on each side with an average width of 16 feet and tie into existing ground with 4:1 side slopes. A 3.4-foot high drop structure would be constructed to achieve a stable slope of 0.7%. This drop structure could be constructed as several smaller drop structures.

In order to achieve the stable channel slope of 0.7% within the reach between Lower Clear Creek Canal and Welby Road, four 3-foot high maximum drop structures would be constructed, along with a bankfull section with a 4-foot bottom width, 1.5-foot depth, and 4:1 side slopes. The channel improvements would be implemented when signs of erosion begin to occur, and the channel begins to degrade.

The channel between Welby Road and the Colorado Agricultural Ditch would be graded in order to achieve a more stable slope and lower invert for the proposed trail culvert. A 1-foot high drop structure would be constructed immediately upstream of the trail culvert, as described in the structure improvements section.

The channel between the Colorado Agricultural Ditch and the railroad has steep side slopes and an incised low flow channel. However, the channel appears to be in good condition and the corridor is too tight to significantly flatten the side slopes or implement a high functioning, low maintenance stream design. No channel improvements are recommended in this portion of the reach.

The intent of the channel improvements is to provide as much of a high functioning, low maintenance, stream as possible within the existing stream corridor. The drop structures are intended to stabilize the channel slope. In general, low height drop structures, between 1-foot to 3-foot are recommended in this corridor. The current criteria at the time of final design should be used for channel improvements. The bankfull section is intended to meander in the overall channel corridor, with varying floodplain benches on each side.

The channel improvements are generally located on private property, with a large portion covered by easements. The large parcel between Colorado Blvd and just downstream of Lower Clear Creek Canal is on private property and has not yet been platted. When development of this parcel occurs, drainage easements and tracts for the floodplain will be dedicated to the City of Thornton. Near the Lower Clear Creek Canal crossing, the drainageway is on property owned by the Lower Clear Creek Canal. Upstream of Lower Clear Creek, tracts and easements are located along the drainageway corridor.

### Structure Improvements

To provide major storm conveyance, several structures require improvements:

- At the old Riverdale Road embankment (Structure A), near the downstream limit, the existing 84-inch CMP would be removed and replaced with three 8-foot wide by 6-foot high RCBCs. A non-levee feature berm with a spillway crest elevation of 5087 could be constructed across the low area north of old Riverdale Road. The berm would allow for additional capacity through the triple RCBC by maximizing the head, and a secondary 48-inch RCP outlet outfalling to the South Platte River would be installed to achieve 100-year capacity. The berm is a potential area for spoils and is not needed for the improvements to meet criteria; therefore, it was not included in the cost estimate. The 48-inch RCP elevation was determined based on crossing under the existing waterline. The triple RCBC is intended to cross over the existing waterline in this location. The waterline elevations used in development of this OSP were based on design plans. The exact waterline elevation and location should be investigated during final design.

  The design incorporated two scenarios.

  - Scenario 1 is based on ignoring the berm, and assuming a berm failure. This Scenario would be used for any FEMA regulated floodplain designs, since the berm would not be a certified levee. In this scenario, the 100-year peak flows would outlet through both the triple RCBCs and the secondary 48-inch RCP outlet. This design was optimized so that the master plan water surface elevation would not overtop the eastern low point elevation of 5086. The pipe-full capacity of the 48-inch RCP was subtracted from the 100-year peak flow in the HEC-RAS model to evaluate this scenario.

  - Scenario 2 is based on the berm keeping water in the smaller west cell. This scenario would not utilize the secondary 48-inch RCP outlet pipe, and the controlling low point elevation would be increased up to the spillway crest elevation of 5087 to better utilize the new RCBCs.

The intent of these structure improvements is to prevent 100-year peak flows from overtopping the low point on the east and minimize impacts to the existing waterline. The proposed configuration shows just one option to provide major storm conveyance, and changes to this configuration will likely occur during final design.

To avoid storm water flowing into the Colorado Agricultural Ditch and reduce the frequency of trail overtopping, the existing two 24-inch RCPs (Structure F) would be replaced with two 36-inch RCPs at the trail immediately downstream of the ditch crossing. The invert of the culverts would be 1 foot lower than the existing culverts on the upstream side and 2 feet lower on the downstream side. The Colorado Agricultural Ditch crosses Drainageway 4100 in a siphon approximately 10 feet upstream of the trail crossing. A 1-foot drop structure would be installed immediately upstream of the crossing, downstream of the ditch siphon crossing. The intent of the culvert replacements would be to prevent the 100-year storm event from spilling into the Colorado Agricultural Ditch, and to prevent the trail from being overtopped in a 10-year event. As designed in this study, the proposed culverts would have capacity for the 50-year storm event, and would keep the 100-year

storm event from spilling into the Colorado Agricultural Ditch. The proposed configuration shows just one option to provide major storm conveyance, and changes to this configuration will likely occur during final design. In addition to the installation of the drop structure, the channel would require grading modifications in the vicinity of the structure to match the lowered invert elevations. A sanitary sewer line is located in this vicinity and could restrict the proposed improvements at this location. As an alternative to the replacement of the existing culverts, the existing berm could be raised to prevent stormwater from entering the agricultural ditch. For both the culvert replacement option and the berm option, the priority was first, to prevent stormwater from entering the Colorado Agricultural Ditch, which could cause flooding along the ditch, and second, to reduce the frequency of trail overtopping.

The structure improvements are generally located on private property covered by easements and tracts.

CLICK HERE TO VIEW REACH DRAINAGEWAY 4100-1 MAP
CLICK HERE TO VIEW REACH DRAINAGEWAY 4100-1 PROFILE

**Operations and Maintenance Costs**

| Maintenance Operation | Cost |
|---|---|
| Crossing Structure | $2,907 |
| Drop Structures | $8,505 |
| Channel Maintenance | $19,908 |
| Manhole (includes only new manholes) | $0 |
| Detention | $0 |
| Total Annual Maintenance Cost[1] | $93,961 |
| Total Annual Maintenance Cost Over 50 Years[2] | $2,018,489 |

[1]Annual cost reflects maintenance operations three times per year, all existing infrastructure to remain, and master plan improvements.
[2]An effective interest rate of 4% was used to determine the total maintenance cost over 50 years, which refers to the total present value of the maintenance costs during a 50-year life cycle.

The total estimated construction cost for improvements in this reach is $3,232,000, or $5,250.000 with maintenance over 50 years.

**Master Plan Cost Estimator**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | | | |
| REACH: | 4100-1 | | | | | | |
| | | ESTIMATED BY: | MD | DATE: | 9/22/2020 | | |

| DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|
| 48x48 Circular | 142 | LF | $327 | $46,410 | Cost includes (2) FES |
| (3) 8x6 Box | 69 | LF | $5,601 | $386,475 | Cost includes (2) headwalls, toewalls, and wingwalls |
| 36x36 Circular | 78 | LF | $282 | $21,998 | Cost includes (2) FES |
| 36x36 Circular | 78 | LF | $282 | $21,998 | Cost inclues (2) FES |
| Potential Berm | 1 | LS | N/A | N/A | Optional, not included in cost |
| Removal of culvert pipe (D>84") | 69 | LF | $142 | $9,747 | |
| Removal of culvert pipe (D<48") | 78 | LF | $38 | $2,964 | |
| Removal of culvert pipe (D<48") | 78 | LF | $38 | $2,964 | |
| Reclamation & seeding (native grasses) | 1 | AC | $1,890 | $1,890 | |
| Reclamation & seeding (native grasses) | 4 | AC | $1,890 | $7,560 | |
| Reclamation & seeding (native grasses) | 1 | AC | $1,890 | $1,890 | |
| Sloping Drop Structure (2-ft) | 1 | EA | $48,266 | $48,266 | |
| Sloping Drop Structure (2-ft) | 1 | EA | $48,266 | $48,266 | |
| Sloping Drop Structure (2-ft) | 1 | EA | $48,266 | $48,266 | |
| Sloping Drop Structure (3.4-ft) | 1 | EA | $116,623 | $116,623 | |
| Sloping Drop Structure (1-ft) | 1 | EA | $45,673 | $45,673 | |
| Sloping Drop Structure (3-ft) | 1 | EA | $98,967 | $98,967 | |
| Sloping Drop Structure (3-ft) | 1 | EA | $84,486 | $84,486 | |
| Sloping Drop Structure (3-ft) | 1 | EA | $94,140 | $94,140 | |
| Sloping Drop Structure (2.8-ft) | 1 | EA | $142,806 | $142,806 | |
| Excavation, Mid Range | 1440 | CY | $45 | $64,800 | |
| Excavation, Mid Range | 8470 | CY | $45 | $381,150 | |
| Excavation, Mid Range | 1550 | CY | $45 | $69,750 | |

| Master Plan Improvement Cost Summary | | | | | |
|---|---|---|---|---|---|
| **Capital Improvement Costs** | | | | | |
| Pipe Culverts and Storm Drains | | | | $90,406 | |
| Concrete Box Culverts | | | | $386,475 | |
| Hydraulic Structures | | | | $727,493 | |
| Channel Improvements | | | | $515,700 | |
| Detention/Water Quality Facilities | | | | $0 | |
| Removals | | | | $15,675 | |
| Landscaping and Maintenance Improvements | | | | $11,340 | |
| Special Items (User Defined) | | | | $0 | |
| ROW/Easements | | | | $0 | |
| **Subtotal Capital Improvement Costs** | | | | **$1,747,089** | |
| **Additional Capital Improvement Costs** | | | | | |
| Dewatering | 3% | | | $15,471 | |
| Mobilization | 5% | | | $87,354 | |
| Traffic Control | 5% | | | $60,219 | |
| Utility Coordination/Relocation | 5% | | | $87,354 | |
| Stormwater Management/Erosion Control | 5% | | | $87,354 | |
| **Subtotal Additional Capital Improvement Costs** | | | | **$337,752** | |
| **Land Acquisition** | | | | | |
| ROW/Easements | | | | $0 | |
| **Other Costs (percentage of Capital Improvement Costs)** | | | | | |
| Engineering | 15% | | | $312,726 | |
| Legal/Administrative | 5% | | | $104,242 | |
| Contract Admin/Construction Management | 10% | | | $208,484 | |
| Contingency | 25% | | | $521,210 | |
| **Subtotal Other Costs** | | | | **$1,146,662** | |
| **Totals** | | | | **$3,231,503** | |

## Reach: Drainageway 4100-2 (Thornton)

### Channel Improvements

In order to achieve the stable channel slope of 0.7% within the reach, eight 3.0-foot high maximum and one 3.7-foot drop structures would be constructed, along with a bankfull section with a 4-foot bottom width, 1.5-foot depth, and 4:1 side slopes. The bankfull section would tie into the existing channel with a 2% bench. The channel improvements would be implemented when signs of erosion begin to occur, and the channel begins to degrade. The existing 6-foot drop structure upstream of Thornton Parkway has been undermined and would be removed and replaced to protect the upstream channel from further erosion.

The intent of the channel improvements is to provide as much of a high functioning, low maintenance, stream as possible within the existing stream corridor. The drop structures are intended to stabilize the channel slope. In general, low height drop structures, between 1-foot to 3-foot are recommended in this corridor. The current criteria at the time of final design should be used for channel improvements. The bankfull section is intended to meander in the overall channel corridor, with varying floodplain benches on each side.

The channel improvements in this reach are located on City of Thornton property.

### Structure Improvements

To provide major storm conveyance, several structures require improvements:

- The pedestrian trail upstream of Detention Basin 316 (Structure H) consists of ten 18-inch culverts. This area should be monitored due to the proximity of the floodplain to private properties immediately upstream of the crossing. If maintenance becomes an issue, a pedestrian bridge could be installed, although it was not included in the selected plan.
- The future 100-year floodplain spills onto 95th Avenue at the trail to Community Park (Structure J). Although this crossing is a trail, removing and replacing the structure would eliminate the upstream future 100-year spill on 95th Avenue. The existing 18-inch CMP would be removed and replaced with a 45-foot long pedestrian bridge. The goal of replacing this structure was to eliminate the 95th Avenue spill. As such, the freeboard criteria would not be met with this alternative. The bridge would be less prone to clogging as compared to the existing structure. Allowable trail slopes would dictate how much higher the bridge could be raised to meet freeboard requirements.
- The single 24-inch RCP at Race Street (Structure L) would be replaced with a 60-inch RCP. The 24-inch RCP serves as the existing Detention Basin 331 outlet. The outlet structure for the detention basin would be modified to ensure that the detention basin discharge does not change downstream of Race Street.

The structure improvements are located in right-of-way and City of Thornton property, with the exception of Race Street (Structure L), which extends onto private property with a tract for the drainageway.

### Storm Drain System Improvements

To prevent Thornton Parkway (Structure K) from being overtopped, a 42-inch RCP would be constructed adjacent to the existing 48-inch RCP on the south under Thornton Parkway and the northeast corner of Community Park. The south storm drain laterals would be disconnected from the existing pipe and reconnected to the new pipe. If needed, it is likely that the pipe invert elevations could be adjusted to connect to the storm drain laterals, if needed. The headwater to depth ratio of the existing pipe exceeds 1.5. However, the existing system consists of over 1,200 feet of pipe, and hydrostatic pressures will not exceed the weight of the pipe.

### Detention

An emergency overflow will be constructed for Detention Basin 316, upstream of the RTD NMRL. The surrounding area is fully developed, and an overland spillway is not feasible. The emergency outlet structure was designed by Olsson and consisted of a modified inlet box with a series of CDOT Type D closed mesh grates that will be constructed over the existing (2) 36-inch RCPs. The structure location was determined based on keeping the structure within the City of Thornton property a minimum of 2 feet. The structure was located on the east side of the existing and future trail to avoid being too close to the existing sanitary sewer. The existing and future trail alignments conflict with the outlet structure location and will need to be modified. A rectangular box with Type D inlet grates was used to best fit within these location constraints and to minimize the trail realignments.

The design criteria used for the overflow box was discussed with the City of Thornton, with input from MHFD regarding the floodplain. The overflow box design was based on effective base flood elevations and peak flows, since the results of this study will not become effective. The following design criteria were used to size the overflow structure:

- The rim of the overflow structure was set at the effective base flood elevation of 5164.30 to avoid a CLOMR or LOMR.
- A maximum of 1.5-foot of headwater, at an elevation of 5165.80, was used in the overflow structure capacity calculations.
- The design discharge was set at the downstream effective design flow of 232 cfs. The existing pipes have capacity to convey 232 cfs at a headwater elevation of 5165.80.

The structure was not sized to accommodate a clogged condition at 1.5 feet of depth; however, it was designed so that water would not pond higher than elevation 5167 in the event that it became 50% clogged. Keeping the water surface elevation below approximately 5167 when the structure is 50% clogged controlled the sizing of the structure. If the structure were to clog 50%, water would pond to elevation 5167.03 to achieve the 232 cfs design release rate. The design discharge is achieved at a water surface elevation of 5165.66.

The intent of these improvements is to reduce the potential for structure flooding in the event that the detention basin outlet structure is clogged. At an elevation of 5166, storm flows would flood the low point at the intersection of Eppinger Boulevard and Yucca Way. At elevation 5167, homes near this intersection, and several homes that back up to the detention basin would begin to flood. The basin has no overflow until it reaches an elevation of nearly 5172, when it would begin to flow south in the vee ditch adjacent to the RTD NMRL to School Tributary.

The detention improvements in this reach are located on City of Thornton property.

CLICK HERE TO VIEW REACH DRAINAGEWAY 4100-2 MAP
CLICK HERE TO VIEW REACH DRAINAGEWAY 4100-2 PROFILE

**Operations and Maintenance Costs**

| Maintenance Operation | Cost |
|---|---|
| Crossing Structure | $4,439 |
| Drop Structures | $9,450 |
| Channel Maintenance | $18,780 |
| Manhole (includes only new manholes) | $846 |
| Detention | $50,534 |
| Total Annual Maintenance Cost[1] | $252,146 |
| Total Annual Maintenance Cost Over 50 Years[2] | $5,416,656 |

[1]Annual cost reflects maintenance operations three times per year, all existing infrastructure to remain, and master plan improvements.
[2]An effective interest rate of 4% was used to determine the total maintenance cost over 50 years, which refers to the total present value of the maintenance costs during a 50-year life cycle.

The total estimated construction cost for improvements in this reach is $5,979,000, or $11,396,000 with maintenance over 50 years.

**Master Plan Cost Estimator**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | | | |
| REACH: | 4100-2 | | | | | | |
| | | ESTIMATED BY: | MD | DATE: | 9/22/2020 | | |

| DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|
| 42x42 Circular | 1229 | LF | $243 | $298,928 | Cost includes (2) FES |
| 60x60 Circular | 166 | LF | $699 | $116,033 | Cost includes (2) headwalls, toewalls, and wingwalls |
| Pedestrian Bridge | 1 | EA | $225,000 | $225,000 | |
| Emergency Overflow | 1 | EA | $127,500 | $127,500 | |
| Remove Failed Drop Structure | 1 | EA | $45,000 | $45,000 | |
| Removal of culvert pipe (D<48") | 50 | LF | $38 | $1,900 | |
| Removal of culvert pipe (D<48") | 166 | LF | $38 | $6,324 | |
| 5-Foot Diameter | 1 | EA | $7,371 | $7,371 | |
| 5-Foot Diameter | 1 | EA | $7,371 | $7,371 | |
| 5-Foot Diameter | 1 | EA | $7,371 | $7,371 | |
| Reclamation & seeding (native grasses) | 0.6 | AC | $1,890 | $1,134 | |
| Reclamation & seeding (native grasses) | 0.26 | AC | $1,890 | $492 | |
| Reclamation & seeding (native grasses) | 2.2 | AC | $1,890 | $4,158 | |
| Sloping Drop Structure (6-ft) | 1 | EA | $267,599 | $267,599 | |
| Sloping Drop Structure (3-ft) | 1 | EA | $282,424 | $282,424 | |
| Sloping Drop Structure (3-ft) | 1 | EA | $183,451 | $183,451 | |
| Sloping Drop Structure (3-ft) | 1 | EA | $241,386 | $241,386 | |
| Sloping Drop Structure (3-ft) | 1 | EA | $212,421 | $212,421 | |
| Sloping Drop Structure (3.7-ft) | 1 | EA | $235,482 | $235,482 | |
| Sloping Drop Structure (1.2-ft) | 1 | EA | $101,274 | $101,274 | |
| Sloping Drop Structure (3-ft) | 1 | EA | $202,767 | $202,767 | |
| Sloping Drop Structure (2.4-ft) | 1 | EA | $194,255 | $194,255 | |
| Sloping Drop Structure (3.1-ft) | 1 | EA | $133,695 | $133,695 | |
| Excavation, Mid Range | 1530 | CY | $45 | $68,850 | |
| Excavation, Mid Range | 630 | CY | $45 | $28,350 | |
| Excavation, Mid Range | 5260 | CY | $45 | $236,700 | |

| Master Plan Improvement Cost Summary | | | | | |
|---|---|---|---|---|---|
| **Capital Improvement Costs** | | | | | |
| Pipe Culverts and Storm Drains | | | | $437,074 | |
| Concrete Box Culverts | | | | $0 | |
| Hydraulic Structures | | | | $2,054,754 | |
| Channel Improvements | | | | $333,900 | |
| Detention/Water Quality Facilities | | | | $0 | |
| Removals | | | | $8,224 | |
| Landscaping and Maintenance Improvements | | | | $5,784 | |
| Special Items (User Defined) | | | | $397,500 | |
| ROW/Easements | | | | $0 | |
| **Subtotal Capital Improvement Costs** | | | | **$3,237,236** | |
| **Additional Capital Improvement Costs** | | | | | |
| Dewatering | 3% | | | $10,017 | |
| Mobilization | 5% | | | $161,862 | |
| Traffic Control | 5% | | | $124,591 | |
| Utility Coordination/Relocation | 5% | | | $161,862 | |
| Stormwater Management/Erosion Control | 5% | | | $161,862 | |
| **Subtotal Additional Capital Improvement Costs** | | | | **$620,194** | |
| **Land Acquisition** | | | | | |
| ROW/Easements | | | | $0 | |
| **Other Costs (percentage of Capital Improvement Costs)** | | | | | |
| Engineering | 15% | | | $578,614 | |
| Legal/Administrative | 5% | | | $192,872 | |
| Contract Admin/Construction Management | 10% | | | $385,743 | |
| Contingency | 25% | | | $964,358 | |
| **Subtotal Other Costs** | | | | **$2,121,587** | |
| **Totals** | | | | **$5,979,017** | |

## Reach: School Tributary (Thornton)

### Storm Drain System Improvements

A storm drain system would be constructed for major storm conveyance, and channels for local drainage could be constructed with development and connected to the storm drain system. To provide major storm conveyance in the storm drain system, an 84-inch RCP would be constructed between the existing end of system west of Monroe Street and the Welby Road existing 84-inch RCPs. A 66-inch RCP would be constructed between Welby Road and the proposed detention basin. The proposed detention basin discharge was used to size the 66-inch storm drain system upstream of the existing 84-inch RCP, and Design Point 102T, which is located at the downstream end of the undeveloped parcels was used to size the 84-inch RCP downstream of the existing pipe. The Colorado Agricultural Ditch Trail and old Welby Road crossings would be removed.

Channel conveyance improvements would be constructed to convey only the development peak flows in Subbasin 2T. The future 100-year peak flow for Subbasin 2T is estimated to be 284 cfs. The channel improvements were not included in the cost estimate, since they serve only the development and would be constructed by the developer.

A lineal easement for storm sewer/open channel has been platted from the Colorado Agricultural Canal to the southeast corner of the undeveloped property, where the present stub out from 88th Avenue exists. The existing pipe is in right-of-way.

### Detention Improvements

A 100-year, 3.7 acre-foot detention basin would be constructed immediately downstream, or east, of the RTD NMRL. A shallow sanitary sewer exists in old Welby Road and should be investigated during final design. A rundown with a forebay or stilling basin would be located downstream of the RTD NMRL culvert. A 6-foot wide by 6-inch deep trickle channel would drain to the micropool. Storm flows would outlet from the detention basin in a 66-inch RCP, with the outlet being restricted to a 64-inch equivalent diameter. A spillway was designed to carry the undetained 100-year peak flows. The existing trail would be realigned to be on top of the berm and spillway. The spillway would be constructed with ADA compliant slopes. A detention basin is located north of the proposed detention basin location. This detention basin should be considered with final design. It is the intent of these improvements to protect the existing detention basin features.

The intent of the detention basin is to reduce the future 100-year peak flows to 460 cfs at the existing storm drain system at Monroe Street based on Design Point 101. The final design volume, release rate, and drain time from the detention basin may vary from this conceptual design. It is recommended to incorporate the detention basin final design into the EPA SWMM 5.1.012 model to ensure that the final design results in peak flows equal to or less than 460 cfs at Design Point 101. The detention basin was sized assuming full downstream development, and no additional on-site detention would be required. This detention basin would not provide water quality capture volume, and water quality treatment would still be required for future development.

An aerial easement from the canal to the RTD right-of-way was platted as a stormwater easement, in anticipation of constructing a detention basin upstream of the canal, as shown on the Welby Station plat. As shown, the detention basin will extend onto RTD right-of-way and will also be located in a sanitary sewer easement.

During final design, additional constraints will need to be further evaluated.

- RTD ROW: Old Welby Road is within the RTD ROW, so there is potential that the grading within the ROW would be acceptable.
- The existing sanitary sewer would likely need to be relocated.
- The detention basin grading extents relative to the Colorado Agricultural Ditch would need to be evaluated.
- The existing pedestrian trail location and relocation alignment.
- The existing pond located to the north of the proposed location.

CLICK HERE TO VIEW REACH SCHOOL TRIBUTARY MAP
CLICK HERE TO VIEW REACH SCHOOL TRIBUTARY PROFILE

**Operations and Maintenance Costs**

| Maintenance Operation | Cost |
|---|---|
| Crossing Structure | $0 |
| Drop Structures | $0 |
| Channel Maintenance | $0 |
| Manhole (includes only new manholes) | $1,598 |
| Detention | $7,752 |
| Total Annual Maintenance Cost[1] | $28,050 |
| Total Annual Maintenance Cost Over 50 Years[2] | $602,571 |

[1]Annual cost reflects maintenance operations three times per year, all existing infrastructure to remain, and master plan improvements.
[2]An effective interest rate of 4% was used to determine the total maintenance cost over 50 years, which refers to the total present value of the maintenance costs during a 50-year life cycle.

The total estimated construction cost for improvements in this reach is $4,084,000, or $4,687,000 with maintenance over 50 years.

**Master Plan Cost Estimator**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | | | |
| REACH: | School Tributary | | | | | | |
| | | ESTIMATED BY: | MD | DATE: | 9/22/2020 | | |

| DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|
| 66x66 Circular | 472 | LF | $499 | $235,528 | |
| 66x66 Circular | 400 | LF | $499 | $199,600 | |
| 66x66 Circular | 337 | LF | $499 | $168,163 | |
| 84x84 Circular | 326 | LF | $794 | $258,844 | |
| 84x84 Circular | 400 | LF | $794 | $317,600 | |
| 84x84 Circular | 389 | LF | $794 | $308,866 | |
| 66x66 Circular | 97 | LF | $740 | $71,790 | Cost includes (1) headwalls, toewalls, and wingwalls |
| 84x84 Circular | 99 | LF | $794 | $78,606 | |
| Removal of culvert pipe (D<48") | 258 | LF | $38 | $9,804 | |
| Removal of culvert pipe (D<48") | 60 | LF | $38 | $2,280 | |
| Removal of culvert pipe (D<48") | 129 | LF | $38 | $4,902 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "P" | 1 | EA | $28,350 | $28,350 | |
| Type "P" | 1 | EA | $28,350 | $28,350 | |
| Type "P" | 1 | EA | $28,350 | $28,350 | |
| Type "P" | 1 | EA | $28,350 | $28,350 | |
| Detention Facility | 3.7 | AF | $86,184 | $318,881 | |

| Master Plan Improvement Cost Summary | | | | | |
|---|---|---|---|---|---|
| **Capital Improvement Costs** | | | | | |
| Pipe Culverts and Storm Drains | | | | $1,865,797 | |
| Concrete Box Culverts | | | | $0 | |
| Hydraulic Structures | | | | $0 | |
| Channel Improvements | | | | $0 | |
| Detention/Water Quality Facilities | | | | $318,881 | |
| Removals | | | | $16,986 | |
| Landscaping and Maintenance Improvements | | | | $0 | |
| Special Items (User Defined) | | | | $0 | |
| ROW/Easements | | | | $0 | |
| **Subtotal Capital Improvement Costs** | | | | **$2,201,664** | |
| **Additional Capital Improvement Costs** | | | | | |
| Dewatering | 3% | | | $9,566 | |
| Mobilization | 5% | | | $110,083 | |
| Traffic Control | 5% | | | $93,290 | |
| Utility Coordination/Relocation | 5% | | | $110,083 | |
| Stormwater Management/Erosion Control | 5% | | | $110,083 | |
| **Subtotal Additional Capital Improvement Costs** | | | | **$433,105** | |
| **Land Acquisition** | | | | | |
| ROW/Easements | | | | $0 | |
| **Other Costs (percentage of Capital Improvement Costs)** | | | | | |
| Engineering | 15% | | | $395,215 | |
| Legal/Administrative | 5% | | | $131,738 | |
| Contract Admin/Construction Management | 10% | | | $263,477 | |
| Contingency | 25% | | | $658,692 | |
| **Subtotal Other Costs** | | | | **$1,449,122** | |
| **Totals** | | | | **$4,083,891** | |

## Reach: B Tributary (Thornton)

### Storm Drain System Improvements

The construction of storm drain system improvements in B Tributary would help separate stormwater from the Colorado Agricultural Ditch. Several potential alignments were considered, including the alignment in the 2002 OSP, routing flows north in Welby Road and then east in Welby Circle, and also routing the flows in Welby Road. The local roads contain storm drain systems, sanitary sewer systems, and water mains. The proposed storm drain system would consist of 48-inch RCP with manholes and would be located in Welby Road to Drainageway 4100. The proposed alignment contains fewer potential utility conflicts with existing storm drain, sanitary sewer, and water systems. A portion of the storm drain system might need to be constructed under the sidewalk to maintain clearance from sanitary sewer and water mains. The proposed storm drain system would cross several existing storm drain laterals, water mains, a canal crossing, and a sanitary sewer main. These potential utility conflicts will need further evaluation during final design of any improvements. The existing storm drain laterals may need to be connected to the new storm drain system. Other utilities, including gas, electric, fiber optic, cable, and telephone were not investigated at this time, but will need to be considered for final design.

The improvements in this reach are generally located in right-of-way.

CLICK HERE TO VIEW REACH B TRIBUTARY MAP
CLICK HERE TO VIEW REACH B TRIBUTARY PROFILE

**Operations and Maintenance Costs**

| Maintenance Operation | Cost |
|---|---|
| Crossing Structure | $293 |
| Drop Structures | $0 |
| Channel Maintenance | $520 |
| Manhole (includes only new manholes) | $846 |
| Detention | $0 |
| Total Annual Maintenance Cost[1] | $4,978 |
| Total Annual Maintenance Cost Over 50 Years[2] | $106,936 |

[1]Annual cost reflects maintenance operations three times per year, all existing infrastructure to remain, and master plan improvements.
[2]An effective interest rate of 4% was used to determine the total maintenance cost over 50 years, which refers to the total present value of the maintenance costs during a 50-year life cycle.

The total estimated construction cost for improvements in this reach is $1,382,000, or $1,489,000 with maintenance over 50 years.

**Master Plan Cost Estimator**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | | | |
| DRAINAGEWAY: | Basin 4100 Tributary B | | | | | | |
| REACH: | B Tributary | | | | | | |
| | | ESTIMATED BY: | MD | DATE: | 9/22/2020 | | |

| DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|
| 48x48 Circular | 2434 | LF | $275 | $669,834 | Cost includes (2) FES |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |

| Master Plan Improvement Cost Summary | | | | | |
|---|---|---|---|---|---|
| **Capital Improvement Costs** | | | | | |
| Pipe Culverts and Storm Drains | | | | $742,977 | |
| Concrete Box Culverts | | | | $0 | |
| Hydraulic Structures | | | | $0 | |
| Channel Improvements | | | | $0 | |
| Detention/Water Quality Facilities | | | | $0 | |
| Removals | | | | $0 | |
| Landscaping and Maintenance Improvements | | | | $0 | |
| Special Items (User Defined) | | | | $0 | |
| ROW/Easements | | | | $0 | |
| **Subtotal Capital Improvement Costs** | | | | **$742,977** | |
| **Additional Capital Improvement Costs** | | | | | |
| Dewatering | 3% | | | $0 | |
| Mobilization | 5% | | | $37,149 | |
| Traffic Control | 5% | | | $37,149 | |
| Utility Coordination/Relocation | 5% | | | $37,149 | |
| Stormwater Management/Erosion Control | 5% | | | $37,149 | |
| **Subtotal Additional Capital Improvement Costs** | | | | **$148,596** | |
| **Land Acquisition** | | | | | |
| ROW/Easements | | | | $0 | |
| **Other Costs (percentage of Capital Improvement Costs)** | | | | | |
| Engineering | 15% | | | $133,736 | |
| Legal/Administrative | 5% | | | $44,579 | |
| Contract Admin/Construction Management | 10% | | | $89,157 | |
| Contingency | 25% | | | $222,893 | |
| **Subtotal Other Costs** | | | | **$490,365** | |
| **Totals** | | | | **$1,381,938** | |

## Reach: D Tributary (Thornton)

### Storm Drain System Improvements

To provide major storm conveyance in both the storm drain system and the street, the existing 30-inch RCP in Gaylord Street between Carrol Court and East 94th Avenue (Pipe 3) should be removed and replaced with a 42-inch RCP. This reach is located in right-of-way and City of Thornton property.

CLICK HERE TO VIEW REACH D TRIBUTARY MAP

**Operations and Maintenance Costs**

| Maintenance Operation | Cost |
|---|---|
| Crossing Structure | $0 |
| Drop Structures | $0 |
| Channel Maintenance | $1,656 |
| Manhole (includes only new manholes) | $752 |
| Detention | $0 |
| Total Annual Maintenance Cost[1] | $7,224 |
| Total Annual Maintenance Cost Over 50 Years[2] | $155,187 |

[1]Annual cost reflects maintenance operations three times per year, all existing infrastructure to remain, and master plan improvements.
[2]An effective interest rate of 4% was used to determine the total maintenance cost over 50 years, which refers to the total present value of the maintenance costs during a 50-year life cycle.

The total estimated construction cost for improvements in this reach is $134,000, or $289,000 with maintenance over 50 years.

## Master Plan Cost Estimator

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | | | |
| DRAINAGEWAY: | Basin 4100 Tributary D | | | | | | |
| REACH: | D Tributary | | | | | | |
| | | ESTIMATED BY: | MD | DATE: | 9/22/2020 | | |

| DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|
| 42x42 Circular | 254 | LF | $238 | $60,452 | |
| Modify Manhole | 1 | EA | $2,250 | $2,250 | |
| Removal of culvert pipe (D<48") | 254 | LF | $38 | $9,649 | |

| Master Plan Improvement Cost Summary | | | | | |
|---|---|---|---|---|---|
| **Capital Improvement Costs** | | | | | |
| Pipe Culverts and Storm Drains | | | | $60,452 | |
| Concrete Box Culverts | | | | $0 | |
| Hydraulic Structures | | | | $0 | |
| Channel Improvements | | | | $0 | |
| Detention/Water Quality Facilities | | | | $0 | |
| Removals | | | | $9,649 | |
| Landscaping and Maintenance Improvements | | | | $0 | |
| Special Items (User Defined) | | | | $2,250 | |
| ROW/Easements | | | | $0 | |
| **Subtotal Capital Improvement Costs** | | | | **$72,351** | |
| **Additional Capital Improvement Costs** | | | | | |
| Dewatering | 3% | | | $0 | |
| Mobilization | 5% | | | $3,618 | |
| Traffic Control | 5% | | | $3,023 | |
| Utility Coordination/Relocation | 5% | | | $3,618 | |
| Stormwater Management/Erosion Control | 5% | | | $3,618 | |
| **Subtotal Additional Capital Improvement Costs** | | | | **$13,877** | |
| **Land Acquisition** | | | | | |
| ROW/Easements | | | | $0 | |
| **Other Costs (percentage of Capital Improvement Costs)** | | | | | |
| Engineering | 15% | | | $12,934 | |
| Legal/Administrative | 5% | | | $4,311 | |
| Contract Admin/Construction Management | 10% | | | $8,623 | |
| Contingency | 25% | | | $21,557 | |
| **Subtotal Other Costs** | | | | **$47,425** | |
| **Totals** | | | | **$133,653** | |

## Reach: West G Tributary (Thornton)

### Channel Improvements

In order to achieve the stable channel slope of 0.4% within the reach, one 3.0-foot high drop structure would be constructed, with a typical channel section of 4 feet wide, and 2.5:1 side slopes tying into existing ground, to limit the amount of grading within the channel. Alternatively, if channel grading is undesirable in this area, a buried drop structure could be constructed to allow for future channel degradation, gradually exposing the drop as the channel stabilizes to its desirable slope. The channel improvements are located on City of Thornton property.

### Storm Drain System Improvements

To provide major storm conveyance in both the storm drain system and the street, the 97th Avenue and York Street existing 48-inch, 36-inch, and 24-inch storm drain systems (Pipes 5 through 8) would be removed and replaced with 66-inch, 60-inch, 42-inch, and 30-inch RCPs. A detailed analysis of the storm drain and street system should be completed in this area when the site south of Thornton Parkway is developed.

If the existing structures were left in place, the combined existing storm system and street capacities for 97th Avenue and the system southeast of Detroit Court that goes underneath Thornton Parkway from 97th Avenue do not contain the 100-year event and could put properties at risk of flooding or inhibit emergency access. Allowable street spread generally controlled street capacities in this area, which would result in a higher risk of inhibiting emergency access, as opposed to property flooding.

Flows that exceed the capacity of the storm drain system in West G Tributary and North G Tributary will flow down Fillmore Street and 97th Avenue, respectively, to the intersection and into a sump on Thornton Parkway. The sump in Thornton Parkway is located north of an undeveloped area. Fire Station #1 may be relocated to this undeveloped site in the future. The total future 100-year peak flow that reaches 97th Avenue and Thornton Parkway (Design Point 120) is 391 cfs., which accounts for the upstream detention basins included in the baseline hydrology. Based on the estimated pipe capacities, a total of 187 cfs will be conveyed in the pipes, and 204 cfs will flow overland to the sump. This analysis is based on pipe-full capacities based on street slopes and supplemental survey and does not include an evaluation of inlets. A detailed analysis of the storm drain and street system should be completed in this area when the site south of Thornton Parkway is developed.

The storm drain system is located in right-of-way.

CLICK HERE TO VIEW REACH WEST G TRIBUTARY MAP
CLICK HERE TO VIEW REACH WEST G TRIBUTARY PROFILE

**Operations and Maintenance Costs**

| Maintenance Operation | Cost |
|---|---|
| Crossing Structure | $0 |
| Drop Structures | $945 |
| Channel Maintenance | $18,578 |
| Manhole (includes only new manholes) | $1,222 |
| Detention | $3,456 |
| Total Annual Maintenance Cost[1] | $72,603 |
| Total Annual Maintenance Cost Over 50 Years[2] | $1,559,666 |

[1]Annual cost reflects maintenance operations three times per year, all existing infrastructure to remain, and master plan improvements.
[2]An effective interest rate of 4% was used to determine the total maintenance cost over 50 years, which refers to the total present value of the maintenance costs during a 50-year life cycle.

The total estimated construction cost for improvements in this reach is $2,282,000, or $3,841,000 with maintenance over 50 years.

**Master Plan Cost Estimator**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | | | |
| DRAINAGEWAY: | Basin 4100 Tributary G West | | | | | | |
| REACH: | West G Tributary | | | | | | |
| | | ESTIMATED BY: | MD | DATE: | 9/22/2020 | | |

| DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|
| 30x30 Circular | 623 | LF | $175 | $108,877 | Cost includes (1) FES |
| 42x42 Circular | 1888 | LF | $238 | $449,344 | |
| 60x60 Circular | 234 | LF | $454 | $106,236 | |
| 66x66 Circular | 251 | LF | $592 | $148,636 | Cost includes (1) headwalls, toewalls, and wingwalls |
| Removal of culvert pipe (48"<D<84") | 251 | LF | $94 | $23,637 | |
| Removal of culvert pipe (48"<D<84") | 234 | LF | $94 | $22,039 | |
| Removal of culvert pipe (D<48") | 623 | LF | $38 | $23,674 | |
| Removal of culvert pipe (D<48") | 1888 | LF | $38 | $71,744 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| 5-Foot Diameter | 1 | EA | $7,371 | $7,371 | |
| 5-Foot Diameter | 1 | EA | $7,371 | $7,371 | |
| 5-Foot Diameter | 1 | EA | $7,371 | $7,371 | |
| 5-Foot Diameter | 1 | EA | $7,371 | $7,371 | |
| 5-Foot Diameter | 1 | EA | $7,371 | $7,371 | |
| 5-Foot Diameter | 1 | EA | $7,371 | $7,371 | |
| 5-Foot Diameter | 1 | EA | $7,371 | $7,371 | |
| 5-Foot Diameter | 1 | EA | $7,371 | $7,371 | |
| 5-Foot Diameter | 1 | EA | $7,371 | $7,371 | |
| Reclamation & seeding (native grasses) | 0.25 | AC | $1,890 | $473 | |
| Sloping Drop Structure (3-ft) | 1 | EA | $94,140 | $94,140 | |
| Excavation, Mid Range | 600 | CY | $45 | $27,000 | |

| Master Plan Improvement Cost Summary | | | | | |
|---|---|---|---|---|---|
| **Capital Improvement Costs** | | | | | |
| Pipe Culverts and Storm Drains | | | | $970,152 | |
| Concrete Box Culverts | | | | $0 | |
| Hydraulic Structures | | | | $94,140 | |
| Channel Improvements | | | | $27,000 | |
| Detention/Water Quality Facilities | | | | $0 | |
| Removals | | | | $141,094 | |
| Landscaping and Maintenance Improvements | | | | $473 | |
| Special Items (User Defined) | | | | $0 | |
| ROW/Easements | | | | $0 | |
| **Subtotal Capital Improvement Costs** | | | | **$1,232,859** | |
| **Additional Capital Improvement Costs** | | | | | |
| Dewatering | 3% | | | $810 | |
| Mobilization | 5% | | | $61,643 | |
| Traffic Control | 5% | | | $53,215 | |
| Utility Coordination/Relocation | 5% | | | $61,643 | |
| Stormwater Management/Erosion Control | 5% | | | $61,643 | |
| **Subtotal Additional Capital Improvement Costs** | | | | **$238,954** | |
| **Land Acquisition** | | | | | |
| ROW/Easements | | | | $0 | |
| **Other Costs (percentage of Capital Improvement Costs)** | | | | | |
| Engineering | 15% | | | $220,772 | |
| Legal/Administrative | 5% | | | $73,591 | |
| Contract Admin/Construction Management | 10% | | | $147,181 | |
| Contingency | 25% | | | $367,953 | |
| **Subtotal Other Costs** | | | | **$809,497** | |
| **Totals** | | | | **$2,281,310** | |

## Reach: North G Tributary (Thornton)

No improvements are recommended as a part of the selected plan. This reach is located in right-of-way and City of Thornton property.

**Operations and Maintenance Costs**

| Maintenance Operation | Cost |
|---|---|
| Crossing Structure | $0 |
| Drop Structures | $0 |
| Channel Maintenance | $12,116 |
| Manhole (includes only new manholes) | $188 |
| Detention | $9,023 |
| Total Annual Maintenance Cost[1] | $63,980 |
| Total Annual Maintenance Cost Over 50 Years[2] | $1,374,436 |

[1]Annual cost reflects maintenance operations three times per year, all existing infrastructure to remain, and master plan improvements.
[2]An effective interest rate of 4% was used to determine the total maintenance cost over 50 years, which refers to the total present value of the maintenance costs during a 50-year life cycle.

## Reach: H Tributary (Thornton)

No improvements are recommended as a part of the selected plan. This reach is located on City of Thornton property, with some pipe segments located through private property.

**Operations and Maintenance Costs**

| Maintenance Operation | Cost |
|---|---|
| Crossing Structure | $0 |
| Drop Structures | $0 |
| Channel Maintenance | $0 |
| Manhole (includes only new manholes) | $376 |
| Detention | $0 |
| Total Annual Maintenance Cost[1] | $1,128 |
| Total Annual Maintenance Cost Over 50 Years[2] | $24,232 |

[1]Annual cost reflects maintenance operations three times per year, all existing infrastructure to remain, and master plan improvements.
[2]An effective interest rate of 4% was used to determine the total maintenance cost over 50 years, which refers to the total present value of the maintenance costs during a 50-year life cycle.

## Reach: J Tributary (Thornton and Adams County)

No improvements are recommended as a part of the selected plan. This reach is located in right-of-way and Adams County Open Space property.

**Operations and Maintenance Costs**

| Maintenance Operation | Cost |
|---|---|
| Crossing Structure | $52 |
| Drop Structures | $0 |
| Channel Maintenance | $5,152 |
| Manhole (includes only new manholes) | $752 |
| Detention | $9,963 |
| Total Annual Maintenance Cost[1] | $47,757 |
| Total Annual Maintenance Cost Over 50 Years[2] | $1,025,925 |

[1]Annual cost reflects maintenance operations three times per year, all existing infrastructure to remain, and master plan improvements.
[2]An effective interest rate of 4% was used to determine the total maintenance cost over 50 years, which refers to the total present value of the maintenance costs during a 50-year life cycle.

## Reach: North K Tributary (Thornton)

### Channel Conveyance Improvements

To convey the future 100-year storm event and prevent McKay Road from being overtopped, the open channel and structures downstream of 100th Avenue and McKay Road, the McKay Road crossing, and the 100th Avenue roadside ditches would need enlargement. The area south of 100th Avenue would continue to flow into the West Sprat Platte Lake. The proposed north roadside ditch upstream of McKay Road would have a 10-foot bottom width, 3:1 side slopes, longitudinal slope of 0.4%, approximately 1-foot of freeboard, and a 100-year depth of 3.3 feet. The channel between McKay Road and the access crossing would have a 10-foot bottom width, 3:1 side slopes, longitudinal slope of 0.2%, approximately 1-foot of freeboard, and a 100-year depth of 4 feet. Downstream of the access crossing, the channel would have a 10-foot bottom width, 3:1 side slopes, longitudinal slope of 0.2%, approximately 1-foot of freeboard, and a 100-year depth of 5 feet. The channel flowline elevations are controlled by the minor storm event storm drain system improvements. The channel downstream of McKay Road to the first driveway crossing has a relatively narrow corridor. If the channel cannot be widened beyond the existing corridor, a wall will need to be constructed. The wall was included in the conceptual design costs for this alternative.

The channel improvements are generally located on City of Thornton property, with the improvements upstream of McKay Road extending onto private property.

### Structure Improvements

The ditch on the south side of 100th Avenue carries minimal flow and Pipe 23 would remain in-place. The existing culverts and pipe (Structures S and T, and Pipe 22) would be removed and replaced with a 12-foot wide by 4-foot high RCBC at the driveway (Structure S), a 12-foot wide by 6-foot high RCBC at the upstream driveway (Structure T), and a 16-foot wide by 3-foot high RCBC on the north side of 100th Avenue crossing McKay Road (Pipe 22). It was assumed that the existing outfall to the Thornton reservoir could be lowered to allow for lower channel upstream. A diversion structure will be constructed upstream of Structure S. Storm flows up to the 2-year storm event will be diverted to the 48-inch RCP. Flows in excess of the 2-year storm event will flow into the 12-foot wide by 4-foot high RCBC.

The crossing structure improvements are located on City of Thornton property and right-of-way.

### Storm Drain System Improvements

The elevation of the intersection of 100th Avenue and McKay Road as it relates to the South Platte River results in a shallow, nearly flat storm drain system. A 48-inch RCP storm drain system would be constructed from the downstream end of the channel conveyance improvements, north to 104th Avenue and into the South Platte River. A flapgate should be installed on the storm drain system to prevent backwater from the South Platte River. This system would capture the future 2-year event from the tributary area north of 100th Avenue and west of McKay Road (Design Point 143) and prevent it from entering the reservoirs, which was Thornton's goal. The area south of 100th Avenue would continue to flow into the West Sprat Platte Lake and the south cell of the West Cooley Reservoirs. Additional alignments were looked into to take the storm drain improvements in between the West Cooley Reservoirs during the alternatives phase, but were not chosen due to lack of cover on the pipe, lack of elevation to work with, as well as conflict with an Xcel right-of-way.

The storm drain system is located in City of Thornton property.

CLICK HERE TO VIEW REACH NORTH K TRIBUTARY MAP
CLICK HERE TO VIEW REACH NORTH K TRIBUTARY PROFILE

**Operations and Maintenance Costs**

| Maintenance Operation | Cost |
|---|---|
| Crossing Structure | $157 |
| Drop Structures | $0 |
| Channel Maintenance | $10,559 |
| Manhole (includes only new manholes) | $1,410 |
| Detention | $0 |
| Total Annual Maintenance Cost[1] | $36,380 |
| Total Annual Maintenance Cost Over 50 Years[2] | $781,511 |

[1]Annual cost reflects maintenance operations three times per year, all existing infrastructure to remain, and master plan improvements.
[2]An effective interest rate of 4% was used to determine the total maintenance cost over 50 years, which refers to the total present value of the maintenance costs during a 50-year life cycle.

The total estimated construction cost for improvements in this reach is $5,255,000, or $6,036,000 with maintenance over 50 years

**Master Plan Cost Estimator**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | | | |
| DRAINAGEWAY: | DFA 0056 | | | | | | |
| REACH: | North K Tributary | | | | | | |
| | | ESTIMATED BY: | MD | DATE: | 9/22/2020 | | |

| DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|
| 12x4 Box | 92 | LF | $1,931 | $177,644 | Cost includes (2) headwalls, toewalls, and wingwalls |
| 12x4 Box | 67 | LF | $2,381 | $159,548 | Cost includes (2) headwalls, toewalls, and wingwalls |
| 48x48 Circular | 4583 | LF | $274 | $1,254,362 | Cost includes (2) FES |
| Wall | 424 | LF | $150 | $63,600 | |
| 16x3 Box | 103 | LF | $3,750 | $386,250 | Cost includes (2) headwalls, toewalls, and wingwalls |
| Diversion Structure | 1 | EA | $30,000 | $30,000 | |
| Removal of culvert pipe (D<48") | 103 | LF | $38 | $3,914 | |
| Removal of culvert pipe (D<48") | 67 | LF | $38 | $2,550 | |
| Removal of culvert pipe (D<48") | 92 | LF | $38 | $3,496 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| Reclamation & seeding (native grasses) | 1 | AC | $1,890 | $1,890 | |
| Reclamation & seeding (native grasses) | 1 | AC | $1,890 | $1,890 | |
| Reclamation & seeding (native grasses) | 2 | AC | $1,890 | $3,780 | |
| Excavation, Mid Range | 5590 | CY | $45 | $251,550 | |
| Excavation, Mid Range | 2130 | CY | $45 | $95,850 | |
| Excavation, Mid Range | 6630 | CY | $45 | $298,350 | |

| Master Plan Improvement Cost Summary | | | | | |
|---|---|---|---|---|---|
| **Capital Improvement Costs** | | | | | |
| Pipe Culverts and Storm Drains | | | | $1,376,267 | |
| Concrete Box Culverts | | | | $337,192 | |
| Hydraulic Structures | | | | $0 | |
| Channel Improvements | | | | $645,750 | |
| Detention/Water Quality Facilities | | | | $0 | |
| Removals | | | | $9,960 | |
| Landscaping and Maintenance Improvements | | | | $7,560 | |
| Special Items (User Defined) | | | | $479,850 | |
| ROW/Easements | | | | $0 | |
| **Subtotal Capital Improvement Costs** | | | | **$2,856,579** | |
| **Additional Capital Improvement Costs** | | | | | |
| Dewatering | 3% | | | $19,372 | |
| Mobilization | 5% | | | $142,829 | |
| Traffic Control | 5% | | | $85,673 | |
| Utility Coordination/Relocation | 5% | | | $142,829 | |
| Stormwater Management/Erosion Control | 5% | | | $142,829 | |
| **Subtotal Additional Capital Improvement Costs** | | | | **$533,532** | |
| **Land Acquisition** | | | | | |
| ROW/Easements | | | | $0 | |
| **Other Costs (percentage of Capital Improvement Costs)** | | | | | |
| Engineering | 15% | | | $508,517 | |
| Legal/Administrative | 5% | | | $169,506 | |
| Contract Admin/Construction Management | 10% | | | $339,011 | |
| Contingency | 25% | | | $847,528 | |
| **Subtotal Other Costs** | | | | **$1,864,562** | |
| **Totals** | | | | **$5,254,673** | |

### Reach: South K Tributary (Thornton)

No improvements are recommended as a part of the selected plan. This reach is located on City of Thornton property.

**Operations and Maintenance Costs**

| Maintenance Operation | Cost |
|---|---|
| Crossing Structure | $0 |
| Drop Structures | $0 |
| Channel Maintenance | $3,804 |
| Manhole (includes only new manholes) | $0 |
| Detention | $0 |
| Total Annual Maintenance Cost[1] | $11,412 |
| Total Annual Maintenance Cost Over 50 Years[2] | $245,155 |

[1]Annual cost reflects maintenance operations three times per year, all existing infrastructure to remain, and master plan improvements.
[2]An effective interest rate of 4% was used to determine the total maintenance cost over 50 years, which refers to the total present value of the maintenance costs during a 50-year life cycle.

### Reach: Colorado Boulevard (Thornton)

#### Channel Conveyance Improvements

The upstream channel along Colorado Boulevard, between the Reserve at Thornton Apartments driveway and 100th Avenue, is undersized, allowing flows to overtop into Colorado Boulevard. The channel would be lowered to increase capacity for the future 100-year storm event. A two-foot drop structure would be constructed at the upstream end of the improvements.

The channel improvements are located on private property with easements dedicated to stormwater.

#### Structure Improvements

In order to provide major storm conveyance and prevent spilling onto Colorado Boulevard, the existing 42-inch RCP under the driveway into the Reserve at Thornton Apartments (Structure U) would need to be supplemented with an additional 30-inch RCP.

The crossing structures are located on private property with easements dedicated to stormwater.

#### Storm Drain System Improvements

To provide major storm conveyance, the existing 36-inch, 30-inch, and 24-inch RCPs (Pipes 26 through 28) should be removed and replaced with 72-inch, 60-inch, and 48-inch RCPs, respectively. The 42-inch RCP at the upstream end of the reach under the grass (Pipe 29) would be lowered 2 feet to prevent flows in excess of 35 cfs from spilling out the east side of the upstream channel onto Colorado Boulevard. Although Colorado Boulevard has capacity for the overflow at this location, the downstream street and storm drain system do not have capacity, and any overtopping at this location will contribute to flooding along the street downstream. The existing pipe has capacity, but is inlet controlled. It may be possible to construct a modified inlet instead of a full replacement.

The storm drain system is generally located in right-of-way.

CLICK HERE TO VIEW COLORADO BOULEVARD TRIBUTARY MAP
CLICK HERE TO VIEW COLORADO BOULEVARD TRIBUTARY PROFILE

**Operations and Maintenance Costs**

| Maintenance Operation | Cost |
|---|---|
| Crossing Structure | $0 |
| Drop Structures | $945 |
| Channel Maintenance | $3,400 |
| Manhole (includes only new manholes) | $752 |
| Detention | $2,458 |
| Total Annual Maintenance Cost[1] | $22,666 |
| Total Annual Maintenance Cost Over 50 Years[2] | $486,912 |

[1]Annual cost reflects maintenance operations three times per year, all existing infrastructure to remain, and master plan improvements.
[2]An effective interest rate of 4% was used to determine the total maintenance cost over 50 years, which refers to the total present value of the maintenance costs during a 50-year life cycle.

The total estimated construction cost for improvements in this reach is $5,443,000, or $5,930,000 with maintenance over 50 years

**Master Plan Cost Estimator**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | | | |
| REACH: | Colorado Boulevard | | | | | | |
| | | ESTIMATED BY: | MD | DATE: | 9/22/2020 | | |

| DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|
| 48x48 Circular | 669 | LF | $278 | $185,861 | Cost includes (1) FES |
| 60x60 Circular | 625 | LF | $454 | $283,750 | |
| 72x72 Circular | 2583 | LF | $691 | $1,785,370 | Cost includes (1) headwalls, toewalls, and wingwalls |
| 42x42 Circular | 488 | LF | $251 | $122,570 | Cost includes (2) FES |
| 30x30 Circular | 128 | LF | $216 | $27,694 | Cost includes (2) FES |
| Removal of culvert pipe (D<48") | 3877 | LF | $38 | $147,327 | |
| Removal of culvert pipe (D<48") | 488 | LF | $38 | $18,531 | |
| 5-Foot Diameter | 1 | EA | $7,371 | $7,371 | |
| 6-Foot Diameter | 1 | EA | $8,127 | $8,127 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Type "B" | 1 | EA | $22,680 | $22,680 | |
| Reclamation & seeding (native grasses) | 0.38 | AC | $1,890 | $715 | |
| Sloping Drop Structure (2-ft) | 1 | EA | $98,328 | $98,328 | |
| Excavation, Mid Range | 980 | CY | $45 | $44,100 | |

| Master Plan Improvement Cost Summary | | | | | |
|---|---|---|---|---|---|
| **Capital Improvement Costs** | | | | | |
| Pipe Culverts and Storm Drains | | | | $2,624,863 | |
| Concrete Box Culverts | | | | $0 | |
| Hydraulic Structures | | | | $98,328 | |
| Channel Improvements | | | | $44,100 | |
| Detention/Water Quality Facilities | | | | $0 | |
| Removals | | | | $165,858 | |
| Landscaping and Maintenance Improvements | | | | $715 | |
| Special Items (User Defined) | | | | $0 | |
| ROW/Easements | | | | $0 | |
| **Subtotal Capital Improvement Costs** | | | | **$2,933,864** | |
| **Additional Capital Improvement Costs** | | | | | |
| Dewatering | 3% | | | $1,323 | |
| Mobilization | 5% | | | $146,693 | |
| Traffic Control | 5% | | | $136,160 | |
| Utility Coordination/Relocation | 5% | | | $146,693 | |
| Stormwater Management/Erosion Control | 5% | | | $146,693 | |
| **Subtotal Additional Capital Improvement Costs** | | | | **$577,562** | |
| **Land Acquisition** | | | | | |
| ROW/Easements | | | | $0 | |
| **Other Costs (percentage of Capital Improvement Costs)** | | | | | |
| Engineering | 15% | | | $526,714 | |
| Legal/Administrative | 5% | | | $175,571 | |
| Contract Admin/Construction Management | 10% | | | $351,143 | |
| Contingency | 25% | | | $877,856 | |
| **Subtotal Other Costs** | | | | **$1,931,284** | |
| **Totals** | | | | **$5,442,710** | |

**Reach: Thornton Parkway (Thornton)**

No improvements are recommended as a part of the selected plan. This reach is located on private property.

**Operations and Maintenance Costs**

| Maintenance Operation | Cost |
|---|---|
| Crossing Structure | $0 |
| Drop Structures | $0 |
| Channel Maintenance | $4,201 |
| Manhole (includes only new manholes) | $0 |
| Detention | $0 |
| Total Annual Maintenance Cost[1] | $12,604 |
| Total Annual Maintenance Cost Over 50 Years[2] | $270,763 |

[1]Annual cost reflects maintenance operations three times per year, all existing infrastructure to remain, and master plan improvements.
[2]An effective interest rate of 4% was used to determine the total maintenance cost over 50 years, which refers to the total present value of the maintenance costs during a 50-year life cycle.

### 6.3 Prioritization and Phasing

In general, the conveyance improvements may be completed at any time. Ideally, structure and channel improvements would be implemented downstream to upstream. However. the reality of the phasing within Basin 4100 and DFA 0056 will be that Thornton and Adams County will construct improvements as funding permits and that will provide the greatest benefits to the citizens.

In general, it is suggested that the recommended plan be implemented from downstream to upstream within each tributary area. However, the improvements can be implemented in a different order, if desired. Following is a more detailed recommendation of phasing and prioritization:

- Crossing structures should be installed first to increase public safety and emergency access
- The Drainageway 4100-1 channel stabilization improvements are a higher priority to prevent the channel from threatening private properties.
- Once the full School Tributary basin is connected to Colorado Boulevard, the likelihood of overtopping the old roadway berm is significantly increased; therefore, the Basin 4100 outfall improvements at old Riverdale Road should be built prior to, or concurrently, with developer constructed School Tributary improvements.
- The drop structures in Drainageway 4100 and West G Tributary should be installed if the channels begin to show further signs of erosion. Low maintenance streams should be evaluated as an alternative to drop structures, if possible. In some areas, the available space for preferred low maintenance stream sections may be limited, due to some reaches being constrained by development.
- The improvements on North K Tributary should be implemented when funding is available to prevent flooding at 100th and McKay and to protect the reservoirs.
- Improvements along School Tributary should generally be implemented as development occurs.

The storm drain improvements are recommended to be installed as needed, based on flooding history and reports.

### 6.4 Water Quality Impacts

It is recommended that any development that occurs in the watershed be required to provide water quality BMPs.

### 6.5 Operations and Maintenance

Routine maintenance should be completed in Basin 4100 and DFA 0056. Maintenance will include weed and debris removal along the open channel drainageways. Maintenance access will be from a combination of adjacent trails and the road.

### 6.6 Environmental and Safety Assessment

Construction of the outfall system plan improvements would impact potential wetlands and riparian habitat in select areas, primarily during the construction of road crossings, and drop structures. A wetland delineation and jurisdictional determination regarding the wetlands should be made to determine permitting requirements.

Providing future conditions 100-year storm event conveyance would increase public safety by preventing the arterial crossing streets from being overtopped. Preventing overtopping at the roads would provide access for emergency vehicles during a large storm event. In addition, the potential flood damage to structures as a result of the 100-year storm would be reduced.

## Legend

- Existing Centerline
- Canals
- Roads
- Contours
- Basin Boundary
- Water Body
- Thornton City Boundary
- Special_Item_Area
- Adams County Boundary
- Sloping Drop Structure
- Manhole
- Modify Manhole
- DIVERSION STRUCTURE
- Emergency Overflow
- Pedestrian Bridge
- Wall
- Detention Facilities
- Channel Improvements

### Storm Drain/Culvert

- Box Culvert
- 30-Inch Diameter
- 36-Inch Diameter
- 42-Inch Diameter
- 48-Inch Diameter
- 60-Inch Diameter
- 66-Inch Diameter
- 72-Inch Diameter
- 84-Inch Diameter

N

0 300 600 1,200 Feet

INSTALL 48-INCH RCP

DIVERSION STRUCTURE

DRIVEWAY REPLACE EXISTING CULVERT WITH 12-FT X 4-FT RCBC

CHANNEL GRADING

DRIVEWAY REPLACE EXISTING CULVERT WITH 12-FT X 4-FT RCBC

CHANNEL GRADING

WALL

MCKAY ROAD REPLACE EXISTING 24-INCH CMP WITH 16-FT X 3-FT RCBC

CHANNEL GRADING

WEST SPRAT PLATTE LAKE

ADAMS COUNTY 88TH AVENUE OPEN SPACE

RACE STREET REPLACE EXISTING 24-INCH RCP WITH 60-INCH RCP

REPLACE 24-INCH RCP WITH 30-INCH RCP

CHANNEL GRADING

3.7-FT DROP STRUCTURE

3-FT DROP STRUCTURE

3-FT DROP STRUCTURE

3-FT DROP STRUCTURE

3.1-FT DROP STRUCTURE

ADD PARALLEL 42-INCH RCP

1.2-FT DROP STRUCTURE

REPLACE 30-INCH RCP WITH 42-INCH RCP

MODIFY MANHOLE

REMOVE AND REPLACE FAILED 6-FT DROP STRUCTURE

CHANNEL GRADING

TRAIL (1) 18-INCH CMP TO BE REMOVED AND REPLACED WITH 45-FT PEDESTRIAN BRIDGE

CHANNEL GRADING

3-FT DROP STRUCTURE

2.4-FT DROP STRUCTURE

TRAIL AT COLORADO AGRICULTURAL DITCH REMOVE (2) 24-INCH RCP AND REPLACE WITH (2) 36-INCH RCP, LOWERED

REPLACE 36-INCH RCP WITH 42-INCH RCP

REPLACE 48-INCH RCP WITH 60-INCH RCP

REPLACE 48-INCH RCP WITH 66-INCH RCP

3-FT DROP STRUCTURE

CHANNEL GRADING

EMERGENCY OVERFLOW BOX

1-FT DROP STRUCTURE

CHANNEL GRADING

3-FT DROP STRUCTURE

3-FT DROP STRUCTURE

2.8-FT DROP STRUCTURE

3-FT DROP STRUCTURE

INSTALL 48-INCH RCP

CHANNEL GRADING

3.4-FT DROP STRUCTURE

REMOVE EXISTING (3) 38-INCH X 24-INCH HERCP
REMOVE EXISTING (2) 30-INCH HDPE

CONSTRUCT 3.7 AF DETENTION POND

INSTALL 66-INCH RCP

INSTALL 84-INCH RCP

INSTALL 84-INCH RCP CONNECT TO EXISTING STORM SYSTEM

REMOVE 18-INCH RCP

2-FT DROP STRUCTURE

CHANNEL GRADING

REPLACE 42-INCH RCP WITH 42-INCH RCP, LOWERED 2-FT

INSTALL 30-INCH RCP PARALLEL TO EXISTING 42-INCH RCP

REPLACE 24-INCH RCP WITH 48-INCH RCP

REPLACE 30-INCH RCP WITH 60-INCH RCP

REPLACE 36-INCH RCP WITH 72-INCH RCP

OLD RIVERDALE ROAD REMOVE EXISTING (1) 84-INCH CMP REPLACE WITH (3) 8-FT X 6-FT RCBC

POTENTIAL BERM

INSTALL 48-INCH RCP SECONDARY CROSSING AT OLD RIVERDALE ROAD

(3) 2-FT DROP STRUCTURES

CHANNEL GRADING

CLICK TO TURN STREETS ON OR OFF

CLICK TO TURN AERIAL ON OR OFF

CLICK TO TURN TOPOGRAPHY ON OR OFF

| | | | |
|---|---|---|---|
| PROJECT: 017-2321<br>DRAWN BY: MD<br>DATE: 09/2020 | **MILE HIGH FLOOD DISTRICT**<br>**CITY OF THORNTON AND ADAMS COUNTY** | **BASIN 4100 AND DFA 0056**<br>**CONCEPTUAL DESIGN MAP** | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | FIGURE<br>4 |

## 7.0 REFERENCES


Acklam & Associates, Inc. January 2003. *As-Built Survey – River Valley Village*.

Adams County. 2013. *Future Land Use Map*.

CDM Smith. September 2016. *88th Avenue Open Space Master Plan.*

City of Thornton. 2008. *Zoning Map.*

J.S. Griffith. March 1986. *Basin 4100 Direct Flow Area 0056: Outfall Systems Planning*.

Kiowa Engineering Corporation. July 2002. *Basin 4100 and Direct Flow Area 0056: Outfall Systems Planning Study Preliminary Design Report.*

EDR. December 10, 2018. *The EDR Aerial Photo Decade Package*.

Jansen Strawn Consulting Engineers. March 2012. *Final Drainage Report: Cherry Lane Subdivision.*

Olsson Associates. November 1, 2017. *Final Drainage Report: Riverdale Ballfield Park*.

Regional Rail Partners. April 12, 2016. *Area F Drainage Plans*.

Steer Davies Gleave. January 13, 2015. Original Thornton at 88th Station Area Master Plan.

Urban Drainage and Flood Control District. Urban Storm Drainage Criteria Manual. January 2016.

U.S. Department of Homeland Security. February 17, 2017. Flood Insurance Study – Adams County, Colorado and Incorporated Areas.

U.S. Department of Homeland Security, Federal Emergency Management Agency. August 29, 2014. *Letter of Map Revision Determination Document, Case No. 14-08-0032P*.

U.S. Department of Homeland Security, Federal Emergency Management Agency. June 24, 2011. *Letter of Map Revision Determination Document, Case No. 10-08-0748P*.

U.S. Department of Homeland Security, Federal Emergency Management Agency. June 27, 2008. *Letter of Map Revision Determination Document, Case No. 08-08-0056P*.

U.S. Department of Homeland Security, Federal Emergency Management Agency. March 5, 2007. *Flood Insurance Rate Map, Adams County, Colorado and Incorporated Areas: Map Numbers 08001C0313H, 08001C0314H, 08001C0318H, 08001C0319H, 08001C0601H, 08001C0602H, and 08001C0606H.*

U.S. Department of Agriculture, Natural Resources Conservations Service. October 16, 2017. Custom Soil Resource Report for Adams County Area, Parts of Adams and Denver Counties, Colorado.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. November 2, 2017. Point Precipitation Frequency Estimates.

# APPENDIX A

# PROJECT CORRESPONDENCE

# MEETING MINUTES

# KICKOFF MEETING MINUTES

**Basin 4100 and DFA 0056 OSP**
**Monday, August 28, 2017**
**1:00 pm at Urban Drainage and Flood Control District**

**Attendees:**

| Name | Company | E-mail |
|---|---|---|
| Brooke Seymour | Urban Drainage and Flood Control District (UDFCD) | bseymour@udfcd.org |
| Anna Sparks | Adams County | ASparks@adcogov.org |
| Marc Pedrucci | Adams County | MPedrucci@adcogov.org |
| Jim Kaiser | City of Thornton (Thornton) | Jim.Kaiser@cityofthornton.net |
| Matt Eberly | City of Thornton | Matt.Eberly@cityofthornton.net |
| Deb Ohlinger | Olsson (Olsson) | dohlinger@olsson.com |
| Amy Gabor | Olsson | agabor@olsson.com |

**Discussion Items:**
The meeting was held to discuss the start of the project, determine known issues and problem areas, and identify other stakeholders that should be involved in the project. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1) Introduction
   a) Other stakeholders will be contacted during the alternatives analysis phase of the project.

2) Project goals
   a) Main areas of concern and observed problems were discussed in detail. These minutes provide a summary of items discussed in the meeting.
      i) Adams County has a parks master plan. Olsson should coordinate improvements with this study.
      ii) UDFCD and Thornton are constructing the first segment of the School Tributary. The design team identified the pre-existing downstream pipe capacity, which should be highlighted as a constraint for the future buildout development of the School Tributary basin.
      iii) RTD is constructing a new detention pond based on hydrologic model updates in 2015. RTD's School Tributary culvert under the railroad was based on updated hydrology performed by Merrick for the city, with UDFCD review. SWMM routing was used to determine the peak discharge, which included "overbank storage" greater than 2 acre-feet.
      iv) Tributaries daylight into Colorado Agricultural Ditch, which has limited capacity.
      v) Basin 4100 detention south of Thornton Parkway was formalized with a 2008 LOMR.
      vi) The floodplain extends into backyards near City Park and in Tributary H. These areas should be evaluated with the alternatives analysis.
      vii) The routing in the old SWMM model does not appear to accurately reflect the existing conditions.
      viii) Outfall paths will be looked at in detail during the alternatives analysis. The old OSP alignments and sizes do not appear to be feasible in some areas.

3) Needed information
   a) Complete mapping and abutting watershed boundaries has been provided by UDFCD.
   b) Survey, with photos and descriptions of shots, will be provided by UDFCD for:
      i) Crossing structures – Photos of both sides of the structures would be helpful.
      ii) Drop structures
      iii) Storm drain system – Olsson will provide a map of needed storm drain system survey limits
      iv) Any needed detention pond outlet structures – Olsson will provide a map of needed outlet structure surveys
   c) GIS layers for utilities, parcels, future land uses will be provided by Thornton and Adams County
   d) Any development, highway, and RTD drainage reports will be provided by Thornton and Adams County. Olsson will request specific development drainage reports as needed.
   e) As-constructed documents for maintenance and CIP projects will be provided by UDFCD, Thornton, and Adams County
   f) As-constructed documents for railroad crossings
   g) Hydraulic capacity of School Tributary pipe

4) New hydrology to be developed
   a) Olsson will use EPA SWMM 5.1.012 and CUHP 2.0.0.
   b) The majority of the watershed is developed. Only future land use conditions will be evaluated.
   c) The detention used on the 2002 OSP will be included in the baseline hydrology. Olsson will utilize stage-storage-discharge information from the 2002 OSP. Olsson will develop new stage-storage-discharge information for more significant detention ponds. Olsson will highlight these detention ponds and UDFCD will provide survey of the outlet structures.
   d) Calibration is not anticipated. A comparison to the 2002 OSP will be included in the report.

5) Schedule to follow agreement
   a) Draft hydrology due November 6, 2017 (10 weeks from meeting). The schedule will be dependent on when needed information is received.

6) Upcoming meetings
   a) During hydrology
   b) After hydrology review

**Action Items:**
- UDFCD
  - Send Olsson watershed boundaries of surrounding studies – *Completed*
  - Provide Olsson with complete mapping – *Completed*
  - Provide survey
- Adams County
  - Send Olsson any relevant GIS files, including streets, utilities, parcels, and existing and future land use
  - Send Olsson any relevant drainage studies in the watershed
  - Send Olsson as-constructed documents for maintenance and CIP projects
  - Send Olsson parks master plan
- Thornton
  - Send Olsson any relevant GIS files, including streets, utilities, parcels, and existing and future land use
  - Send Olsson as-constructed documents for railroad crossings
  - Send Olsson Hydraulic capacity of School Tributary pipe

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    - Send Olsson any relevant drainage studies in the watershed
    - Send Olsson as-constructed documents for maintenance and CIP projects
    - Verify detention pond locations from 2002 OSP
    - Send Olsson RTD detention pond information
- Olsson
    - Send map of needed storm drain system survey
    - Send map of needed outlet structure survey
    - Coordinate additional information needs with UDFCD, Adams County, and Thornton

Please contact Olsson at 303-237-2072 if there are any changes or questions with these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.

Minutes prepared by: Amy Gabor
cc: Attendees, Shea Thomas, File

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# DETENTION POND SENSITIVITY MEETING MINUTES

**Basin 4100 and DFA 0056 OSP**
**Wednesday, November 15, 2017**
**9:00 am at Urban Drainage and Flood Control District**

**Attendees:**

| Name | Company | E-mail |
|---|---|---|
| Brooke Seymour | Urban Drainage and Flood Control District (UDFCD) | bseymour@udfcd.org |
| Jim Kaiser | City of Thornton (Thornton) | Jim.Kaiser@cityofthornton.net |
| Matt Eberly | City of Thornton | Matt.Eberly@cityofthornton.net |
| Amy Gabor | Olsson (Olsson) | agabor@olsson.com |
| Hannah Pring | Olsson | hpring@olsson.com |

**Discussion Items:**
The meeting was held to discuss the results of the detention pond sensitivity analysis, identify which ponds to be included in the model, and any other known areas of concern that should be considered moving forward. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

a) Olsson completed a sensitivity analysis of the detention ponds from the 2002 OSP. Olsson modeled several scenarios: all the detention from the 2002 OSP, no detention at all, and several scenarios where select detention ponds with larger impacts were included. Main areas of concern and observed problems as they related to detention pond locations were discussed in detail. These minutes provide a summary of items discussed in the meeting.

   i) Downstream of pond 316, Basin 4100 BFE's were mapped and based on Pond 316.
   ii) Design Point 130 to 120T is a reach known for flooding. This stretch is downstream of Pond 331 and should be further evaluated.
   iii) Olsson stated that the peak flows are generally lower than the old study. Jim noted that the development in some areas is older, so they may not be designed to old OSP study flows.
   iv) Old MDP shows flows at Pond 307 going east, which is incorrect. The Olsson model shows both the pond outflow and overflow going south. Pond 307 does not have a large impact and will not be modeled.

b) Conclusions from meeting

   i) Olsson will move forward with modeling ponds 316, 331, 302, and 322.
   ii) Ponds 326, 327, and 329 will need further analysis and one will most likely be included in the model.
   iii) Pond 316 was included in a LOMR. Thornton will send the stage-storage-discharge information from the LOMR to be included in the model.
   iv) The 2002 OSP information is adequate to use for ponds 322, 331, and for 326, 327, or 329, if they are modeled.
   v) The RTD project regraded the station so that the entire site outflows to School Tributary. Olsson does not need to include the RTD detention pond, but subbasin boundaries will need to be adjusted for Subbasins 1, 5, and 10.

2) Information Regarding Alternatives

   a) Design Point 154/153 goes to the lakes, but 151 keeps 5- to 10-year out of lakes (Tributary K). The lake is being regraded and the finger will be filled in around Design Point 154.

   b) Mining operations have changed the topography of the lakes since previous OSP.

   c) 2002 OSP had incorrect flows at School Tributary railroad crossing. Subbasins 2 and 3 travel independently to the railroad. The 2002 OSP had a total of approximately 400 cfs coming to the railroad, but only approximately 250 cfs crossing under the railroad. Merrick confirmed the discrepancy and completed new hydrology, which included inadvertent detention, or overbank storage, at the railroad.

   d) FasTracks replaced every crossing under the railroad. Thornton is interested in what amount of detention is needed downstream of School Tributary. Thornton will state where the detention pond should be placed for the conceptual design.

   e) Adams County is planning park improvements in Subbasin 37.

   f) Pond 304 should be further analyzed to see if the current outlet is adequately designed to handle all three flows coming into the pond. The berm between Pond 304 and the river is the old embankment of Riverdale Road. The existing outlet pipe, which is a large diameter CMP, is above a critical 30-inch treated water line. The old road embankment to the east also contains both the 30-inch treated water line and a 36-inch raw water supply line. Therefore, the capacity/stability of the outlet pipe and the overtopping of the berm should be analyzed. The Prior OSP had concepts for a spillway to the South Platte River which should be re-evaluated based upon current hydrology from this study, as well as existing topography, including the South Platte Regional Trail on the river side below the berm. The capacity of the Regional Trail bridge should also be verified against the outlet pipe's discharge.

**Action Items:**

- Thornton
  - Send LOMR information for updated information on pond 316
  - Send Olsson record drawings for FasTracks pipes
  - Send Olsson information for RTD pond to update subbasin boundaries
- Olsson
  - Evaluate need for Detention Ponds 326, 327, and/or 329

Please contact Olsson at 303-237-2072 if there are any changes or questions with these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.

Minutes prepared by: Hannah Pring
cc: Attendees, Shea Thomas, Anna Sparks, Marc Pedrucci, File

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# DETENTION POND SENSITIVITY MEETING MINUTES

**Basin 4100 and DFA 0056 OSP**
**Wednesday, November 27, 2017**
**10:00 am Conference Call**

**Attendees:**

| Name | Representing | E-mail |
|---|---|---|
| Brooke Seymour | Urban Drainage and Flood Control District (UDFCD) | bseymour@udfcd.org |
| Jim Kaiser | City of Thornton (Thornton) | Jim.Kaiser@cityofthornton.net |
| Anna Sparks | Adams County | asparks@adcogov.org |
| Amy Gabor | Olsson (Olsson) | agabor@olsson.com |

## Discussion Items:

The meeting was held to discuss the results of the detention pond sensitivity analysis, identify which ponds to be included in the model, and any other known areas of concern that should be considered moving forward. All conclusions made in the Pond Sensitivity Meeting on November 15, 2017 were confirmed in this meeting. Please reference the November 15, 2017 – Detention Pond Sensitivity Meeting Minutes for a comprehensive account of the meeting.

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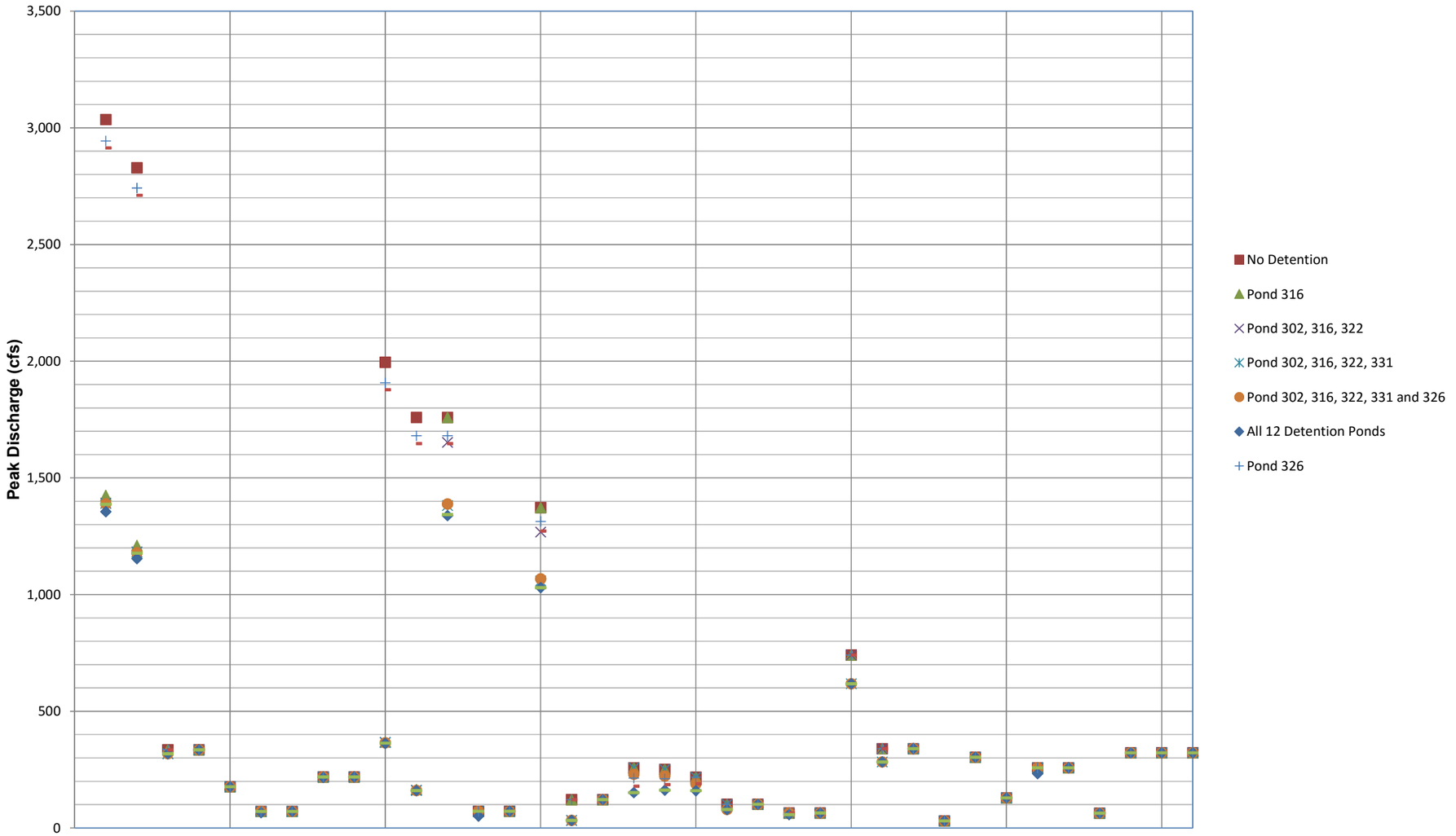
## Table A - Basin 4100 Baseline Peak Flows Along Drainageway Centerline

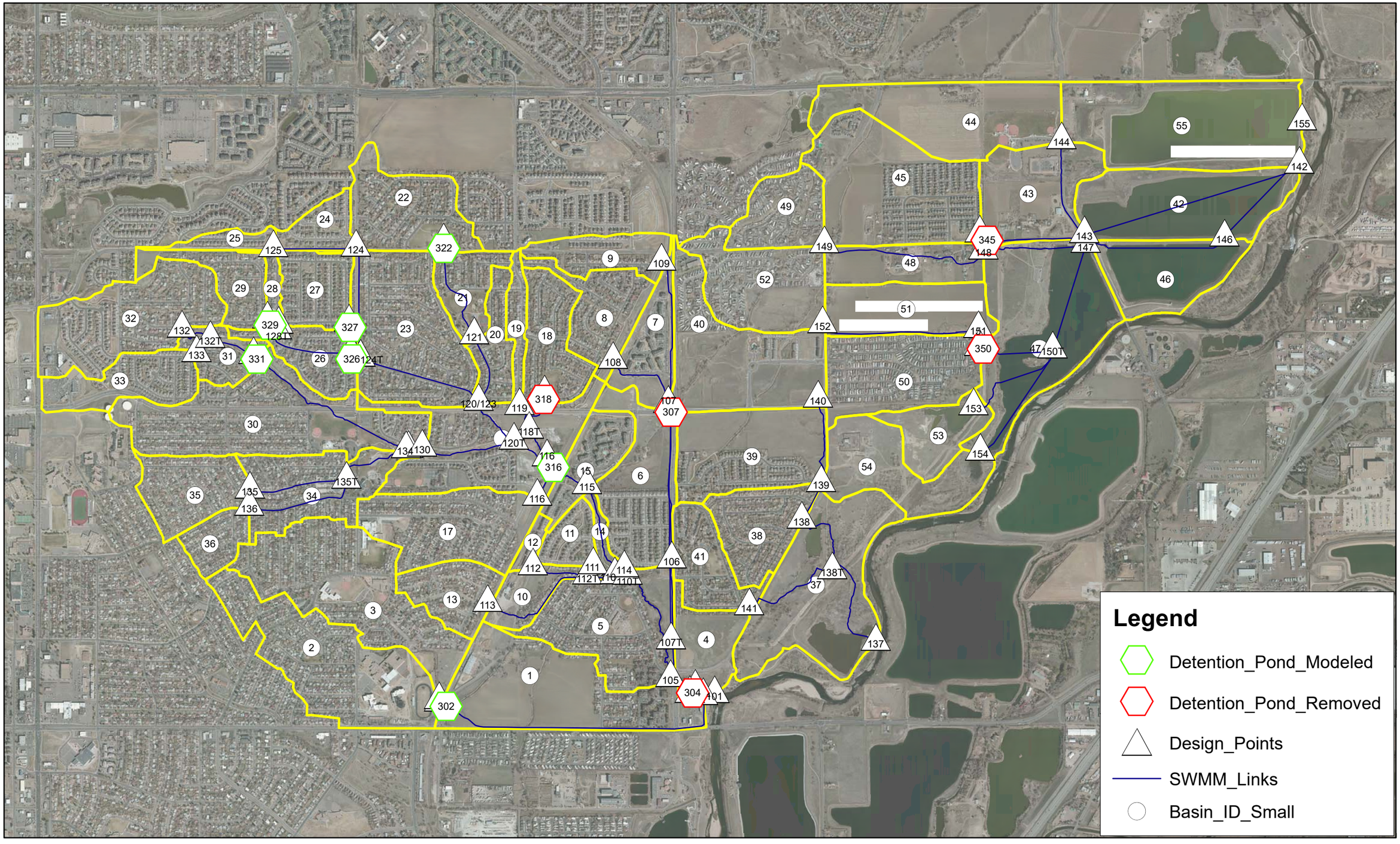
| Design Point | Pond Inflow-Outflow Under Full Detention Scenerio | | Future Peak Flows (cfs) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | cfs | % Reduction | $Q_{100}$, No Detention | $Q_{100}$ - Pond 316[1] | $Q_{100}$ - Ponds 302, 316, 322[1] | $Q_{100}$ - Ponds 302, 316, 322, 331[1] | $Q_{100}$ - Ponds 302, 316, 322, 331, 327[1] | $Q_{100}$ - Pond 326[1] | $Q_{100}$ - Pond 326, 327[1] | $Q_{100}$ - Ponds 302, 316, 322, 331, 326, 327, 329[1] | $Q_{100}$ - Full Detention[2] |
| 101 | | | 3,036 | 1,425 | 1,392 | 1,391 | 1,389 | 2,944 | 2,914 | 1,387 | 1,355 |
| 102T | | | 2,829 | 1,211 | 1,183 | 1,181 | 1,179 | 2,742 | 2,711 | 1,177 | 1,154 |
| 102O | | | 335 | 335 | 319 | 319 | 319 | 335 | 335 | 319 | 319 |
| 302 | 16 | 5% | 335 | 335 | 335 | 335 | 335 | 335 | 335 | 335 | 335 |
| 103 | | | 176 | 176 | 176 | 176 | 176 | 176 | 176 | 176 | 176 |
| 104O | | | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 65 |
| 304 | 5 | 8% | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 |
| 107O | | | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 216 |
| 307 | 2 | 1% | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 |
| 110T | | | 1,996 | 368 | 367 | 366 | 365 | 1,908 | 1,878 | 363 | 363 |
| 116O | | | 1,759 | 164 | 163 | 161 | 161 | 1,681 | 1,648 | 161 | 161 |
| 316 | 1,177 | 88% | 1,759 | 1,759 | 1,653 | 1,381 | 1,389 | 1,681 | 1,648 | 1,343 | 1,338 |
| 118O | | | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 51 |
| 318 | 21 | 30% | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 |
| 120T | | | 1,373 | 1,373 | 1,268 | 1,059 | 1,068 | 1,313 | 1,272 | 1,030 | 1,030 |
| 122O | | | 122 | 122 | 33 | 33 | 33 | 122 | 122 | 33 | 33 |
| 322 | 89 | 73% | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 |
| 124T | | | 258 | 258 | 258 | 258 | 230 | 213 | 179 | 151 | 151 |
| 126O | | | 251 | 251 | 251 | 251 | 223 | 211 | 186 | 162 | 162 |
| 326 | -3 | -2% | 218 | 218 | 218 | 218 | 190 | 218 | 190 | 160 | 160 |
| 127O | | | 102 | 102 | 102 | 102 | 79 | 102 | 79 | 79 | 79 |
| 327 | 22 | 22% | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 |
| 129O | | | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 57 | 57 |
| 329 | 7 | 11% | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 |
| 130 | | | 741 | 741 | 741 | 618 | 618 | 741 | 741 | 618 | 618 |
| 131O | | | 340 | 340 | 340 | 283 | 283 | 340 | 340 | 283 | 283 |
| 331 | 56 | 17% | 340 | 340 | 340 | 340 | 340 | 340 | 340 | 340 | 340 |
| 136 | | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 138 | | | 303 | 303 | 303 | 303 | 303 | 303 | 303 | 303 | 303 |
| 140 | | | 129 | 129 | 129 | 129 | 129 | 129 | 129 | 129 | 129 |
| 145O | | | 258 | 258 | 258 | 258 | 258 | 258 | 258 | 258 | 233 |
| 345 | 25 | 10% | 258 | 258 | 258 | 258 | 258 | 258 | 258 | 258 | 258 |
| 149 | | | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 | 64 |
| 150O | | | 323 | 323 | 323 | 323 | 323 | 323 | 323 | 323 | 322 |
| 350 | 1 | 0% | 323 | 323 | 323 | 323 | 323 | 323 | 323 | 323 | 323 |
| 150 | | | 323 | 323 | 323 | 323 | 323 | 323 | 323 | 323 | 323 |

Notes:
1. Scenerios are independent, not cumulative.
2. Full Detention Includes twelve listed ponds.

**Figure A**
**Basin 4100**
**Baseline Peak Flows vs. Drainageway Station**



# Pond Sensitivity Analysis



# PROGRESS MEETING MINUTES

**Basin 4100 and DFA 0056 OSP**
**Monday, January 29, 2018**
**11:00 am at Urban Drainage and Flood Control District**

**Attendees:**

| Name | Representing | E-mail |
|---|---|---|
| Brooke Seymour | Urban Drainage and Flood Control District (UDFCD) | bseymour@udfcd.org |
| Dave Skuodas | UDFCD | dskuodas@udfcd.org |
| Jim Kaiser | City of Thornton (Thornton) | Jim.Kaiser@cityofthornton.net |
| Matt Eberly | Thornton | Matt.Eberly@cityofthornton.net |
| Russ Nelson | Adams County | RNelson@adcogov.org |
| Amy Gabor | Olsson (Olsson) | agabor@olsson.com |
| Deb Ohlinger | Olsson | dohlinger@olsson.com |
| Hannah Pring | Olsson | hpring@olsson.com |

**Discussion Items:**
The meeting was held to discuss the draft hydrology analysis and report and direction for beginning the alternatives analysis. While this summary in not intended to represent a comprehensive account of the meeting, it is intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1) Draft hydrology comments
   a) Reservoirs
      i) Downstream infrastructure – verify
         (1) Comment was for Thornton internal use only.
   b) Planned Construction
      i) School Tributary UDFCD project status
         (1) CIP completed west of Monroe and daylights into open space.
         (2) This OSP should confirm Merrick hydraulic analysis of downstream constraint.
         (3) OSP to highlight acre-feet of detention required to attenuate 100-year flow.
   c) Land Use
      i) 88th and 104th Station Area Master Plans – Thornton will provide
   d) Outfall Descriptions and Major Crossing Structure Inventory Table to be completed with next phase of the project
      i) The Outfall Descriptions section will include a description of the School Tributary projects.
   e) Design Rainfall
      i) Depth reduction factors (DRFs) should be used for 2-15 square mile (sm) watersheds for the 2-, 5, and 10-year storm events. Based on Table 5-3 in USDCM, 2 sm is not adjusted, and 5 sm is adjusted. CUHP will interpolate factors between 2 and 5 square miles. Based on conversations with UDFCD on other projects regarding how many different models need to be run with the DRFs, we did not apply the factor for this study because all design points have tributary areas below 5 sm, which is the first column in Table 5-3 with a correction factor. The largest tributary area is 2.6 sm. Is this approach acceptable for this study?
         (1) Approach was found to be acceptable.
   f) Subwatershed Delineation
      i) Discuss – Subwatershed boundaries reflect the major storm event conditions and generally do not include storm drain systems, with the exception of detention pond outlets.
         (1) Consider re-wording to clarify that only minor storm systems were ignored, and pond outlets and major storm systems were included in the model.
         (2) Intersection of Thornton Parkway and Colorado is shown to go to the south in the hydrology.
      ii) Discuss – Subwatersheds were delineated to avoid shapes with elongated tails and very narrow and long shapes, in accordance with modeling guidance.
   g) Hydrograph Routing
      i) Will use USDCM Eq. 6-8 for Manning's n where streams may provide more substantial attenuation. Otherwise will increase Manning's n by 25%.
         (1) Olsson will review Manning's n values and clarify text.
   h) Previous Studies
      i) Future percent imperviousness difference of 7%.
         (1) Include more description on what caused the difference. Note that the previous studies assigned the reservoirs an imperviousness value of 2%. Current modeling techniques would recommend that the reservoirs be assigned a value of 100% imperviousness. 100% was used for all reservoirs.
         (2) Imperviousness values were developed from using the National Land Cover Database, so this difference could also account for differences in the previous study.
         (3) Olsson will provide separate comparisons for Basin 4100 and DFA 0056.
      ii) Additional watershed acreage difference from 2002 OSP is due to delineating the basins based on LiDAR.
         (1) The largest difference is for sub-basins 44 and 55, previously numbered 38 and 42, respectively. Delineation was done using LiDAR data, and differences were due to changes that have since been made in the watershed. A figure comparing the old study watershed areas and this study was presented during the meeting is included in the meeting minutes.
   i) Pond Sensitivity Analysis
      i) Sub-basin 43 ponding
         (1) Route Subbasin 43 to Subbasin 55 in ditch.
      ii) Pond 350
         (1) Pond 350 minor storm routing versus overflow will be considered during the alternative analysis. No changes will be made to the baseline hydrology.
      iii) Future road to change flow path – include in baseline hydrology?
         (1) Road construction has not occurred yet, but West Spratt Platte Lake has already had work done to fill in the southern finger of the lake. The boundary between 53 and 47 will be altered to represent this construction and the future changes.
      iv) Spillways
         (1) Future South Platte River spillways in and out of the gravel pits were discussed. The hydraulics between the gravel pits and the South Platte River will not be considered for this study. No changes will be made to baseline hydrology and routing.
      v) Sub-basin 53 drainage
         (1) Boundary between sub-basins 53 and 47 will be re-delineated to reflect changes to the West Spratt Platte Lake where the finger was filled in.
   j) SWMM Routing
      i) Figure B-2C – future change?
         (1) Boundary between sub-basins 53 and 47 will be re-delineated as previously described.
2) Problem areas and alternatives analysis

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a) Basin 4100 outfall, what should the existing CMP and Trail Bridge be replaced with? The waterline location in the old Riverdale Road will be considered when determining alternatives.
b) Could the area near the Basin 4100 outfall a potential water quality location? If so, what would be the best implementation? Generally, on-line water quality is not recommended. If it is implemented, it is best to size a water quality pond for the entire tributary area to avoid upstream treated flows to fill up the available area for water quality downstream. Thornton would like to evaluate the amount of water quality capture volume needed for School Tributary and the Basin 4100 drainageway downstream of the railroad. No detention is needed there, just controlled discharge.
c) Consider the Welby Station area plans and potential detention.
d) Consider the 100th & McKay design Olsson completed several years ago.

3) Schedule – submit final hydrology report on February 19, 2018
4) Website
   a) Website is complete and Olsson will provide a link to it today.

**Action Items:**

- Thornton
  - Provide project record drawings for School Tributary project.
  - Provide 88th and 104th Station Area Master Plans
  - Provide Merrick School Tributary downstream hydraulic analysis.
- Olsson:
  - Provide link to website

Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.

Minutes prepared by: Hannah Pring
cc: Attendees, Shea Thomas, Marc Pedrucci, File

## Legend

- DFA 0056
- Small Basin ID
- Basin 4100
- Contours
- Large Basin ID (ID, Area, Ac LU, Fu LU)
- Design Point (1XX)
- Storage Unit (3XX)
- Conveyance Element (2XX)
- Drainageway (X)
- Water Body
- Subbasins
- Thornton City Boundary
- Adams County
- Roads

**Imperviousness (%)**

- 2-5
- 6-10
- 11-20
- 21-30
- 31-40
- 41-50
- 51-60
- 61-70
- 71-80
- >81

**Future Land Use**

- Commercial
- Employment Center
- Institutional
- Mixed Use
- Parks and Open Space
- Residential High
- Residential Low
- Residential Medium
- Riverdale Ballfields
- Urban Reserve
- Urban Village

**Hydrologic Soil Group**

- A
- C
- D

Note: Dummy links modeled in SWMM are not shown in figure.

N

0 400 800 1,600 Feet

DFA 0056

BASIN 4100

North K Tributary

South K Tributary

West Sprat Platte Lake

North G Tributary

West G Tributary

Thornton Parkway

H Tributary

4100 Drainageway

D Tributary

B Tributary

J Tributary

School Tributary

River Valley Village

Cherrylane

ADAMS COUNTY 88TH AVENUE OPEN SPACE

Colorado Agricultural Canal

Lower Clear Creek Canal

RTD NWRL

Colorado Boulevard

Thornton Pkwy

E 104th Ave

E 102nd Dr

E 102nd Ct

E 101st Ave

E 100th Ln

E 100th Ave

E 100th Pl

E 99th Pl

E 99th Way

E 98th Ave

E 97th Ave

E 96th Dr

E 96th Ave

E 91st Ave

E 89th Pl

E 88th Pl

E 88th Ave

E 108th Dr

E 107th Pl

E 106th Ave

Homestead Pl

Hudson Ct

Roxbury Rd

Fairfax Way

Colorado Blvd

Steele St

York St

Elizabeth St

Downing St

Washington St

Claude Ct

Columbine Ct

Addison St

Irving St

Emerson St

Clarkson St

Essex St

Lowell Blvd

Rainbow Ave

McKinley Blvd

Dennehine Blvd

Welby Rd

Perl St

Brighton Rd

Frontage Rd

I-25 Access

### INTERACTIVE FIGURES

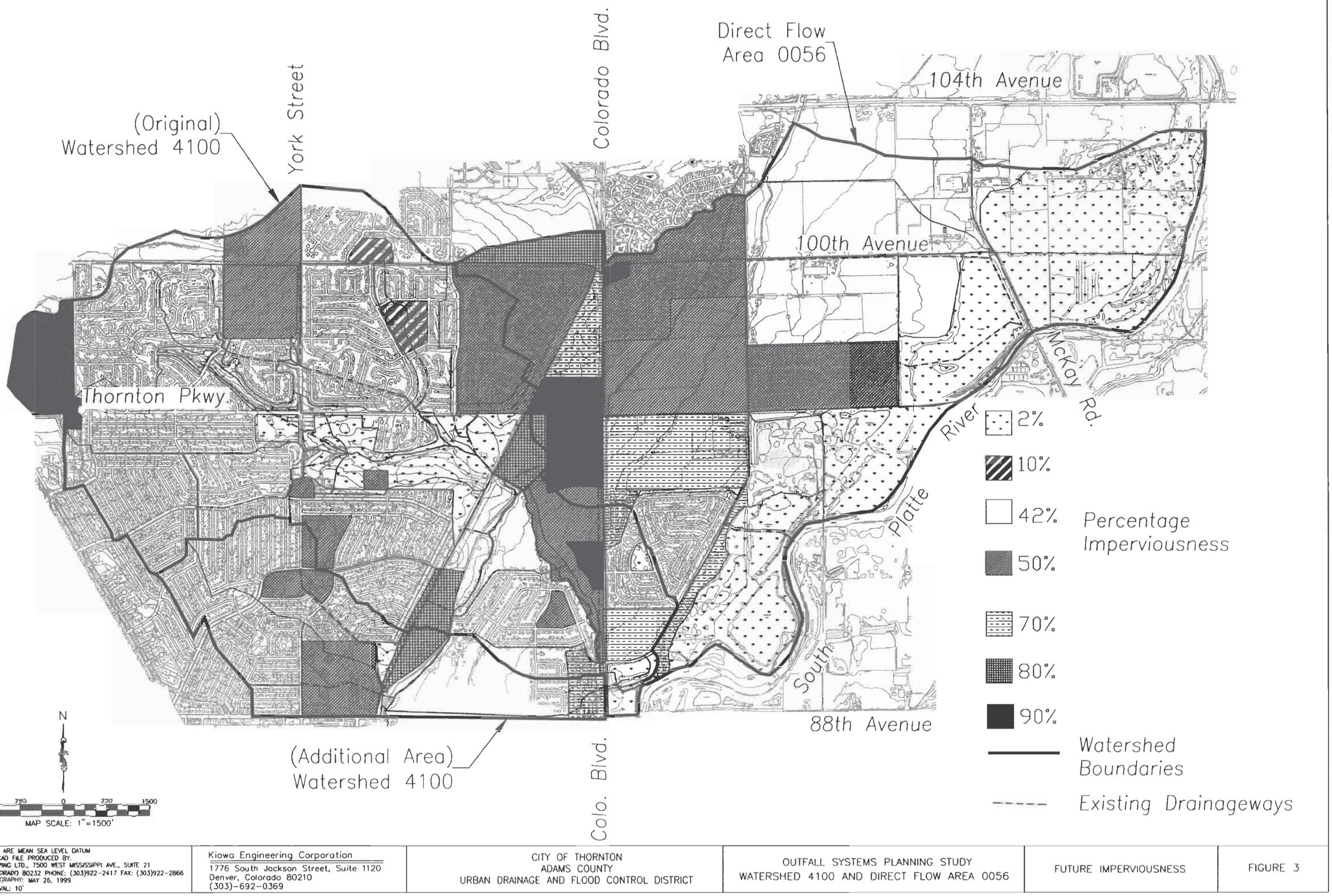
STUDY AREA
SUBBASIN BOUNDARIES
SOILS
FUTURE LAND USE
EXISTING LAND USE PERCENT IMPERVIOUS
FUTURE LAND USE PERCENT IMPERVIOUS
SWMM ROUTING

CLICK TO TURN STREETS ON OR OFF

CLICK TO TURN AERIAL ON OR OFF

CLICK TO TURN TOPOGRAPHY ON OR OFF

| | | | |
|---|---|---|---|
| PROJECT: 017-2321<br>DRAWN BY: HH<br>DATE: 06/2018 | **URBAN DRAINAGE AND FLOOD CONTROL DISTRICT, CITY OF THORNTON AND ADAMS COUNTY** | **BASIN 4100 AND DFA 0056 HYDROLOGY WORKMAP** | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | FIGURE<br>B-1 |

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| ALL ELEVATIONS ARE MEAN SEA LEVEL DATUM<br>MAP AND AUTOCAD FILE PRODUCED BY:<br>[illegible] MAPPING LTD., 7500 WEST MISSISSIPPI AVE., SUITE 21<br>LAKEWOOD, COLORADO 80232 PHONE: (303)922-2417 FAX: (303)922-2866<br>DATE OF PHOTOGRAPHY: MAY 26, 1999<br>CONTOUR INTERVAL: 10' | Kiowa Engineering Corporation<br>1776 South Jackson Street, Suite 1120<br>Denver, Colorado 80210<br>(303)-692-0369 | CITY OF THORNTON<br>ADAMS COUNTY<br>URBAN DRAINAGE AND FLOOD CONTROL DISTRICT | OUTFALL SYSTEMS PLANNING STUDY<br>WATERSHED 4100 AND DIRECT FLOW AREA 0056 | FUTURE IMPERVIOUSNESS | FIGURE 3 |

DFA 056
WATERSHED
FROM THIS 2018
STUDY

Direct Flow
Area 0056

BASIN 4100
WATERSHED
FROM THIS 2018
STUDY

(Original)
Watershed 4100

York Street

Colorado Blvd.

104th Avenue

100th Avenue

Thornton Pkwy.

Riverdale Road

McKay Rd.

River

Union Pacific RR

South Platte

88th Avenue

Major Watersh
Boundaries

Subwatershed
Boundaries

51 Subwatershed

N

# PROGRESS MEETING MINUTES

**Basin 4100 and DFA 0056 OSP**
**Tuesday, July 31, 2018**
**11:00 am at Olsson Associates**

**Attendees:**

| Name | Representing | E-mail |
|---|---|---|
| Brooke Seymour | Urban Drainage and Flood Control District (UDFCD) | bseymour@udfcd.org |
| Dave Skuodas | UDFCD | dskuodas@udfcd.org |
| Jim Kaiser | City of Thornton (Thornton) | Jim.Kaiser@cityofthornton.net |
| Matt Eberly | Thornton | Matt.Eberly@cityofthornton.net |
| Russ Nelson | Adams County | RNelson@adcogov.org |
| Marc Pedrucci | Adams County | mpedrucci@adcogov.org |
| Amy Gabor | Olsson (Olsson) | agabor@olsson.com |
| Deb Ohlinger | Olsson | dohlinger@olsson.com |
| Chance Uhrich | Olsson | curhich@olsson.com |
| Hannah Pring | Olsson | hpring@olsson.com |

**Discussion Items:**

The meeting was held to discuss the draft alternatives analysis and report and direction for completing the alternatives analysis. While this summary in not intended to represent a comprehensive account of the meeting, it is intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1) Draft Alternatives Analysis

   a) Tributary B

      i) Thornton requests that Tributary B be included in the alternatives analysis. Stormwater currently discharges into the ditch. Thornton would like to separate the stormwater from the ditch flows.

      ii) The previous OSP proposed a storm sewer that flowed under local streets, but there would be many utilities along the proposed alignment.

      iii) A potential option is to convey flow up Welby, or up Welby and turn right, outfalling into the existing detention pond southeast of Welby Circle. However, this pond is not sized for any additional flows.

   b) Survey

      i) Thornton will provide survey for the conceptual design. Olsson will send additional information regarding survey needs.

   c) Additional detention basins

      i) Detention basins to be added to the baseline hydrology:

         (1) North G Tributary upstream of E 98th Avenue

         (2) Colorado Boulevard at E 96th Avenue (review drainage study, if available, to determine if modeling is needed)

         (3) J Tributary north of E 96th Avenue and 94th Avenue (review drainage studies)

      ii) Detention basins on H Tributary and West G Tributary will not be added to the baseline hydrology, but will be discussed within the report and recommendations will be based on engineering expertise.

   d) Comments on alternatives

      i) In the Adams County Open Space area, update alternatives to route flows into Middle Pond and construct a formal outlet structure. Olsson will evaluate the feasibility of using the old ditch alignment. South Pond will be avoided altogether. Include recommendations for any future trail crossings.

      ii) Clarify text regarding the intent of the DFA 0056 alternatives.

      iii) Review record drawings for the School Tributary 84" culvert under new Welby.

      iv) Include an alternative for a spillway and slope hardening at the downstream end of Drainageway 4100.

      v) Evaluate channel improvements at the downstream end of Drainageway 4100.

      vi) Incorporate low maintenance streams in conceptual design.

   e) Storm drain systems

      i) UDFCD will confirm what information should be included regarding storm drain systems, as there is limited survey information for plan and profile drawings.

   f) Maintenance costs – only where we evaluated alternatives?

      i) UDFCD will confirm how maintenance costs should be addressed.

   g) Dividing costs between jurisdictions

      i) Costs in the OSP will be based on existing jurisdictional boundaries.

      ii) Jurisdiction boundaries will be updated based on the latest information.

2) The OSP floodplain is based on assumptions that would be different included in a FHAD floodplain (i.e. the inclusion of private detention basins).

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**O** 303.237.2072 / **olsson.com**

3) ,Schedule

   a) Anticipated comments

      i) Comments were provided to Olsson Associates on 8/1/2018.

4) Meetings

   a) After comments, if needed

   b) Public meeting

      i) Will be held after alternatives analysis comments have been addressed.

      ii) High School is a potential meeting location.

**Action Items:**

- Thornton
  - Provide drainage plan for Colorado Boulevard detention basin
  - Provide record drawings for School Tributary 84” culvert under Welby
  - Provide survey
- UDFCD
  - Confirm how the conceptual design storm plan and profiles should be represented for storm drain recommended improvements
  - Confirm how maintenance costs should be evaluated
- Olsson
  - Forward updated survey request to Thornton – *completed 8/1/2018*

Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.

Minutes prepared by: Hannah Pring
cc: Attendees, File

# PROGRESS MEETING MINUTES

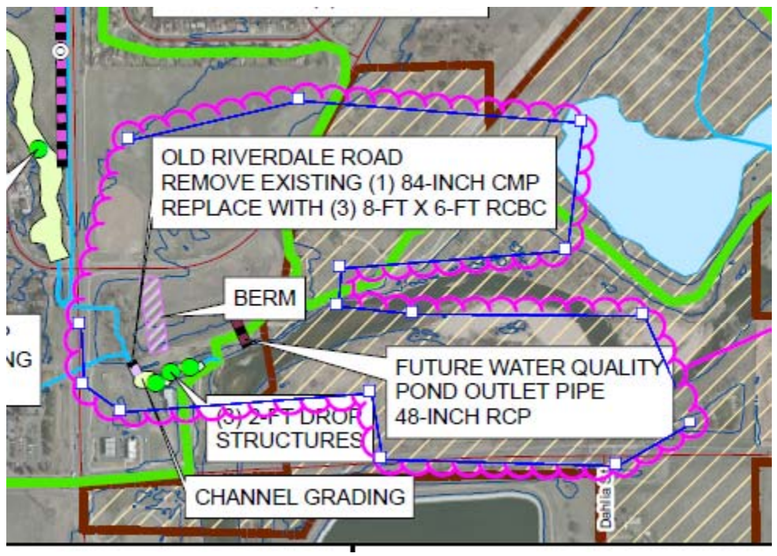
**Basin 4100 and DFA 0056 OSP**
**Monday, July 20, 2020**
**10:00-11:40 am Microsoft Teams**

| Name | Representing | E-mail |
|---|---|---|
| Dave Skuodas | Mile High Flood Control District (MHFCD) | dskuodas@udfcd.org |
| Jim Kaiser | City of Thornton (Thornton) | Jim.Kaiser@cityofthornton.net |
| Rachelle Plas | Thornton | Rachelle.Plas@cityofthornton.net |
| Russ Nelson | Adams County | RNelson@adcogov.org |
| Amy Gabor | Olsson (Olsson) | agabor@olsson.com |
| Deb Ohlinger | Olsson | dohlinger@olsson.com |
| Hannah Pring | Olsson | hpring@olsson.com |

**Discussion Items:**
The meeting was held to discuss the conceptual design and report and direction for completing the project. While this summary in not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1) Drainageway 4100-1: Old Riverdale Road Crossing

**Jim Kaiser, PDF page 11: Existing water line lowering and possibly the width of the receiving channel will not accommodate a 28-foot wide structure. Consider lower invert to provide head to a single large box (10x7(?)) at the existing culvert location. Berm to maximize "low flow" culvert capacity. Spill to east for a secondary outlet that goes UNDER the eastern reach of the waterlines. Significant head available to reduce needed size.**




- See Old Riverdale Road attachment for mark ups with conceptual design to discuss.
  - The future Police Training Facility is no longer considering this location for water quality in the design. The water quality portion of the conceptual design will be eliminated. The concept with remain as is.
  - Additional information will be added to the map to articulate what is shown, so that it is clear without having to reference the text that the goal is to avoid the water line, potentially add a berm with a spillway that would engage in higher events in order to maximize the head on the existing culvert, and that the additional pipe is being added to handle a 100-year event.
  - Additional information will be added to the report suggesting that the current configuration is one option, and changes will likely occur during design. The berm will be shown as a potential area for project spoils and will not be included in the cost estimate.

2) Drainageway 4100-1: Old Riverdale Road Detention

**Rachelle Plas, PDF pg 431: Why was the cost of the pond and berm not included?**

- Water quality cost was assumed to be development related. The water quality only serves the development, and the berm is related to separating the water quality pond from the main drainageway. The floodplain in this area was evaluated for both with and without the berm since it would not be a formal levee.
  - As discussed above, the water quality pond will be removed from the conceptual design and the berm will not be included in the cost since it will be shown as a potential spoil area.

3) Drainageway 4100-1: Colorado Agricultural Ditch Crossing

**Jim Kaiser PDF pg 63: The Colorado Ag canal goes under the thalweg in a siphon; this "crossing info" must be a carryover from the previous MDP. That said, the trail crossing that goes "through" the siphon is a 1 36" (?) RCP on a sharp skew; making it a fairly long pipe. This should be updated in the table, if not the model, too. See photo 2020 07 09_092206**

- The existing structure information is based on survey information. The original information provided to Olsson was for the Colorado Agricultural Ditch crossing, and not the drainageway crossing, see attachment “Crossing F. Thornton resurveyed the area and provided the updated survey, see attachment “Crossing F – Corrected”. It reports dual 18-inch RCPs crossing underneath the canal. However, it appears that this information may be incorrect. When zoomed in on the photographs, it appears that the pipes may actually

be 30-inch RCPs. See Surveyor's photo below. Olsson confirmed during a site visit that the crossing is dual pipes. The size was not verified by Olsson during the site visit.

- Verify size?
  - Thornton will look for as-built information on this crossing, re-measure the size, and survey the trail for overtopping elevation.
  - Olsson will remove the recommendation for the two 42-inch pipes.
- If size is incorrect update existing and conceptual design? Alternatives models and information will not be updated.
  - A statement will be added in the conceptual design to document the the pipe size and note that it changed from the alternatives. The full report will be updated with exception of the alternatives analysis section.

Surveyor Image – Crossing F Corrected

Olsson Image of Colorado Agricultual Ditch Crossing from Field Visit

J Tributary

**Rachelle Plas, PDF pg 456: It looks like this has been done by the ADCO trail? Or did they not improve the culvert?**

- Previous direction was to provide a size, if it is needed for future park improvements. Existing size is unknown. Will check with Adams County to see if they have records of this culvert.
  - Remove improvements from conceptual design since it has been built. Adams County will provide as-built information to confirm that it was sized for the existing flows and meets criteria.
  - Add information to the conceptual design regarding the peak flows through the pond in the lower J Tributary, to help plan for future park infrastructure.

4) North K Tributary

**Rachelle Plas, PDF pg 456: Is this alignment selected due to the grades in the area? Was straight east after the diversion structure too flat?**

- The alignment was evaluated during the alternatives analysis. An alignment straight east did not have enough cover over the pipe, as well as a potential conflict with an existing storm drain pipe (see report Page 38 for additional discussion). Text will be added to the Conceptual Design section to clarify why this alignment was selected.
  - There is also an Xcel ROW in this location that would make this alignment difficult. One goal of Thornton's is to keep the first flush / minor storms out of the basins.
  - Olsson will double check previous alignments and analysis to ensure that the conceptual design alignment is the best alternative in this area. Text will be added to the report regarding the other alignments considered and why this alignment was selected.

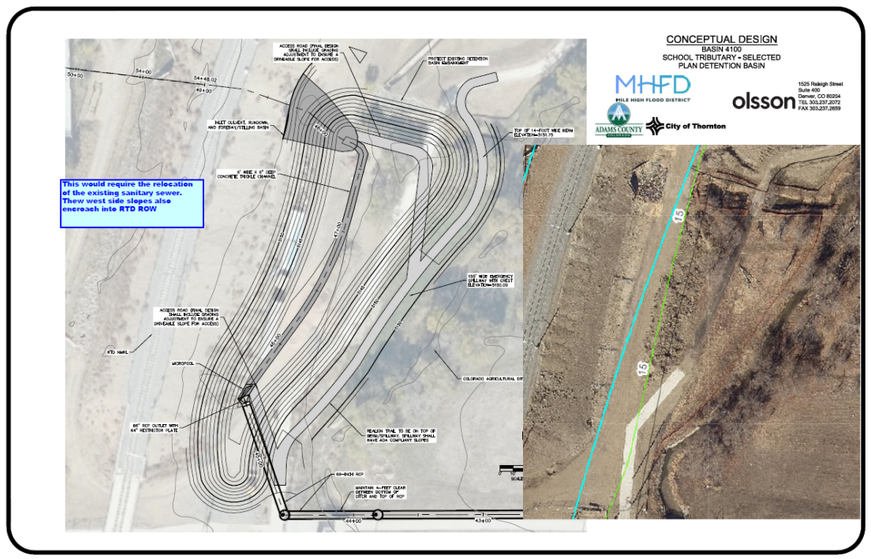
5) Colorado Boulevard

**Dave Skuodas, PDF pg 11: Is this really necessary? What does this buy us? Is no flow allowed in Colorado Blvd or is this intended to capture all of the 100-year?**

- The pipe lowering is needed to eliminate a spill onto Colorado Boulevard.
  - Clarify and give context on the map as to what the purpose of the proposed improvement is.

6) School Tributary: Detention

**Jim Kaiser, PDF pg 636: This would require the relocation of the existing sanitary sewer. The west side slopes also encroach into RTD ROW**




- LiDAR does not reflect area very well with newer development and construction of the pond to the north. It is possible that the sanitary sewer would need to be relocated. Alternatively, grading could start outside of RTD ROW and potentially move closer to the canal, or the trail could be relocated to the east side of the canal and could cross back over with a pedestrian bridge. Additional information would be needed to fully determine the best approach to fit the required detention in this location. The sanitary sewer and ROW will be added to the plan, and discussed further in the report.

    - Old Welby Road was within the RTD ROW, so there is potential that the slopes in the RTD ROW would be acceptable.

    - Add information to report, plan view and detailed figure to note constraints of this area and factors that will need to be considered with final design. The constraints are the RTD ROW, sanitary sewer line, agrictultural ditch, trail, pond ot the north, and downstream flows.

7) General Comments

**Dave Skuodas, PDF pg 41: I don't support the idea of check structures. The reason for this, the access to install a check structure is pretty tight, meaning it will be disruptive to install one. Perhaps not to the channel, but to the area we need to use for access. True "check structures" eventually become drop structures, which means we'd need to come back and perhaps convert them. If that's going to be the case, I'd rather do restorative work upstream and downstream of fully designed and constructed drop structures so we only have to get in there once. Let's discuss this further at our review meeting.**

- How are HFLMS being implemented at a master planning level in developed areas? The tighter corridors and structure inverts do not make an actual HFLMS design feasible in many locations in this drainageway.

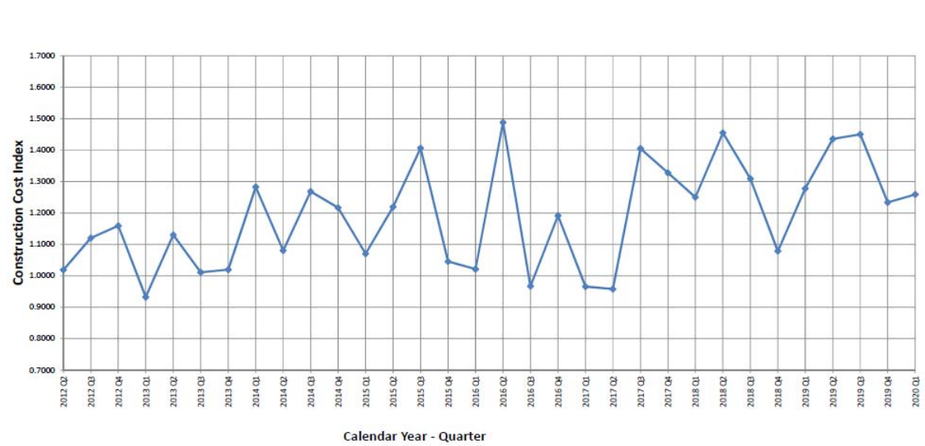
    - Given the current conditions, it is more likely for MHFD to perform linear restoration to the channel in this location, as opposed to installing check structures. This area should include low height drop structures (1'-3' high) to establish a stable slope with some channel re-shaping. Text should be added to the report explaining that this work should be done once signs of erosion start to occur and the channel begins to unravel.

    - Bordering property ownership is to be verified by Olsson along this portion of the corridor.

**Dave Skuodas, PDF pg, 42: In looking at some recent bids, I could see upping all of these unit costs by around 50% across the board. Seems pretty consistent.**

- Unit costs are determined using the Swift tool/UD_MP_Cost. The base unit costs are from 2012, and then the latest CDOT CCI information (see below) is input to determine the current unit costs. The unit costs do appear to be low as compared to current bids. Should the CCI factor be increased from what CDOT shows to raise all unit costs? How are other MDPs being updated?

    - Unit costs will be updated via the CCI cost index and information will be added to the report text explaining how and why the change was made.




**Dave Skuodas, PDF pg 48: (Conceptual Design Report Text) This is all pretty hard to follow, particularly because the Conceptual Design map doesn't show much.**

- This section of the report should be compared to the Alternatives Map, which includes each alternative. The Conceptual Design map only shows the improvements that were included in the Selected Plan. The Conceptual Design section of the report coincides with the map, eliminating any alternatives that were not chosen for the selected plan and conceptual design. Is additional clarification in the report needed?

    - Clarification should be added to the map to explain why status quo was recommended for J and H Tributary.

**Dave Skuodas, PDF pg 55: (Public Safety weighted at 10% on the Alternatives Decision Matrix) It doesn't seem like this should be weighted so low...**

- Public safety will be increased to 15% and cost will be lower to 15%. Based on the new results, the recommended alternatives did not change.

    - Public Safety will be moved to the first column, so it is more clear that it is an item of high importance to the project.

8) Conceptual Design Map

**Dave Skuodas: It would be helpful to see the existing public ROW/drainage easements if at all possible, perhaps as a differently shaded polygon for the corridor we have to work within.**

- ROW/Easement information does not appear to be available for download. Can this linework be provided?

    - Adams County and Thornton will provide GIS information for ROW and easements, if they are available, and available information will be included in the map.

9) What should we be referring the development area north of the proposed Riverdale water quality location?

    - This comment is no longer applicable since the water quality was eliminated in item #1.

10) Other

    - Thornton noted that there are improvements being made to Riverdale Road, but that some water will still flow over the road to the north into Adams County parks and open space, like it does today.

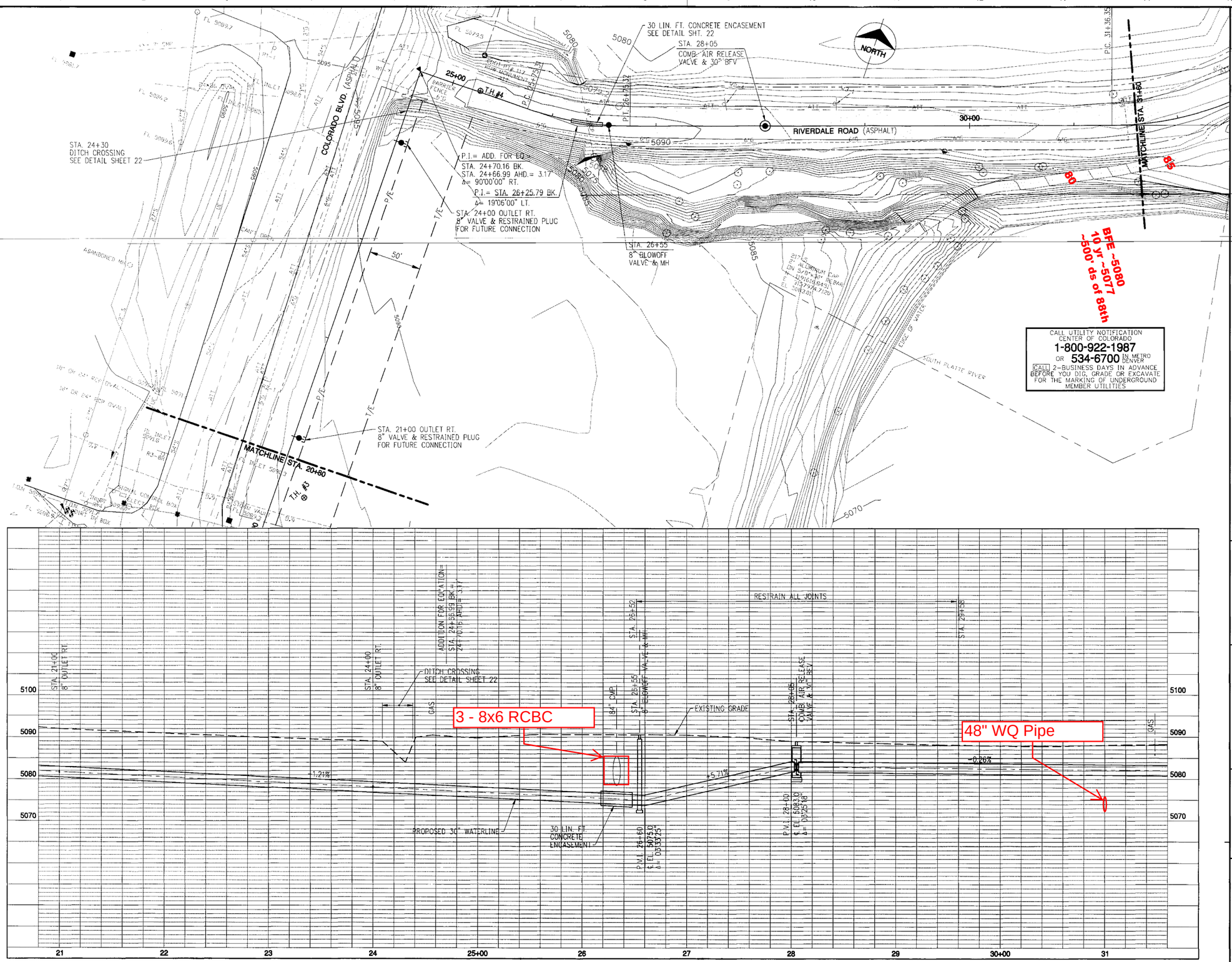
**Action Items:**

- Thornton
    - Provide ROW and Easement GIS information, if available.
    - Provide field verification information for Colorado Agricultural Ditch crossing.

- Adams County
    - Provide ROW and Easement GIS information, if available.
    - Provide plans for trail crossing, if available.

Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.

Minutes prepared by: Hannah Pring
cc: Attendees, File




| no. | date | by | revision |
|---|---|---|---|
| 1 | 1/8/97 | DAW | CONFORMING TO CONSTRUCTION RECORDS |

HORIZ. 40 0 40 80 SCALE IN FEET

VERT. 10 0 10 20 SCALE IN FEET

McDonnell

| | |
|---|---|
| date FEBRUARY 17, 1995 | detailed D. WINDER |
| designed P. FISCHER | checked L.F.C. |

City of Thornton

ZONE 1 IMPROVEMENT
PLAN AND PROFILE
STA. 20+80 TO STA. 31+60

| | |
|---|---|
| project 94-269-1 | contract |
| drawing 5 | rev. 1 |

sheet 5 of 33 sheets

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CITY OF THORNTON
ZONE 1 IMP.
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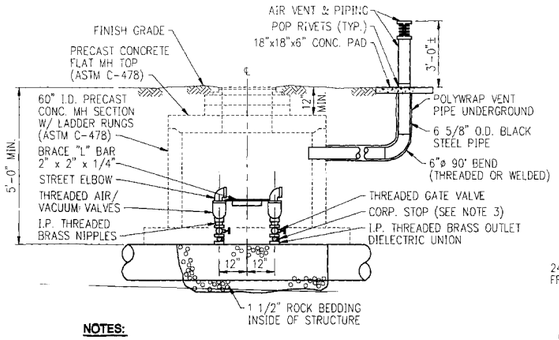


**NOTES:**

1. 1 1/2" ROCK SHALL BE PLACED IN BOTTOM OF MH TO CROWN OF PIPE ONLY.
2. ALL PIPE AND FITTINGS SHALL BE BRASS.
3. WITH I.P. THREADED OUTLET, CORP. STOP SHALL BE I.P. THREADED BOTH ENDS (MUELLER H-10012). FOR DIRECT TAP ON PIPE, CORP. STOP SHALL BE MUELLER (CC) THREADED ONE END, I.P. THREADED OTHER (H-10003).

SECTION
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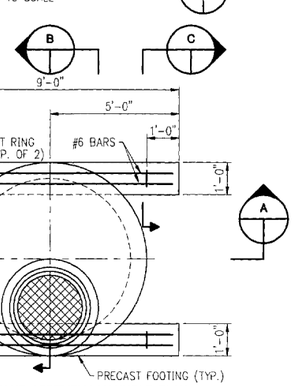
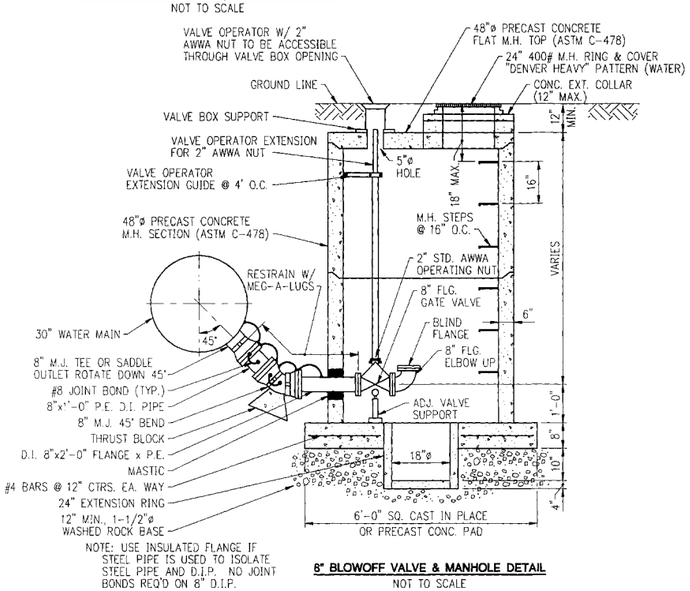
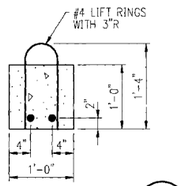



AIR RELIEF VALVE ASSEMBLY MANHOLE PLAN
NOT TO SCALE




NOTE: USE INSULATED FLANGE IF STEEL PIPE IS USED TO ISOLATE STEEL PIPE AND D.I.P. NO JOINT BONDS REQ'D ON 8" D.I.P.

8" BLOWOFF VALVE & MANHOLE DETAIL
NOT TO SCALE

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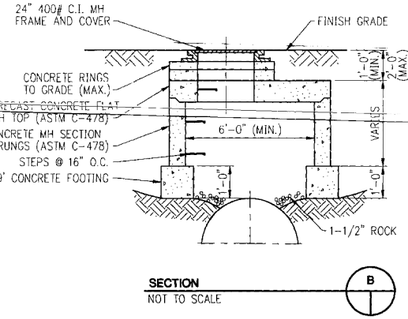


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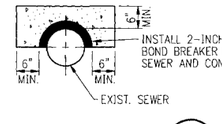


SECTION
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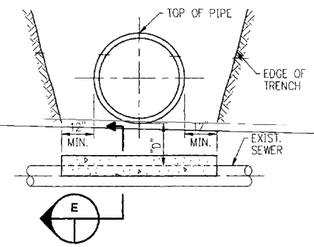
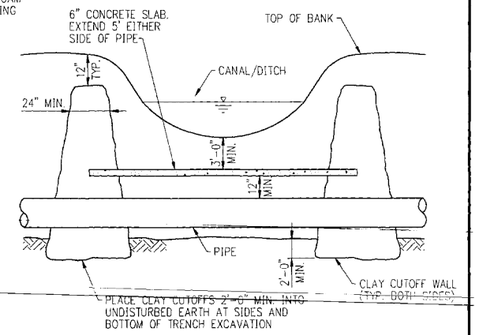
INSTALL 2-INCH THICK STYROFOAM BOND BREAKER BETWEEN EXISTING SEWER AND CONCRETE




**PARTIAL ENCASEMENT STORM & SANITARY SEWER CROSSING DETAIL (WITH "D" LESS THAN 2 FEET)**
NOT TO SCALE




**CANAL/ DITCH CROSSING DETAIL**
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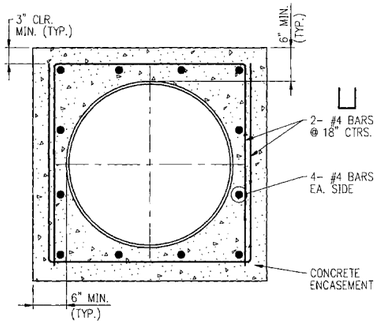


**CONCRETE ENCASEMENT DETAIL**
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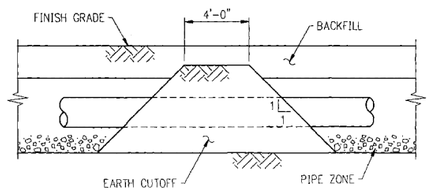
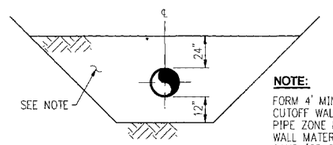


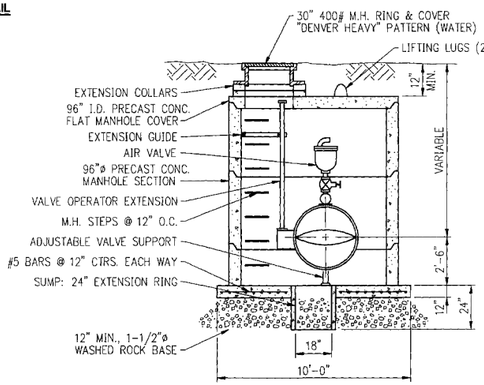

ELEVATION



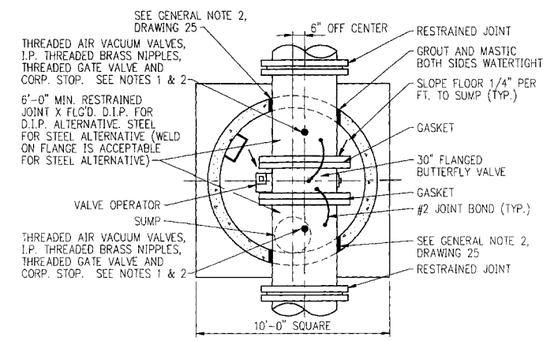

**NOTE:**

FORM 4' MIN. THICK EARTH CUTOFF WALL TO REPLACE PIPE ZONE MATERIAL. CUTOFF WALL MATERIAL TO BE SILTY SAND (OR SAND) AND 20 LB. BENTONITE CLAY PER CU. YD. OR 1000 PSI CONCRETE. PLACE CUTOFF WALLS AS SHOWN IN WET AREAS.

**EARTH CUTOFF WALL DETAILS**
NOT TO SCALE




ELEVATION
NOT TO SCALE




**NOTES:**

1. ALL PIPE AND FITTINGS SHALL BE BRASS.
2. WITH I.P. THREADED OUTLET, CORP. STOP SHALL BE I.P. THREADED BOTH ENDS (MUELLER H-10012). FOR DIRECT TAP ON PIPE, CORP. STOP SHALL BE MUELLER (CC) THREADED ONE END, I.P. THREADED OTHER (H-10003).

**COMBINATION AIR RELEASE & 30" BUTTERFLY VALVE MANHOLE PLAN**
NOT TO SCALE

| no. | date | by | revision |
|---|---|---|---|
| | 1/8/97 | DAW | CONFORMING TO CONSTRUCTION RECORDS |

McDonnell

| date | detailed |
|---|---|
| FEBRUARY 17, 1995 | D. WINDER |
| designed | checked |
| P. FISCHER | L.F.C. |

City of Thornton

ZONE 1 IMPROVEMENT

MISCELLANEOUS DETAILS I

| project | contract |
|---|---|
| 94-269-1 | |

drawing 22 rev. –

sheet 22 of 33 sheets

file TH2MD022.DWG 04-04-1995 04:57 DAW

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BRIDGE/CULVERT INFORMATION

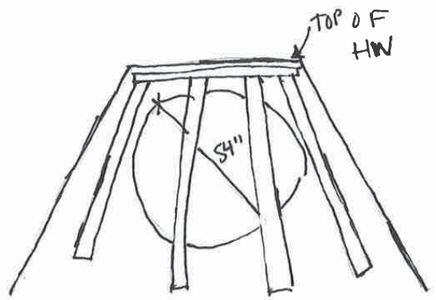
Crossing Name: F

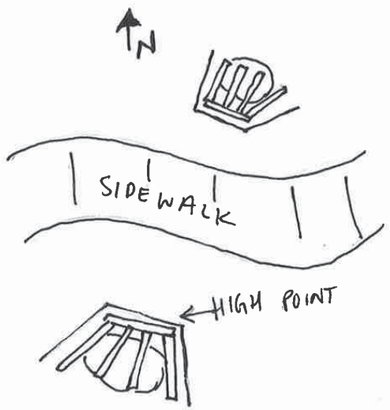
| BRIDGE | | CULVERT | |
|---|---|---|---|
| Alignment | | Inside Dimensions | |
| Bridge Opening Width W | | •Rise (Diameter) | 54" |
| Bridge Opening Length L | | •Span | |
| Piers (see below for quantity, type) | | Shape | CIRCULAR |
| •Width | | Material | RCP |
| •Pier Cap Width | | Length of Culvert | |
| •Pier Cap Height | | Road Elevation | |
| Elevation Top | | Outlet | |
| Elev Low Steel | | •Siltation Depth | |
| Bridge Opening Sideslopes | | •End Projection | |
| Embankment Sideslopes | | Embankment Sideslopes | |
| •Entrance | | •Entrance | |
| •Outlet | | •Outlet | |
| Entrance | | Entrance | |
| •Wingwall Angle | | •Wingwall Angle | |
| •Wingwall Length | | •Wingwall Length | |
| •Angle of Bridge Skew | | •Angle of Bridge Skew | |
| Top of Railing | | Top of HEAD WALL: | SEE REMARKS |
| Invert Elevations | | Invert Elevations | |
| •Entrance | | •Entrance | 5138.23' |
| •Outlet | | •Outlet | 5137.68' |
| High Point in Road Centerline | | High Point | 5143.79' |
| Deck Elevations | | Elevation Top | |

REMARKS: TOP OF HEADWALL SOUTH OF THE SIDE WALK = 5143.79'
TOP OF HEADWALL NORTH OF THE SIDE WALK = 5143.08'
• HIGH POINT IS AT THE TOP OF HEAD WALL ON THE SOUTH SIDE FOR THIS CROSSING.

SKETCH

INVERTS SIMILAR FOR NORTH & SOUTH SIDES




# F - In (South)

Note: No image was obtained for F - Out (North) due to difficulties on site.

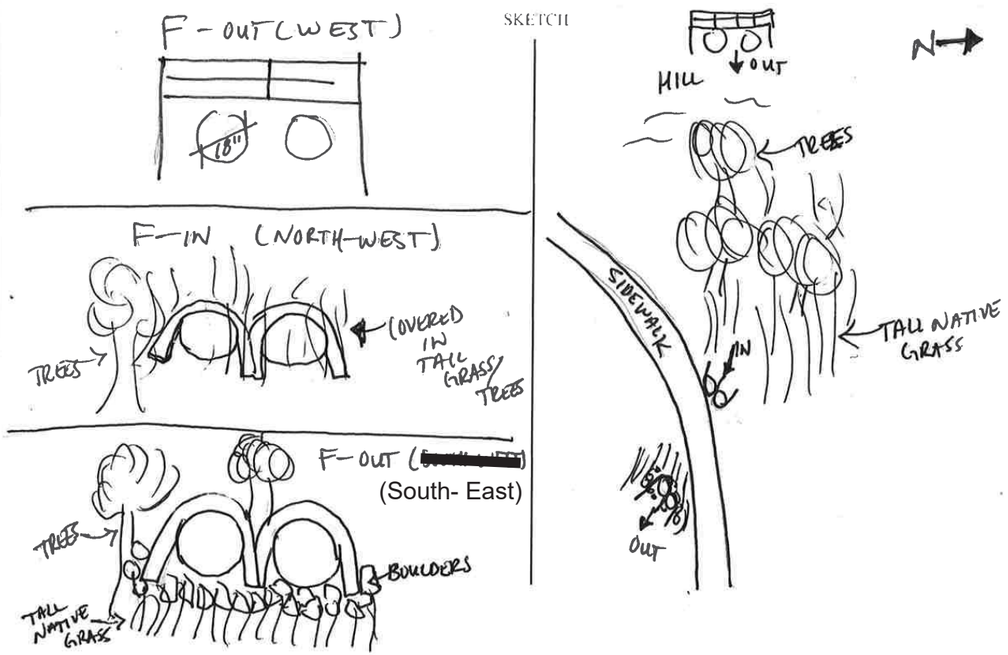
BRIDGE/CULVERT INFORMATION

Crossing Name: Crossing F - Correction

| BRIDGE | | CULVERT | |
|---|---|---|---|
| Alignment | | Inside Dimensions | |
| Bridge Opening Width W | | •Rise (Diameter) | 18" |
| Bridge Opening Length L | | •Span | |
| Piers (see below for quantity, type) | | Shape | CIRCULAR |
| •Width | | Material | RCP |
| •Pier Cap Width | | Length of Culvert | |
| •Pier Cap Height | | Road Elevation | |
| Elevation Top | | Outlet | |
| Elev Low Steel | | •Siltation Depth | |
| Bridge Opening Sideslopes | | •End Projection | |
| Embankment Sideslopes | | Embankment Sideslopes | |
| •Entrance | | •Entrance | |
| •Outlet | | •Outlet | |
| Entrance | | Entrance | |
| •Wingwall Angle | | •Wingwall Angle | |
| •Wingwall Length | | •Wingwall Length | |
| •Angle of Bridge Skew | | •Angle of Bridge Skew | |
| Top of Railing | | Top of Railing | |
| Invert Elevations | | Invert Elevations | |
| •Entrance | | •Entrance | 5139.11' |
| •Outlet | | •Outlet | 5135.00' |
| High Point in Road Centerline | | High Point in ~~Road Centerline~~ | 5143.79' |
| Deck Elevations | | Elevation Top | SIDEWALK |

REMARKS: ELEVATION AT F-OUT-WEST = 5148.25'

SKETCH




F - Out (West)

F - In (North-West)

F - Out (South-East)

Basin 4100 and DFA 0056 Outfall Systems Plan | Project Open House | December 12, 2018

| Name | Address | Phone Number | Email Address |
|---|---|---|---|
| Please Print<br>GARY & JANET BUGG | Address 2523 E 98TH PL<br>City/Zip THORNTON, CO 80229 | 303-252-4859 | Janetpunkin141@hotmail.com |
| Please Print<br>Bob & Donna Hull | Address 8831 Monroe St<br>City/Zip Thornton, Co 80229 | 303-287-2322 | |
| Please Print<br>MARY WELSCH | Address 10145 FILLMORE ST.<br>City/Zip | 303-252-0274 | |
| Please Print<br>FRANK NEWTON | Address 2600 Eppinger Blvd.<br>City/Zip Thornton, CO 80229 | | ENEWT999@AOL.COM |
| Please Print<br>JOHN STRACHAN | Address 9765 Downing Dr<br>City/Zip Thornton, CO 80229 | 303-457-8508 | JCSTRACHAN@COMCAST.NET |
| Please Print<br>A. Hawthorne | Address 5227 E 100th Way<br>City/Zip Thornton CO | 303-452-9334 | |
| Please Print<br>Helen Stoner | Address 9381 Nagel Dr.<br>City/Zip Thornton | 303 725-9870 | |
| Please Print<br>Jim Kaiser | Address 12450 Washington St<br>City/Zip Thornton | 720/970 6266 | jim.kaiser@cityofthornton.net |
| Please Print<br>Deb Ohlinger | Address 1525 Raleigh St. Ste 400<br>Denver CO 80204<br>City/Zip | 303-237-2072 | dohlinger@olsson.com |
| Please Print<br>Hannah Pring | Address 1525 Raleigh St Ste 400<br>City/Zip Denver CO 80204 | 303-237-2072 | hpring@olsson.com |
| Please Print | Address<br>City/Zip | | |
| Please Print | Address<br>City/Zip | | |

# PUBLIC MEETING COMMENT FORM

*Basin 4100 and DFA 0056 Outfall Systems Plan – December 12, 2018*

Name: Helen Stones

Street Address: 9381 Nagel Dr.

City/State/Zip: Thornton CO 80229

Phone Number: 303 725 9870

E-mail Address:

1. Please share your comments about the project.

Need retainer walls need replacing to hold back flooding in back yards, 5 houses on Nagel Dr. on both sides of Street.

2. Do you have any questions that were not answered at the meeting? (We can respond to your question if you provide contact info above.)

3. Are you aware of any drainage problems in the study area?

Same as above

Please place your comment form in the box provided at the meeting,
mail to Deb Ohlinger, Olsson, 1525 Raleigh Street, 400, Denver, CO 80204,
or email to dohlinger@olsson.com
by December 31, 2018

## COMMENT RESPONSES

**This document functions as a response from Olsson to the comments provided by the Urban Drainage and Flood Control District and City of Thornton. The following information should be used in conjunction with the updated Draft Outfall Systems Plan for Basin 4100 and DFA 0056 provided with this document.**

1. Jim, PDF pg 8: South K Tributary alignment
    a. The alignments shown on Figure 1 represent the major storm event flow path. The figure was not updated, but the following text was added to the report: “The drainageway paths shown on Figure 1 represent the major storm event flow paths. In some areas, such as South K Tributary, minor storm events will flow along a different path. Additionally, Tributary B is intercepted by the Colorado Agricultural Canal. The flow path shown on Figure 1 represents the path flow would take in a major storm event, assuming the canal was full.”
2. Jim, PDF pg 10: Though it is not needed for detention since it is immediately upstream of the SPR, I thought the hydrology/routing of this detention basin still needed to be analyzed in order to address the adequacy of the 84-inch pipe and/or to size the overflow spillway to the river. Routing the flow may significantly reduce the resulting structure(s) size needed.
    a. Detention basin at Drainageway 4100 and School Tributary was not included, since it did not have a significant impact on major peak flows, per the sensitivity analysis. A spillway was evaluated at this location. The alternatives could be refined with survey of the existing culvert.
3. Brooke, PDF pg 10: Please clearly define goals to be met with improvements for each outfall.
    a. A “Reach Goals” section has been added in the alternatives section and will also be included in the conceptual design to keep the goals with the proposed improvements.
4. Jim, PDF pg 28: I'm not aware of this detention basin overtopping into Colorado. Please check pond routing.
    a. Colorado Boulevard detention basin has been added to the model and all model routing has been verified. The detention basin does not significantly reduce peak flows; however, it did show a slight increase in what storm event the pipes have capacity for, which is now the 2-year storm event. The results are similar to the 2002 OSP in this location, but with lower flows as a result of using different models and rainfall. The tributary area includes the neighborhood west of the RTD NMRL. There is likely inadvertent detention occurring at the RTD NMRL crossings that reduce the flows that reach this point. A statement to this effect was added to the report in Section 4.2.
5. Shea, PDF pg 34: This may be ok for alternatives analysis just to compare costs of each alt, but the conceptual design should be a LMS and not a series of checks.
    a. Per discussions with UDFCD, alternatives will continue to show check structures and LMS will be implemented in conceptual design.
6. Jim, PDF pg 36: This is not a viable alternative. Spillways protect dams from over topping. There is no danger to the railroad embankment over topping, since at stages above 5172 water would begin to flow south to the School Tributary. In addition, when this was formalized as regional detention, the "pond" embankment was built to keep the 100-year BFE off the railroad embankment. Given the relatively small size of the tributary area, constructing a spillway to discharge an unattenuated flow is also not called for. My bigger concern is with the lack of a secondary outlet. Our concept is to construct a chimney, or "bathtub drain" above the existing outlet pipes, with the crest elevation at the modeled 100-year BFE, if not slightly below, which presently is 5164.2. At this elevation, there is roughly 3 feet of freeboard before an insurable structure would be impacted (and over 50 acre feet of volume). Providing a means for flows through a secondary outlet allows this freeboard to also be routed "detention" for a 500-year event as well as the base outlet not performing to design due to clogging of the grate over the structure. Note, there is no channel capacity downstream to handle 1346 cfs of flow. A 40-foot crest would be passing well over 500 cfs at 3-feet, severely damaging downstream infrastructure and possibly insurable structures, yet the "dam" is not endangered, and we are only on the brink of danger for upstream structures.
    a. Per 07/31/18 meeting, Olsson will continue to provide an alternative that satisfies a formal emergency spillway criteria. The comment above can be incorporated in the conceptual design, based on the Selected Plan letter provided by the sponsors.
7. Jim, PDF pg 36: The previous masterplan called for constructing a spillway with armored bank down to the South Platte River. This may well be less than the $542k culverts. Also, the trail/bridge crossing downstream, or even the channel in between, likely cannot handle the unattenuated flows this would allow.
    a. Detention basin at Drainageway 4100 and School Tributary was not included, since it did not have a significant impact on major peak flows, per the sensitivity analysis. A spillway was evaluated at this location. The alternatives could be refined if the existing culvert is surveyed. There is a chance that the invert is lower, which could result in smaller improvements.
8. Shea, PDF pg 36: If this is WOTUS, we do not recommend on-line regional water quality. (Stormwater should be treated before released to WOTUS).
    a. Added statement about not meeting the requirements of the MS4 permit.
9. Matt, PDF pg 36: Riffle and Pool?
    a. A statement was added with alternatives assumptions. LMS will be evaluated with the conceptual design. The main goal of the alternatives is to identify the total vertical required drop height.
10. Shea, PDF pg 37: These channel depths are not acceptable. Could the ditch be flumed over the stream? Could a flow-in/flow-out configuration be used?
    a. Added a flume in this location
    b. Channel depths at the new Welby Road are 15’ deep due to the elevation of the new pipe that was installed. A storm drain alternative was added as an alternative, given the deep channel section.
11. Matt, PDF pg 37: Is there an issue with not meeting freeboard?
    a. Added a statement that this bridge could increase risk of clogging but should be better than culvert crossing risk of clogging. Trail slopes would dictate required extents of improvements if needed to raise proposed bridge and may limit how much it could be raised.

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Denver, CO 80204
**TEL** 303.237.2072
**FAX** 303.237.2659
www.olsson.com

12. Shea, PDF pg 37: Is stabilization needed? This is a pretty established area, if it's not eroding why do anything here? If it is eroding, improve with a LMS (Ok to wait for LMS until conceptual design).
    a. The alternatives were updated to only evaluate areas that appeared to be unstable. Text was added to the general alternative description to clarify. Portions of this area have an eroded low flow, but in general, the rest of the channel appears stable. The channel stabilization alternative was updated to show check structures where the low flow showed signs of erosion and channel improvements where the entire channel showed signs of erosion. LMS will be considered in the conceptual design.
13. Shea, PDF g 37 (on School Trib): This should be an LMS. Ok to wait until conceptual design.
    a. Per discussions with UDFCD, alternatives will continue to show alternative as is and LMS will be implemented in conceptual design.
14. Shea, PDF pg 38 (on North G): The reach description doesn't indicate signs of erosion - is achieving the stable slope necessary?
    a. The G Tributary channel is incised but is in open space. Check structure recommendation was updated with survey elevations at the upstream structure.
15. Jim, PDF pg 38: A lot of work could be done to increase detention basin volumes for $1.5 million in storm drain improvements.
    Jim, PDF pg 38: Are the detentions of NW of 97th and York, NW of 98th and York, and NW of 110th and York inadequate to meter the flow downstream to the capacity of the street and storm system.?
    a. Storm drain improvements along West G Tributary are based on pipe-full capacities using street slopes in 97th Avenue. The analysis shows the system (street and storm drain system) capacity between a 10-year and 50-year storm event. The 97th street capacity was limited by spread, not depth, so the system would likely not flood properties, but could inhibit emergency vehicle access. The storm drain system on West G Tributary west of Detroit Street was evaluated based on street slopes, not survey information. A more detailed analysis of the system, including inlet calculations and StormCAD using surveyed elevations may show there is adequate capacity. Because the existing conditions analysis is conceptual in nature, these improvements are recommended to be implemented with reports of flooding, or if there is a history of flooding. However, we do recommend a more detailed look at flooding in Thornton Parkway with the new Fire Station proposed development and the existing system may need to be evaluated for that development.
    b. Detention basins 326, 327, and 329 were modeled using the 2002 OSP. Volumes were checked using LiDAR data to verify the 2002 OSP volumes and generally agreed, so the 2002 OSP storage-discharge values were used. Based on the EPA SWMM output and elevations corresponding to the volumes calculated using LiDAR, it appears that these three detention basins will overflow the spillway in a future 100-year event. The 2002 OSP outflows are similar and also show overtopping of the spillways. This is likely due to different modeling techniques than what was used for design. Increasing the storm drain capacity could help prevent spillway overtopping. Substantially increasing the capacities of these detention basins does not appear to be feasible, as they are confined on all sides by houses and streets, have relatively steep side slopes, and are already shown as not having enough capacity. Detention basin 327 appears to have some space available to increase capacity, but there is a playground in this area and it is likely not enough detention storage could be achieved in this one location to eliminate storm drain improvements. The rest of West G Tributary is developed, so detention improvements were not evaluated.
16. Jim PDF pg 38: Is the detention north of 98th Place inadequate to attenuate the flow to the capacity of the existing 30-inch pipe?
    a. Per discussions with the project sponsors, the Tributary H pond was not added to the baseline model, but a statement was added to the report that the system likely has capacity for detained flows. Storm drain improvements were still included in the alternatives analysis, but were taken out of the recommended plan.
17. Jim, PDF pg 39: Perhaps North K should only be viewed as that tributary area west of West Spratt that could be routed through the 2-year basing described above. areas east of this tributary to100th & McKay would then be "East K" tributary.
    a. Suggested routing has been incorporated. If this is the selected alternative, conceptual design will utilize suggested naming for proposed improvements.
18. Matt, PDF pg 39: Further Discussion – North K: It is assumed that the existing outfall to the City reservoir can be lowered to allow for the enlarged channel upstream.
    a. This will be further evaluated, if needed, during the conceptual design.
19. Brooke, PDF pg 71: SWMM: 223
    a. Link 223 is a dummy link, and was therefore not shown on Figure B-1, for clarity. A note is included in the legend that states that dummy links are not shown on this figure. The dummy links are shown on the routing schematic.
20. Brooke, PDF pg 71: Is it possible to keep selected aerial, street and topo settings, while switching between interactive figures? (I like to leave aerial and streets on.)
    a. Made the aerial and streets default to being on with selections. User may still turn them on or off if they wish.
21. Jim, PDF pg 71/72: Subbasin 11 boundary and design point routing
    a. The subbasin boundary delineations and SWMM routing are based on major storm events and generally ignore storm drain systems. The subbasin boundary in the comment reflects the routing of this area based on the storm drain system, when the storm drain is assumed full, or clogged, stormwater will flow from Adams Street onto Welby Circle and continue to the south. To be consistent with the rest of the model, the suggested edit was not incorporated.
22. Jim, PDF pg 72: 113 flows to the Colorado Agricultural canal
    a. B Tributary flows into canal, which we consider full for baseline. Hydrology currently reflects routing with this policy, which results in B Tributary entering Drainageway 4100 farther downstream. Per discussions with UDFCD, kept baseline modeling this way, noting the canal routing reality, and then re-routed model for alternatives analysis when storm flows are separated.
23. Jim, PDF pg 74: K Tributary routing
    a. For baseline conditions, the hydrologic routing represents major flow paths and does not model the minor storm drain systems. Where low areas and detention basins are present, but not modeled, the flow path of where water would go in the event it overtopped the detention basin was used. The overland flowpaths

were verified in this area using the LiDAR information and no changes to routing were incorporated. The suggested minor storm event routing was evaluated during the alternatives analysis.

24. Brooke, PDF pg 181: Include seeding. Any riprap needed? (typical for all channel improvements)
    a. Channel improvements are based on a wide floodplain, with limited shear stresses and velocities. Outside of riprap at drop structure locations, select areas of riprap may be needed at bends. However, the alternatives analysis is based on a general channel section and was not fully modeled. Select areas of riprap installation can be evaluated in the conceptual design.
25. Brooke, PDF pg 183: Please identify drops by approx. station (or lump together in one row). Typical. PDF pg 193: For items that are a standard unit price per each - one row for each item type would simplify.
    a. Cost estimates are a direct output from SWIFT. Per discussions with UDFCD, only minor clarifying text edits to the SWIFT output were completed. The number of rows of output was not adjusted for the alternative analysis. The cost estimates will be fully updated, including stations of improvements, in Excel for the conceptual design.

# ALTERNATIVES ANALYSIS COMMENT RESPONSES

## Basin 4100 and DFA 0056 OSP

1. Jim, page 9: Replacing a crossing structurewith the railroad culvert.
    a. School Tributary RTD NMRL crossing was added to the tables, in addition to the trail and old Welby Rd crossings.

2. Brooke, page 31: “It is likely LiDAR doesn’t pick up the inverts. I suggest modeling at full capacity.” Jim, Page 36: COT can do.
    a. Analysis, text, tables, and figures were updated with survey points provided by the City of Thornton.

3. Jim, Page 38: “the 2006 design assumed a nominal detention basin would be constructed in the "triangle" between the RTD ROW, CoAg canal and the existing ST channel, providing several AF of capacity. Thus we would not have a "deep channel" but an excavated basin with an outlet elevation below the CoAg. (to be built by developer to meet downstream capacity goals) this was discussed in the previous version, but not this time. Why?”
    a. A flume was evaluated instead of the previous channel alternatives to reduce the channel depths, based on UDFCD comments. The original detention basin alternative included a detention basin between the RTD ROW and the CoAg ditch. The detention basin alternative was updated to show additional storage upstream of the RTD NMRL based on UDFCD comments that the detention basin on the east side of the RTD NMRL would not be regional and to see about adding detention volume upstream of the tracks. This option was less expensive and doesn’t require a separate detention basin, although a potential utility conflict could be a limiting factor. A description and cost of adding detention on the east side of the tracks was added to the report narrative. If the alternate location is in the selected plan, the conceptual design plans/costs/text will reflect the alternate location.

4. Jim, Page 38: “Which is it?”
    a. Referring to two different flows referencing the maximum capacity of the downstream system. The 460 cfs capacity is for the whole storm drain system (Design Point 101). 425 cfs is what the limit would be at Design Point 102T to achieve the 460 cfs at the downstream end (which accounts for the tributary area between Design Point 101 and 102T entering the storm drain system). The text was clarified with the following:

        “If off-line detention facilities are constructed with new development to reduce the future peak flows down to existing conditions, regional detention basins may not be necessary to meet the existing pipe capacity. The 100-year future peak flow at Monroe Street, Design Point 102T, would need to be below 425 cfs, in order to not exceed the 460 cfs capacity of the storm drain system at the downstream end. Meeting this target discharge should be verified with any future development drainage reports and construction projects.”

5. Jim, Page 40: Both the trail and 98th Avenue embankment create ~1 acre foot detention basins. Would increasing one or both of these basins by raising the trail/berm provide enough attenuation to prevent overtopping of 98th? Is the street capacity of Fillmore Street adequate to convey the flow that overtops 98th?
    a. The detention basins were added to the baseline hydrology in the last submittal. The detention basins reduce the 100-year flows from 55 cfs to 48 cfs. Based on the calculated pipe capacity of 17 cfs, the system has capacity for the future 10-year storm event. Based on the stage-discharge information, the detention basins 28.8 cfs can be released from the detention basins before they overtop (future 25-year). This is more likely the flow that will be in the storm drain system. The 17 cfs is just based on Manning’s equation for pipe full capacity. Text was added to the report referring to the storm event capacity, as well as stating the potential benefit of raising the berms if street flooding is considered/observed to be too frequent or severe, including at Thornton Parkway’s sump.

6. Brooke, Page 52: Should J Trib centerline follow the alignment through the proposed crossing structure?
    a. J Tributary generally follows Riverdale Rd. The crossing structure is located on a separate drainage channel tributary to J Tributary. The alignment was not updated.

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January 19, 1998

Mr. Ben Urbonas, P.E.
Chief, Master Planning Program
Urban Drainage And Flood Control District
2480 West 26th Avenue, Suite 156 B
Denver, Colorado 80211

**BY HAND DELIVERY**

Re: Legal opinion in regard to alternative and planned drainage facilities in general as contained in alternatives development and evaluation reports

Dear Ben:

You have asked me to provide you with a legal opinion that you may use to initially evaluate in general all alternatives development and evaluation reports for compliance with the law of the State of Colorado applicable to drainage. What follows is such an opinion which will need to be supplemented by a short legal opinion in regard to each report to either indicate that no further comment is necessary or that certain other factors, other than those noted herein, will need to be considered before proceeding to the selection and construction of drainage improvements contained in that specific report.

In order to properly evaluate these reports you first must take note of the following comments in regard to the law of drainage in Colorado:

## I. GENERAL LEGAL DRAINAGE PRINCIPLES

Natural drainage conditions may be altered by an upper (dominant) owner provided the water is not sent down in a manner or quantity to do more harm than formerly to the lower



(servient) owner, Hankins v. Borland, 163 Colo. 575, 431 P.2d 1007 (1967). Colorado follows the "rule of reasonableness" as related to drainage matters and in each drainage situation, the court will look at the relationship of the parties and at who is doing what to whom in order to determine "what is reasonable under the circumstances". Prior to the Hankins case, the Colorado Supreme Court ruled in Ambrosio v. Perl-Mack, 143 Colo. 49, 317 P.2d 803 (1960), that downstream owners had to accept additional runoff from an upstream developer.

As the engineering technology has become more precise in drainage matters, it is possible to determine from the actual development and from land use decisions that will determine future development what the additional (more than natural) runoff will be because landowners make their land impermeable.

The Colorado Legislature in 1973 recognized this and adopted Sec. 30-28-113(4)(b) which requires developers in unincorporated areas to detain greater than historical flows. As a matter of drainage practice, cities as well as counties and the Urban Drainage District work to identify with precision "who is doing what" to whom so that the cost of drainage solutions to problems created by future development can be placed on those who would change the use of land from permeable to impermeable. Runoff from existing development is also computed and the need, if any, to solve existing drainage problems can be determined and costs of solutions estimated.

Drainage matters historically were resolved between or among property owners. However, as urbanization (multiple property owners) has taken place, governments have become involved for several reasons. In some cases, the government itself helped create additional runoff by making improvements. In other cases, government approved land use changes without regard to the problems of additional runoff. In still other situations, government got involved because constituents (owners) wanted government help in the difficult and expensive field of determining (identifying) where the additional runoff was coming from and the paying of costs of solutions. For whatever the reason, whenever government gets involved, it can be expected to be treated like a private party. 2 Farnham, Water and Water Rights, pp. 975 and 977, adopted by the Colorado Supreme Court in City of Boulder v. Boulder and White Rock Ditch Co., 73 Colo. 426, 216 P. 553 (1923). A municipality can be held to its negligence. It can also determine whether to become involved at all, if it did not create the problem.

An update of these legal principles has yielded the conclusion that the law of drainage as set forth above has not really changed to any substantially degree over the years. Both the Hankins and Ambrosio cases continue to be cited by the Colorado courts when dealing with the law of drainage. In the case of Metro Docheff v. City of Broomfield, 623 P. 2d 69 (Colo. App.

1980) the Colorado Court of Appeals held that: "Although we recognize the right of the owner of higher land to a drainage easement over the lower land of others, . . . the discharge of water will be enjoined as a continuing trespass if the drain sends the water down 'in a manner or quantity to do more harm than formerly.'" In the case of Hoff v. Ehrlich, 511 P. 2d 523 (Colo. App. 1973) the Colorado Court of Appeals was faced with the question of the propriety of a servient owner blocking drainage from a dominant estate in order to protect the servient owner's land. The Court held that: "The owner of the dominant estate has a legal and natural easement or servitude in the lower or servient estate for the drainage of surface water flowing in its natural course and manner . . . When an interruption in the natural flow or passage of surface waters is caused by the servient owner to the detriment or injury of the estate of the dominant owner, the court should issue a mandatory injunction for the opening of the easement which has been blocked . . . [the servient owner] may not act to the extent that damage is caused thereby to the dominant landowner . . . in order for the owner of the servient estate to be afforded a remedy, it must be evident that the water was sent down in a manner or quantity causing more harm than it formerly had done."

If a government permits the development which in turn causes "more harm than formerly", then the government, as well as the developers, may be held liable. (Cases consistently move toward governmental, as well as developers' liability.) See Metro Docheff, *supra*, which held as follows: "The trial court found that the city had accepted the streets and storm drains for maintenance and control and, therefore, had exclusive control over the water collected in the subdivision. It determined that by approving the subdivision and drainage plan and accepting control, the city interfered with the natural conditions and thereby caused surface water to be collected and discharged upon plaintiff's land 'in a greater quantity or in different manner than had previously occurred under natural conditions."

Recently, governmental entities have raised in their defense of drainage cases the Governmental Immunity Act. In two recent cases, that defense has not been successful. In Burnworth v. Adams County, 826 P. 2d 368 (Colo. App. 1991) the Colorado Court of Appeals held that actions ". . . against public entities arising from the maintenance of a sewer, a storm sewer, or a storm drainage system." were not prohibited by the Governmental Immunity Act. In the case of Scott v. City of Greeley, 931 P. 2d 525 (Colo. App. 1996), the Colorado Court of Appeals again denied protection under the Governmental Immunity Act to a public entity when it argued that the damage complained of was the result of a design flaw rather than from the operation of a facility. The facts were that the City designed and constructed a new storm water line which was 42" and connected it to a line which was only 15". This caused the water to back up, or surcharge, through the storm drains and manhole covers, overtopping the curb and flooding adjacent property. In addition to the denial of protection to the entity under the



Governmental Immunity Act, the Court also rejected the City's defense that the connection to the smaller pipe was only temporary.

Any improvements upstream must be made taking into consideration the outlet capability downstream. (Long line of case law.) See Hankins, *supra*, which states: "The trial court has found that the water which these defendants have sent into the Borland drain is in greater quantity and more rapid in time — a finding fully justified by the evidence. Under such circumstances it is the court's duty to determine what the dominant owners must do in order to prevent their increased waste water from damaging the servient owner."

Colorado generally imposes strict liability on owners of dams (regional detention ponds). (Long line of cases.)

Interfering with natural drainageways or channels is generally looked upon with disfavor by Colorado Courts. However, builders of irrigation canals, railroads, and highways in other times were not aware or were unconcerned with the problems they might be creating in the future by artificially blocking natural drainageways. Sometimes the very passage of time (at least eighteen years) provides an argument that the blockage should be allowed to be continued because parties have relied and should be able to continue to rely on this "protection". Generally, the laws of nature prevail in these situations and artificial structures such as canals, railroads and highways do not rise to the status of permanent dams which require spillways and other features under the jurisdiction in the State of Colorado of the State Engineer.

With the enactment of federal environmental (including water quality) provisions, the quality of the runoff may also have an effect, as well as on other ecological matters.

Natural waters are subject to the doctrine of prior appropriation in Colorado and what may have become a water right must also be considered with any plan for the "handling" of surface runoff in natural waterways.

Finally, any drainage, "facility" built by a government must be maintained. "If you're not going to maintain it, then don't build it!" is the theme of a long line of cases.

## II. GENERAL COMMENTS ON COMMONLY PROPOSED FACILITIES AND CONSTRUCTION TECHNIQUES

1. It is my understanding that the purpose of all reports in regard to this subject is to

examine alternatives which will, if implemented, improve upon and/or formalize the drainage that is within the study area.

2. In general, consideration must be given to any potential adverse effects of the selected alternative on properties within the study area and downstream of the study area.

3. If any selected facilities would increase or materially change the direction of the flows across downstream property in a study area, the downstream property has a right to claim damages and/or protection from such a material increase or change in flow. Thus, care should be taken to make sure that increased flows from upstream facilities are accommodated by sufficiently increasing the size of the downstream channels and conduits. If in final design, the selected alternative still has the effect of placing water on the residents and land owners in the area that they either never had or in a quantity larger than what they have had previously, the same must be revised to eliminate that result or the selected alternative must not be constructed.

4. If re-alignment of a channel is the selected alternative, careful consideration should be given to the channel's geometry, alignment and ability to carry flood flows so as not to create additional potential damages to surrounding landowners.

5. If the selected alternative is the collection of overland flows from a specific area and returning those flows to a drainage structure of some kind, care should be taken not to adversely impact landowners in the area.

6. If a selected alternative involves the redirection of flows from their historic path, prior to its finalization in the design process, caution should be taken that this redirection will not cause any increase in damage to those adjacent or downstream of the proposed redirection.

7. If any selected alternative, when it is finalized in the design process, is changed to include a plan for the diversion of runoff from one watershed to another; extreme caution should be used in implementing that portion of the selected alternative since the participants may be faced with the imposition of strict liability for any damage that occurs from any size storm event if it can be shown that the same would not have been suffered if the diversion had not occurred.

8. If the construction of crossing structures over irrigation canals are part of the selected alternative for the project, caution must be taken in regard to the capacity of those crossing structures. The structures, when designed for the design event, should not cause any more water than presently exists to flow into those canals.



9. The intentional routing, as opposed to inadvertent inflows, of flood flows into an irrigation ditch should be eliminated from any plan if at all possible unless a written agreement from the owner of the irrigation ditch is obtained permitting the use of the ditch to carry those flood flows. The participants have no control over the available capacity of the ditch at the time it would be necessary to carry flood flows so the ditch cannot realistically be used to control the flows downstream.

10. If an alternative is being selected that relies upon inadvertent detention and the participants do not intend to formalize such detention by written agreement, it is my opinion that the effect of that non-formalized inadvertent detention cannot be taken into consideration in the final design.

11. If a selected alternative includes the formalization of inadvertent detention it will be necessary for at least one of the participants to formalize that detention by entering into a written agreement with the owner of the facility causing the detention. The agreement must prohibit the owner from operating or modifying the facility in a way that would have the effect of lessening the inadvertent detention of the facility necessary to implement the selected alternative. Further, the owner must either agree to maintain the facility so that the same does not lose its current inadvertent detention or agree to permit at least one of the participants to maintain the facility.

12. If the owner of the facility will not agree to maintain the inadvertent detention facility, at least one of the participants should confirm in writing to all of the participants that the participant is committed to maintaining the inadvertent detention facility in a manner that assures the necessary inadvertent detention to implement the alternative. This should be done prior to the implementation of any of the alternatives involving inadvertent detention. The level of maintenance must at least permit the facility to function as relied upon in flooding events and not fail structurally during the design and larger events.

13. Any formalized detention facilities that are utilized in the final design of a project will need to be the subject of a written agreement between the owner and at least one participant that the facility will be maintained in a manner that assures the necessary flood storage to implement the design and that adequate maintenance will be performed by either the owner or the participant so that the facility will function as designed in flooding events and that it will not fail structurally during the design and larger events.

The participating entities must agree amongst themselves, in writing, that any one of the participants may enforce the terms of the agreement with the owner of the facility if the responsible participant does not. This agreement must include the maintenance of no more than

a certain level of water in the facility at any one time and that any one of the participants may, at their sole cost and expense, maintain the facility so that its effectiveness in the selected alternative will be continued in perpetuity.

14. The embankments of all detention facilities should be designed so that they will not fail during a design event.

15. If a potential wetland is involved in a design alternative, it will be necessary that a Section 404 Permit from the United States Army Corps of Engineers be applied for and obtained, if necessary. Such a Permit should be obtained before any construction is done on the recommended alternative.

16. During construction of the selected facilities, care should be taken in constructing those facilities so that downstream property is not adversely affected temporarily by such construction. Usually, with the exception of the construction of detention facilities, the best method to avoid that problem is construction from the downstream limit of the project in an upstream direction which would then have the effect of having the downstream facilities ready to accept any increased flows as a result of the project.

If you have any questions in regard to my comments and opinions contained in this letter, please feel free to telephone me to discuss the same.

Very truly yours,

Edward J. Krisor

Edward J. Krisor

# *Selected Plan* for the Basin 4100 and DFA 0056 Outfall Systems Plan

**November 27, 2019**

The *Selected Plan* for Basin 4100 and DFA 0056 agreed upon by the City of Thornton and Adams County and the Mile High Flood District (*MHFD*) (hereinafter *City of Thornton*, *Adams County* and *MHFD* shall jointly be referred to as "*Sponsors*") to be shown by Olsson in the final *Basin 4100 and DFA 0056 Outfall Systems Plan* report (hereinafter called "*Final Report*") is described in general and specific terms below.

## SELECTED PLAN AND DIRECTLY RELATED ISSUES

Unless specifically directed otherwise below, this *Selected Plan* to be shown in the *Final Report* essentially follows the recommendations made by *Olsson* in the *Basin 4100 and DFA 0056 Outfall Systems Plan Alternatives Analysis Report* dated May 2019 (hereinafter called "*Alternatives*") based on the following principal elements, goals and objectives:

- Minimize stormwater and flood-related damages to drainageways, public infrastructure and private property. Do this with value engineering and practicalities of implementation in mind.
- Institute an approach that balances the development in the watershed with stormwater management implementation that complements drainageway and stream stability solutions, that as a system, provide multiple benefits that include:
    - Water quality protection and enhancement;
    - Water quantity resources protection;
    - Preservation of natural character of the waterways and their terrestrial and aquatic habitat resource;
    - Wherever possible, provide public use and access and/or trails within the corridors of identified waterways in order to provide maintenance access that will also provide for active and passive recreation of the public.
- Consider the needs for new and upgraded roadway crossings when such improvements are practicable, affordable and add significant value in relation to the cost.

*Olsson* shall address all items that are specified in the *Final Report* as described in the agreement between *MHFD* and *Olsson* for this project, which includes developing, describing and showing a conceptual design based on the Recommended Plan in the *Alternatives*, with the following exceptions:

1. During the development of the recommended plan, Thornton expressed several concerns with the recommended 40ft x 10ft emergency spillway structure. In addition to the impracticality of boring twin 7.5 diameter pipes under a live rail line, in use 20 hours per day, with over 100 scheduled trains, the recommended outlet to Basin 4100 (Basin 316) produces a greater danger to downstream structures, due to the instant and inherent efficiency of a weir, than impounding additional depth upstream of the railroad embankment. Further, there is virtually no danger of "overtopping" the railroad embankment resulting in a dam failure mode due to the limited tributary area in relation to the volume that would need be detained prior to overtopping. At the

same time, it is recognized that the lack of a secondary outlet in case there is significant clogging of the primary outlet structure, produces a major flooding danger to upstream properties from the design storm, much less consecutive storms in a monsoon pattern. Therefore, the recommended plan should provide a secondary outlet to match the capacity of downstream channels at a nominal depth above the BFE, but below the Lowest Adjacent Grade of any existing structure. This structure would connect to the existing outlet culverts resulting in no needed improvements to the existing culverts under the railroad.

2. For the School Tributary, Thornton recommends the "Alternative Detention" be implemented by future development due to the utility conflicts cited for potential detention west of the RTN NMRL embankment.

Also show and describe all recommended facilities, costs and actions on a reach-by-reach of the drainageway. In general, the *Final Report* shall provide, show, and recommend the following:

1. Under a section in the *Final Report* titled "General Recommendations", recommend:
   a) That the controlling jurisdictions take steps to stabilize all major waterways when their watershed urbanizes, rehabilitate existing degraded reaches of the waterways and their tributaries, and aggressively control erosion and sediment transport during construction activities.
   b) That Sponsors and any other jurisdiction having land use control powers in this watershed require new land development and significant redevelopment and publicly funded projects to provide to the maximum extent practicable runoff volume control practices (i.e., minimize directly connected impervious areas and employ infiltrating BMPs) whenever site conditions permit.
   c) That the controlling jurisdictions take steps to require that all BMPs for all new development, redevelopment, and publicly funded projects provide to the maximum extent practicable a Water Quality Capture Volume (*WQCV*) as recommended in the Urban Storm Drainage Criteria Manual – Volume 3, after accounting for volume reductions achieved using volume control practices as recommended under Item 1.b above.
   d) That all jurisdictions having land use control powers in this watershed continue to implement their floodplain management regulations, including regulation of the 100-year floodway and floodplain.
   e) Recommend that these jurisdictions adopt a policy, if not already done so, of preserving the defined floodplains as open spaces to the maximum extent possible and that at least 1-foot freeboard be provided for the lowest floor above the 100-year flood elevation shown on the latest flood hazard area delineation or FIRM maps for all human occupied structures built adjacent to, or within, the defined 100-year floodplains.
   f) That all jurisdictions having land use control powers in this watershed continue to participate in FEMA's flood insurance Community Rating System and public education programs.
2. List on the plan view and profile sheet of the conceptual design, where appropriate, the recommended wetland mitigations that will be needed to implement recommended improvements, if any.

3. Show on appropriate plan and profile sheets facilities to arrest the vertical degradation of the low-flow channel of natural and man-made waterways and to help rehabilitate, as much as possible their stable function and habitat.
4. Recommend rehabilitating eroded and degraded banks where needed and desired to arrest the horizontal erosion along natural waterways using bio-engineered methods that combine buried soil riprap and revegetation with native species of riparian and dryland vegetation.
5. Show on plan view and profile sheet the needed buttressing of critical utilities and other structures that may be endangered by stream erosion.
6. Using the input from stakeholders and the public, work with *Sponsors* and affected other local jurisdictions to prioritize the recommended facilities and actions that are listed in the *Final Report* and clearly articulate them in that document.
7. Describe the recommended type and schedule of maintenance activities for all improved facilities recommended in the *Final Report*.
8. Consider the various functions of all natural waterways in the study watersheds and their impacts. Floodplain, including flood conveyance, riparian habitat, open space, aesthetics, recreation, urban development, water quality, utilities, transportation and other features should be considered.
9. Acknowledge in the *Final Report*, that land-use changes to the contributing watersheds affect the flood hazard nature (i.e., runoff rates, volumes and depths), the transport of sediment, and the water quality of the receiving natural waterways. The *Final Report*, under "General Recommendations" shall suggest that Sponsors and any other jurisdiction having land use control powers in these watersheds monitor land-use changes and whenever the land-use changes result in imperviousness ratios that exceed the projections identified in the *Final Report*, these jurisdiction take steps to further limit increases in stormwater runoff through the use of additional on-site detention, infiltrating BMPs and *WQCV* BMPs, thereby reducing the runoff rates, volumes and future damage potentials to the *Final Report* levels.

**EXECUTIVE SUMMARY**

Include an Executive Summary in the *Final Report* written in plain, non-technical language, which is directed primarily at the general public and elected officials. This summary should, at the minimum, contain the following, as well as other items listed in *MHFD's* checklist, for preparation of the final major drainageway plan conceptual design report:

1. A brief summary of the planning process including numbers of progress and public meetings and a list of issues raised at each meeting.
2. A brief description of the decisions made by project sponsors during this project.
3. A brief summary of all design criteria specifically developed for this plan.
4. A brief summary of the following sections of the *Final Report*: Purpose and Scope, Study Area Description, Alternative Evaluation, Recommended Plan, and Conceptual Design.
5. A map showing the area and all recommended improvements.
6. Tabular and narrative summaries of costs showing costs for capital improvements,

engineering/administrative/contingencies, and land values. Each cost estimate shall be sorted by drainageway, reach, tributary, and by jurisdiction. The reach length (miles), tributary catchment area (square miles), and their totals should also be included in tabular form.

Incorporate the following notes on each drawing:

"*This drawing is for master planning purposes and represents preliminary and conceptual engineering. Alternatives to this master plan will be considered by local agencies and the Mile High Flood District provided the alternative offers an equivalent intent of the plan, including hydraulic capacity, water quality, stream stability and natural waterway features. The alternative must comply with all requirements of the local jurisdiction and the Mile High Flood District. In addition, there may be State and Federal requirements that will need to be considered and met. This drawing does not provide a final design and shall not be used for construction purposes."*

*"Local Cities, Towns, City and Counties, and Counties manage and regulate all land use change, development and redevelopment activities within and adjacent to the 100-year floodplains in order to prevent, to a maximum extent possible, future flood damages to buildings and structures from the 100-year flood and to minimize damages from larger floods. The recommendations of this plan provide a set of options subscribed to by Cities, Towns, City and Counties, and Counties in carrying out their floodplain management and regulatory responsibilities and obligations."*

*"Many activities that occur in or affect ditches, drainages, creeks, ponds or wetlands require a Section 404 Permit Authorization from the US Army Corps of Engineers. During preliminary design, and prior to final design or starting work, contact the Corps' Denver Regulatory Office at 303-979-4120 for appropriate permit authority to avoid compromising and delaying the completion of the project."*

**ADDITIONAL DIRECTION**

1. Unit costs should be updated to reflect the most current costs available using the UD-MP Cost worksheet.
2. Include an Acknowledgements section listing all participants and stakeholders in this study. Include in the list their name, organization and function in the planning process.
3. Show all maintenance access routes along all reaches. To the extent feasible, the alignment of these routes shall be coordinated with existing and planned recreational trails identified using input provided by Sponsors, special districts and other local stakeholders.
4. Summarize cost estimates of improvements by jurisdiction where those improvements are located, by the reach in which the improvements are located and overall project totals.
5. Report estimated costs for maintenance of all facilities, including detention ponds, storm sewer outfall points, grade control structures, etc. reported in the *Final Report.*
6. Prepare a GIS shapefile of all proposed improvements using the MHFD SWIFT tool.

# APPENDIX B

# HYDROLOGIC ANALYSIS

## Legend

- DFA 0056
- Small Basin ID
- Basin 4100
- Contours
- Large Basin ID (ID, Area / AC, Ck LU, Fu LU)
- Design Point (1XX)
- Storage Unit (3XX)
- Conveyance Element (2XX)
- Drainageway (X)
- Water Body
- Subbasins
- Thornton City Boundary
- Adams County
- Roads

**Imperviousness (%)**

- 2-5
- 6-10
- 11-20
- 21-30
- 31-40
- 41-50
- 51-60
- 61-70
- 71-80
- >81

**Future Land Use**

- Commercial
- Employment Center
- Institutional
- Mixed Use
- Parks and Open Space
- Residential High
- Residential Low
- Residential Medium
- Riverdale Ballfields
- Urban Reserve
- Urban Village

Note: Dummy links modeled in SWMM are not shown in figure.

**Hydrologic Soil Group**

- A
- C
- D

N

0 400 800 1,600 Feet

DFA 0056

BASIN 4100

North G Tributary

West G Tributary

D Tributary

H Tributary

B Tributary

School Tributary

North K Tributary

South K Tributary

J Tributary

4100 Drainageway

Thornton Parkway

Colorado Boulevard

Colorado Agricultural Canal

Lower Clear Creek Canal

RTD NMRL

West Sprat Platte Lake

River Valley Village

Cherrylane

ADAMS COUNTY 88TH AVENUE OPEN SPACE

E 104th Ave

E 102nd Dr

E 102nd Ct

E 101st Ave

E 100th Ln

E 100th Ave

E 100th Pl

E 99th Pl

E 98th Way

E 97th Ave

E 96th Dr

E 91st Ave

E 89th Pl

E 88th Pl

E 88th Ave

E 96th Ave

E 107th Pl

E 108th Dr

E 109th Ave

Homestead Pl

Thornton Pkwy

Grant St

Steele St

York St

Elizabeth St

Downing St

Washington St

Irving St

Emerson St

Jackson St

Clarkson St

Eaton St

Mc Elwain Blvd

Rainbow Ave

Devonshire Blvd

Valley Rd

Cherry St

Birch St

Dunkirk St

Fronterra Rd

Brighton Rd

Quivas St

Pecos St

Holly St

Huron St

Fillmore Pl

Thorton Cir

Thorton Ct

Pontiac Pkwy

Quentin Rd

Columbine Cir

Jackson Cir

Jackson St

Vine St

Cherry St

Birch St

Dunkirk St

Fronterra Rd

Brighton Rd

**INTERACTIVE FIGURES**

STUDY AREA
SUBBASIN BOUNDARIES
SOILS
FUTURE LAND USE
EXISTING LAND USE PERCENT IMPERVIOUS
FUTURE LAND USE PERCENT IMPERVIOUS
SWMM ROUTING

CLICK TO TURN STREETS ON OR OFF

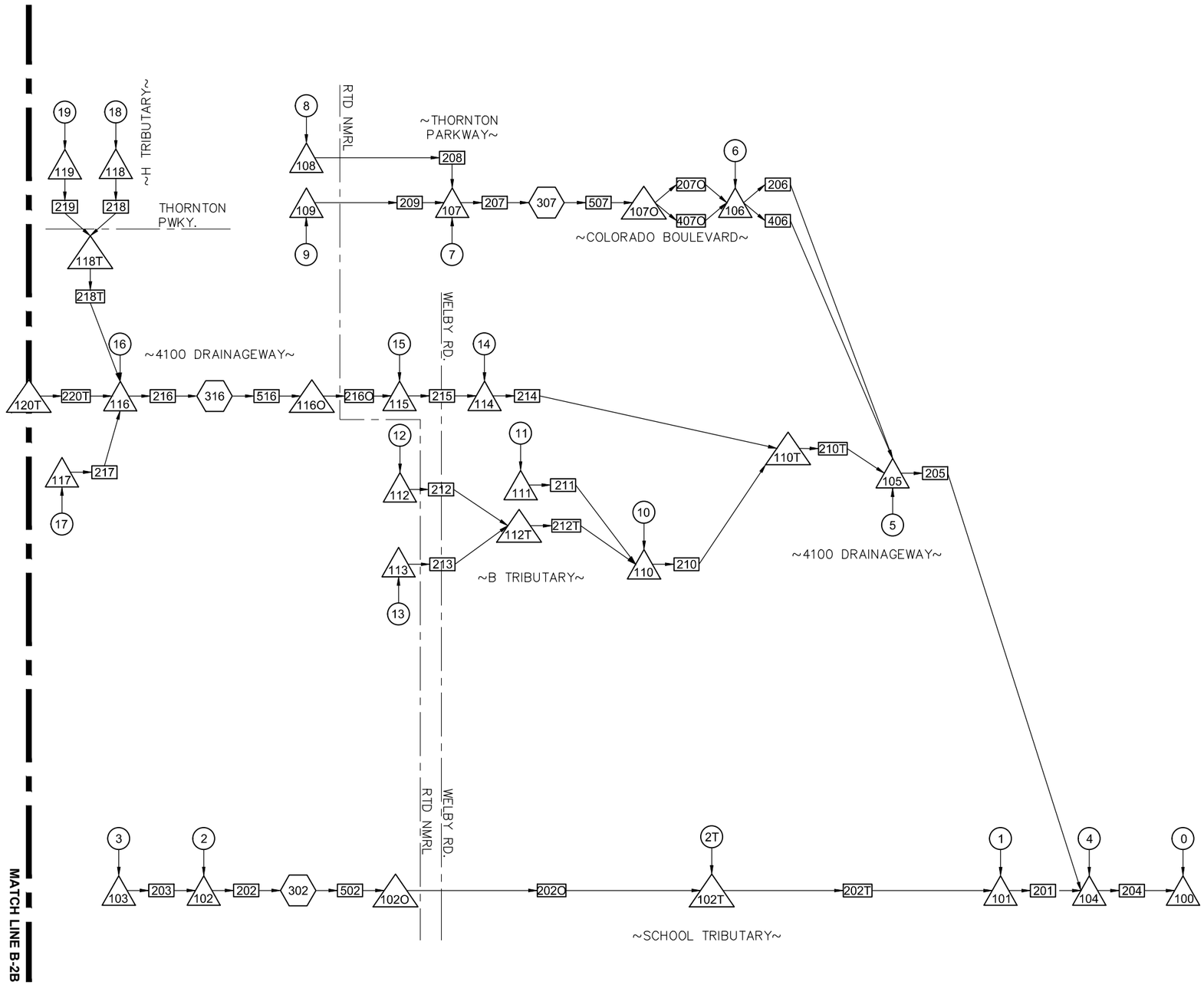
CLICK TO TURN AERIAL ON OR OFF

CLICK TO TURN TOPOGRAPHY ON OR OFF

| | | | |
|---|---|---|---|
| PROJECT: 017-2321<br>DRAWN BY: HH<br>DATE: 06/2018 | **MILE HIGH FLOOD DISTRICT, CITY OF THORNTON, AND ADAMS COUNTY** | **BASIN 4100 AND DFA 0056 HYDROLOGY WORKMAP** | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | FIGURE<br>B-1 |

LEGEND

- XX — SUBWATERSHED ID
- 1XX — DESIGN POINT ID
- 2XX — CONVEYANCE ELEMENT ID
- 3XX — DETENTION BASIN ID
- 4XX — OVERFLOW CONVEYANCE ELEMENT ID
- 5XX — POND OUTLET ID




| REV NO. | DATE | REVISIONS DESCRIPTION |
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REVISIONS


olsson

1525 Raleigh Street
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Denver, CO 80204
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FAX 303.237.2659


designed by: AG
drawn by: JH
checked by: DO/DK
project no.: 017-2321
date: 10/2017

MILE HIGH FLOOD DISTRICT,
CITY OF THORNTON AND ADAMS COUNTY

BASIN 4100 AND DFA 0056

SWMM ROUTING

FIGURE
B-2A

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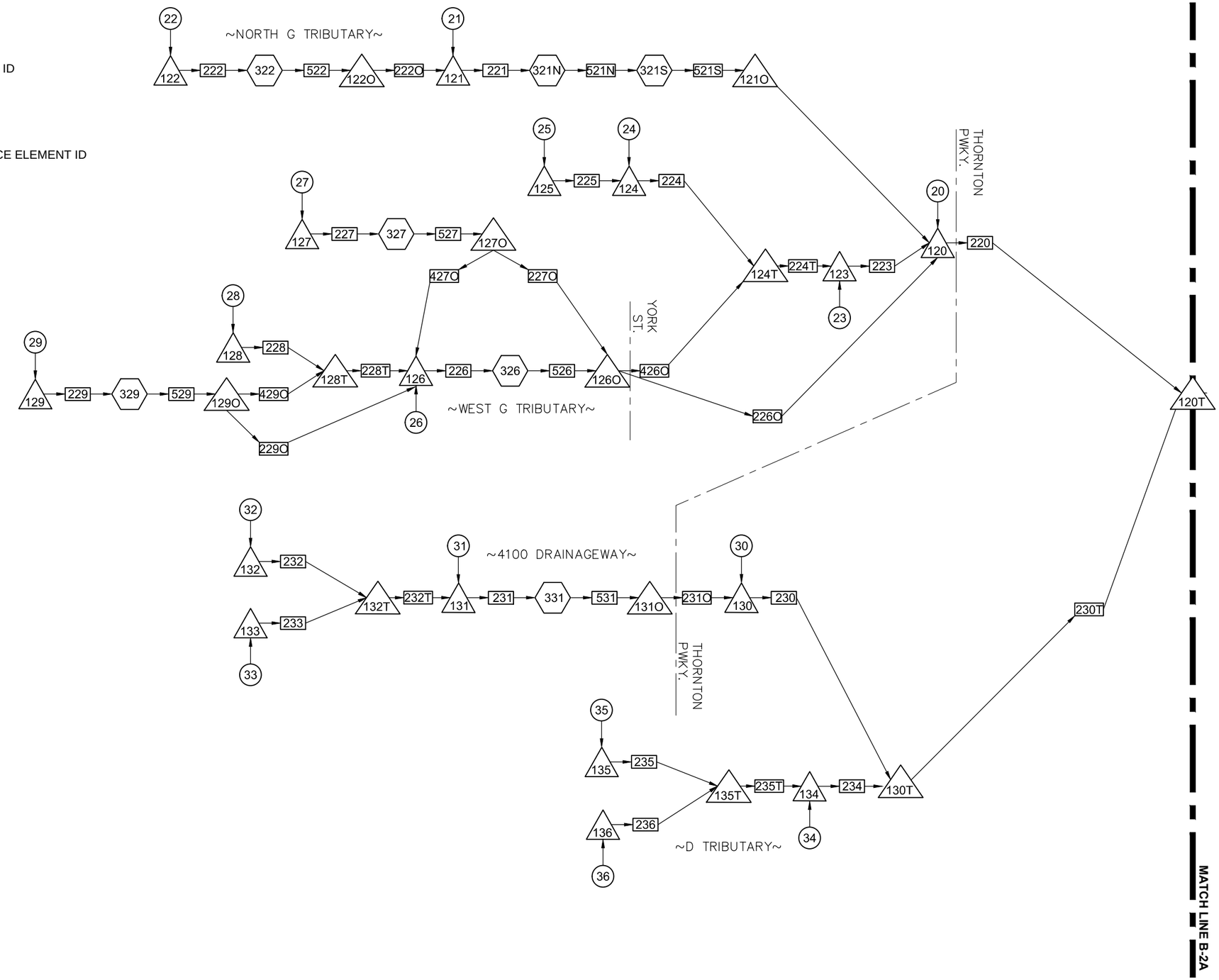


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MILE HIGH FLOOD DISTRICT,
CITY OF THORNTON AND ADAMS COUNTY

BASIN 4100 AND DFA 0056

SWMM ROUTING

FIGURE
B-2B

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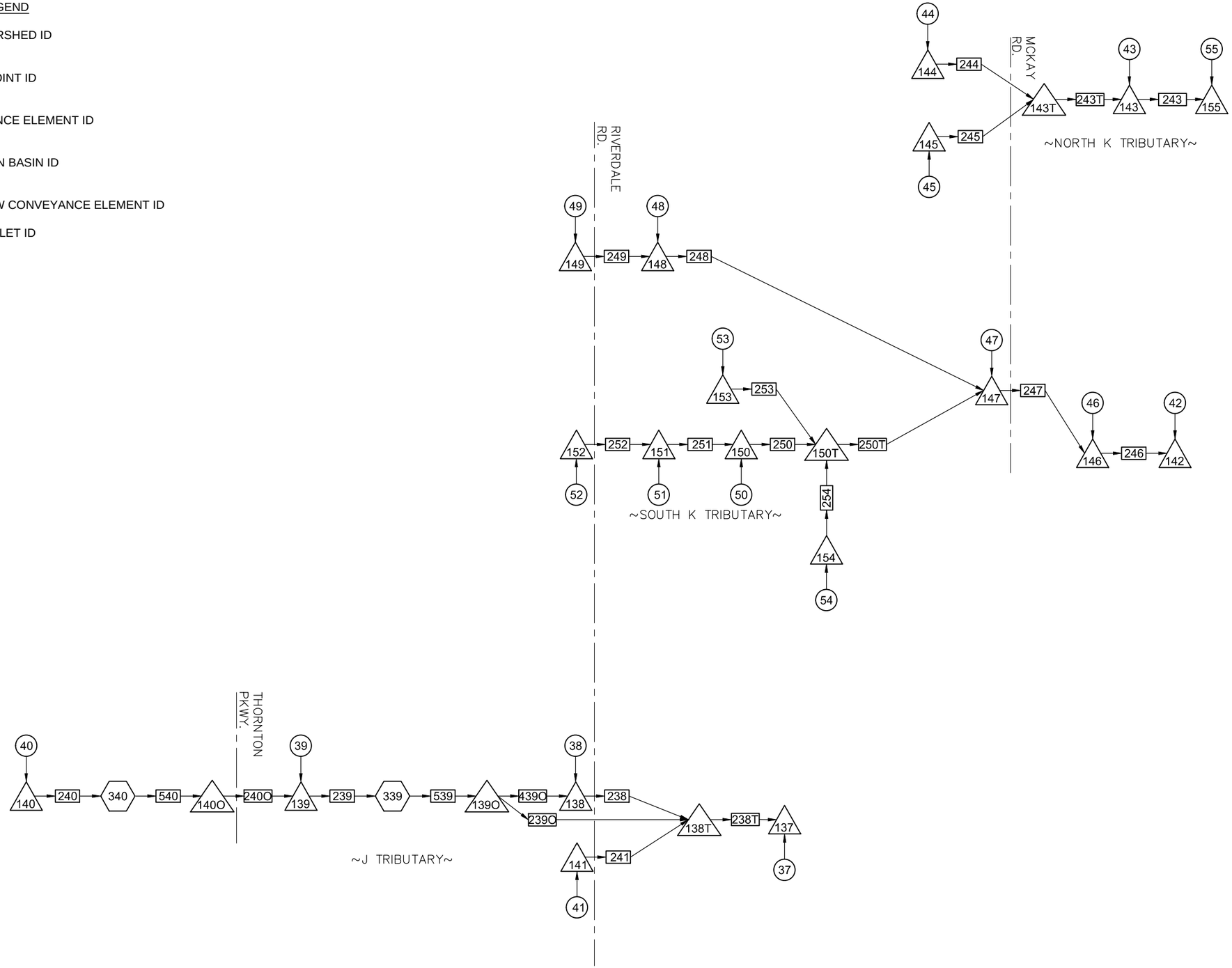


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MILE HIGH FLOOD DISTRICT,
CITY OF THORNTON AND ADAMS COUNTY

BASIN 4100 AND DFA 0056

SWMM ROUTING

FIGURE
B-2C

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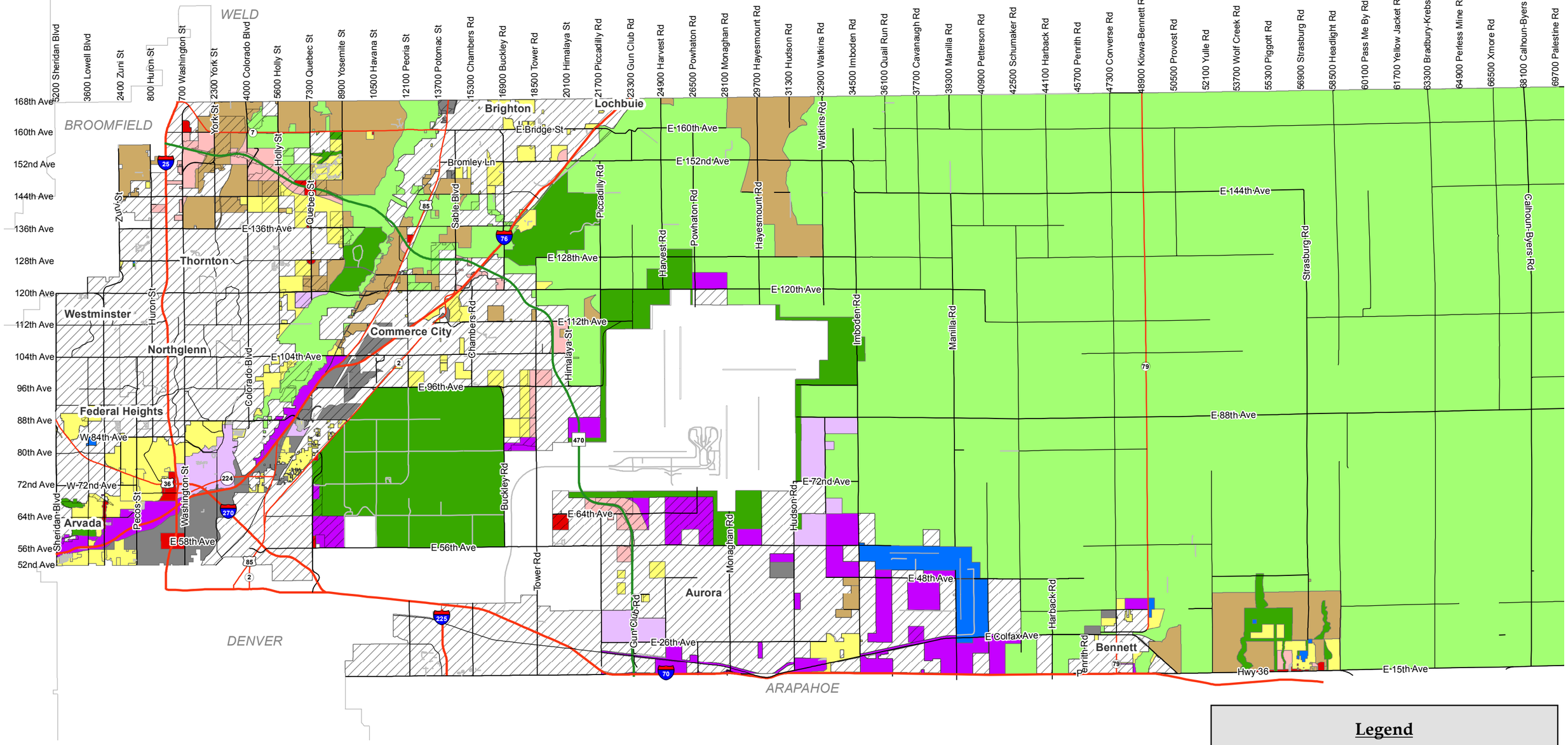
# LAND USE MAPS

# Adams County, Colorado

## 2013 Future Landuse





Adams County Business Solutions Group
4430 South Adams County Parkway, 1st Floor
Brighton, CO 80601 Tel: 720.523.6800
www.adcogov.org/gis

Date: 3/20/2017

3 1.5 0 3 6
Miles

N
W E
S

**Legend**

- Activity Center
- Agriculture
- Commercial
- Industrial
- Residential
- Estate Residential
- Low Intensity Mixed Use
- Mixed Use/Employment
- Parks and Open Space
- Public


Disclaimer:
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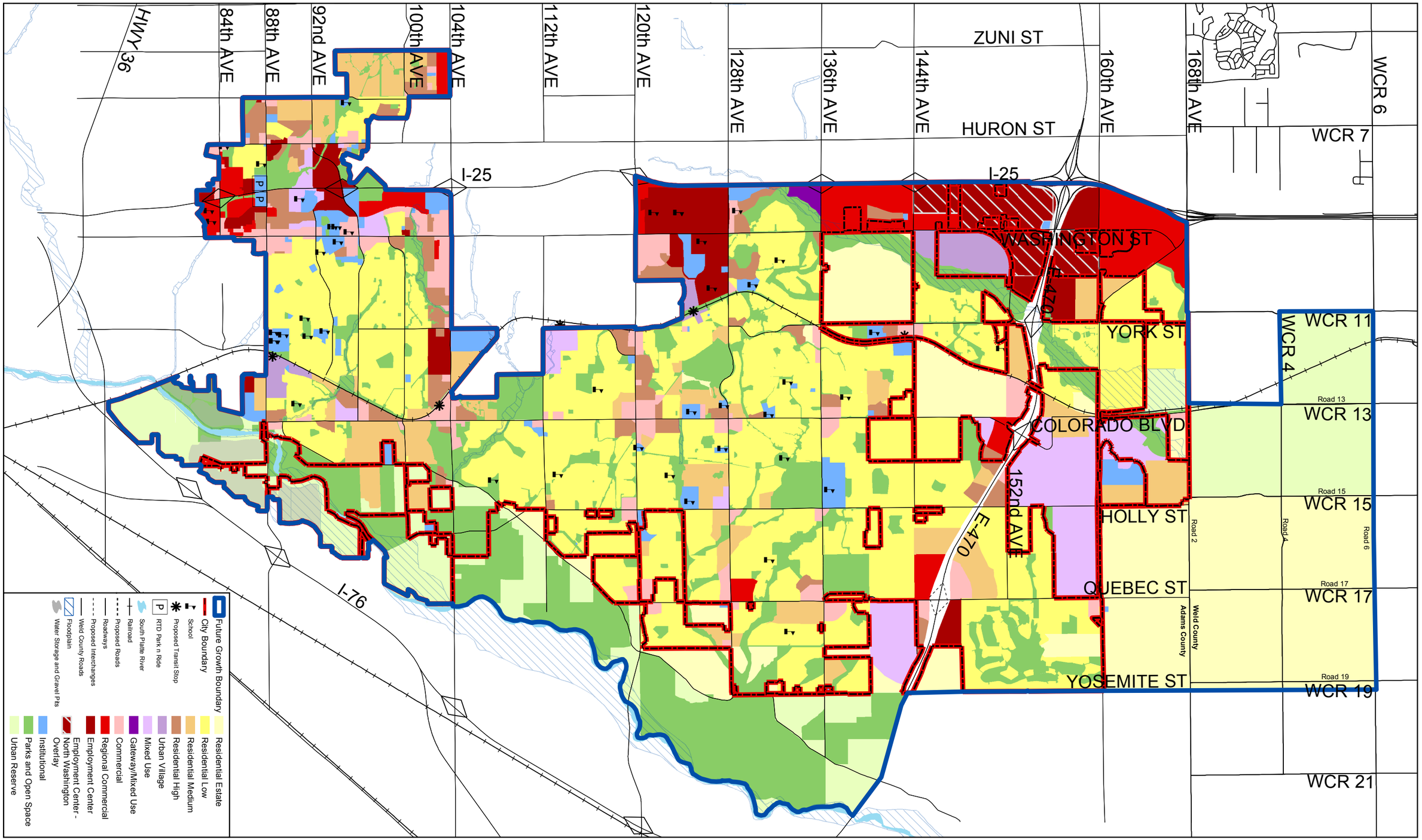


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DISCLAIMER: The City of Thornton GIS has made every reasonable effort to represent geographic data as accurately as possible, and assumes no liability associated with the use or misuse of its products. Information contained herein is for representational purposes only and is not intended to be substituted for accurate boundary locations, legal or professional opinions.

# City of Thornton, Colorado

9500 Civic Center Dr. Thornton CO. 80229-4326 (303) 538-7295

## Future Land Use Map

Adopted by Thornton City Council
September 11, 2012
Revised by Resolution C.D. No. 2017-153
August 8, 2017

1 inch = 5,167 feet

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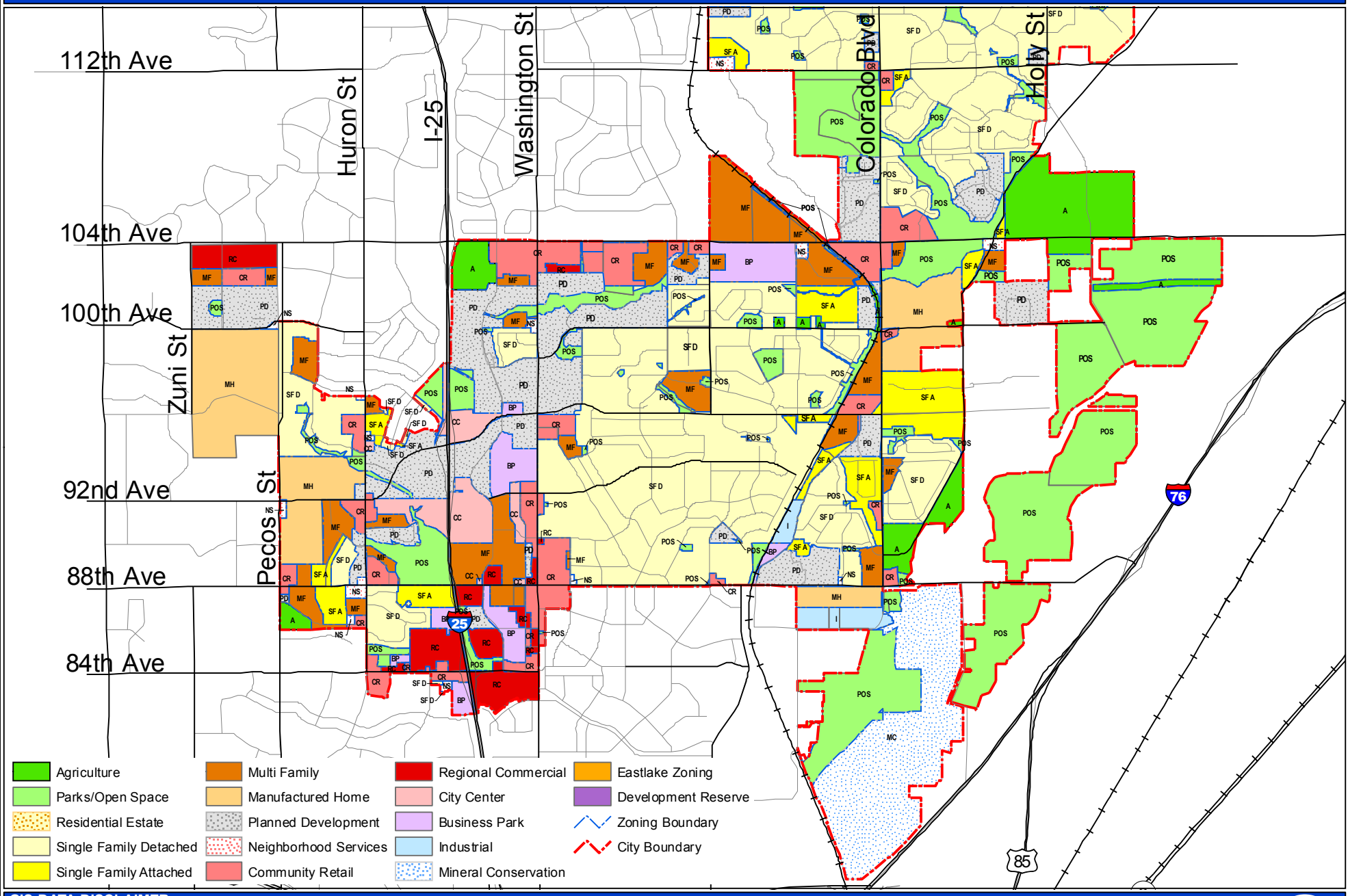
# City of Thornton

9500 Civic Center Drive
Thornton, Colorado 80229
(303) 538-7295

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## Zoning
### Southern Part of City

Zoning current as of 12/16/2008

1 inch equals 4,025 feet

S:\ArcGIS\StandardMaps\Web_Zoning_South.mxd

## Table B-1 - Unadjusted Rainfall Distributions

| 1Hr Depth | 0.832 |
|---|---|
| Return Period | 2 |
| Time | Depth |
| 0:05 | 0.0166 |
| 0:10 | 0.0333 |
| 0:15 | 0.0699 |
| 0:20 | 0.1331 |
| 0:25 | 0.2080 |
| 0:30 | 0.1165 |
| 0:35 | 0.0524 |
| 0:40 | 0.0416 |
| 0:45 | 0.0250 |
| 0:50 | 0.0250 |
| 0:55 | 0.0250 |
| 1:00 | 0.0250 |
| 1:05 | 0.0250 |
| 1:10 | 0.0166 |
| 1:15 | 0.0166 |
| 1:20 | 0.0166 |
| 1:25 | 0.0166 |
| 1:30 | 0.0166 |
| 1:35 | 0.0166 |
| 1:40 | 0.0166 |
| 1:45 | 0.0166 |
| 1:50 | 0.0166 |
| 1:55 | 0.0083 |
| 2:00 | 0.0083 |

| 1Hr Depth | 1.11 |
|---|---|
| Return Period | 5 |
| Time | Depth |
| 0:05 | 0.0222 |
| 0:10 | 0.0411 |
| 0:15 | 0.0966 |
| 0:20 | 0.1698 |
| 0:25 | 0.2775 |
| 0:30 | 0.1443 |
| 0:35 | 0.0644 |
| 0:40 | 0.0488 |
| 0:45 | 0.0400 |
| 0:50 | 0.0400 |
| 0:55 | 0.0333 |
| 1:00 | 0.0333 |
| 1:05 | 0.0333 |
| 1:10 | 0.0333 |
| 1:15 | 0.0278 |
| 1:20 | 0.0244 |
| 1:25 | 0.0244 |
| 1:30 | 0.0244 |
| 1:35 | 0.0244 |
| 1:40 | 0.0166 |
| 1:45 | 0.0166 |
| 1:50 | 0.0166 |
| 1:55 | 0.0166 |
| 2:00 | 0.0144 |

| 1Hr Depth | 1.37 |
|---|---|
| Return Period | 10 |
| Time | Depth |
| 0:05 | 0.0274 |
| 0:10 | 0.0507 |
| 0:15 | 0.1123 |
| 0:20 | 0.2055 |
| 0:25 | 0.3425 |
| 0:30 | 0.1644 |
| 0:35 | 0.0767 |
| 0:40 | 0.0589 |
| 0:45 | 0.0521 |
| 0:50 | 0.0438 |
| 0:55 | 0.0438 |
| 1:00 | 0.0438 |
| 1:05 | 0.0438 |
| 1:10 | 0.0438 |
| 1:15 | 0.0438 |
| 1:20 | 0.0343 |
| 1:25 | 0.0260 |
| 1:30 | 0.0260 |
| 1:35 | 0.0260 |
| 1:40 | 0.0260 |
| 1:45 | 0.0260 |
| 1:50 | 0.0260 |
| 1:55 | 0.0233 |
| 2:00 | 0.0178 |

| 1Hr Depth | 1.77 |
|---|---|
| Return Period | 25 |
| Time | Depth |
| 0:05 | 0.0230 |
| 0:10 | 0.0619 |
| 0:15 | 0.0885 |
| 0:20 | 0.1416 |
| 0:25 | 0.2655 |
| 0:30 | 0.4425 |
| 0:35 | 0.2124 |
| 0:40 | 0.1416 |
| 0:45 | 0.0885 |
| 0:50 | 0.0885 |
| 0:55 | 0.0566 |
| 1:00 | 0.0566 |
| 1:05 | 0.0566 |
| 1:10 | 0.0425 |
| 1:15 | 0.0425 |
| 1:20 | 0.0319 |
| 1:25 | 0.0319 |
| 1:30 | 0.0248 |
| 1:35 | 0.0248 |
| 1:40 | 0.0248 |
| 1:45 | 0.0248 |
| 1:50 | 0.0248 |
| 1:55 | 0.0248 |
| 2:00 | 0.0248 |

| 1Hr Depth | 2.1 |
|---|---|
| Return Period | 50 |
| Time | Depth |
| 0:05 | 0.0273 |
| 0:10 | 0.0735 |
| 0:15 | 0.1050 |
| 0:20 | 0.1680 |
| 0:25 | 0.3150 |
| 0:30 | 0.5250 |
| 0:35 | 0.2520 |
| 0:40 | 0.1680 |
| 0:45 | 0.1050 |
| 0:50 | 0.1050 |
| 0:55 | 0.0672 |
| 1:00 | 0.0672 |
| 1:05 | 0.0672 |
| 1:10 | 0.0504 |
| 1:15 | 0.0504 |
| 1:20 | 0.0378 |
| 1:25 | 0.0378 |
| 1:30 | 0.0294 |
| 1:35 | 0.0294 |
| 1:40 | 0.0294 |
| 1:45 | 0.0294 |
| 1:50 | 0.0294 |
| 1:55 | 0.0294 |
| 2:00 | 0.0294 |

| 1Hr Depth | 2.47 |
|---|---|
| Return Period | 100 |
| Time | Depth |
| 0:05 | 0.0247 |
| 0:10 | 0.0741 |
| 0:15 | 0.1136 |
| 0:20 | 0.1976 |
| 0:25 | 0.3458 |
| 0:30 | 0.6175 |
| 0:35 | 0.3458 |
| 0:40 | 0.1976 |
| 0:45 | 0.1531 |
| 0:50 | 0.1235 |
| 0:55 | 0.0988 |
| 1:00 | 0.0988 |
| 1:05 | 0.0988 |
| 1:10 | 0.0494 |
| 1:15 | 0.0494 |
| 1:20 | 0.0296 |
| 1:25 | 0.0296 |
| 1:30 | 0.0296 |
| 1:35 | 0.0296 |
| 1:40 | 0.0296 |
| 1:45 | 0.0296 |
| 1:50 | 0.0296 |
| 1:55 | 0.0296 |
| 2:00 | 0.0296 |

| 1Hr Depth | 3.43 |
|---|---|
| Return Period | 500 |
| Time | Depth |
| 0:05 | 0.0343 |
| 0:10 | 0.1029 |
| 0:15 | 0.1578 |
| 0:20 | 0.2744 |
| 0:25 | 0.4802 |
| 0:30 | 0.8575 |
| 0:35 | 0.4802 |
| 0:40 | 0.2744 |
| 0:45 | 0.2127 |
| 0:50 | 0.1715 |
| 0:55 | 0.1372 |
| 1:00 | 0.1372 |
| 1:05 | 0.1372 |
| 1:10 | 0.0686 |
| 1:15 | 0.0686 |
| 1:20 | 0.0412 |
| 1:25 | 0.0412 |
| 1:30 | 0.0412 |
| 1:35 | 0.0412 |
| 1:40 | 0.0412 |
| 1:45 | 0.0412 |
| 1:50 | 0.0412 |
| 1:55 | 0.0412 |
| 2:00 | 0.0412 |

# Table B-2 - Detention Basin Stage-Storage-Discharge Information

**Design Point 316 - Drainageway 4100: Union Pacific Railroad Embankment**

| Elevation | Stage (ft) | Area (sf) | Volume (AF) | Discharge (cfs) |
|---|---|---|---|---|
| 5152.3 | 0 | 22,000 | 0 | 0.00 |
| 5153 | 0.7 | 59,012 | 0.627 | 0.70 |
| 5154 | 1.7 | 111,281 | 2.55 | 2.23 |
| 5155 | 2.7 | 251,085 | 6.602 | 4.24 |
| 5156 | 3.7 | 375,069 | 13.742 | 6.75 |
| 5157 | 4.7 | 447,885 | 23.176 | 15.29 |
| 5158 | 5.7 | 505,814 | 34.116 | 54.93 |
| 5159 | 6.7 | 542,816 | 46.15 | 109.45 |
| 5160 | 7.7 | 590,463 | 59.155 | 135.07 |
| 5161 | 8.7 | 618,714 | 73.033 | 143.96 |
| 5162 | 9.7 | 650,622 | 87.601 | 152.34 |
| 5163 | 10.7 | 700,403 | 103.105 | 160.29 |
| 5164 | 11.7 | 759,679 | 119.86 | 167.85 |
| 5165 | 12.7 | 854,831 | 138.382 | 175.09 |
| 5166 | 13.7 | 940,000 | 158.976 | 182.05 |
| 5167 | 14.7 | 1,029,980 | 181.853 | 188.74 |

Stage-area values from *Villages North Subdivision Filing No. 5 Pond 301 Construction Plans* . Stage-discharge calculated using UD_Detention, version 3.07 based on pond details

**Design Point 331 -Drainageway 4100: Race Street**

| Volume (AF) | Discharge (cfs) |
|---|---|
| 0 | 0.00 |
| 0.10 | 9.30 |
| 0.70 | 28.00 |
| 2.20 | 40.00 |
| 4.30 | 40.00 |
| 5.60 | 74.60 |
| 6.90 | 200.00 |
| 8.40 | 850.00 |

Values from 2002 OSP

**Design Point 302 - School Tributary: Railroad North of 88th Avenue**

| Elevation | Stage (ft) | Area (sf) | Volume (AF) | Elevation | Stage (ft) | Discharge (cfs) |
|---|---|---|---|---|---|---|
| 5148.89 | 0.00 | 0 | 0 | 5148.89 | 0.00 | 0.00 |
| 5150.00 | 1.11 | 131 | 0 | 5150.20 | 1.31 | 25.00 |
| 5151.00 | 2.11 | 724 | 0.01 | 5150.80 | 1.91 | 50.00 |
| 5152.00 | 3.11 | 1,554 | 0.04 | 5151.20 | 2.31 | 75.00 |
| 5153.00 | 4.11 | 2,769 | 0.09 | 5153.10 | 4.21 | 100.00 |
| 5154.00 | 5.11 | 5,388 | 0.18 | 5153.30 | 4.41 | 102.00 |
| 5155.00 | 6.11 | 9,693 | 0.35 | 5154.40 | 5.51 | 191.00 |
| 5156.00 | 7.11 | 19,727 | 0.69 | 5157.50 | 8.61 | 351.00 |
| 5157.00 | 8.11 | 31,643 | 1.28 | 5158 | 9.11 | 369 |
| 5158.00 | 9.11 | 61,945 | 2.36 | 5158.04 | 9.15 | 371 |
| 5159.00 | 10.11 | 99,023 | 4.2 | 5159 | 10.11 | 407 |
| 5159.89 | 11.00 | 99,023 | 6.5 | 5159.89 | 11.00 | 500 |

Values from *Railroad Crossing Analysis at 88th Avenue and Welby Road*

**Design Point 321N/321S - North G Tributary: Yorkborough Park**

| Elevation | Stage (ft) | Area (sf) | Volume (AF) | Discharge (cfs) |
|---|---|---|---|---|
| **321S - Southern Detention Basin** | | | | |
| 5198.37 | 0 | 0 | 0.00 | 0.00 |
| 5199 | 0.63 | 20 | 0.00 | 1.87 |
| 5200 | 1.63 | 359 | 0.00 | 10.45 |
| 5201 | 2.63 | 5,354 | 0.07 | 19.31 |
| 5202 | 3.63 | 15,802 | 0.31 | 24.53 |
| 5203 | 4.63 | 23,544 | 0.76 | 28.82 |
| 5204 | 5.63 | 30,671 | 1.39 | 155.55 |
| 5205 | 6.63 | 39,344 | 2.19 | 723.20 |
| **321N - Northern Detention Basin** | | | | |
| 5216.17 | 0 | 0 | 0.00 | 0.00 |
| 5217 | 0.83 | 70 | 0.00 | 3.01 |
| 5218 | 1.83 | 721 | 0.01 | 12.75 |
| 5219 | 2.83 | 2,466 | 0.05 | 20.41 |
| 5220 | 3.83 | 5,053 | 0.13 | 25.40 |
| 5221 | 4.83 | 9,812 | 0.30 | 29.56 |
| 5222 | 5.83 | 20,142 | 0.65 | 33.24 |
| 5222.65 | 6.48 | 30,668 | 1.03 | 35.41 |
| 5223 | 6.83 | 36,336 | 1.30 | 139.39 |
| 5224 | 7.83 | 60,650 | 2.41 | 894.08 |

Stage-area-discharge calculated using UD-Detention 3.07 using LiDAR and outlet structure survey

**Design Point 322 - North G Tributary: 100th Avenue**

| Volume (AF) | Discharge (cfs) |
|---|---|
| 0 | 0.00 |
| 0.70 | 6.40 |
| 3.60 | 24.00 |
| 7.00 | 38.00 |
| 8.30 | 39.00 |
| 12.20 | 500.00 |

Values from 2002 OSP

**Design Point 326 - West G Tributary: York Street**

| Volume (AF) | Discharge (cfs) |
|---|---|
| 0 | 0.00 |
| 0.20 | 35.00 |
| 0.70 | 58.00 |
| 1.70 | 89.00 |
| 2.80 | 140.00 |
| 3.50 | 375.00 |
| 4.20 | 750.00 |

Values from 2002 OSP

**Design Point 327 - West G Tributary: York Street, north of 326**

| Volume (AF) | Discharge (cfs) |
|---|---|
| 0 | 0.00 |
| 0.30 | 8.00 |
| 0.90 | 24.00 |
| 1.70 | 100.00 |
| 1.80 | 200.00 |
| 1.90 | 500.00 |

Values from 2002 OSP

**Design Point 329 - West G Tributary: High Street**

| Volume (AF) | Discharge (cfs) |
|---|---|
| 0 | 0.00 |
| 0.10 | 21.00 |
| 0.80 | 28.00 |
| 1.00 | 36.00 |
| 1.10 | 100.00 |

Values from 2002 OSP

**Design Point 339 - J Tributary: Cherrylane Pond A**

| Elevation | Stage (ft) | Area (sf) | Discharge (cfs) |
|---|---|---|---|
| 5079.38 | 0 | 0 | 0.00 |
| 5080 | 0.62 | 4,674 | 0.13 |
| 5081 | 1.62 | 19,677 | 0.47 |
| 5082 | 2.62 | 24,349 | 0.92 |
| 5083 | 3.62 | 27,372 | 1.46 |
| 5084 | 4.62 | 30,874 | 2.06 |
| 5085 | 5.62 | 34,392 | 8.32 |
| 5086 | 6.62 | 38,240 | 34.29 |
| 5087 | 7.62 | 42,540 | 50.13 |
| 5088 | 8.62 | 46,952 | 63.79 |
| 5089 | 9.62 | 51,487 | 165.92 |
| 5090 | 10.62 | 51,487 | 356.50 |

Stage-area values from *Final Drainage Report: Cherry Lane Subdivision.* Elevation 5090 added based on LiDAR area. Stage-discharge calculated using design plans and UD-Detention, version 3.07

**Design Point 340 - J Tributary: River Valley Village, 96th and Riverdale**

| Elevation | Stage (ft) | Area (sf) | Discharge (cfs) |
|---|---|---|---|
| 5089.8 | 0 | 0 | 0.00 |
| 5092 | 2.2 | 6,514 | 10.21 |
| 5093 | 3.2 | 40,684 | 13.29 |
| 5094 | 4.2 | 66,995 | 15.78 |
| 5095 | 5.2 | 89,247 | 17.93 |
| 5096 | 6.2 | 103,191 | 19.85 |
| 5097 | 7.2 | 114,771 | 1084.25 |
| 5098 | 8.2 | 120029 | 3417.34 |

Stage-area-discharge calculated using UD-Detention 3.07 based on LiDAR and as-built plans

**Design Point 307 - Colorado Boulevard Tributary: Colorado Blvd. & Welby Rd.**

| Storage (AF) | Discharge (cfs) |
|---|---|
| 0 | 0.00 |
| 0.70 | 5.00 |
| 1.70 | 8.00 |
| 2.60 | 275.00 |
| 2.80 | 325.00 |
| 2.90 | 390.00 |
| 3.10 | 450.00 |
| 3.20 | 500.00 |
| 3.30 | 600.00 |
| 3.4 | 1000.00 |

Values from 2002 OSP

# DETENTION BASIN INFORMATION

MERRICK & COMPANY
McLaughlin Water Engineers
A Division of Merrick & Company

**MEMORANDUM**
February 20, 2015

TO: CDGB School Tributary Team

FROM: Merrick & Company

**RE: Railroad Crossing Analysis at 88th Avenue and Welby Road**

---

As requested by the design team, we have performed an analysis of the existing capacity of the culverts crossing the railroad just north of 88th Avenue including the effect of inadvertent detention upstream of the railroad. The purpose of this analysis is to calculate the maximum headwater conditions during the 100-year event.

This memo describes the railroad crossing analysis for existing conditions and conclusions.

**Analysis**

Currently, there is approximately 2.36 acre-feet of inadvertent detention upstream of the railroad between elevations 5148.89 (the existing invert of the twin 60" CMP's) to 5158 (back of walk elevation at 88th Avenue). This detention matches closely to the 2.3 acre-feet inadvertent detention accounted for in the Master Plan for this area. A stage-storage table and curve were created using 1-foot contour data. For elevation 5159, the volume was approximated by vertically extending existing features to determine volume above elevation 5158. The completed stage-storage table and curve are attached.

CADD drawings and survey data of existing conditions were used to determine inverts and lengths of culvert pipes. The existing double 60" CMP pipes at the railroad have an average upstream invert of 5148.89 and an average downstream invert of 5147.7. The length is approximately 61.1 feet. Downstream of the railroad, triple 24" elliptical RCP pipes cross under Welby Road with average upstream invert of 5146.04, average downstream invert of 5145.41, and average length of 46.2 feet.

The discharge through the study site is influenced by the following conditions:

1. Welby Road – approximately 230 foot long weir at elevation 5153.
2. 3-24" RCP's under Welby Road, downstream of the railroad crossing
3. 2-60" CMP's at the railroad.

An iterative procedure to determine the outflow rating considered each of the three possible constraints. This was accomplished by iteratively using the headwater and weir flow calculations for the Welby crossing as the tailwater for the railroad crossing. To simplify analysis, the triple 24" RCP's are assumed to have no significant tailwater conditions. Calculations for determining the discharge curve are attached.

The inadvertent detention and calculated stage-storage curve were added to the existing conditions SWMM model. The results are shown below.

**Results**

The results of the SWMM model indicate that the peak inflow to the inadvertent detention was 411 cfs. At the upstream side of the 2-60" CMP's, the routed peak flow is 371 cfs. This flow would correspond to a headwater elevation of 5158.04. This will create a negligible spill condition in 88th Avenue.

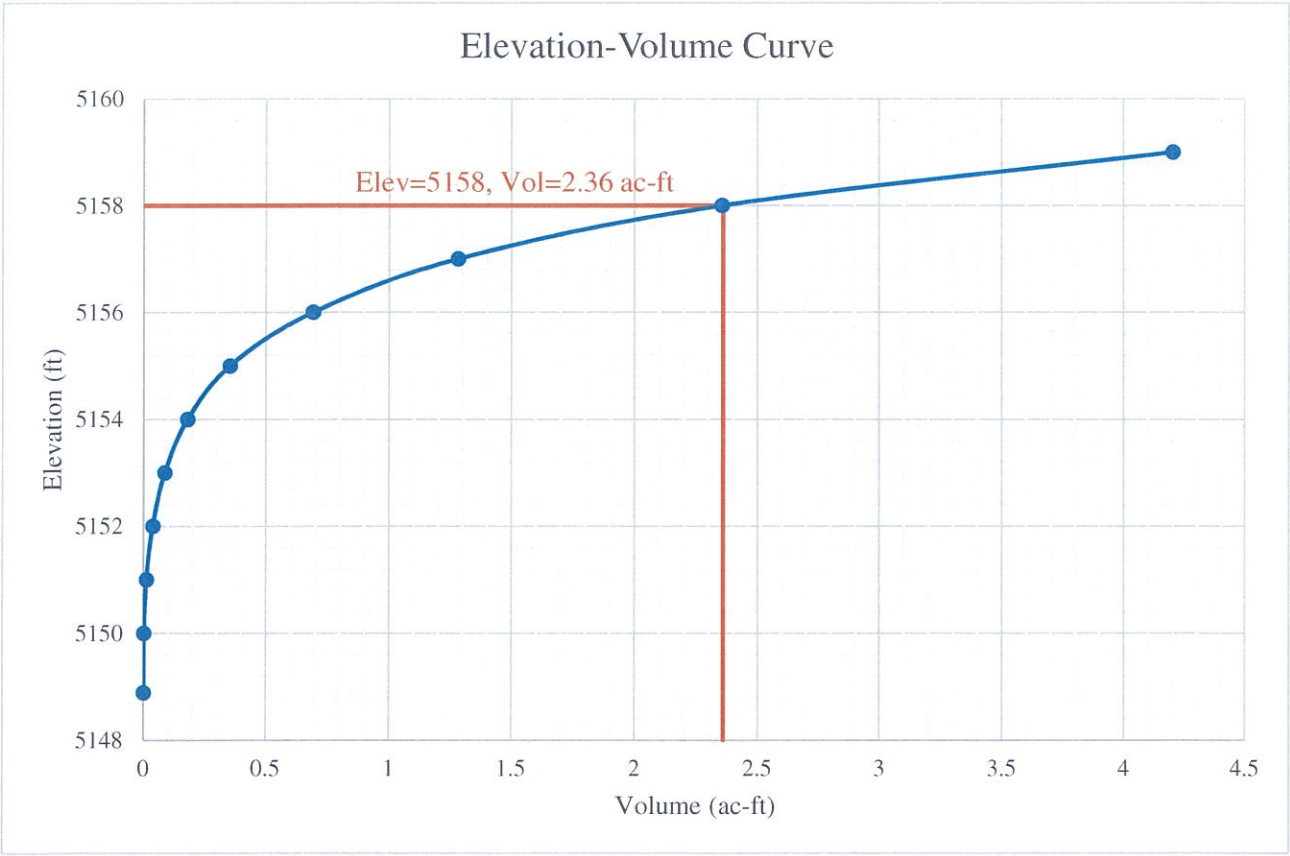
**Conclusion**

The inadvertent detention upstream of the railroad crossing has a volume of approximately 2.36 acre-feet. Adding this detention to the SWMM model, coupled with a rating curve for the twin 60" CMP's, results in a headwater elevation of 5158.04, slightly above the back of curb at the 88th and railroad intersection. This would leave no freeboard at the crossing. The peak flow through the culverts is about 371 cfs with negligible spill onto 88th Avenue. The value of 371 cfs is greater than the value of 285 cfs which has recently been used by RTD for the crossing design.

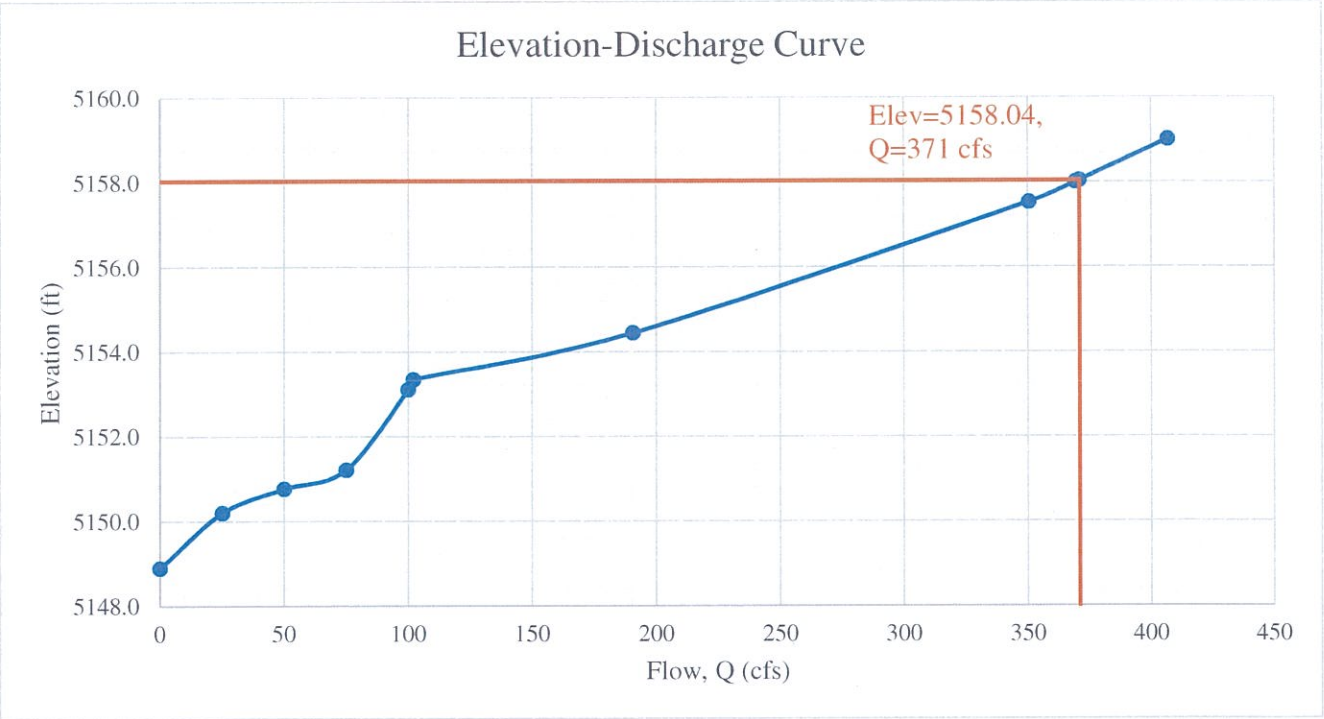
Attachments:
1. Stage-storage table and curve for inadvertent detention
2. Stage-discharge table and curve for inadvertent detention
3. 3-24" RCP detailed hydraulic calculations
4. Welby Weir and Pipe Calculations for 3-24" RCP's
5. 2-60" CMP detailed hydraulics calculations
6. Site Layout

**- END OF MEMORANDUM -**

| Elevation (ft) | Stage (ft) | Area (sf) | ΔV (cf) | Σ V (cf) | Σ V (ac-ft) |
|---|---|---|---|---|---|
| 5148.89 | 0 | 0.00 | | 0.00 | 0.00 |
| | | | 72.80 | | |
| 5150 | 1.11 | 131.17 | | 72.80 | 0.00 |
| | | | 427.73 | | |
| 5151 | 2.11 | 724.28 | | 500.52 | 0.01 |
| | | | 1,139.39 | | |
| 5152 | 3.11 | 1,554.49 | | 1,639.91 | 0.04 |
| | | | 2,161.59 | | |
| 5153 | 4.11 | 2,768.68 | | 3,801.49 | 0.09 |
| | | | 4,078.42 | | |
| 5154 | 5.11 | 5,388.16 | | 7,879.91 | 0.18 |
| | | | 7,540.72 | | |
| 5155 | 6.11 | 9,693.27 | | 15,420.63 | 0.35 |
| | | | 14,710.36 | | |
| 5156 | 7.11 | 19,727.44 | | 30,130.98 | 0.69 |
| | | | 25,685.07 | | |
| 5157 | 8.11 | 31,642.70 | | 55,816.05 | 1.28 |
| | | | 46,793.68 | | |
| 5158 | 9.11 | 61,944.65 | | 102,609.73 | 2.36 |
| | | | 80,483.78 | | |
| 5159 | 10.11 | 99,022.90 | | 183,093.50 | 4.20 |

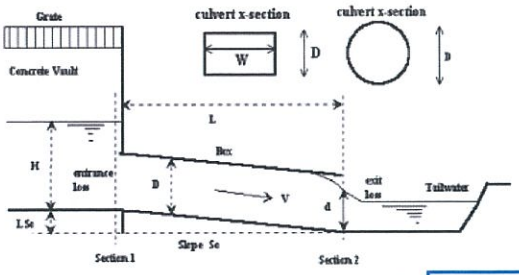


| Elevation (ft) | Stage (ft) | Discharge (cfs) |
|---|---|---|
| 5148.9 | 0.0 | 0 |
| 5150.2 | 1.3 | 25 |
| 5150.8 | 1.9 | 50 |
| 5151.2 | 2.3 | 75 |
| 5153.1 | 4.2 | 100 |
| 5153.3 | 4.5 | 102 |
| 5154.4 | 5.5 | 191 |
| 5157.5 | 8.6 | 351 |
| 5158.0 | 9.1 | 369 |
| 5158.04 | 9.1 | 371 |
| 5159.0 | 10.1 | 407 |



# CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

**Project:** 3. School Tributary
**Basin ID:** Triple 24" RCP Rating
**Status:**




## Design Information (Input):

**Circular Culvert:** Barrel Diameter in Inches — D = 24 inches
Inlet Edge Type (choose from pull-down list) — Square End with Headwall

**OR:**

**Box Culvert:** Barrel Height (Rise) in Feet — Height (Rise) = ft.
Barrel Width (Span) in Feet — Width (Span) = ft.
Inlet Edge Type (choose from pull-down list) — Square Edge w/ 90-15 Deg. Headwall

| | | | |
|---|---|---|---|
| Number of Barrels | No = | 3 | |
| Inlet Elevation at Culvert Invert | Inlet Elev = | 5146.04 | ft. elev. |
| Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.) | Outlet Elev = | 5145.41 | ft. elev. |
| Culvert Length in Feet | L = | 46.19 | ft. |
| Manning's Roughness | n = | 0.013 | |
| Bend Loss Coefficient | $K_b$ = | 0 | |
| Exit Loss Coefficient | $K_x$ = | 1 | |

## Design Information (calculated):

| | | |
|---|---|---|
| Entrance Loss Coefficient | $K_e$ = | 0.50 |
| Friction Loss Coefficient | $K_f$ = | 0.57 |
| Sum of All Loss Coefficients | $K_s$ = | 2.07 |
| Orifice Inlet Condition Coefficient | $C_d$ = | 0.86 |
| Minimum Energy Condition Coefficient | $KE_{low}$ = | -0.0342 |

## Calculations of Culvert Capacity (output):

| Water Surface Elevation (ft., linked) | Tailwater Surface Elevation ft | Culvert Inlet-Control Flowrate cfs | Culvert Outlet-Control Flowrate cfs | Controlling Culvert Flowrate cfs (output) | Inlet Equation Used: | Flow Control Used |
|---|---|---|---|---|---|---|
| 5146.040 | | 0.00 | 0.00 | **0.00** | No Flow (WS < inlet) | N/A |
| 5147.550 | | 25.20 | 30.24 | **25.20** | Regression Eqn. | INLET |
| 5148.751 | | 55.80 | 50.01 | **50.01** | Regression Eqn. | OUTLET |
| 5150.430 | | 83.10 | 75.02 | **75.02** | Regression Eqn. | OUTLET |
| 5152.780 | | 109.80 | 100.03 | **100.03** | Orifice Eqn. | OUTLET |
| 5153.000 | | 111.90 | 102.09 | **102.09** | Orifice Eqn. | OUTLET |
| 5153.250 | | 114.30 | 104.35 | **104.35** | Orifice Eqn. | OUTLET |
| 5153.500 | | 116.40 | 106.53 | **106.53** | Orifice Eqn. | OUTLET |
| 5153.525 | | 116.70 | 106.76 | **106.76** | Orifice Eqn. | OUTLET |
| 5153.527 | | 116.70 | 106.76 | **106.76** | Orifice Eqn. | OUTLET |
| 5153.573 | | 117.00 | 107.16 | **107.16** | Orifice Eqn. | OUTLET |
| 5153.750 | | 118.80 | 108.71 | **108.71** | Orifice Eqn. | OUTLET |
| 5154.000 | | 120.90 | 110.85 | **110.85** | Orifice Eqn. | OUTLET |
| 5154.500 | | 125.10 | 114.97 | **114.97** | Orifice Eqn. | OUTLET |
| 5155.000 | | 129.30 | 118.93 | **118.93** | Orifice Eqn. | OUTLET |
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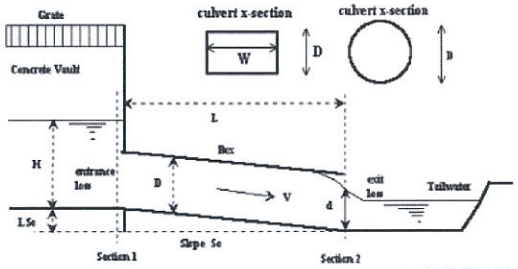
3-24" Eplliptical RCPs

| Elev | H above 5153 | Q from UD-Culvert (cfs) | Q Weir (cfs) | Q Total (cfs) |
|---|---|---|---|---|
| 5146.040 | -7.0 | 0 | 0 | **0** |
| 5147.550 | -5.4 | 25 | 0 | **25** |
| 5148.750 | -4.3 | 50 | 0 | **50** |
| 5150.430 | -2.6 | 75 | 0 | **75** |
| 5152.780 | -0.2 | 100 | 0 | **100** |
| 5153.000 | 0.0 | 102 | 0 | **102** |
| 5153.250 | 0.3 | 104 | 86 | **191** |
| 5153.500 | 0.5 | 107 | 244 | **350** |
| 5153.525 | 0.5 | 107 | 262 | **369** |
| 5153.527 | 0.5 | 107 | 264 | **371** |
| 5153.573 | 0.6 | 107 | 299 | **406** |
| 5153.750 | 0.8 | 109 | 448 | **557** |
| 5154.000 | 1.0 | 111 | 690 | **801** |
| 5154.500 | 1.5 | 115 | 1,268 | **1,383** |
| 5155.000 | 2.0 | 119 | 1,952 | **2,071** |

| | |
|---|---|
| Road elev | 5153 |
| L | 230 |
| C | 3 |

# CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

**Project:** 5. School Tributary
**Basin ID:** Double 60" CMP Rating
**Status:**




## Design Information (Input):

**Circular Culvert:** Barrel Diameter in Inches — D = 60 inches
Inlet Edge Type (choose from pull-down list) — Square End with Headwall

**OR:**

**Box Culvert:** Barrel Height (Rise) in Feet — Height (Rise) = ft.
Barrel Width (Span) in Feet — Width (Span) = ft.
Inlet Edge Type (choose from pull-down list) — Square Edge w/ 90-15 Deg. Headwall

| | | | |
|---|---|---|---|
| Number of Barrels | No = | 2 | |
| Inlet Elevation at Culvert Invert | Inlet Elev = | 5148.89 | ft. elev. |
| Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.) | Outlet Elev = | 5147.7 | ft. elev. |
| Culvert Length in Feet | L = | 61.07 | ft. |
| Manning's Roughness | n = | 0.024 | |
| Bend Loss Coefficient | $K_b$ = | 0 | |
| Exit Loss Coefficient | $K_x$ = | 1 | |

## Design Information (calculated):

| | | |
|---|---|---|
| Entrance Loss Coefficient | $K_e$ = | 0.50 |
| Friction Loss Coefficient | $K_f$ = | 0.76 |
| Sum of All Loss Coefficients | $K_s$ = | 2.26 |
| Orifice Inlet Condition Coefficient | $C_d$ = | 0.86 |
| Minimum Energy Condition Coefficient | $KE_{low}$ = | -0.0163 |

## Calculations of Culvert Capacity (output):

| Water Surface Elevation (ft., linked) | Tailwater Surface Elevation ft | Culvert Inlet-Control Flowrate cfs | Culvert Outlet-Control Flowrate cfs | Controlling Culvert Flowrate cfs (output) | Inlet Equation Used: | Flow Control Used |
|---|---|---|---|---|---|---|
| 5148.890 | 5146.040 | 0.00 | 0.00 | **0.00** | No Flow (WS < inlet) | N/A |
| 5150.195 | 5147.550 | 25.20 | 141.39 | **25.20** | Min. Energy. Eqn. | INLET |
| 5150.760 | 5148.750 | 50.00 | 156.36 | **50.00** | Min. Energy. Eqn. | INLET |
| 5151.209 | 5150.430 | 75.00 | 154.19 | **75.00** | Min. Energy. Eqn. | INLET |
| 5153.108 | 5152.780 | 197.80 | 100.04 | **100.04** | Regression Eqn. | OUTLET |
| 5153.341 | 5153.000 | 215.00 | 102.01 | **102.01** | Regression Eqn. | OUTLET |
| 5154.440 | 5153.250 | 293.40 | 190.62 | **190.62** | Regression Eqn. | OUTLET |
| 5157.526 | 5153.500 | 457.00 | 350.53 | **350.53** | Regression Eqn. | OUTLET |
| 5158.000 | 5153.525 | 476.80 | 369.43 | **369.43** | Regression Eqn. | OUTLET |
| 5158.040 | 5153.527 | 478.40 | 371.01 | **371.01** | Regression Eqn. | OUTLET |
| 5159.000 | 5153.573 | 515.80 | 406.85 | **406.85** | Regression Eqn. | OUTLET |
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City of Thornton

Railroad Crossing Analysis
88th Avenue and Welby Road

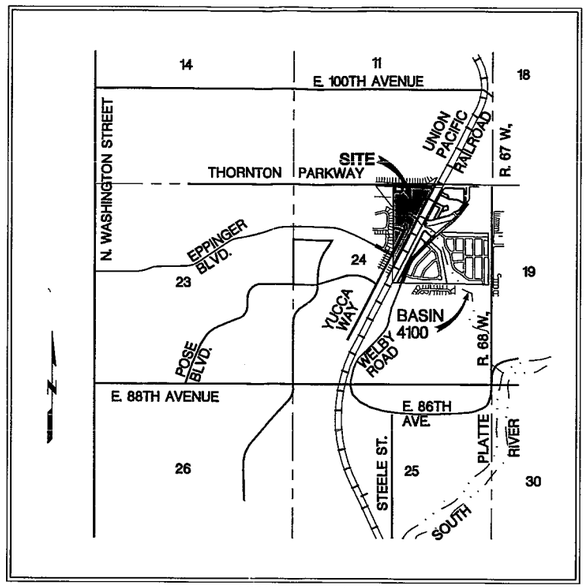
MERRICK & COMPANY
McLaughlin Water Engineers
A DIVISION OF MERRICK & COMPANY
2420 Alcott St
Denver, CO 80211
T303.964.3333
F303.964.3355

File Copy

# VILLAGES NORTH SUBDIVISION FILING No. 5
# POND 301 CONSTRUCTION PLANS

**A PORTION OF THE NE 1/4 OF SECTION 24, TOWNSHIP 2 SOUTH, RANGE 68 WEST OF THE 6TH PRINCIPAL MERIDIAN, CITY OF THORNTON, COUNTY OF ADAMS, STATE OF COLORADO**

## COVER SHEET




**VICINITY MAP**
SCALE: 1" = 2000'

**SHEET INDEX**


| | |
|---|---|
| SHEET 1 OF 9 | COVER SHEET |
| SHEET 2 OF 9 | POND 301 |
| SHEET 3 OF 9 | GRADING AND EROSION CONTROL PLAN |
| SHEET 4 OF 9 | OUTLET STRUCTURE PLAN AND PROFILE |
| SHEET 5 OF 9 | FOREBAY PLAN AND PROFILE |
| SHEET 6 OF 9 | DETAILS 1 OF 2 |
| SHEET 7 OF 9 | DETAILS 2 OF 2 |
| SHEET 8 OF 9 | SECTION LOCATIONS |
| SHEET 9 OF 9 | SECTIONS AND PROFILES |


**AGENCIES**

| | | |
|---|---|---|
| CITY OF THORNTON | 9500 CIVIC CENTER DR., THORNTON CO. 80229 | (303) 538-7610 |
| TRI-COUNTY HEALTH DEPARTMENT | 4857 S. BROADWAY, ENGLEWOOD CO 80110 | (303) 761-1340 |
| COLORADO STATE HEALTH DEPARTMENT | 4210 E. 11th AVE., DENVER CO 80222 | (303) 757-9210 |
| XCEL ENERGY | 5460 W. 60th AVE., ARVADA CO 80003 | (303) 425-3953 |
| CITY OF THORNTON FIRE AND RESCUE | 9500 CIVIC CENTER DR., THORNTON CO. 80229 | (303) 538-7338 |

**DEVELOPER/OWNER:**


**VILLNO, Inc.**
**3600 S. LOGAN STREET, SUITE 200**
**ENGLEWOOD, CO 80110**
**(303) 333-6000**
**FAX: (303) 777-7694**

**CONTACT:**
DAN SHELDON


**ENGINEER:**


VISION LAND CONSULTANTS, INC.

CIVIL ENGINEERS
CONSTRUCTION MANAGERS

538 COMMONS DRIVE
GOLDEN, CO 80401
PHONE:(303)674-7355 FAX:(303)674-3263

**CONTACT:**
DOUGLAS J. RICHTER, P.E.


**CALL BEFORE YOU DIG**
CALL UTILITY NOTIFICATION CENTER OF COLORADO
**1-800-922-1987**
12600 W. COLFAX AVE., SUITE B-310
LAKEWOOD, COLORADO 80215
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES

COLORADO REGISTERED PROFESSIONAL ENGINEER
DOUGLAS J. RICHTER
36651
9/6/05
Signed

| DATE | NO. | REVISIONS | BY |
|---|---|---|---|
| 1/14/05 | 2 | REVISIONS - UDFCD 9/20/04 REVIEW | DJR |
| 4/19/05 | 3 | REVISIONS - UDFCD 2/23/05 REVIEW | CM |
| 8/03/05 | 4 | REVISIONS - UDFCD 6/29/05 REVIEW | CM |
| 9/08/05 | 5 | REVISIONS - UDFCD 8/31/05 REVIEW | CM |

DATE 07/02/04 DRAWN BY KJC
JOB NO. 2117.E1 CHECKED BY DJR
DO NOT SCALE, USE DIMENSION ONLY

RELEASED FOR CONSTRUCTION
City of Thornton Public Works
GP
SEP 14 2005
These plans were reviewed for compliance with City Standards and are on file in the City of Thornton Public Works Department. Approval is granted for a period of one year from the date of approval. Improvements must be constructed within this period or the plans must be resubmitted for review.

**BENCHMARK**

BEING AN ADAMS COUNTY MONUMENT STAMPED "95.0208 1995 2S68W S13". 3-1/4" ALUMINUM SURVEY MARK DISK LOCATED NW OF THE INTERSECTION OF COLORADO BLVD. AND E. 100TH AVE. HAVING AN NAVD 1988 DATUM ELEVATION OF 5220.58 FEET.

**ENGINEER'S CERTIFICATION**

THESE CONSTRUCTION PLANS FOR VILLAGES NORTH SUBDIVISION FILING NO. 5 HAVE BEEN PREPARED BY ME (OR UNDER MY DIRECT SUPERVISION) IN ACCORDANCE WITH THE REQUIREMENTS OF THE STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND PUBLIC IMPROVEMENTS OF THE CITY OF THORNTON.

DOUGLAS J. RICHTER, P.E.
COLORADO NO. 36651

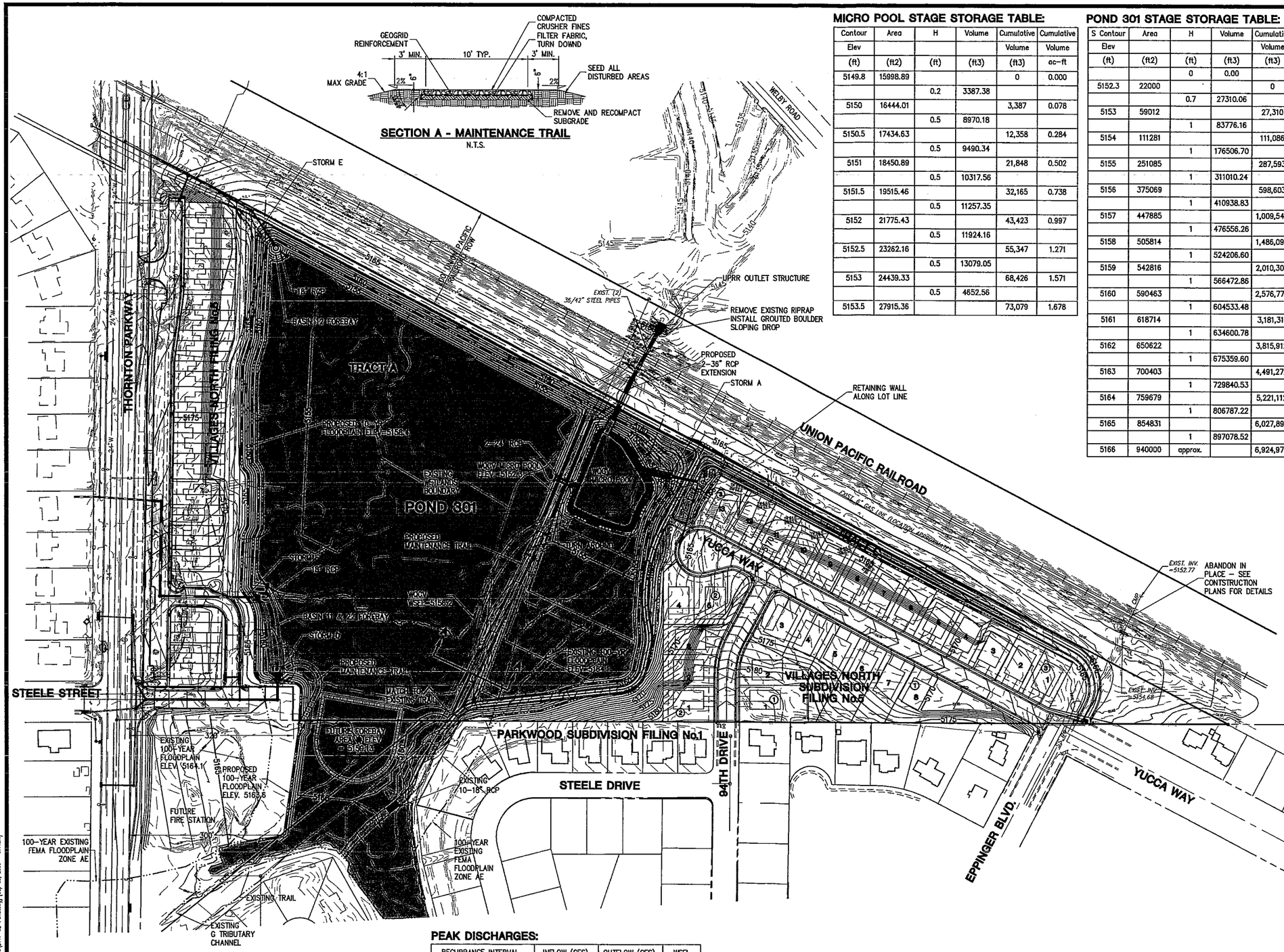
"WORK SHALL BE CONSTRUCTED TO THE CITY OF THORNTON STANDARDS AND SPECIFICATIONS. THIS APPROVAL IS FOR CONFORMANCE TO THESE STANDARDS AND SPECIFICATIONS AND OTHER CITY REQUIREMENTS. THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER."


CIVIL ENGINEERS
CONSTRUCTION MANAGERS
538 COMMONS DRIVE
GOLDEN, CO 80401
PHONE:(303)674-7355 FAX:(303)674-3263
VISION LAND CONSULTANTS, INC.


VILLAGES NORTH SUBDIVISION FILING No. 5
POND 301 CONSTRUCTION PLANS
COVER SHEET
THORNTON, COLORADO

SHEET
1 of 9

[Initials] [G:\2117.D-Villages\P-Plans & Dwgs\Cover\Pond\2117-01-COR.dwg] [Sep 09, 2005 - 8:18am]




## MICRO POOL STAGE STORAGE TABLE:

| Contour Elev (ft) | Area (ft2) | H (ft) | Volume (ft3) | Cumulative Volume (ft3) | Cumulative Volume ac-ft |
|---|---|---|---|---|---|
| 5149.8 | 15998.89 | | | 0 | 0.000 |
| | | 0.2 | 3387.38 | | |
| 5150 | 16444.01 | | | 3,387 | 0.078 |
| | | 0.5 | 8970.18 | | |
| 5150.5 | 17434.63 | | | 12,358 | 0.284 |
| | | 0.5 | 9490.34 | | |
| 5151 | 18450.89 | | | 21,848 | 0.502 |
| | | 0.5 | 10317.56 | | |
| 5151.5 | 19515.46 | | | 32,165 | 0.738 |
| | | 0.5 | 11257.35 | | |
| 5152 | 21775.43 | | | 43,423 | 0.997 |
| | | 0.5 | 11924.16 | | |
| 5152.5 | 23262.16 | | | 55,347 | 1.271 |
| | | 0.5 | 13079.05 | | |
| 5153 | 24439.33 | | | 68,426 | 1.571 |
| | | 0.5 | 4652.56 | | |
| 5153.5 | 27915.36 | | | 73,079 | 1.678 |

## POND 301 STAGE STORAGE TABLE:

| S Contour Elev (ft) | Area (ft2) | H (ft) | Volume (ft3) | Cumulative Volume (ft3) | Cumulative Volume ac-ft |
|---|---|---|---|---|---|
| | | 0 | 0.00 | | |
| 5152.3 | 22000 | | | 0 | 0.000 |
| | | 0.7 | 27310.06 | | |
| 5153 | 59012 | | | 27,310 | 0.627 |
| | | 1 | 83776.16 | | |
| 5154 | 111281 | | | 111,086 | 2.550 |
| | | 1 | 176506.70 | | |
| 5155 | 251085 | | | 287,593 | 6.602 |
| | | 1 | 311010.24 | | |
| 5156 | 375069 | | | 598,603 | 13.742 |
| | | 1 | 410938.83 | | |
| 5157 | 447885 | | | 1,009,542 | 23.176 |
| | | 1 | 476556.26 | | |
| 5158 | 505814 | | | 1,486,098 | 34.116 |
| | | 1 | 524206.60 | | |
| 5159 | 542816 | | | 2,010,305 | 46.150 |
| | | 1 | 566472.86 | | |
| 5160 | 590463 | | | 2,576,778 | 59.155 |
| | | 1 | 604533.48 | | |
| 5161 | 618714 | | | 3,181,311 | 73.033 |
| | | 1 | 634600.78 | | |
| 5162 | 650622 | | | 3,815,912 | 87.601 |
| | | 1 | 675359.60 | | |
| 5163 | 700403 | | | 4,491,272 | 103.105 |
| | | 1 | 729840.53 | | |
| 5164 | 759679 | | | 5,221,112 | 119.860 |
| | | 1 | 806787.22 | | |
| 5165 | 854831 | | | 6,027,899 | 138.382 |
| | | 1 | 897078.52 | | |
| 5166 | 940000 | approx. | | 6,924,978 | 158.976 |

KEYMAP
1" = 1000'

1"=100'

| DATE | NO. | REVISIONS | BY |
|---|---|---|---|
| 1/14/05 | 2 | REVISIONS - UDFCD 9/20/04 REVIEW | DJR |
| 4/19/05 | 3 | REVISIONS - UDFCD 2/23/05 REVIEW | CM |
| 8/03/05 | 4 | REVISIONS - UDFCD 6/29/05 REVIEW | CM |
| 9/08/05 | 5 | REVISIONS - UDFCD 8/31/05 REVIEW | CM |

DRAWN BY CMM
CHECKED BY DJR
DATE 07/02/04
JOB NO. 2117.E1
DO NOT SCALE, USE DIMENSION ONLY


CIVIL ENGINEERS
CONSTRUCTION MANAGERS
538 COMMONS DRIVE
GOLDEN, CO 80401
PHONE:(303)674-7355 FAX:(303)674-3263


VISION LAND CONSULTANTS, INC.

VILLAGES NORTH SUBDIVISION FILING No. 5

# POND 301

THORNTON, COLORADO

SHEET
2 of 9

## CALL BEFORE YOU DIG

CALL UTILITY NOTIFICATION CENTER OF COLORADO
**1-800-922-1987**
12600 W. COLFAX AVE., SUITE B-310
LAKEWOOD, COLORADO 80215
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES

## VOLUME TOTALS:

| LOCATION | VOLUME (ACRE FT) |
|---|---|
| MICRO POOL VOLUME | 1.15 |
| WQCV VOLUME | 17.88 |
| BASIN 11 & 22 FOREBAY | 0.098 |
| BASIN 12 FOREBAY | 0.028 |

## PEAK DISCHARGES:

| RECURRANCE INTERVAL | INFLOW (CFS) | OUTFLOW (CFS) | WSEL |
|---|---|---|---|
| 10-YEAR | 514 | 162 | 5158.4 |
| 100-YEAR | 1346 | 227 | 5163.6 |

## DRAINAGE AREA:

| BASIN | DRAINAGE AREA (SQ. MI.) |
|---|---|
| 11 & 22 | 0.084 |
| 12 | 0.02 |
| POND 301 | 1.535 |

## NOTE:

1. SEE VISION LAND CONSULTANTS, INC. CONSTRUCTION PLANS FOR NORTH VILLAGES FILING NO. 5 FOR STORM SEWER A-F DESIGNS AND DITCH PROFILE ALONG U.P.R.R. EMBANKMENT

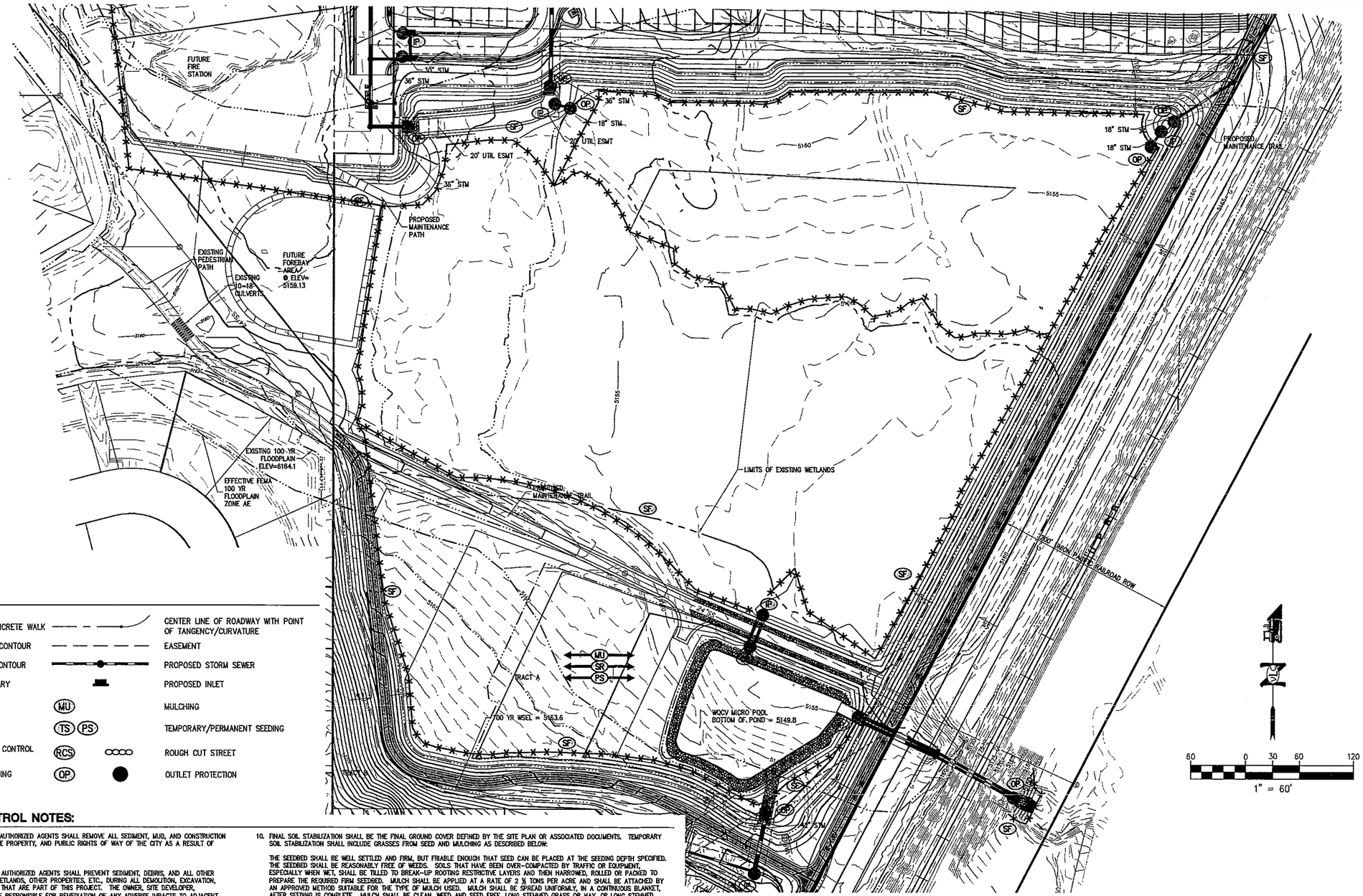
## BENCHMARK

BEING AN ADAMS COUNTY MONUMENT STAMPED "95.0208 1995 2S68W S13". 3-1/4" ALUMINUM SURVEY MARK DISK LOCATED NW OF THE INTERSECTION OF COLORADO BLVD. AND E. 100TH AVE. HAVING AN NAVD 1988 DATUM ELEVATION OF 5220.58 FEET.

## LEGEND

- 5400 — PROPOSED CONTOUR INDEX
- PROPOSED CONTOUR
- 5400 — EXISTING CONTOUR INDEX
- EXISTING CONTOUR
- PROPOSED 100 YR WSEL LIMITS

[Xrefs] [x:\2117.E1-Villages\P-Plans & Dwgs\Const\Pond\2117-02-POND.dwg] [Sep 09, 2005 - 8:41am]




## LEGEND

- 10' PROPOSED CONCRETE WALK
- 8055 — EXISTING GROUND CONTOUR
- 6260 — FINISHED GRADE CONTOUR
- PROPERTY BOUNDARY
- (SF) SILT FENCE
- (IP) INLET PROTECTION
- (VTC) VEHICLE TRACKING CONTROL
- (SR) SURFACE ROUGHENING
- CENTER LINE OF ROADWAY WITH POINT OF TANGENCY/CURVATURE
- EASEMENT
- PROPOSED STORM SEWER
- PROPOSED INLET
- (MU) MULCHING
- (TS) (PS) TEMPORARY/PERMANENT SEEDING
- (RCS) ROUGH CUT STREET
- (OP) OUTLET PROTECTION

## GRADING AND EROSION CONTROL NOTES:

1. THE OWNER, SITE DEVELOPER, CONTRACTOR AND/OR THEIR AUTHORIZED AGENTS SHALL REMOVE ALL SEDIMENT, MUD, AND CONSTRUCTION DEBRIS THAT MAY ACCUMULATE IN THE FLOW LINES, PRIVATE PROPERTY, AND PUBLIC RIGHTS OF WAY OF THE CITY AS A RESULT OF THIS CONSTRUCTION PROJECT. REMOVAL SHALL BE CONDUCTED WITHIN 48 HOURS.
2. THE OWNER, SITE DEVELOPER, CONTRACTOR, AND/OR THEIR AUTHORIZED AGENTS SHALL PREVENT SEDIMENT, DEBRIS, AND ALL OTHER POLLUTANTS FROM ENTERING THE ADJACENT WATERWAYS, WETLANDS, OTHER PROPERTIES, ETC., DURING ALL DEMOLITION, EXCAVATION, TRENCHING, BORING, OR OTHER CONSTRUCTION OPERATIONS THAT ARE PART OF THIS PROJECT. THE OWNER, SITE DEVELOPER, CONTRACTOR, AND/OR THEIR AUTHORIZED AGENTS SHALL BE RESPONSIBLE FOR REMEDIATION OF ANY ADVERSE IMPACTS TO ADJACENT WATERWAYS, WETLANDS, OTHER PROPERTIES, ETC., RESULTING FROM WORK DONE AS PART OF THIS PROJECT.
3. ROUGH-CUT STREETS SHALL BE SURFACE ROUGHENED AND MULCHED OR ROUGH-CUT STREET CONTROL IMPLEMENTED WITHIN SEVEN DAYS COMPLETION OF OVERLOT GRADING. IF PAVING IS TO OCCUR WITHIN 14 DAYS AFTER FINAL GRADING ROUGH CUT STREET CONTROL SHALL BE WAIVED.
4. THE OWNER, SITE DEVELOPER, CONTRACTOR, AND/OR THEIR AUTHORIZED AGENTS SHALL PREVENT LOSS OF CUT AND FILL MATERIAL BEING TRANSPORTED TO AND FROM THE SITE BY TAKING APPROPRIATE MEASURES. ALL MUD AND SEDIMENT TRACKED ONTO PUBLIC STREETS SHALL BE CLEANED.
5. APPROVED EROSION AND SEDIMENT CONTROL "BEST MANAGEMENT PRACTICES" SHALL BE MAINTAINED AND FULLY FUNCTIONAL FOR THE ENTIRE DURATION OF THIS PROJECT.
6. ALL DOWNSTREAM EROSION/SEDIMENT CONTROL FACILITIES MUST BE IN PLACE PRIOR TO COMMENCEMENT OF GRADING OPERATIONS OR ANY OTHER SITE DISTURBANCES.
7. VEHICLE TRACKING CONTROL (VTC) SHALL CONSIST OF ANGULAR ROCK MATERIAL (2-4 INCHES IN DIAMETER) AT A DEPTH OF NOT LESS THAN 6 INCHES AT ALL INGRESS AND EGRESS POINTS.
8. FUGITIVE DUST EMISSIONS RESULTING FROM GRADING ACTIVITIES AND/OR WIND SHALL BE CONTROLLED USING REASONABLY AVAILABLE CONTROL TECHNOLOGY AS DEFINED BY THE COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT.
9. FINAL OR TEMPORARY SOIL STABILIZATION MEASURES SHALL BE APPLIED: (1) TO DISTURBED AREAS AND STOCKPILES WITHIN 14 DAYS AFTER FINAL GRADE IS REACHED, (2) WITHIN 14 DAYS TO DISTURBED AREAS WHICH MAY NOT BE AT FINAL GRADE BUT WILL REMAIN DORMANT FOR LONGER THAN 30 DAYS, AND (3) WITHIN 14 DAYS OF STOCKPILE CONSTRUCTION ON ANY STOCKPILE WHICH WILL REMAIN DORMANT FOR LONGER THAN 30 DAYS.
10. FINAL SOIL STABILIZATION SHALL BE THE FINAL GROUND COVER DEFINED BY THE SITE PLAN OR ASSOCIATED DOCUMENTS. TEMPORARY SOIL STABILIZATION SHALL INCLUDE GRASSES FROM SEED AND MULCHING AS DESCRIBED BELOW:

    THE SEEDBED SHALL BE WELL SETTLED AND FIRM, BUT FRIABLE ENOUGH THAT SEED CAN BE PLACED AT THE SEEDING DEPTH SPECIFIED. THE SEEDBED SHALL BE REASONABLY FREE OF WEEDS. SOILS THAT HAVE BEEN OVER-COMPACTED BY TRAFFIC OR EQUIPMENT, ESPECIALLY WHEN WET, SHALL BE TILLED TO BREAK-UP ROOTING RESTRICTIVE LAYERS AND THEN HARROWED, ROLLED OR PACKED TO PREPARE THE REQUIRED FIRM SEEDBED. MULCH SHALL BE APPLIED AT A RATE OF 2 ½ TONS PER ACRE AND SHALL BE ATTACHED BY AN APPROVED METHOD SUITABLE FOR THE TYPE OF MULCH USED. MULCH SHALL BE SPREAD UNIFORMLY, IN A CONTINUOUS BLANKET, AFTER SEEDING IS COMPLETE. MULCH SHALL BE CLEAN, WEED AND SEED FREE, LONG STEMMED GRASS OR HAY, OR LONG STEMMED STRAW OF OATS, WHEAT OR RYE. AT LEAST 50% OF MULCH, BY WEIGHT, SHALL BE TEN INCHES OR LONGER. MULCH SHALL BE SPREAD BY HAND OR BLOWER-TYPE MULCH SPREADER. MULCHING SHALL BE STARTED ON THE WINDWARD SIDE OF RELATIVELY FLAT AREAS OR ON THE UPPER PART OF A STEEP SLOPE AND CONTINUED UNIFORMLY UNTIL THE AREA IS COVERED. THE MULCH SHALL NOT BE BUNCHED. IMMEDIATELY FOLLOWING SPREADING, THE MULCH SHALL BE ANCHORED TO THE SOIL BY A V-TYPE WHEEL LAND PACKER OR A SCALLOPED-DISK LAND PACKER DESIGNED TO FORCE MULCH INTO THE SOIL SURFACE A MINIMUM OF 3 INCHES. ALL SEEDED AREAS SHALL BE MULCHED AFTER SEEDING ON THE SAME DAY AS THE SEEDING.

    THE TYPE OF A SEED MIX USED WILL DEPEND UPON THE FOLLOWING FACTORS: TEMPORARY VS. PERMANENT REVEGETATION; TIME OF YEAR; SOIL TYPE AND SLOPE. AS A GENERAL RULE, TEMPORARY REVEGETATION WILL UTILIZE ANNUAL GRASSES WHILE PERMANENT REVEGETATION SHOULD UTILIZE PERENNIAL GRASSES. THE SEED MIX AND RATE OF APPLICATION SHALL BE AS FOLLOWS (HYDRO SEEDING SHALL BE USED IN LIMITED APPLICATION ON A SITE SPECIFIC BASIS):

    TO PROVIDE TEMPORARY EROSION CONTROL BETWEEN THE SEEDING DATES SPECIFIED, UTILIZE SURFACE ROUGHENING (ON THE CONTOUR OR PERPENDICULAR TO PREVAILING WINDS) AND APPLY A MULCH.

    THE SEEDING DATES FOR PERENNIAL SPECIES ARE GENERALLY IN THE SPRING FROM MARCH THROUGH EARLY MAY, AND IN THE FALL AFTER MID-OCTOBER UNTIL SNOW COVER PRECLUDES PLANTING. FALL SEEDING IS REFERRED TO AS "DORMANT SEEDING" BECAUSE THE SEEDS WILL LIE DORMANT THROUGH THE WINTER AND GERMINATE IN THE SPRING.

    PERENNIAL GRASSES CAN BE SEEDED USING A DRILL SEEDER IN AREAS PREVIOUSLY PLANTED WITH TEMPORARY GRASS COVER. IN THIS CASE, THE ANNUAL GRASS MAY NEED TO BE MOWED FOR THE DRILL TO OPERATE. BROADCAST SEEDING OR HYDRO SEEDING OF PERMANENT GRASSES SHOULD NOT BE DONE WITH A LIVE CROP OF ANNUAL GRASSES WITHOUT FIRST REWORKING AND PREPARING THE TOPSOIL.
11. THE DISCHARGE OF ANY WATER CONTAMINATED BY WASTE PRODUCTS FROM CUTTING OPERATIONS TO ADJACENT WATERWAYS, WETLANDS, OTHER PROPERTIES, ETC., IS PROHIBITED. THE OWNER, SITE DEVELOPER, CONTRACTOR, AND/OR THEIR AUTHORIZED AGENTS SHALL PROTECT ALL ADJACENT WATERWAYS, WETLANDS, OTHER PROPERTIES, ETC., ADJACENT TO ANY LOCATION WHERE PAVEMENT CUTTING OPERATIONS INVOLVING WHEEL CUTTING, SAW CUTTING OR ABRASIVE WATER JET CUTTING ARE TO TAKE PLACE. THE OWNER, SITE DEVELOPER, CONTRACTOR, AND/OR THEIR AUTHORIZED AGENTS SHALL REMOVE AND PROPERLY DISPOSE OF ALL WASTE PRODUCTS GENERATED BY SAID CUTTING OPERATIONS ON A DAILY BASIS.

## CALL BEFORE YOU DIG

CALL UTILITY NOTIFICATION CENTER OF COLORADO

**1-800-922-1987**

12600 W. COLFAX AVE., SUITE B-310
LAKEWOOD, COLORADO 80215

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

## BENCHMARK

BEING AN ADAMS COUNTY MONUMENT STAMPED "95.0208 1995 2S68W S13". 3-1/4" ALUMINUM SURVEY MARK DISK LOCATED NW OF THE INTERSECTION OF COLORADO BLVD. AND E. 100TH AVE. HAVING AN NAVD 1988 DATUM ELEVATION OF 5220.58 FEET.

"WORK SHALL BE CONSTRUCTED TO THE CITY OF THORNTON STANDARDS AND SPECIFICATIONS. THIS APPROVAL IS FOR CONFORMANCE TO THESE STANDARDS AND SPECIFICATIONS AND OTHER CITY REQUIREMENTS. THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER."

"I HEREBY CERTIFY THAT THIS EROSION CONTROL PLAN FOR VILLAGE NORTH FILING No. 5 WAS PREPARED BY ME (OR UNDER MY DIRECT SUPERVISION) IN ACCORDANCE WITH THE PROVISIONS OF THE CITY OF THORNTON STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA FOR THE OWNERS THEREOF"

DOUGLAS J. RICHTER, P.E. COLORADO NO. 36651

| DATE | NO. | REVISIONS | BY |
|---|---|---|---|
| 1/14/05 | 2 | REVISIONS - UDFCD 9/20/04 REVIEW | DJR |
| 4/19/05 | 3 | REVISIONS - UDFCD 2/23/05 REVIEW | CM |
| 6/03/05 | 4 | REVISIONS - UDFCD 6/29/05 REVIEW | CM |
| 9/08/05 | 5 | REVISIONS - UDFCD 9/31/05 REVIEW | CM |

DATE 07/02/04 DRAWN BY KJC
JOB NO. 2117.E1 CHECKED BY DJR

DO NOT SCALE, USE DIMENSION ONLY

CIVIL ENGINEERS
CONSTRUCTION MANAGERS
538 COMMONS DRIVE
GOLDEN, CO 80401
PHONE:(303)674-7355 FAX:(303)674-3263

VISION LAND CONSULTANTS, INC.

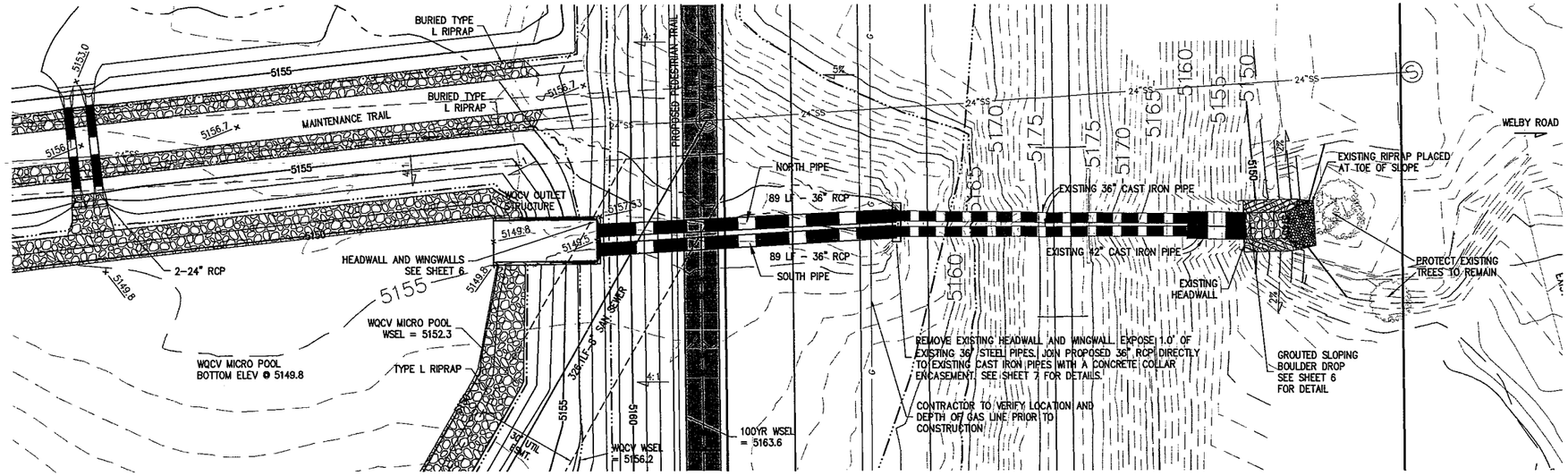
VILLAGES NORTH SUBDIVISION FILING No. 5

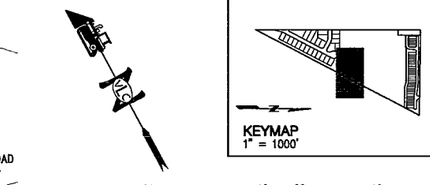
# GRADING AND EROSION CONTROL PLAN

THORNTON, COLORADO

SHEET 3 of 9

[anric] (G:\2117.01-Villages\3-Plans & Dwgs\Const\Pond\2117-03-POND.dwg) [Sep 09, 2005 - 9:51am]




## BENCHMARK

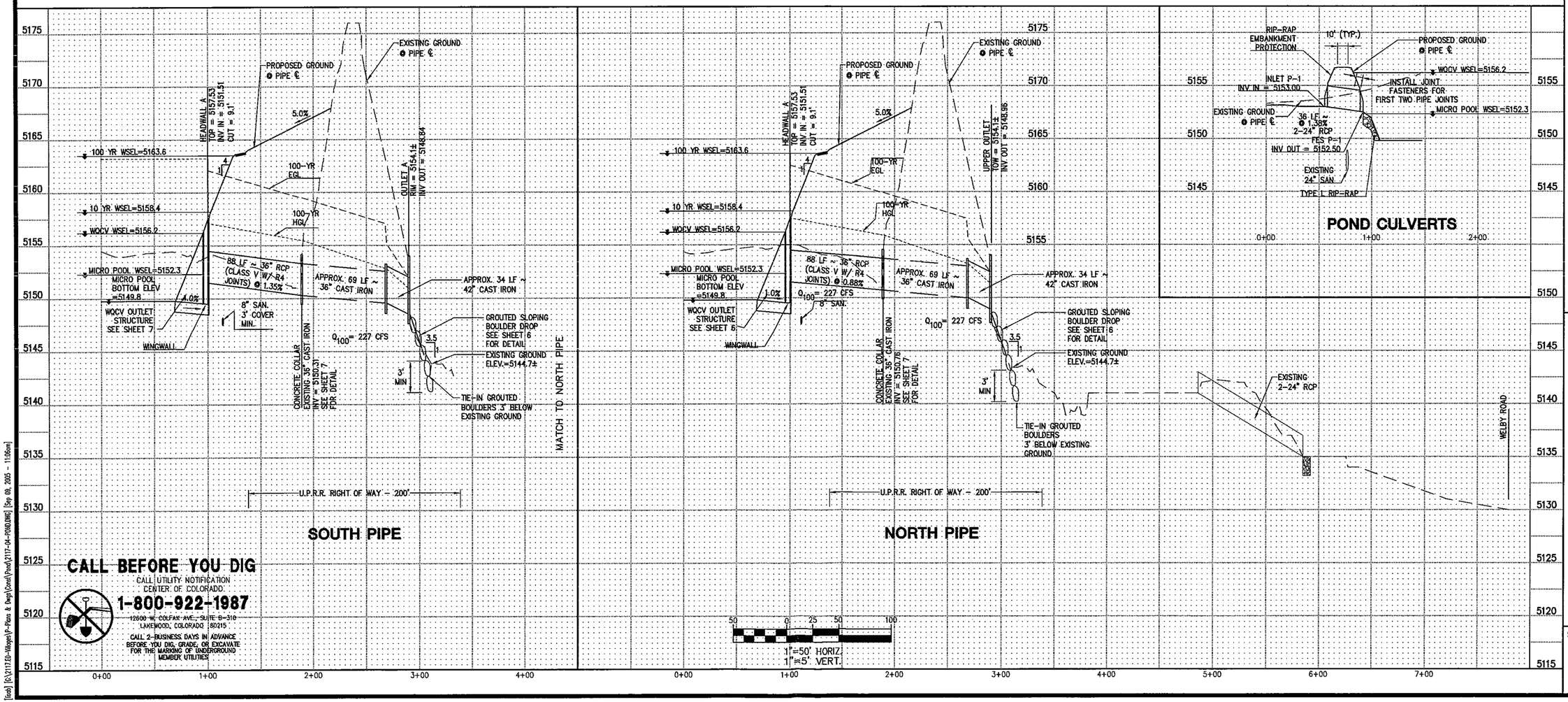
BEING AN ADAMS COUNTY MONUMENT STAMPED "95.0208 1995 2S68W S13". 3-1/4" ALUMINUM SURVEY MARK DISK LOCATED NW OF THE INTERSECTION OF COLORADO BLVD. AND E. 100TH AVE. HAVING AN NAVD 1988 DATUM ELEVATION OF 5220.58 FEET.

## LEGEND

- 5400 — PROPOSED CONTOUR INDEX
- PROPOSED CONTOUR
- PROPOSED EASEMENT
- 100 LF ~ 8" SAN — PROPOSED SANITARY SEWER LINE
- PROPOSED STORM SEWER LINE
- PROPOSED STORM SEWER INLET
- 5400 — EXISTING CONTOUR INDEX
- EXISTING CONTOUR
- × 5994.1 EXISTING SPOT ELEVATION
- EXISTING STORM SEWER LINE

| NO. | DATE | REVISONS | BY |
|---|---|---|---|
| 2 | 1/14/05 | REVISIONS – UDFCD 9/20/04 REVIEW | DJR |
| 3 | 4/19/05 | REVISIONS – UDFCD 2/23/05 REVIEW | CM |
| 4 | 8/03/05 | REVISIONS – UDFCD 6/29/05 REVIEW | CM |
| 5 | 9/08/05 | REVISIONS – UDFCD 8/31/05 REVIEW | CM |

DATE 07/02/04 DRAWN BY CMM
JOB NO. 2117.E1 CHECKED BY DJR
DO NOT SCALE, USE DIMENSION ONLY

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CONSTRUCTION MANAGERS
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PHONE:(303)674-7355 FAX:(303)674-3263
VISION LAND CONSULTANTS, INC.

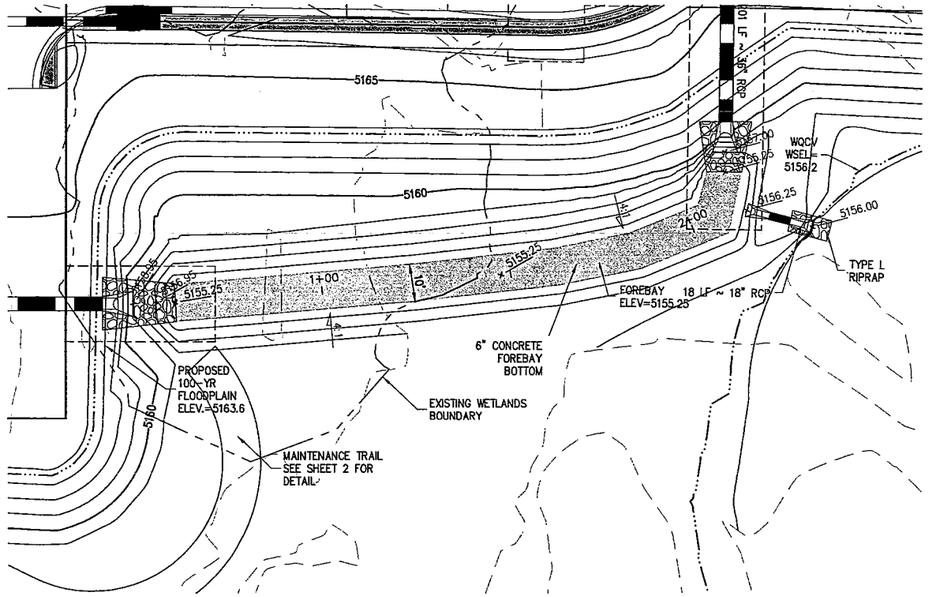

VILLAGES NORTH SUBDIVISION FILING No. 5

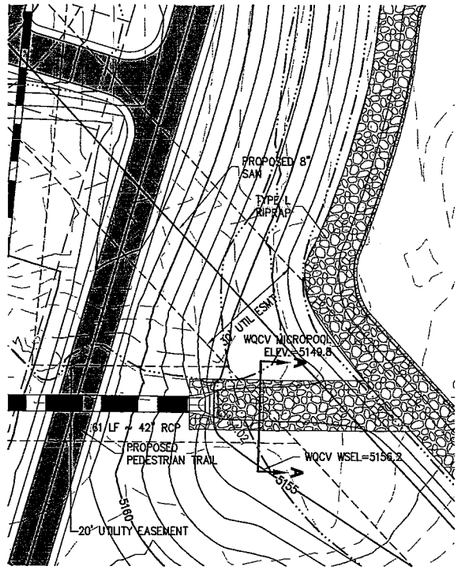
# OUTLET STRUCTURE PLAN AND PROFILE

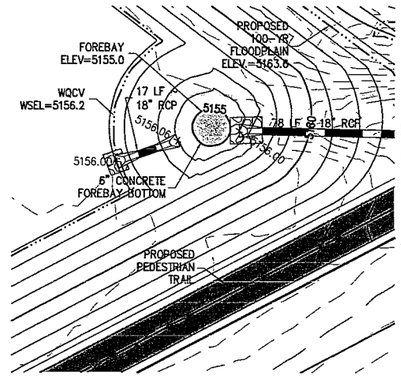
THORNTON, COLORADO

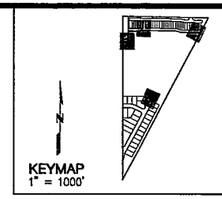
SHEET 4 of 9

[Eosd] [C:\2117.ED-Wagon\P-Plans & Dwgs\Const\Pond\2117-04-POND.DWG] [Sep 09, 2005 - 11:06am]




1"=20' HORIZ.
1"=2' VERT.

## BENCHMARK

BEING AN ADAMS COUNTY MONUMENT STAMPED "95.0208 1995 2S68W S13". 3-1/4" ALUMINUM SURVEY MARK DISK LOCATED NW OF THE INTERSECTION OF COLORADO BLVD. AND E. 100TH AVE. HAVING AN NAVD 1988 DATUM ELEVATION OF 5220.58 FEET.

## LEGEND

| | |
|---|---|
| 5400 | PROPOSED CONTOUR INDEX |
| | PROPOSED CONTOUR |
| | PROPOSED EASEMENT |
| 100 LF ~ 8" SAN | PROPOSED SANITARY SEWER LINE |
| | PROPOSED STORM SEWER LINE |
| | PROPOSED STORM SEWER INLET |
| 5400 | EXISTING CONTOUR INDEX |
| | EXISTING CONTOUR |
| × 5994.1 | EXISTING SPOT ELEVATION |
| | EXISTING STORM SEWER LINE |

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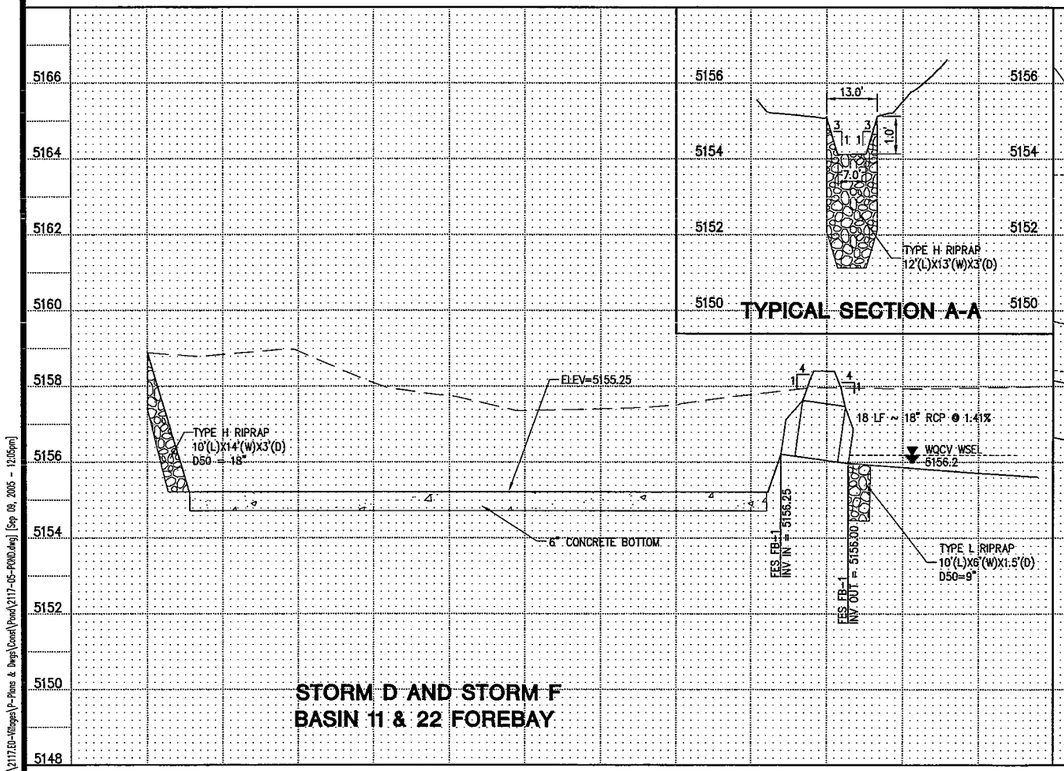
## STORM D AND STORM F BASIN 11 & 22 FOREBAY

## STORM A AND WQCV MICRO POOL

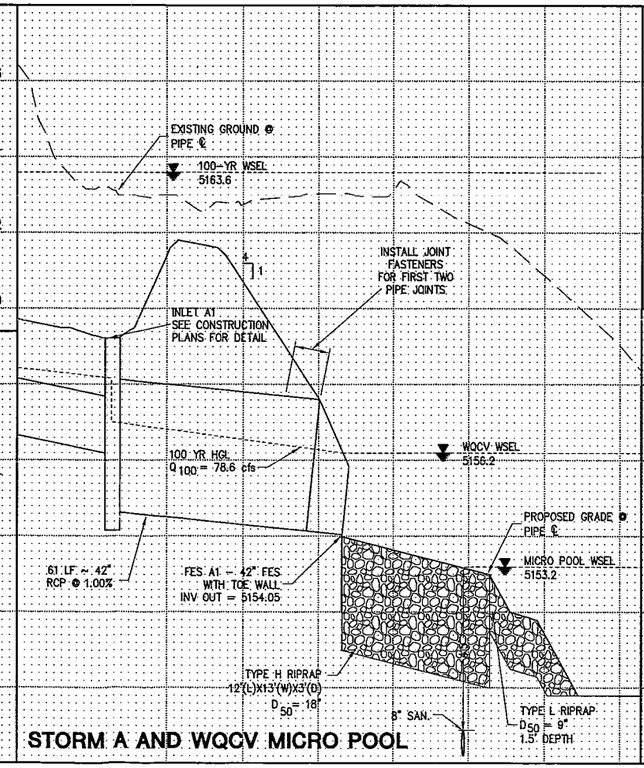
## STORM E AND BASIN 12 FOREBAY

**DRAINAGE AREA:**

| BASIN | DRAINAGE AREA (SQ. MI.) | VOLUME (ACRE FT) |
|---|---|---|
| 11&22 | 0.082 | 0.098 |
| 12 | 0.018 | 0.028 |
| POND 301 | 1.535 | 140.36 |



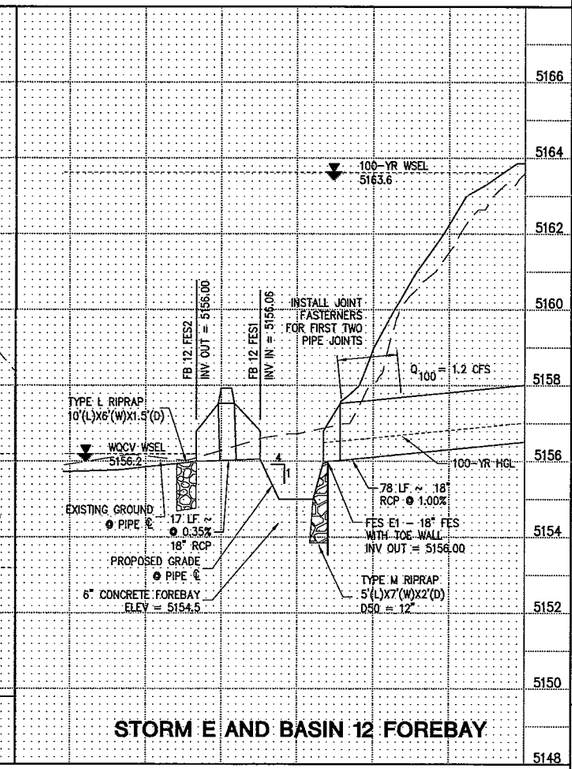

STORM D AND STORM F
BASIN 11 & 22 FOREBAY




TYPICAL SECTION A-A




STORM A AND WQCV MICRO POOL




STORM E AND BASIN 12 FOREBAY

| NO. | DATE | REVISIONS | BY |
|---|---|---|---|
| 1 | 1/14/05 | REVISIONS – UDFCD 9/20/04 REVIEW | DJR |
| 2 | 4/19/05 | REVISIONS – UDFCD 2/23/05 REVIEW | CM |
| 3 | 8/03/05 | REVISIONS – UDFCD 6/29/05 REVIEW | CM |
| 4 | 9/08/05 | REVISIONS – UDFCD 8/31/05 REVIEW | CM |
| 5 | | | |

DATE 07/02/04 DRAWN BY CMM
JOB NO. 2117.E1 CHECKED BY DJR
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CONSTRUCTION MANAGERS
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VISION LAND CONSULTANTS, INC.

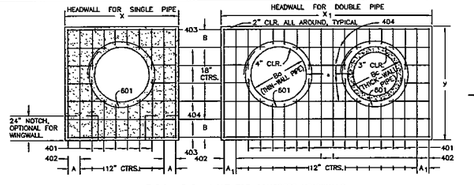

VILLAGES NORTH SUBDIVISION FILING No. 5

# FOREBAY PLAN AND PROFILE

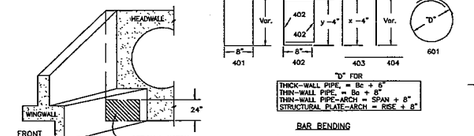
THORNTON, COLORADO

SHEET 5 of 9

[form] [G:\2117.E1-Villages\7-Plans & Dwgs\Const\Pond\2117-05-P080.dwg] [Sep 09, 2005 - 12:05pm]



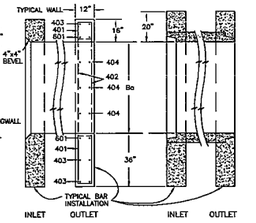

TYPICAL BAR LAYOUT FOR CONCRETE HEADWALLS

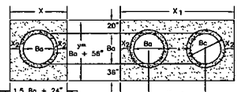






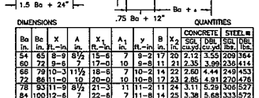
BAR BENDING



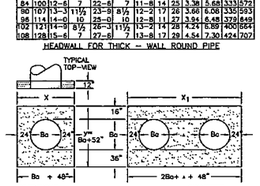

| DIMENSIONS | | | | | | | | QUANTITIES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CONCRETE | | STEEL ■ | |
| Bo in. | Bc in. | X ft.-in. | A in. | $X_1$ ft.-in. | $A_1$ in. | y ft.-in. | B in. | $X_2$ | SQ. CU.YDS. | DIR. LOAD | SQ. LBS. | DIR. LOAD |
| 54 | 63 | 8-9 | 8½ | 15-6 | 7 | 9-2 | 17 | 20 | 2.12 | 3.55 | 209 | 364 |
| 60 | 72 | 8-5 | 7 | 17-0 | 10 | 8-8 | 11 | 21 | 2.35 | 3.99 | 236 | 414 |
| 66 | 79 | 10-3 | 11½ | 18-6 | 7 | 10-2 | 14 | 22 | 2.61 | 4.44 | 249 | 453 |
| 72 | 86 | 11-0 | 10 | 20-0 | 10 | 10-8 | 17 | 23 | 2.86 | 4.91 | 270 | 478 |
| 78 | 93 | 11-9 | 8½ | 21-3 | 11 | 11-2 | 11 | 24 | 3.11 | 5.39 | 308 | 527 |
| 84 | 100 | 12-5 | 7 | 22-6 | 7 | 11-8 | 14 | 25 | 3.38 | 5.68 | 333 | 572 |
| 90 | 107 | 13-3 | 11½ | 23-3 | 8½ | 11-2 | 17 | 26 | 3.61 | 6.06 | 330 | 593 |
| 96 | 114 | 14-0 | 10 | 25-0 | 10 | 12-8 | 11 | 27 | 3.94 | 6.48 | 379 | 649 |
| 102 | 121 | 14-9 | 8½ | 26-3 | 11½ | 13-2 | 14 | 28 | 4.24 | 6.89 | 405 | 664 |
| 108 | 128 | 15-6 | 7 | 27-6 | 7 | 13-8 | 17 | 29 | 4.54 | 7.30 | 424 | 707 |

HEADWALL FOR THICK – WALL ROUND PIPE



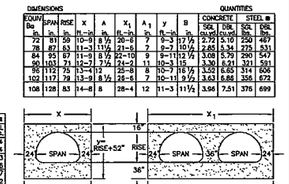

| DIMENSIONS | | | | | | | | QUANTITIES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CONCRETE | | STEEL ■ | |
| EQUIV. Bo in. | SPAN ft.-in. | RISE ft.-in. | X ft.-in. | A in. | $X_1$ ft.-in. | $A_1$ in. | y ft.-in. | B in. | SQ. CU.YDS. | DIR. LOAD | SQ. LBS. | DIR. LOAD |
| 66 | 6-1 | 4-7 | 10-1 | 10½ | 19-2 | 11 | 8-11 | 13½ | 2.52 | 4.70 | 232 | 424 |
| 72 | 7-0 | 5-1 | 11-0 | 10 | 21-0 | 10 | 8-5 | 12½ | 2.80 | 5.20 | 282 | 509 |
| 84 | 7-11 | 5-7 | 11-11 | 9½ | 22-10 | 9 | 9-11 | 12½ | 3.08 | 5.70 | 291 | 540 |
| 93 | 8-10 | 6-1 | 12-10 | 9 | 24-8 | 8 | 10-5 | 15½ | 3.36 | 6.33 | 309 | 622 |
| 102 | 9-9 | 6-7 | 13-9 | 8½ | 26-6 | 7 | 10-11 | 13½ | 3.63 | 6.86 | 379 | 673 |
| 111 | 10-11 | 7-1 | 14-11 | 9½ | 28-10 | 9 | 11-5 | 12½ | 4.05 | 7.67 | 377 | 711 |
| 120 | 11-10 | 7-10 | 16-0 | 9 | 30-8 | 8 | 11-11 | 15½ | 4.36 | 8.28 | 365 | 731 |
| 132 | 12-10 | 8-4 | 16-10 | 9 | 32-6 | 8 | 12-8 | 11 | 4.75 | 9.03 | 441 | 839 |
| 144 | 13-11 | 8-10 | 17-9 | 10½ | 34-5 | 11 | 13-2 | 13½ | 5.13 | 9.84 | 448 | 931 |
| 150 | 15-4 | 9-3 | 19-4 | 12 | 37-8 | 8 | 13-7 | 16½ | 5.69 | 10.88 | 490 | 953 |
| 159 | 15-10 | 9-10 | 19-10 | 9 | 38-8 | 8 | 14-2 | 11 | 5.89 | 11.25 | 534 | 1019 |

HEADWALL FOR THIN – WALL PIPE ARCH



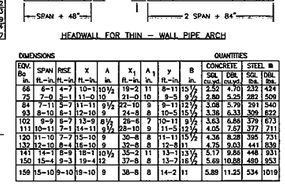

| DIMENSIONS | | | | | | | | QUANTITIES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CONCRETE | | STEEL ■ | |
| Bo in. | X ft.-in. | A in. | $X_1$ ft.-in. | $A_1$ in. | y ft.-in. | B in. | $X_2$ | SQ. CU.YDS. | DIR. LOAD | SQ. LBS. | DIR. LOAD |
| 54 | 8-9 | 7 | 15-3 | 11½ | 9-10 | 15 | 20 | 2.10 | 3.70 | 231 | 358 |
| 60 | 9-0 | 10 | 16-6 | 7 | 9-4 | 18 | 23 | 2.35 | 4.25 | 217 | 398 |
| 66 | 8-8 | 7 | 17-9 | 8½ | 9-10 | 12 | 24 | 2.58 | 4.70 | 252 | 454 |
| 72 | 10-0 | 10 | 18-0 | 10 | 10-4 | 15 | 25 | 2.78 | 5.17 | 255 | 472 |
| 78 | 10-6 | 7 | 20-0 | 10 | 10-10 | 18 | 26 | 2.98 | 5.56 | 276 | 499 |
| 84 | 11-0 | 10 | 21-0 | 10 | 11-4 | 12 | 27 | 3.19 | 5.95 | 297 | 553 |
| 90 | 11-6 | 7 | 22-0 | 10 | 11-10 | 15 | 28 | 3.40 | 6.36 | 317 | 571 |
| 96 | 12-0 | 10 | 23-0 | 10 | 12-4 | 18 | 29 | 3.62 | 6.75 | 291 | 597 |
| 102 | 12-6 | 7 | 24-0 | 10 | 12-10 | 12 | 30 | 3.84 | 7.21 | 364 | 663 |
| 108 | 13-0 | 10 | 25-0 | 10 | 13-4 | 15 | 31 | 4.06 | 7.63 | 362 | 678 |

HEADWALL FOR THIN – WALL ROUND PIPE




| DIMENSIONS | | | | | | | | QUANTITIES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | CONCRETE | | STEEL ■ | |
| EQUIV. Bo in. | SPAN ft.-in. | RISE ft.-in. | X ft.-in. | A in. | $X_1$ ft.-in. | $A_1$ in. | y ft.-in. | B in. | SQ. CU.YDS. | DIR. LOAD | SQ. LBS. | DIR. LOAD |
| 66 | 6-1 | 4-7 | 10-1 | 10½ | 19-2 | 11 | 8-11 | 13½ | 2.52 | 4.70 | 232 | 424 |
| 72 | 7-0 | 5-1 | 11-0 | 10 | 21-0 | 10 | 8-5 | 12½ | 2.80 | 5.20 | 282 | 509 |
| 84 | 7-11 | 5-7 | 11-11 | 9½ | 22-10 | 9 | 9-11 | 12½ | 3.08 | 5.70 | 291 | 540 |
| 93 | 8-10 | 6-1 | 12-10 | 9 | 24-8 | 8 | 10-5 | 15½ | 3.36 | 6.33 | 309 | 622 |
| 102 | 9-9 | 6-7 | 13-9 | 8½ | 26-6 | 7 | 10-11 | 13½ | 3.63 | 6.86 | 379 | 673 |
| 111 | 10-11 | 7-1 | 14-11 | 9½ | 28-10 | 9 | 11-5 | 12½ | 4.05 | 7.67 | 377 | 711 |
| 120 | 11-10 | 7-10 | 16-0 | 9 | 30-8 | 8 | 11-11 | 15½ | 4.36 | 8.28 | 365 | 731 |
| 132 | 12-10 | 8-4 | 16-10 | 9 | 32-6 | 8 | 12-8 | 11 | 4.75 | 9.03 | 441 | 839 |
| 144 | 13-11 | 8-10 | 17-9 | 10½ | 34-5 | 11 | 13-2 | 13½ | 5.13 | 9.84 | 448 | 931 |
| 150 | 15-4 | 9-3 | 19-4 | 12 | 37-8 | 8 | 13-7 | 16½ | 5.69 | 10.88 | 490 | 953 |
| 159 | 15-10 | 9-10 | 19-10 | 9 | 38-8 | 8 | 14-2 | 11 | 5.89 | 11.25 | 534 | 1019 |

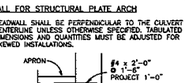
HEADWALL FOR STRUCTURAL PLATE ARCH




| SKEW ANGLE (DEGREES) | FACTOR (COSEC²) |
|---|---|
| 90 | 1.000 |
| 80 | 1.015 |
| 70 | 1.064 |
| 60 | 1.153 |
| 50 | 1.305 |
| 45 | 1.414 |
| 40 | 1.556 |
| 35 | 1.743 |
| 30 | 2.000 |

SKEW FACTOR TABLE

HEADWALL SHALL BE PERPENDICULAR TO THE CULVERT CENTERLINE UNLESS OTHERWISE SPECIFIED. TABULATED DIMENSIONS AND QUANTITIES MUST BE ADJUSTED FOR SKEWED INSTALLATIONS.




WHEN APRON IS REQUIRED

## GENERAL NOTES

1. CONCRETE SHALL BE CLASS B.
2. HEADWALL SHALL BE PERPENDICULAR TO THE CULVERT ℄ UNLESS OTHERWISE SHOWN ON THE PLANS. TABULATED DIMENSIONS AND QUANTITIES MUST BE ADJUSTED FOR SKEWED INSTALLATIONS.
3. FOR WINGWALL DETAILS, SEE STANDARD M-601-20.
4. VOLUME OCCUPIED BY PIPE HAS BEEN DEDUCTED FROM STEEL AND CONCRETE QUANTITIES.
5. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED ¾ ".
6. ALL BARS SHALL HAVE A 2" MINIMUM CLEARANCE.

* WHEN TWO OR MORE CONDUITS ARE LAID SIDE BY SIDE, THEY SHALL BE PLACED SO THAT THE ADJACENT PIPES WILL BE ½ INSIDE DIAMETER OR ½ INSIDE SPAN OR 3 FEET APART (INCLUDING WALL THICKNESS) WHICHEVER IS LESS.

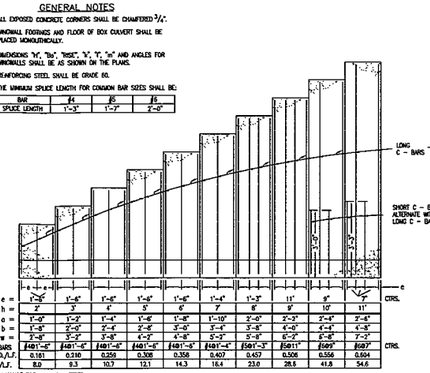
■ ADD 0.89 x (X OR $X_1$) (LB.) WHEN APRON IS REQUIRED.

| Colorado Department of Transportation | Computer File Information | Standard Plan Revised | HEADWALLS FOR PIPE CULVERTS | STANDARD PLAN NO. M-601-10 |
|---|---|---|---|---|
| DOT 4201 East Arkansas Avenue, Denver, Colorado 80222, Phone: (303) 757-9083 FAX: (303) 757-9820 | Path: www.dot.state.co.us/DevelopProjects/DesignSupport/MStandards/ | Date: | Issued By: Project Development Branch October 1, 2000 | Sheet No. 1 of 1 |
| Project Development Branch SD | Drawing File Name: 6010100101.dwg | Comments: | | |
| | Acad Version: R14 Scale: NA Units: English | | | |

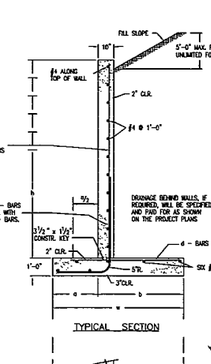
## GENERAL NOTES

1. ALL EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED ¾".
2. WINGWALL FOOTINGS AND FLOOR OF BOX CULVERT SHALL BE PLACED MONOLITHICALLY.
3. DIMENSIONS "H", "Bo", "RISE", "X", "Y", "B" AND ANGLES FOR WINGWALLS SHALL BE AS SHOWN ON THE PLANS.
4. REINFORCING STEEL SHALL BE GRADE 60.
5. THE MINIMUM SPLICE LENGTH FOR COMMON BAR SIZES SHALL BE:

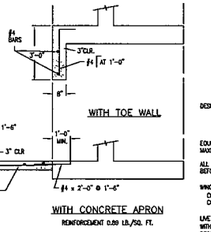
| BAR | #4 | #5 | #6 |
|---|---|---|---|
| SPLICE LENGTH | 1'-3" | 1'-7" | 2'-0" |

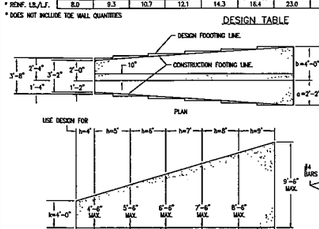


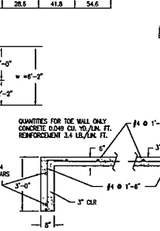

DESIGN TABLE

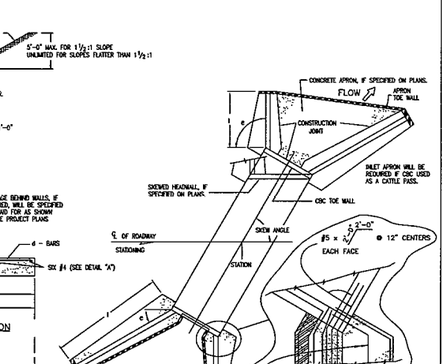



TYPICAL SECTION




TYPICAL CULVERT LAYOUT

DESIGN DATA:
UNIT STRESSES: $f_s$ = 24,000 PSI
$f_c$ = 1,200 PSI
n = 9

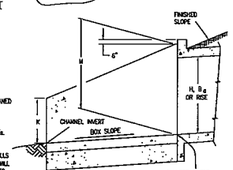
EQUIVALENT FLUID PRESSURE = 36 LBS./CU. FT.
MAXIMUM TOE PRESSURE = 1 TON/SQ. FT.

ALL CONSTRUCTION JOINTS SHALL BE THOROUGHLY CLEANED BEFORE CONCRETE IS POURED.

WINGWALL AND APRON CONCRETE SHALL BE:
CONCRETE CLASS B, OR D (BOX CULVERT) FOR CBC's.
CONCRETE CLASS B, OR D (WALL) FOR PIPES.

LIVE LOAD SURCHARGE HAS NOT BEEN CONSIDERED. WALLS WITHIN ½ OF THE EDGE OF THE ROADWAY SHOULDER WILL REQUIRE A SPECIAL DESIGN IN ACCORDANCE WITH AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES.

APRON REQUIRED AS INLET OF THE CBC, IF USED FOR CATTLE PASSAGE.




BOX ELEVATION

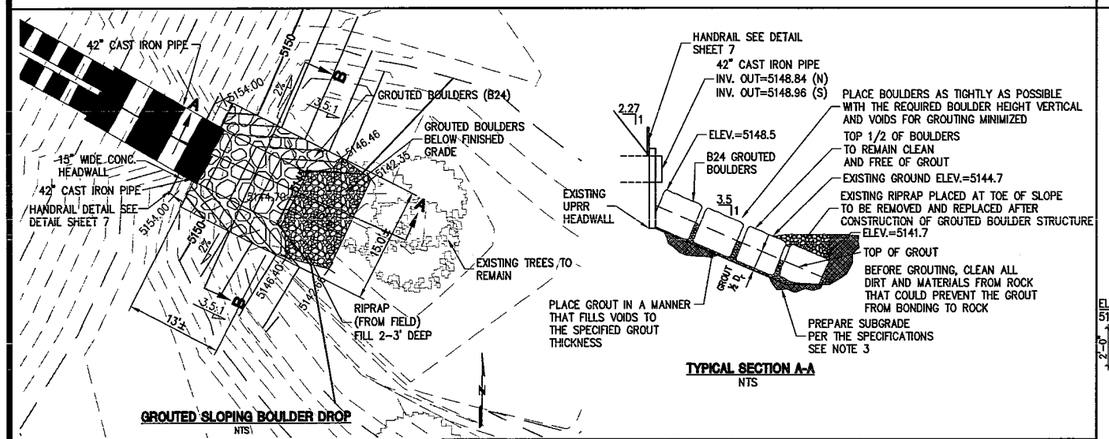
H = H, Bo OR RISE + (1'-0")
UNLESS OTHERWISE SHOWN ON PLANS.

| Colorado Department of Transportation | Computer File Information | Standard Plan Revised | WINGWALLS FOR PIPE OR BOX CULVERTS | STANDARD PLAN NO. M-601-20 |
|---|---|---|---|---|
| DOT 4201 East Arkansas Avenue, Denver, Colorado 80222, Phone: (303) 757-9083 FAX: (303) 757-9820 | Path: www.dot.state.co.us/DevelopProjects/DesignSupport/MStandards/ | Date: | Issued By: Project Development Branch October 1, 2000 | Sheet No. 1 of 1 |
| Project Development Branch SD | Drawing File Name: 6010200101.dwg | Comments: | | |
| | Acad Version: R14 Scale: NA Units: English | | | |

| DATE | NO. | REVISIONS | BY |
|---|---|---|---|
| 1/14/05 | 2 | REVISIONS – UDFCD 9/20/04 REVIEW | DJR |
| 4/19/05 | 3 | REVISIONS – UDFCD 2/23/05 REVIEW | CM |
| 8/03/05 | 4 | REVISIONS – UDFCD 6/29/05 REVIEW | CM |
| 9/08/05 | 5 | REVISIONS – UDFCD 8/31/05 REVIEW | CM |

DATE 07/02/04 DRAWN BY CMM
JOB NO. 2117.E1 CHECKED BY DJR
DO NOT SCALE, USE DIMENSION ONLY

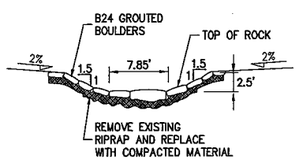

CIVIL ENGINEERS
CONSTRUCTION MANAGERS
538 COMMONS DRIVE
GOLDEN, CO 80401
PHONE:(303)674-7355 FAX:(303)674-3263

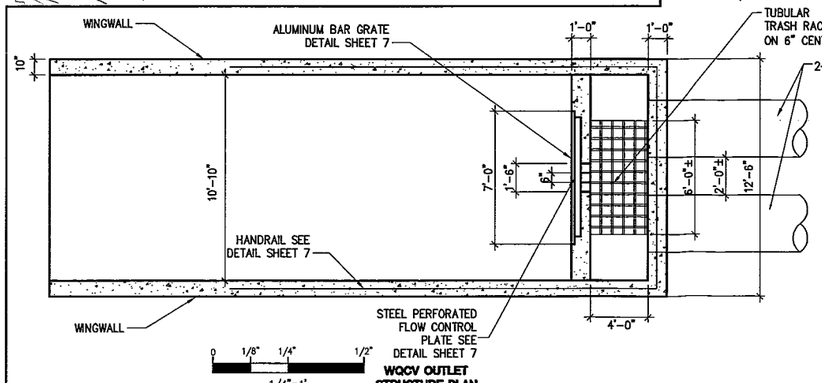

GROUTED SLOPING BOULDER DROP
NTS



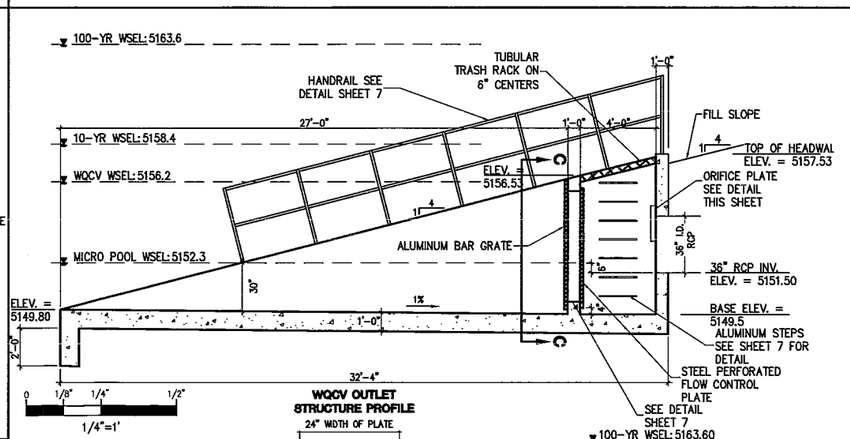

TYPICAL SECTION A-A
NTS



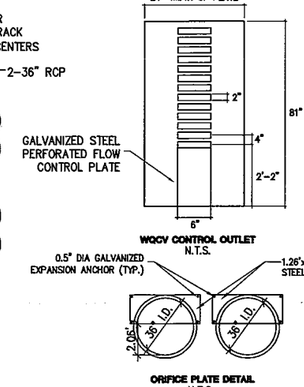

TYPICAL SECTION B-B
NTS

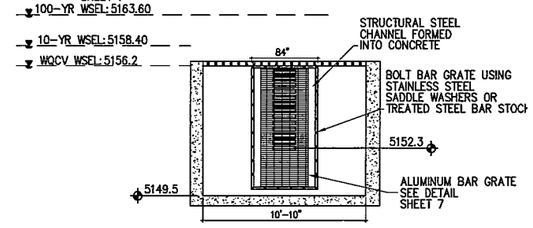



WQCV OUTLET STRUCTURE PLAN




WQCV OUTLET STRUCTURE PROFILE




SECTION C-C
N.T.S.

## NOTE TO CONTRACTOR:

1. THE ABOVE DETAILS ARE FOR ILLUSTRATIVE PUPOSES ONLY. ALL HEADWALLS, WINGWALLS, TOE WALLS AND MANHOLES SHALL BE CONSTRUCTED ACCORDING TO THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) M & S STANDARDS.
2. WQCV OUTLET SHALL BE CONSTRUCTED ACCORDING TO URBAN DRAINAGE & FLOOD CONTROL DISTRICT (UDFCD) DRAINAGE CRITERIA MANUAL (VOL. 3) STANDARDS.
3. GROUTED SLOPING BOULDER DROP SHALL BE CONSTRUCTED ACCORDING TO URBAN DRAINAGE & FLOOD CONTROL DISTRICT DRAINAGE CRITERIA MANUAL (VOL. 1 & 2) STANDARDS.

VISION LAND CONSULTANTS, INC.

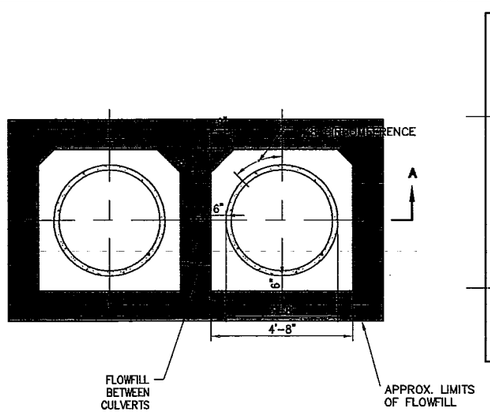
VILLAGES NORTH SUBDIVISION FILING No. 5

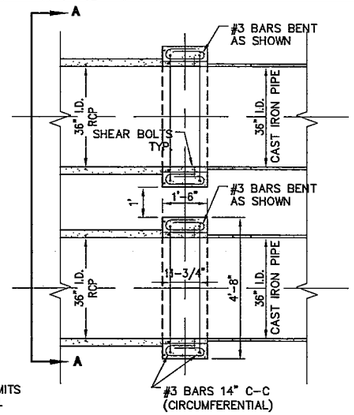
# DETAILS 1 OF 2

THORNTON, COLORADO

SHEET 6 of 9

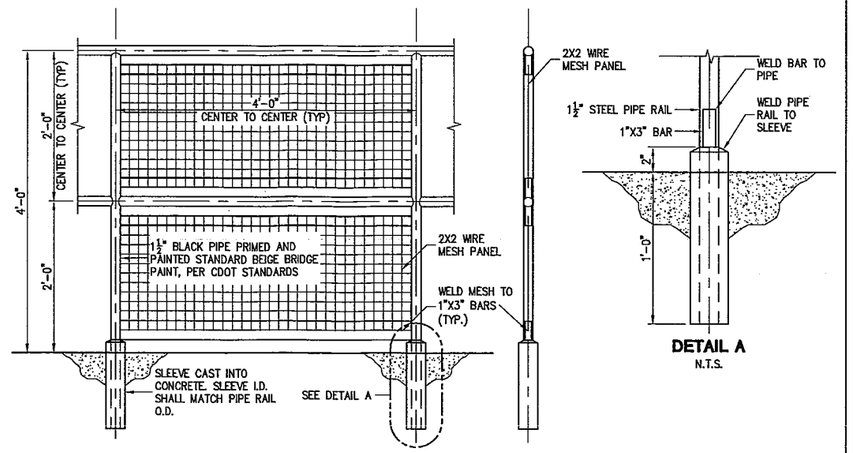
[xrefs] [G:\2117.E0-Hillgeon\P-Plans & Dwgs\Const\Pond\2117-06-POND.dwg] [Sep 09, 2005 - 10:53am]




## REINFORCED CONCRETE COLLAR EACH 36" CULVERT SECTION A-A

NOTE:
1. PROVIDE SHEAR BOLTS WITHIN CONCRETE COLLAR TO IMBED INTO CAST IRON PIPE TO PREVENT SLIPPAGE.

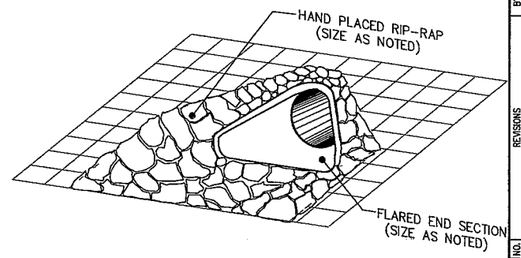



## STEEL HAND RAIL DETAIL

N.T.S.

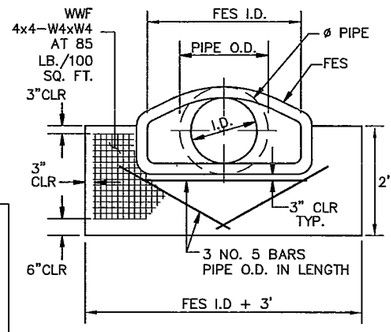
## DETAIL A

N.T.S.




## TYPICAL STORM SEWER OUTLET

ISOMETRIC VIEW N.T.S.




## CONCRETE CUTOFF WALL DETAIL

NOT TO SCALE

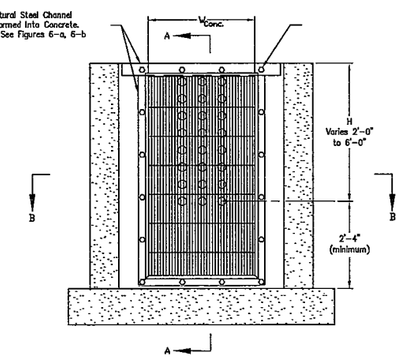
| BY | DJR | CM | CM | CM | CM |
|---|---|---|---|---|---|
| REVISIONS | | REVISIONS – UDFCD 9/20/04 REVIEW | REVISIONS – UDFCD 2/23/05 REVIEW | REVISIONS – UDFCD 6/29/05 REVIEW | REVISIONS – UDFCD 8/31/05 REVIEW | | |
| NO. | | 2 | 3 | 4 | 5 | | |
| DATE | | 1/14/05 | 4/19/05 | 8/03/05 | 9/08/05 | | |

DRAWN BY CMM
CHECKED BY DJR
DATE 07/02/04
JOB NO. 2117.E1
DO NOT SCALE, USE DIMENSION ONLY


CIVIL ENGINEERS
CONSTRUCTION MANAGERS
538 COMMONS DRIVE
GOLDEN, CO 80401
PHONE:(303)674-7355 FAX:(303)674-3263


VISION LAND CONSULTANTS, INC.

Note: Vertical WQCV Trash Racks are shown in Figures 6, 6–a, and 6–b for suggested standardized outlet design. Adverse–Slope Trash Rack design may be used for non–standardized designs, but must meet minimum design criteria.




## Elevation

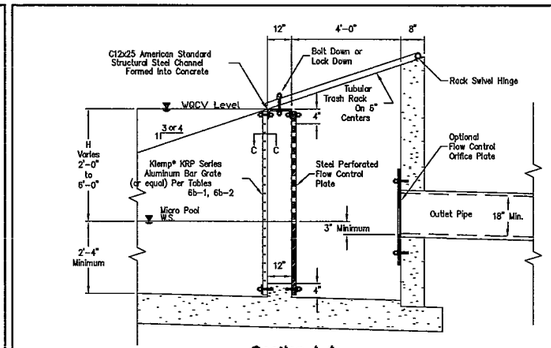
WQCV Trash Racks:

1. Well–screen trash racks shall be stainless steel and shall be attached by intermittent welds along the edge of the mounting frame.
2. Bar grate trash racks shall be aluminum and shall be bolted using stainless steel hardware.
3. Trash Rack widths are for specified trash rack material. Finer well–screen or mesh size than specified is acceptable, however, trash rack dimensions need to be adjusted for materials having a different open area/grass area ratio (R value)
4. Structural design of trash rack shall be based on full hydrostatic head with zero head downstream of the rack.

Overflow Trash Racks:

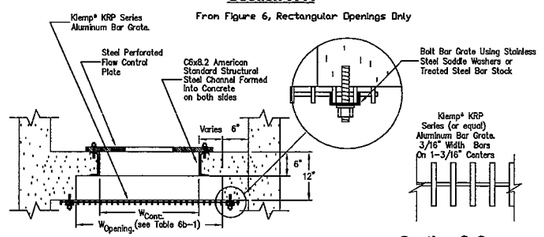
1. All trash racks shall be mounted using stainless steel hardware and provided with hinged and lockable or boltable access panels.
2. Trash racks shall be stainless steel, aluminum, or steel. Steel trash racks shall be hot dip galvanized and may be hot powder painted after galvanizing.
3. Trash Racks shall be designed such that the diagonal dimension of each opening is smaller than the diameter of the outlet pipe.
4. Structural design of trash rack shall be based on full hydrostatic head with zero head downstream of the rack.

| | |
|---|---|
| Urban Drainage and Flood Control District<br>Drainage Criteria Manual (V.3)<br>File: Details.dwg | Figure 6<br>Suggested WQCV Outlet Standardized Trash Rack Design |




## Section A-A

From Figure 6, Rectangular Openings Only




## Section B-B - Plan View

From Figure 6, Rectangular Openings Only




## Section C-C

From Figure 6, Rectangular Openings Only

Limits for this Standardized Design:
1. All outlet plate openings are rectangular.
2. Height of all rectangular openings = 2 inches.
3. For trash rack opening width ($W_{Opening}$), see Table 6b–1
4. Concrete opening for outlet plate ($W_{Conc}$) = W + 12 inches

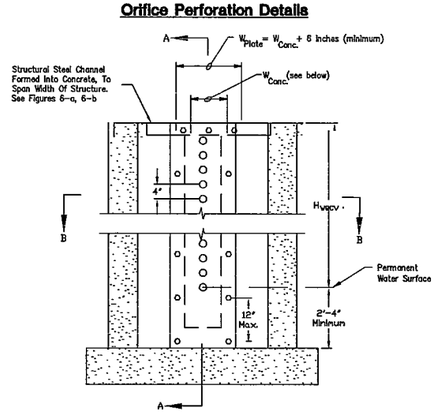
R Value = (net open area)/(gross rack area)

= 0.71 for cross rods on 2" centers
= 0.77 for cross rods on 4" centers

*Klemp Corporation, Orem, Utah, USA

| | |
|---|---|
| Urban Drainage and Flood Control District<br>Drainage Criteria Manual (V.3)<br>File: Details.dwg | Figure 6–b<br>Suggested Standardized Trash Rack and Outlet Design For WQCV Outlets With Rectangular Openings |

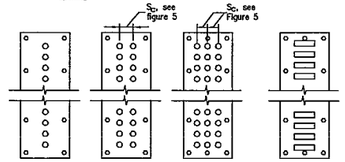
## Orifice Perforation Details




Circular Openings: W Obtained From Table 6a–1

Rectangular Openings: $W_{Conc.}$ = (Width of Rectangular Perforation W) + 12"

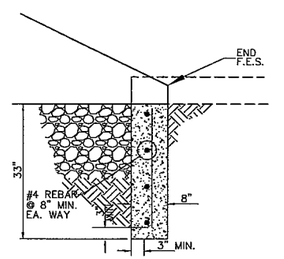
Rectangular Openings: $W_{Opening}$ (see Figure 6–b) Obtained From Table 6b–1




## Example Perforation Patterns

Note: The goal in designing the outlet is to minimize the number of columns of perforations that will drain the WQCV in the desired time. Do not, however, increase the diameter of circular perforations or the height of the rectangular perforations beyond 2 inches. Use the allowed perforation shapes and configurations shown above along with Figure 5 to determine the pattern that provides an area per row closest to that required without exceeding it.

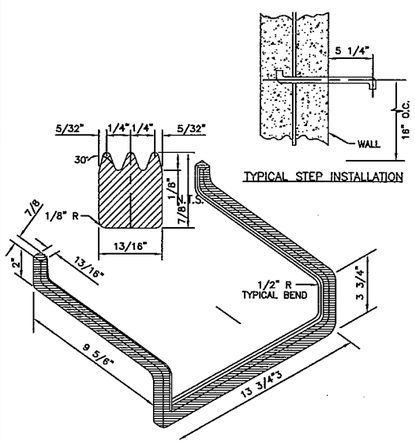
| | |
|---|---|
| Urban Drainage and Flood Control District<br>Drainage Criteria Manual (V.3)<br>File: Details.dwg | Figure 4<br>Orifice Details for Draining WQCV |




## SIDE VIEW

NOT TO SCALE

## CONCRETE F.E.S. DETAILS




## TYPICAL MANHOLE STEP INSTALLATION

EXTRUDED ALUMINUM STEP

## UDFCD DRAINAGE CRITERIA VOL 3 DETAILS

N.T.S.

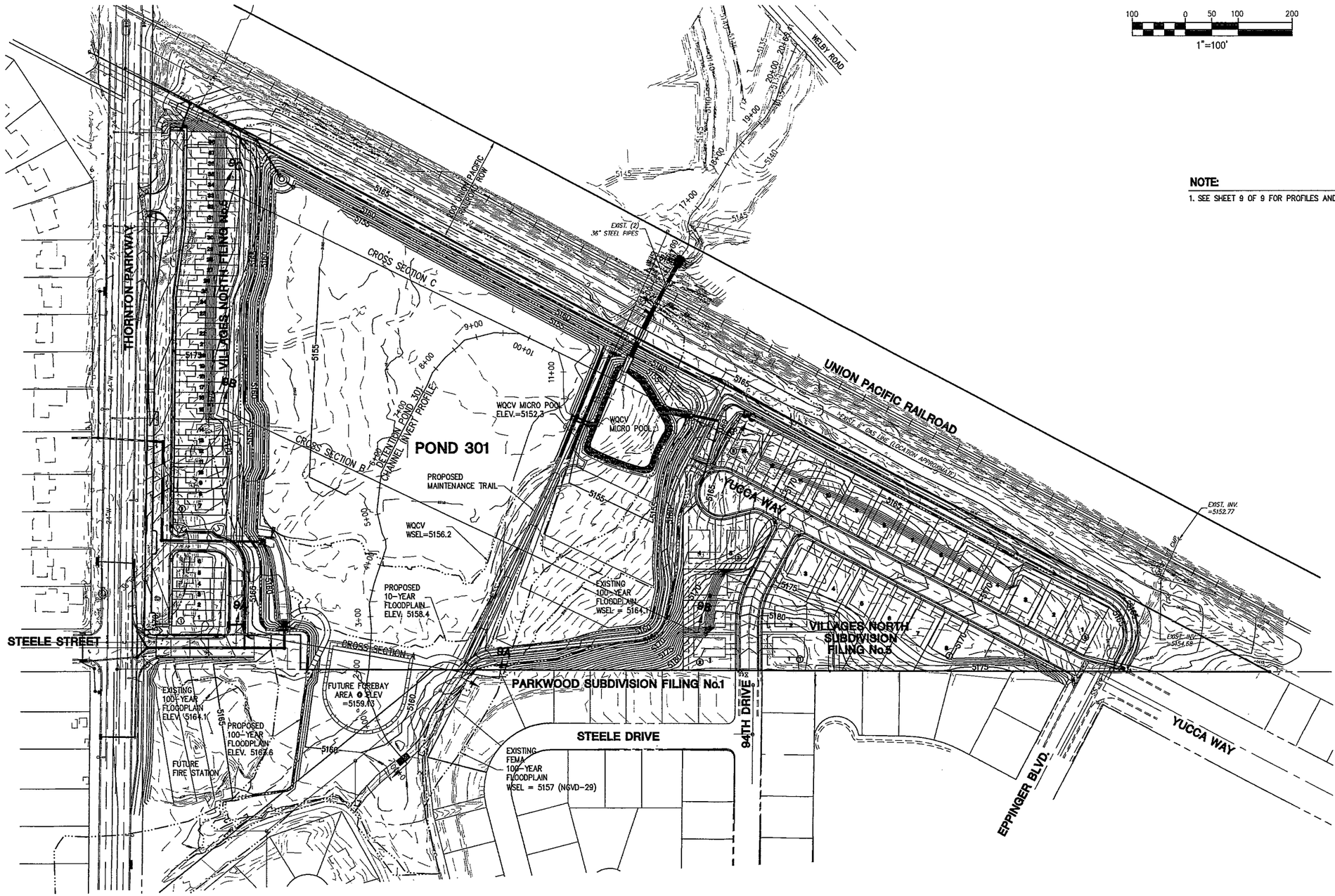
VILLAGES NORTH SUBDIVISION FILING No. 5

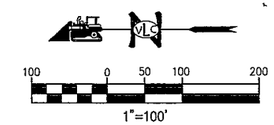
# DETAILS 2 OF 2

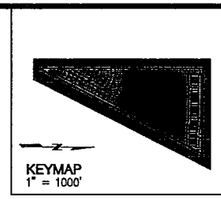
THORNTON, COLORADO

SHEET 7 of 9

[basic] [O:\2117.E0-Village\A]-Plans & Dwgs\Const\Pond\2117-07-POND.dwg] [Sep 08, 2005 - 5:04pm]




**NOTE:**

1. SEE SHEET 9 OF 9 FOR PROFILES AND SECTIONS.

## CALL BEFORE YOU DIG

CALL UTILITY NOTIFICATION CENTER OF COLORADO

**1-800-922-1987**

12600 W. COLFAX AVE., SUITE B-310
LAKEWOOD, COLORADO 80215

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

## BENCHMARK

BEING AN ADAMS COUNTY MONUMENT STAMPED "95.0208 1995 2S68W S13". 3-1/4" ALUMINUM SURVEY MARK DISK LOCATED NW OF THE INTERSECTION OF COLORADO BLVD. AND E. 100TH AVE. HAVING AN NAVD 1988 DATUM ELEVATION OF 5220.58 FEET.

## LEGEND

| | |
|---|---|
| 5400 | PROPOSED CONTOUR INDEX |
| | PROPOSED CONTOUR |
| 5400 | EXISTING CONTOUR INDEX |
| | EXISTING CONTOUR |
| | 100 YR WSEL LIMITS |

| DATE | NO. | REVISIONS | BY |
|---|---|---|---|
| 1/14/05 | 2 | REVISIONS - UDFCD 9/20/04 REVIEW | DJR |
| 4/19/05 | 3 | REVISIONS - UDFCD 2/23/05 REVIEW | CM |
| 8/03/05 | 4 | REVISIONS - UDFCD 6/29/05 REVIEW | CM |
| 9/08/05 | 5 | REVISIONS - UDFCD 8/31/05 REVIEW | CM |

DATE 07/02/04 DRAWN BY CMM
JOB NO. 2117.E1 CHECKED BY DJR

DO NOT SCALE, USE DIMENSION ONLY


CIVIL ENGINEERS
CONSTRUCTION MANAGERS
538 COMMONS DRIVE
GOLDEN, CO 80401
PHONE:(303)674-7355 FAX:(303)674-3263

VISION LAND CONSULTANTS, INC.

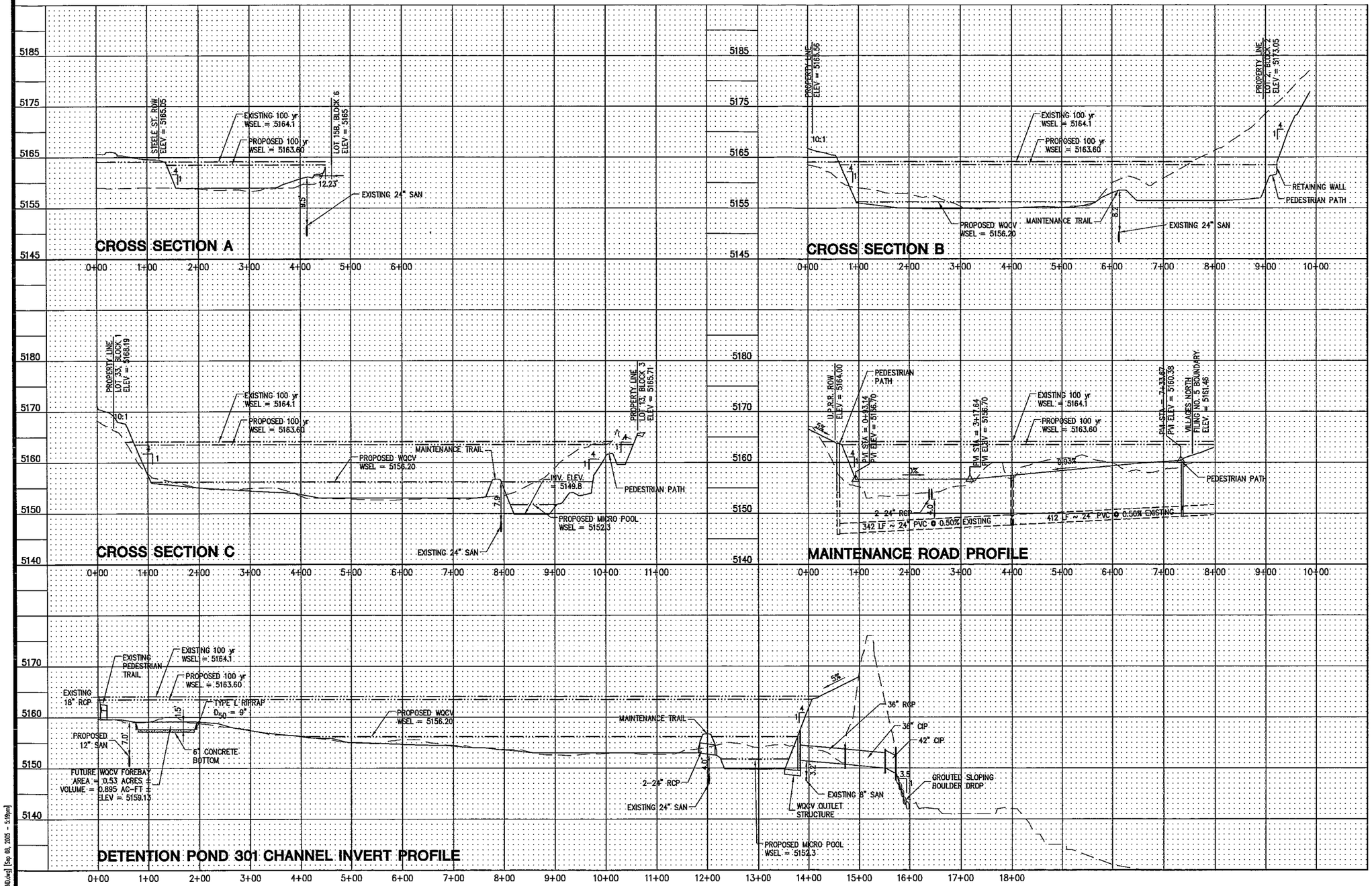

VILLAGES NORTH SUBDIVISION FILING No. 5

# SECTION LOCATIONS

THORNTON, COLORADO



[terric] [G:\2117.E0-Villages\P-Plans & Dwgs\Const\Pond\2117-08-POND.dwg] [Sep 08, 2005 - 5:15pm]




## LEGEND

- EXISTING GROUND
- FINISHED GRADE
- WATER SURFACE ELEVATION (WSEL)

| DATE | NO. | REVISIONS | BY |
|---|---|---|---|
| 1/14/05 | 2 | REVISIONS – UDFCD 9/20/04 REVIEW | DJR |
| 4/19/05 | 3 | REVISIONS – UDFCD 2/23/05 REVIEW | CM |
| 8/03/05 | 4 | REVISIONS – UDFCD 6/29/05 REVIEW | CM |
| 9/08/05 | 5 | REVISIONS – UDFCD 8/31/05 REVIEW | CM |

DATE 07/02/04 DRAWN BY CMM
JOB NO. 2117.E1 CHECKED BY DJR

DO NOT SCALE, USE DIMENSION ONLY

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VISION LAND CONSULTANTS, INC.

VILLAGES NORTH SUBDIVISION FILING No. 5

# SECTIONS AND PROFILES

THORNTON, COLORADO

SHEET 9 of 9

[lenic] [G:\2117.ED-Villages\P-Plans & Dwgs\Const\Pond\2117-09-POND.dwg] [Sep 08, 2005 - 5:19pm]

JANSEN STRAWN
CONSULTING ENGINEERS

PROJECT : Cherrylane
PROJECT NO. : D10017

DATE : 2/1/2011
BY : JGD

## EUR / Detention Calculations

### Required Volume

| Tributary Area (ac) | % Impervious |
|---|---|
| 72.48 | 34.0% |

| | | | |
|---|---|---|---|
| **EURV =** | **2.34** | **ac-ft** | *( From UDFCD Standard Spreadsheet )* |
| EURV = | 101,930 | cu-ft | |
| **100-yr Detention =** | **4.40** | **ac-ft** | *( $V_{100}$ = (1.78*I-0.002*I$^2$ -3.56)/900 * A )* |
| 100-yr Detention = | 191,707 | cu-ft | |

**Total Required Volume = 4.40 ac-ft** *(V100 + WQCV)*
**= 191,707 cu-ft**

**Max Allowable Release Rate**

$Q_{100}$ = 93.48 cfs ( 1.00 cfs/ac + Pass-through )

### Provided Volume

| Contour Elevation | Ft$^2$ | 1/3 (A1 + A2 + (A1A2)$^{1/2}$) D | Total Volume (ft$^3$) | Total Volume (ac-ft) |
|---|---|---|---|---|
| 5080.00 | 4,674 | | 0 | 0.00 |
| 5081.00 | 19,677 | 11,314 | 11,314 | 0.26 |
| 5082.00 | 24,349 | 21,972 | 33,285 | 0.76 |
| 5083.00 | 27,372 | 25,846 | 59,131 | 1.36 |
| 5084.00 | 30,874 | 29,105 | 88,236 | 2.03 |
| 5085.00 | 34,392 | 32,617 | 120,854 | 2.77 |
| 5086.00 | 38,240 | 36,299 | 157,153 | 3.61 |
| 5087.00 | 42,540 | 40,371 | 197,524 | 4.53 |
| 5088.00 | 46,952 | 44,728 | 242,251 | 5.56 |
| 5089.00 | 51,487 | 49,202 | 291,454 | 6.69 |

| | WSEL | Depth (ft) | |
|---|---|---|---|
| EURVWSEL = | 5084.42 | 4.42 | |
| 100-yr = | 5086.86 | 6.86 | *(V100 + WQCV)* |

JANSEN STRAWN CONSULTING ENGINEERS
1165 S. Pennsylvania St. - Denver, CO 80210
p: 303.561.3333 f: 303.561.3339

JANSEN STRAWN
CONSULTING ENGINEERS

PROJECT : Cherrylane
PROJECT NO. : D10017

DATE : 2/1/2011
BY : JGD

## Overflow Weirs

**POND WEIR**

$Q_{100}$ = 72.40 cfs

Weir Equation => $Q=CLH^{3/2}$

Try Weir Release:

$Q_{100}$ = 72.40 cfs

C = 3.00

L = 23.00 ft

**Flow Depth = 1.03 ft**

**USE: Proposed 23'x1.5' Spillway**

JANSEN STRAWN CONSULTING ENGINEERS
1165 S. Pennsylvania St. - Denver, CO 80210
p: 303.561.3333 f: 303.561.3339

JANSEN STRAWN
CONSULTING ENGINEERS

PROJECT : Cherrylane
PROJECT NO. : D10017

DATE : 2/1/2011
BY : JGD

## Grate Capacity Calculations

A. Verify grate can pass the 100-year flow:

$Q_{100}$ = 93.48 cfs

Determine the area necessary to pass the required flow through grate:

$A = Q / (C*(2GH)^{1/2})$

Q: 93.48 cfs
C: 0.65
G: 32.2 $ft/s^2$
H: 3.44 ft

$A_{open}$ = 9.67 $ft^2$ (Required)

Try: ***Standard Grate***

Grate size: (L*W) 8.51 X 3.42 ft

Area of grate = 29.06 $Ft^2$

*Open Areas*

Open Area Length: 34.50 in
Open Area Width: 5.34 in
Number of Open Areas = 12

Area of grate open to flow = Σ Open Areas 15.35 $ft^2$

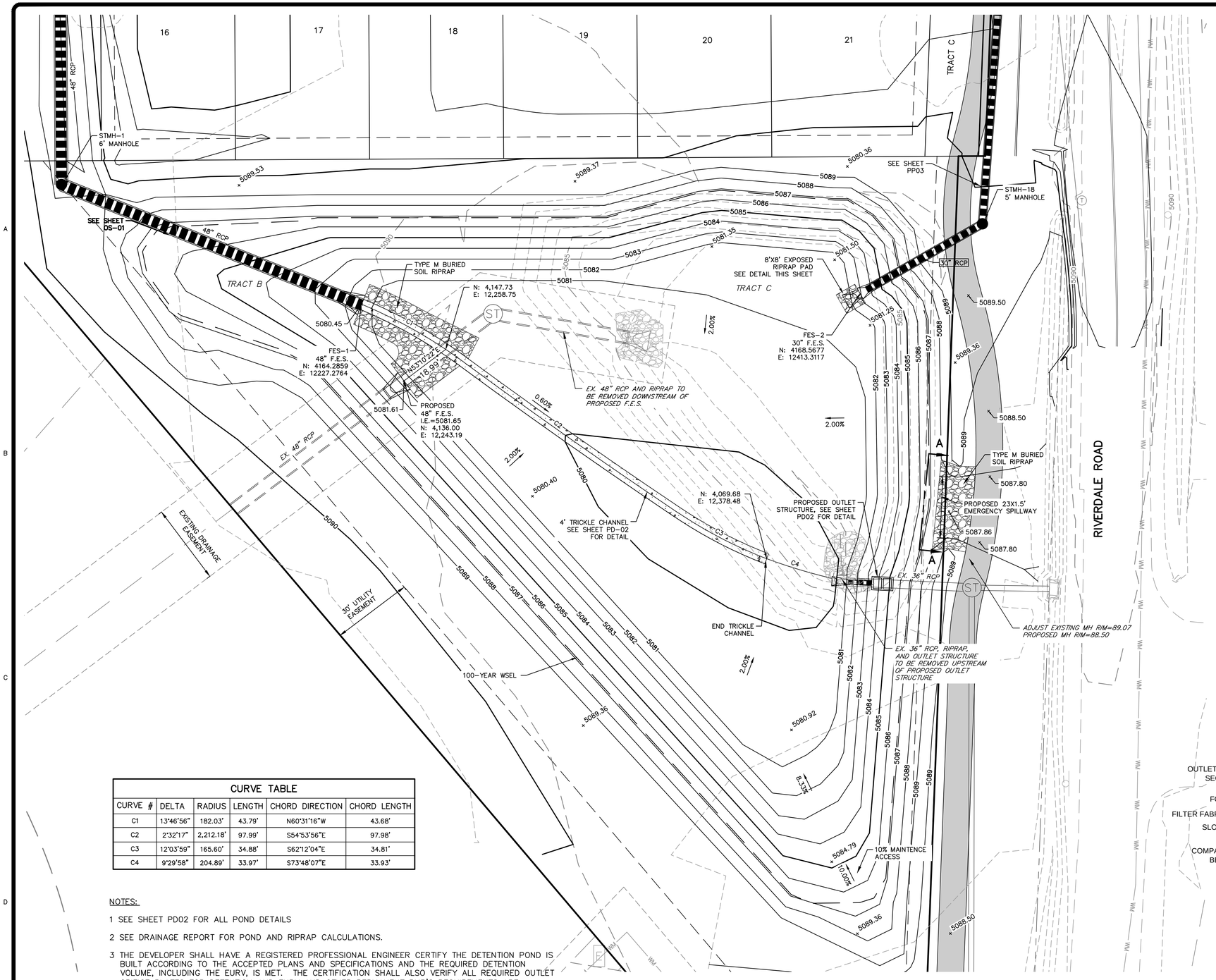
*% Open = 52.8%*

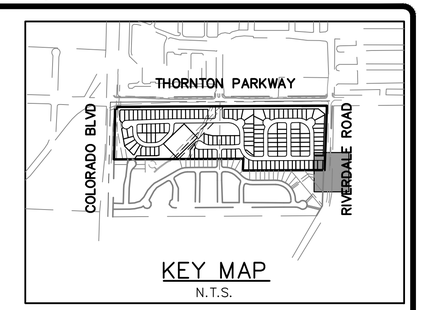
**Area** 10.75 $Ft^2$ > 9.67 $Ft^2$**

**Grate can pass the required flow**

** 30% reduction of the open area of the inlet has been applied for a clogging factor

JANSEN STRAWN CONSULTING ENGINEERS
1165 S. Pennsylvania St. - Denver, CO 80210
p: 303.561.3333 f: 303.561.3339




KEY MAP
N.T.S.

## LEGEND

- 5990 — EXISTING 5' CONTOUR
- 5988 — EXISTING 1' CONTOUR
- 5990 — PROPOSED 5' CONTOUR
- 5988 — PROPOSED 1' CONTOUR
- 2.00% — FLOW DIRECTION
- SIDEWALK/TRAILS
- PROPOSED STORM SEWER, MANHOLE, AND INLET

| CURVE TABLE | | | | | |
|---|---|---|---|---|---|
| CURVE # | DELTA | RADIUS | LENGTH | CHORD DIRECTION | CHORD LENGTH |
| C1 | 13°46'56" | 182.03' | 43.79' | N60°31'16"W | 43.68' |
| C2 | 2°32'17" | 2,212.18' | 97.99' | S54°53'56"E | 97.98' |
| C3 | 12°03'59" | 165.60' | 34.88' | S62°12'04"E | 34.81' |
| C4 | 9°29'58" | 204.89' | 33.97' | S73°48'07"E | 33.93' |

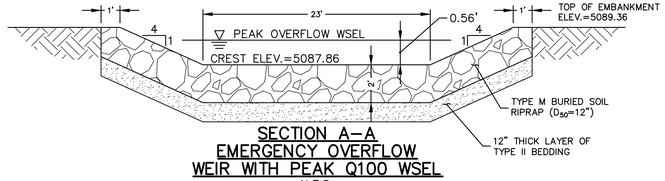
NOTES:

1 SEE SHEET PD02 FOR ALL POND DETAILS

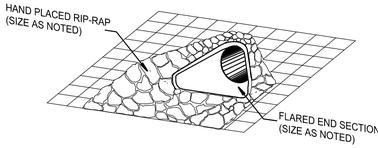
2 SEE DRAINAGE REPORT FOR POND AND RIPRAP CALCULATIONS.

3 THE DEVELOPER SHALL HAVE A REGISTERED PROFESSIONAL ENGINEER CERTIFY THE DETENTION POND IS BUILT ACCORDING TO THE ACCEPTED PLANS AND SPECIFICATIONS AND THE REQUIRED DETENTION VOLUME, INCLUDING THE EURV, IS MET. THE CERTIFICATION SHALL ALSO VERIFY ALL REQUIRED OUTLET ORIFICE PLATES FOR DETENTION AND EURV AND OTHER PERMANENT BMP'S REQUIREMENTS ARE INSTALLED PER THE APPROVED PLANS AND SPECIFICATIONS, AND SHALL SHOW THE AS-BUILT VOLUMES FOR THE 100-YEAR, 10-YEAR STORM EVENTS, AND FOR THE EURV. THE CERTIFICATION SHALL BE PROVIDED TO THE TOWN OF ERIE ENGINEERING STAFF BEFORE A CERTIFICATE OF OCCUPANCY CAN BE ISSUED.

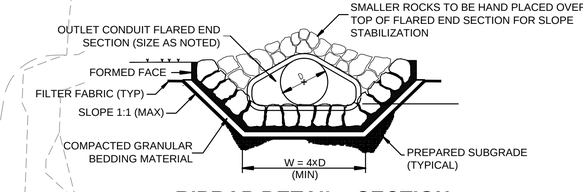
WORK SHALL BE CONSTRUCTED TO CITY OF THORNTON STANDARDS AND SPECIFICATIONS. THIS APPROVAL IS FOR CONFORMANCE WITH THESE STANDARDS AND SPECIFICATIONS AND OTHER CITY REQUIREMENTS. THE DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER OR LANDSCAPE PROFESSIONAL.




SECTION A-A
EMERGENCY OVERFLOW
WEIR WITH PEAK Q100 WSEL
N.T.S.




STORM SEWER OUTLET
ISOMETRIC
N.T.S.




RIPRAP DETAIL - SECTION
N.T.S.

| DETENTION / WQ POND SUMMARY | |
|---|---|
| EURV (ac-ft) | 2.34 |
| 100-YR INCL. EURV (ac-ft) | 4.40 |
| EURV WSEL | 5084.42 |
| 100-YR WSEL | 5086.86 |
| EURV RELEASE RATE | 72-HOUR |
| 100-YR RELEASE RATE (cfs) | 93.48 |
| MAX POND DEPTH TO SPILLWAY | 8.61 |

0 10 20 40
SCALE: 1" = 20'
ORIGINAL GRAPHIC SCALE


JANSEN STRAWN
CONSULTING ENGINEERS
45 WEST 2ND AVENUE
DENVER, CO 80223
P.303.561.3333
F.303.561.3339


COLORADO REGISTERED PROFESSIONAL ENGINEER
THOMAS C. JANSEN
35942
Jan 14, 2016
FOR AND ON BEHALF OF
JANSEN STRAWN CONSULTING ENGINEERS, INC.

BENCHMARK:

NGS STATION "J 411"

STAINLESS STEEL ROD ACCESSED THROUGH A 5" LOGO CAP STAMPED "J 411 1984", LOCATED IN THORNTON, AT THE INTERSECTION OF EAST 104TH AVENUE AND RIVERDALE ROAD, 467.2 FEET NORTH OF THE CENTERLINE OF THE AVENUE, 121.1 FEET EAST OF THE CENTER OF THE ROAD, AND 1.0 FEET EAST OF THE SOUTHEAST CORNER OF A CHAIN LINK FENCE AROUND A WATER PUMPING STATION. THE STATION MARK IS 1.0 FEET NORTH FROM A WITNESS POST AND 3.3 FEET BELOW THE ROAD.

ELEVATION = 5098.47 FEET (NAVD 1988).

CALL UTILITY NOTIFICATION CENTER OF COLORADO
811
CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

| No. | Description of Revisions | Date | By |
|---|---|---|---|
| 2 | CITY COMMENTS | 01/14/16 | TL |
| 1 | METRO WASTEWATER RECLAMATION COMMENTS | 12/30/15 | JDE/TL |
| | CITY COMMENTS | 12/22/15 | TL |

Designed By:
Checked By:

# CHERRYLANE SUBDIVISION

## POND DETAIL PLAN

Date: 11/11/2015
Job No.: 10017

# PD01

Sheet 39 of 47

# AS-BUILT SURVEY

PHASE ONE-RIVER VALLEY VILLAGE SUBDIVISION, BEING A PART OF THE SOUTH ONE-HALF OF THE SOUTHWEST ONE-QUARTER OF SECTION 18, TOWNSHIP 2 SOUTH, RANGE 67 WEST OF THE 6TH P.M., CITY OF THORNTON, COUNTY OF ADAMS, STATE OF COLORADO.

PAGE 1 OF 6

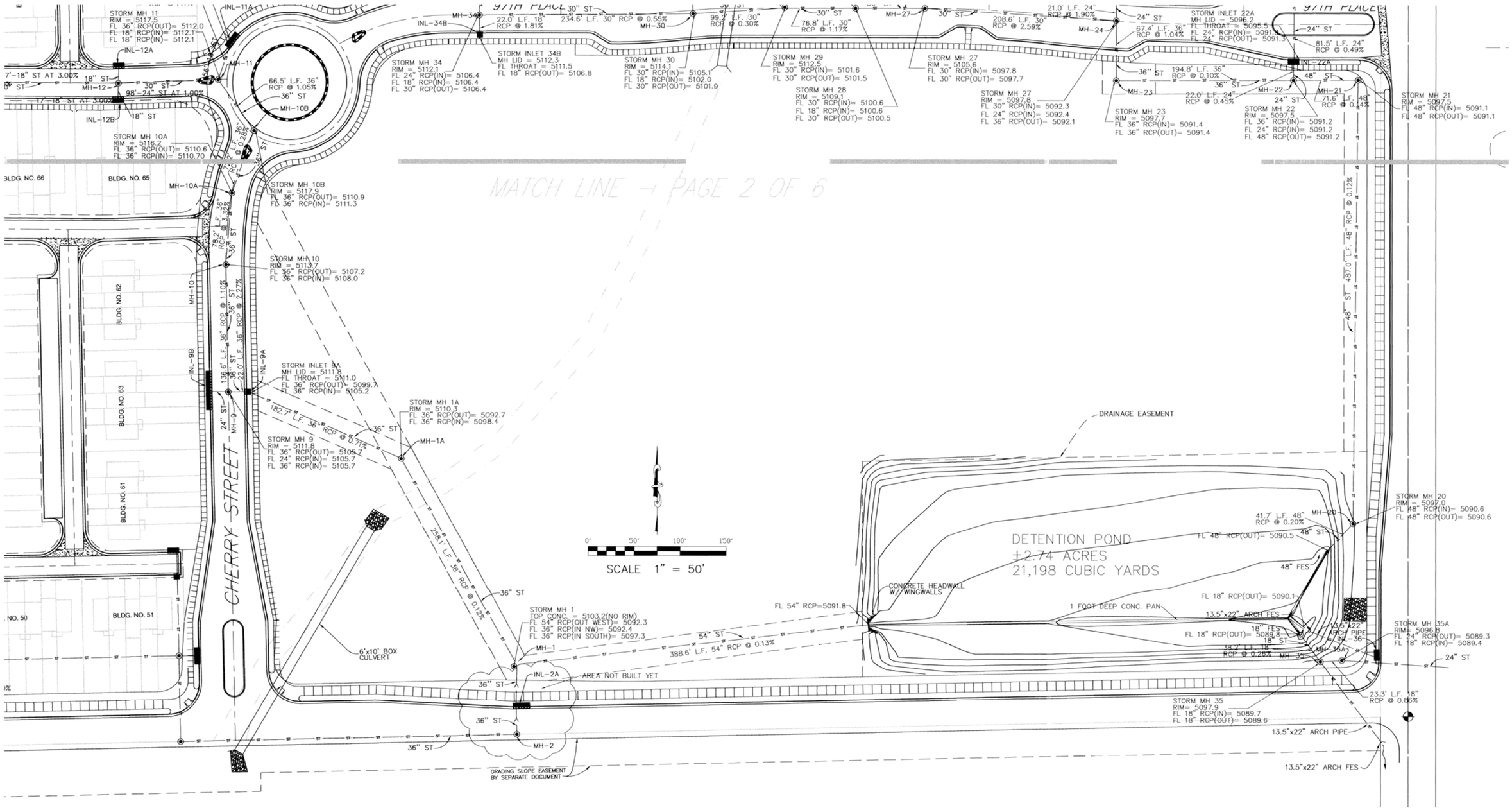
LEGEND

——ST—— STORM SEWER LINE

CERTIFICATE OF SURVEY:

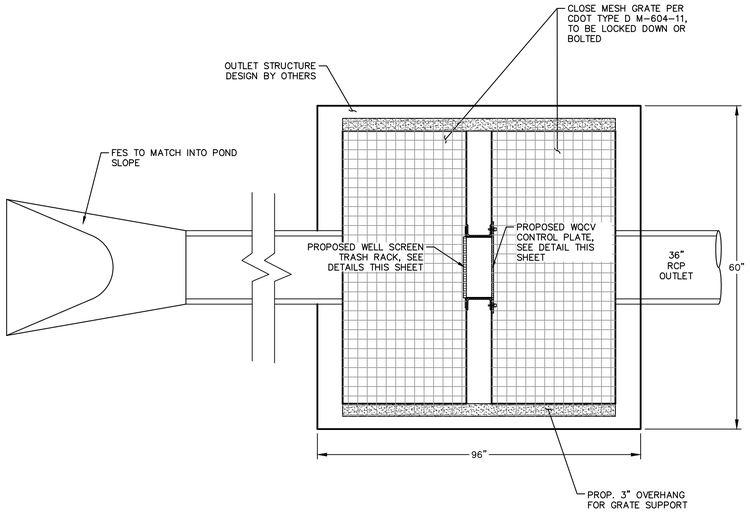
I hereby certify specifically and only to the CITY OF THORNTON, that the as-built information shown hereon dated January 31, 2003, is correct to the best of my knowledge and belief.

ROBERT A. RICKARD - LS #28283
(FOR AND ON BEHALF OF ACKLAM & ASSOCIATES, INC.)

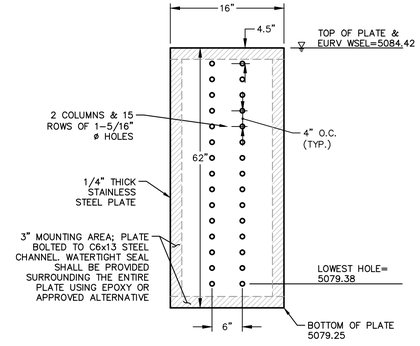



| | | | | | | |
|---|---|---|---|---|---|---|
| RIVER VALLEY VILLAGE<br>STORM SEWER AS-BUILTS<br>RIVERDALE ROAD | CALL UTILITY NOTIFICATION CENTER OF COLORADO<br>1-800-922-1987<br>or 534-6700 IN METRO DENVER<br>CALL 2 BUSINESS DAYS IN ADVANCE, BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES | REVISIONS | ACKLAM & ASSOCIATES, INC.<br>P.O. Box 795 - 1001 East Bridge Street<br>Brighton, Colorado 80601<br>303-659-8546 | DESIGN: RBG<br>DATE: 01/31/2003<br>CHECK: RAR | PROJ. NO. 03-103<br>BOOK:<br>PAGE: | SCALE: 1" = 50'<br>FILE NO. 18-27-12LL<br>SHT: 1 of 6 |

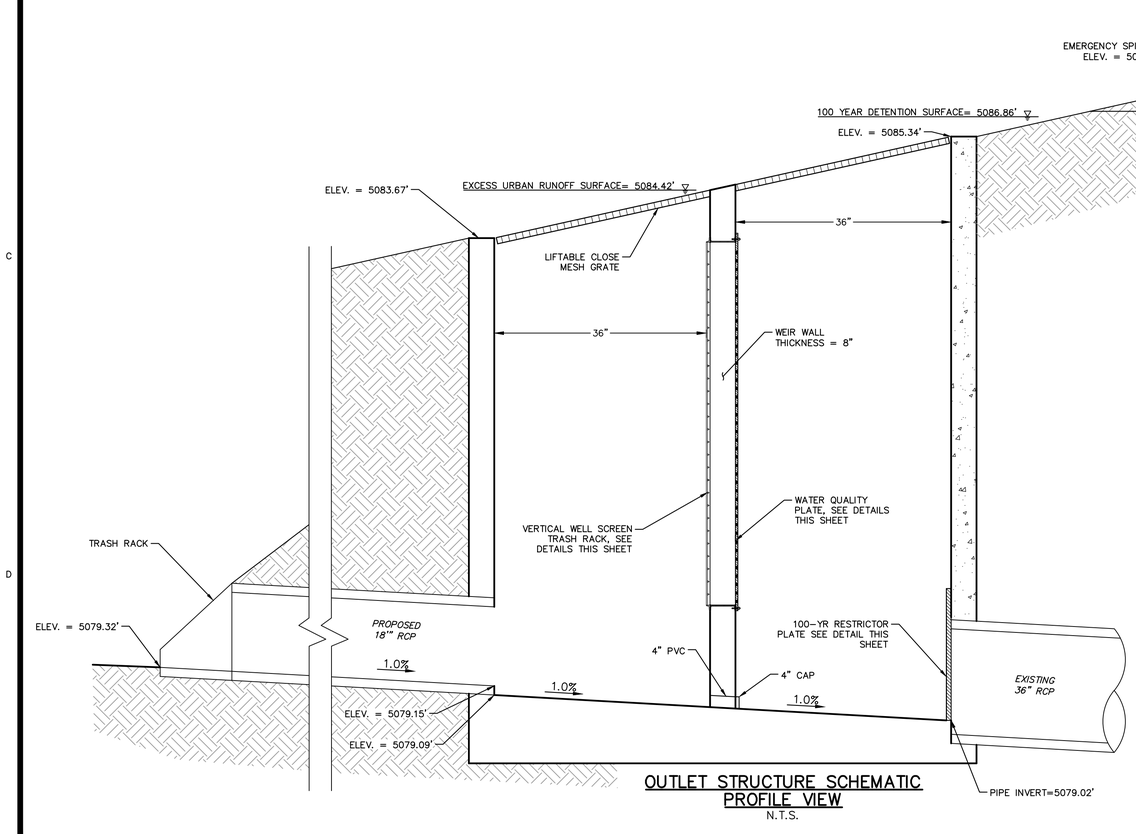
F:\SURVEY\CHRIS\03-103\pdbuilt2.dwg, 02/10/2003 08:36:58 AM, RBG




## OUTLET STRUCTURE SCHEMATIC PLAN VIEW
N.T.S.



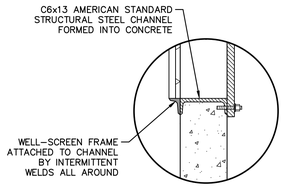

## WQCV CONTROL PLATE DETAIL
WQCV IS DRAINED IN 40-HOURS
N.T.S.



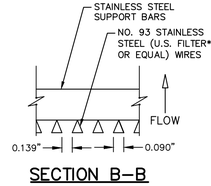

## OUTLET STRUCTURE SCHEMATIC PROFILE VIEW
N.T.S.




## 100-YR RESTRICTOR PLATE DETAIL
N.T.S.



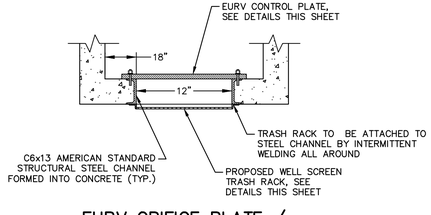

## DETAIL A
N.T.S.




## SECTION B-B
N.T.S.

DIMENSIONS OF TRASH RACK WITHIN THE MOUNTING FRAME = 6 INCHES WIDE x 62 INCHES HIGH

ORDERING SPECIFICATIONS
- #93 VEE WIRE
- 0.139" OPENINGS BETWEEN WIRES
- TE 0.074"X0.75" SUPPORT RODS ON 1" SPACING (O.C.)
- TOTAL SCREEN THICKNESS = 1.03"
- 1.0" x 1.5" FLAT BAR CARBON STEEL FRAME




## EURV ORIFICE PLATE / TRASH RACK PLAN VIEW
N.T.S.

JANSEN STRAWN
CONSULTING ENGINEERS
45 WEST 2ND AVENUE
DENVER, CO 80223
P.303.561.3333
F.303.561.3339

COLORADO REGISTERED PROFESSIONAL ENGINEER
THOMAS C. LANGEN
35942
Apr 02, 2013
FOR AND ON BEHALF OF JANSEN STRAWN CONSULTING ENGINEERS, INC.

BENCHMARK:

CALL UTILITY NOTIFICATION CENTER OF COLORADO
811
CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

| No. | Description of Revisions | Date | By |
|---|---|---|---|
| 2 | CITY COMMENTS | 01/14/16 | TL |
| 1 | METRO WASTEWATER RECLAMATION COMMENTS | 12/30/15 | JDE/TL |
| | CITY COMMENTS | 12/22/15 | TL |

Designed By:
Checked By:

CHERRYLANE SUBDIVISION

POND DETAILS

Date: 11/11/2015
Job No.: 10017

PD02

Sheet 40 of 47

# CUHP INPUT TABLE

# CUHP SUBCATCHMENTS

Columns with this color heading are for required user-input
Columns with this color heading are for optional override values
Columns with this color heading are for program-calculated values

| | | | | | | | | | Maximum Depression Storage (Watershed inches) | | Horton's Infiltration Parameters | | | DCIA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($mi^2$) | Length to Centroid (mi) | Length (mi) | Slope (ft/ft) | Existing Percent Imperviousness | Future Percent Imperviousness | Pervious | Impervious | Initial Rate (in/hr) | Decay Coefficient (1/seconds) | Final Rate (in/hr) | Level 0, 1, or 2 |
| 0 | 100 | Rainfall | 0.0105 | 0.1428 | 0.1996 | 0.0179 | 48.61 | 91.07 | 0.35 | 0.10 | 4.832 | 0.00079 | 0.958 | 0 |
| 1 | 101 | Rainfall | 0.0294 | 0.1554 | 0.2652 | 0.0086 | 45.78 | 45.78 | 0.35 | 0.07 | 3.172 | 0.00171 | 0.543 | 0 |
| 2T | 102T | Rainfall | 0.1298 | 0.2954 | 0.5277 | 0.0233 | 13.84 | 76.84 | 0.35 | 0.09 | 3.000 | 0.00180 | 0.500 | 0 |
| 2 | 102 | Rainfall | 0.1625 | 0.5829 | 1.0762 | 0.0160 | 44.10 | 44.10 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 3 | 103 | Rainfall | 0.1733 | 0.4995 | 1.0111 | 0.0199 | 39.24 | 39.24 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 4 | 104 | Rainfall | 0.0534 | 0.1834 | 0.3736 | 0.0108 | 16.10 | 45.72 | 0.35 | 0.08 | 3.294 | 0.00164 | 0.574 | 0 |
| 5 | 105 | Rainfall | 0.1292 | 0.3298 | 0.6996 | 0.0121 | 35.86 | 45.81 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 6 | 106 | Rainfall | 0.1032 | 0.2292 | 0.7773 | 0.0150 | 35.16 | 67.75 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 7 | 107 | Rainfall | 0.0552 | 0.2651 | 0.5356 | 0.0227 | 45.06 | 79.83 | 0.35 | 0.09 | 3.000 | 0.00180 | 0.500 | 0 |
| 8 | 108 | Rainfall | 0.0656 | 0.2206 | 0.5687 | 0.0270 | 32.42 | 32.42 | 0.36 | 0.08 | 3.095 | 0.00175 | 0.524 | 0 |
| 9 | 109 | Rainfall | 0.0468 | 0.1958 | 0.4797 | 0.0330 | 37.87 | 45.67 | 0.35 | 0.07 | 3.067 | 0.00176 | 0.517 | 0 |
| 10 | 110 | Rainfall | 0.0361 | 0.3042 | 0.3413 | 0.0182 | 34.57 | 55.79 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 11 | 111 | Rainfall | 0.0281 | 0.0980 | 0.2324 | 0.0126 | 53.70 | 53.70 | 0.36 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 12 | 112 | Rainfall | 0.0102 | 0.0773 | 0.1966 | 0.0150 | 42.31 | 51.81 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 13 | 113 | Rainfall | 0.0515 | 0.1223 | 0.3643 | 0.0336 | 41.63 | 41.63 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 14 | 114 | Rainfall | 0.0121 | 0.1597 | 0.3092 | 0.0079 | 23.67 | 23.67 | 0.39 | 0.09 | 3.000 | 0.00180 | 0.500 | 0 |
| 15 | 115 | Rainfall | 0.0490 | 0.0902 | 0.3001 | 0.0129 | 53.98 | 64.42 | 0.35 | 0.09 | 3.000 | 0.00180 | 0.500 | 0 |
| 16 | 116 | Rainfall | 0.1493 | 0.1546 | 0.7114 | 0.0104 | 31.40 | 35.43 | 0.37 | 0.08 | 3.505 | 0.00152 | 0.626 | 0 |
| 17 | 117 | Rainfall | 0.1122 | 0.3543 | 0.6577 | 0.0181 | 40.41 | 42.98 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 18 | 118 | Rainfall | 0.0668 | 0.2143 | 0.4625 | 0.0360 | 36.25 | 36.25 | 0.35 | 0.07 | 4.333 | 0.00107 | 0.833 | 0 |
| 19 | 119 | Rainfall | 0.0214 | 0.2499 | 0.5109 | 0.0400 | 50.16 | 50.16 | 0.35 | 0.07 | 5.000 | 0.00070 | 1.000 | 0 |
| 20 | 120 | Rainfall | 0.0380 | 0.1733 | 0.4779 | 0.0300 | 41.41 | 41.41 | 0.35 | 0.07 | 4.920 | 0.00074 | 0.980 | 0 |
| 21 | 121 | Rainfall | 0.0440 | 0.1446 | 0.4346 | 0.0278 | 28.34 | 28.34 | 0.35 | 0.08 | 4.429 | 0.00101 | 0.857 | 0 |
| 22 | 122 | Rainfall | 0.0905 | 0.1620 | 0.5273 | 0.0145 | 32.93 | 37.03 | 0.36 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 23 | 123 | Rainfall | 0.1521 | 0.5025 | 0.8766 | 0.0229 | 43.75 | 43.75 | 0.35 | 0.07 | 3.928 | 0.00129 | 0.732 | 0 |
| 24 | 124 | Rainfall | 0.0303 | 0.0920 | 0.3181 | 0.0284 | 47.40 | 47.40 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 25 | 125 | Rainfall | 0.0171 | 0.1177 | 0.4303 | 0.0112 | 47.24 | 47.24 | 0.37 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 26 | 126 | Rainfall | 0.0517 | 0.1012 | 0.4362 | 0.0312 | 47.99 | 47.99 | 0.35 | 0.07 | 4.176 | 0.00115 | 0.794 | 0 |
| 27 | 127 | Rainfall | 0.0531 | 0.1151 | 0.4413 | 0.0267 | 53.32 | 53.32 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 28 | 128 | Rainfall | 0.0109 | 0.1217 | 0.3552 | 0.0221 | 49.74 | 49.74 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 29 | 129 | Rainfall | 0.0475 | 0.1314 | 0.6069 | 0.0260 | 39.19 | 42.04 | 0.35 | 0.07 | 3.065 | 0.00176 | 0.516 | 0 |
| 30 | 130 | Rainfall | 0.1872 | 0.5029 | 1.0375 | 0.0307 | 37.15 | 37.34 | 0.35 | 0.08 | 3.617 | 0.00146 | 0.654 | 0 |
| 31 | 131 | Rainfall | 0.0338 | 0.1411 | 0.3240 | 0.0272 | 33.00 | 33.00 | 0.36 | 0.08 | 4.273 | 0.00110 | 0.818 | 0 |
| 32 | 132 | Rainfall | 0.1337 | 0.1771 | 0.8517 | 0.0259 | 47.55 | 50.00 | 0.35 | 0.08 | 3.395 | 0.00158 | 0.599 | 0 |
| 33 | 133 | Rainfall | 0.0651 | 0.3138 | 0.5855 | 0.0383 | 56.38 | 56.38 | 0.36 | 0.08 | 4.024 | 0.00124 | 0.756 | 0 |
| 34 | 134 | Rainfall | 0.0922 | 0.3604 | 0.6774 | 0.0285 | 40.12 | 40.12 | 0.35 | 0.08 | 3.034 | 0.00178 | 0.508 | 0 |
| 35 | 135 | Rainfall | 0.0675 | 0.2126 | 0.4426 | 0.0342 | 45.31 | 45.31 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 36 | 136 | Rainfall | 0.0309 | 0.1576 | 0.3133 | 0.0024 | 44.61 | 44.61 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 37 | 137 | Rainfall | 0.1741 | 0.4279 | 0.8340 | 0.0027 | 15.76 | 16.48 | 0.40 | 0.10 | 4.036 | 0.00123 | 0.759 | 0 |
| 38 | 138 | Rainfall | 0.0699 | 0.2366 | 0.4130 | 0.0107 | 33.99 | 33.99 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 39 | 139 | Rainfall | 0.1202 | 0.3042 | 0.6051 | 0.0160 | 24.47 | 43.62 | 0.36 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 40 | 140 | Rainfall | 0.1455 | 0.3087 | 0.9918 | 0.0175 | 25.05 | 29.42 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 41 | 141 | Rainfall | 0.0585 | 0.2104 | 0.4337 | 0.0101 | 37.59 | 37.59 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 42 | 142 | Rainfall | 0.1367 | 0.3955 | 0.6979 | 0.0015 | 68.59 | 68.59 | 0.40 | 0.10 | 4.103 | 0.00119 | 0.776 | 0 |
| 43 | 143 | Rainfall | 0.0997 | 0.1745 | 0.6741 | 0.0061 | 25.66 | 51.09 | 0.35 | 0.10 | 3.063 | 0.00177 | 0.516 | 0 |
| 44 | 144 | Rainfall | 0.1394 | 0.3510 | 1.2356 | 0.0086 | 7.65 | 44.24 | 0.37 | 0.10 | 3.000 | 0.00180 | 0.500 | 0 |
| 45 | 145 | Rainfall | 0.1710 | 0.3452 | 0.6872 | 0.0113 | 27.39 | 54.35 | 0.36 | 0.09 | 3.018 | 0.00179 | 0.505 | 0 |
| 46 | 146 | Rainfall | 0.0840 | 0.2253 | 0.4103 | 0.0010 | 69.98 | 69.98 | 0.40 | 0.10 | 4.358 | 0.00105 | 0.840 | 0 |
| 47 | 147 | Rainfall | 0.1744 | 0.3492 | 0.6383 | 0.0010 | 54.26 | 60.34 | 0.40 | 0.10 | 3.614 | 0.00146 | 0.654 | 0 |
| 48 | 148 | Rainfall | 0.0608 | 0.2669 | 0.5360 | 0.0078 | 15.18 | 74.92 | 0.35 | 0.10 | 3.000 | 0.00180 | 0.500 | 0 |
| 49 | 149 | Rainfall | 0.0593 | 0.3611 | 0.5397 | 0.0237 | 44.73 | 46.06 | 0.35 | 0.07 | 3.632 | 0.00145 | 0.658 | 0 |
| 50 | 150 | Rainfall | 0.1128 | 0.3493 | 0.6277 | 0.0046 | 47.97 | 55.38 | 0.35 | 0.08 | 3.438 | 0.00156 | 0.610 | 0 |
| 51 | 151 | Rainfall | 0.0833 | 0.3270 | 0.5816 | 0.0123 | 6.75 | 36.91 | 0.40 | 0.10 | 3.264 | 0.00165 | 0.566 | 0 |
| 52 | 152 | Rainfall | 0.1022 | 0.2932 | 0.5829 | 0.0331 | 33.44 | 50.27 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 53 | 153 | Rainfall | 0.0644 | 0.1169 | 0.3410 | 0.0024 | 21.99 | 21.99 | 0.40 | 0.10 | 4.878 | 0.00077 | 0.969 | 0 |
| 54 | 154 | Rainfall | 0.0949 | 0.3690 | 0.6387 | 0.0101 | 14.45 | 14.45 | 0.40 | 0.10 | 4.803 | 0.00081 | 0.951 | 0 |
| 55 | 155 | Rainfall | 0.1967 | 0.2777 | 0.5925 | 0.0126 | 69.70 | 69.70 | 0.37 | 0.09 | 3.675 | 0.00143 | 0.669 | 0 |

# EPA SWMM 5.1
# INPUT PARAMETERS

```
[TITLE]
;;Project Title/Notes

[OPTIONS]
;;Option             Value
FLOW_UNITS           CFS
INFILTRATION         HORTON
FLOW_ROUTING         KINWAVE
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
ALLOW_PONDING        NO
SKIP_STEADY_STATE    NO

START_DATE           01/01/2005
START_TIME           00:00:00
REPORT_START_DATE    01/01/2005
REPORT_START_TIME    00:00:00
END_DATE             01/01/2005
END_TIME             06:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:05:00
WET_STEP             00:05:00
DRY_STEP             01:00:00
ROUTING_STEP         0:00:05

INERTIAL_DAMPING     PARTIAL
NORMAL_FLOW_LIMITED  BOTH
FORCE_MAIN_EQUATION  H-W
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         12.557
MAX_TRIALS           8
HEAD_TOLERANCE       0.005
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[FILES]
;;Interfacing Files
USE INFLOWS "F:\2017\2001-2500\017-2321\40-Design\Calcs\WTRS\1 HYDROLOGY\Baseline\CUHP 2.0.0\Input
Files\13_Fut_100yr_0mi^2_.txt"

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
CONSTANT         0.0
DRY_ONLY         NO

[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
102              5148.89    0          0          0          0
102O             5148.89    0          0          0          0
103              5151       0          0          0          0
104              5080       0          0          0          0
105              5085       0          0          0          0
108              5179       0          0          0          0
109              5194       0          0          0          0
110              5120       0          0          0          0
110T             5104       0          0          0          0
111              5123       0          0          0          0
112              5164       0          0          0          0
112T             5123       0          0          0          0
113              5166       0          0          0          0
114              5105       0          0          0          0
115              5132       0          0          0          0
116              5152.3     0          0          0          0
116O             5152.3     0          0          0          0
117              5162       0          0          0          0
118T             5158       0          0          0          0
119              5172       0          0          0          0
120              5177       0          0          0          0
```





```
120T             5158       0          0          0          0
121              5216.17    0          0          0          0
122              5259       0          0          0          0
122O             5259       0          0          0          0
123              5177       0          0          0          0
124              5286       0          0          0          0
124T             5222       0          0          0          0
125              5316       0          0          0          0
126              5213       0          0          0          0
127              5241       0          0          0          0
128              5266       0          0          0          0
128T             5264       0          0          0          0
129              5267       0          0          0          0
131              5250       0          0          0          0
131O             5250       0          0          0          0
130T             5183       0          0          0          0
132              5286       0          0          0          0
132T             5279       0          0          0          0
133              5293       0          0          0          0
135              5273       0          0          0          0
135T             5236       0          0          0          0
136              5276       0          0          0          0
138              5079       0          0          0          0
138T             5073       0          0          0          0
139              5087       0          0          0          0
140              5092       0          0          0          0
141              5093       0          0          0          0
143              5054       0          0          0          0
144              5075       0          0          0          0
145              5067       0          0          0          0
146              5054       0          0          0          0
147              5055       0          0          0          0
148              5073       0          0          0          0
149              5115       0          0          0          0
150              5056       0          0          0          0
150T             5055       0          0          0          0
151              5061       0          0          0          0
152              5100       0          0          0          0
153              5063       0          0          0          0
154              5069       0          0          0          0
118              5173       0          0          0          0
107              5138       0          0          0          0
143T             5055       0          0          0          0
134              5184       0          0          0          0
130              5183       0          0          0          0
121O             5198.37    0          0          0          0
140O             5089.8     0          0          0          0
102T             5097       0          0          0          0
101              5084.35    0          0          0          0

[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
100              5067       FREE                        NO
137              5069       FREE                        NO
142              5051       FREE                        NO
155              5046       FREE                        NO

[DIVIDERS]
;;Name           Elevation  Diverted Link    Type       Parameters
;;-------------- ---------- ---------------- ---------- ----------
129O             5267       429O             OVERFLOW   0          0          0          0
127O             5241       427O             OVERFLOW   0          0          0          0
126O             5213       426O             OVERFLOW   0          0          0          0
139O             5079.38    439O             OVERFLOW   0          0          0          0
107O             5138       407O             OVERFLOW   0          0          0          0
106              5110       406              OVERFLOW   0          0          0          0

[STORAGE]
;;Name           Elev.    MaxDepth   InitDepth  Shape      Curve Name/Params            N/A      Fevap
Psi      Ksat     IMD
;;-------------- -------- ---------- ---------- ---------- ---------------------------- -------- --------
         -------- --------
;OSP - 301
316              5152.3   14.7       0          TABULAR    316Pond                      0        0
```

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 302 | 5148.89 | 11 | 0 | TABULAR | 302Pond | | 0 | 0 |
| ;OSP - 307 | | | | | | | | |
| 322 | 5259 | 12.2 | 0 | FUNCTIONAL | 0 | 0 | 43560 | 0 | 0 |
| ;OSP - 305 | | | | | | | | |
| 331 | 5250 | 8.4 | 0 | FUNCTIONAL | 0 | 0 | 43560 | 0 | 0 |
| ;OSP - 303 | | | | | | | | |
| 327 | 5241 | 1.9 | 0 | FUNCTIONAL | 0 | 0 | 43560 | 0 | 0 |
| ;OSP - 302 | | | | | | | | |
| 326 | 5213 | 4.2 | 0 | FUNCTIONAL | 0 | 0 | 43560 | 0 | 0 |
| ;OSP - 304 | | | | | | | | |
| 329 | 5267 | 1.1 | 0 | FUNCTIONAL | 0 | 0 | 43560 | 0 | 0 |
| 321S | 5198.37 | 6.63 | 0 | TABULAR | Pond321S | | | 0 | 0 |
| 307 | 5138 | 3.4 | 0 | FUNCTIONAL | 0 | 0 | 43560 | 0 | 0 |
| 340 | 5089.8 | 8.2 | 0 | TABULAR | Pond340 | | | 0 | 0 |
| 339 | 5079.38 | 10.62 | 0 | TABULAR | Pond339 | | | 0 | 0 |
| 321N | 5216.17 | 7.83 | 0 | TABULAR | Pond321N | | | 0 | 0 |

[CONDUITS]

| ;;Name | From Node | To Node | Length | Roughness | InOffset | OutOffset | InitFlow | MaxFlow |
|---|---|---|---|---|---|---|---|---|
| 203 | 103 | 102 | 41 | .045 | 0 | 0 | 0 | 0 |
| 205 | 105 | 104 | 514 | .045 | 0 | 0 | 0 | 0 |
| 406 | 106 | 105 | 1999 | .02 | 6 | 12 | 0 | 0 |
| 407O | 107O | 106 | 2603 | .045 | 7 | 6 | 0 | 0 |
| 208 | 108 | 107 | 1396 | .045 | 0 | 20 | 0 | 0 |
| 209 | 109 | 107 | 2407 | .045 | 0 | 7 | 0 | 0 |
| 210 | 110 | 110T | 216 | .045 | 0 | 10 | 0 | 0 |
| 211 | 111 | 110 | 407 | .045 | 0 | 0 | 0 | 0 |
| 212 | 112 | 112T | 939 | .045 | 0 | 0 | 0 | 0 |
| 212T | 112T | 110 | 450 | 0.02 | 0 | 0 | 0 | 0 |
| 213 | 113 | 112T | 2015 | .02 | 0 | 16 | 0 | 0 |
| 214 | 114 | 110T | 136 | .045 | 0 | 0 | 0 | 0 |
| 215 | 115 | 114 | 1625 | .045 | 0 | 6 | 0 | 0 |
| 216 | 116 | 316 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 216O | 116O | 115 | 864 | .045 | 0 | 4 | 0 | 0 |
| 217 | 117 | 116 | 720 | .045 | 0 | 0 | 0 | 0 |
| 218 | 118 | 118T | 750 | .045 | 3 | 0 | 0 | 0 |
| 218T | 118T | 116 | 583 | .045 | 0 | 0 | 0 | 0 |
| 219 | 119 | 118T | 474 | .045 | 0 | 8 | 0 | 0 |
| 220 | 120 | 120T | 913 | .045 | 0 | 0 | 0 | 0 |
| 220T | 120T | 116 | 636 | .045 | 0 | 0 | 0 | 0 |
| 221O | 121O | 120 | 1215 | .02 | 5.63 | 0 | 0 | 0 |
| 222 | 122 | 322 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 222O | 122O | 121 | 1335 | .02 | 10.57 | 0 | 0 | 0 |
| 223 | 123 | 120 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 224 | 124 | 124T | 1847 | .02 | 0 | 0 | 0 | 0 |
| 224T | 124T | 123 | 2136 | .02 | 0 | 0 | 0 | 0 |





| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 225 | 125 | 124 | 1376 | .02 | 0 | 0 | 0 | 0 |
| 226 | 126 | 326 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 426O | 126O | 124T | 223 | 0.02 | 9.5 | 0 | 0 | 0 |
| 227 | 127 | 327 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 427O | 127O | 126 | 733 | 0.02 | 7 | 7 | 0 | 0 |
| 228 | 128 | 128T | 96 | .02 | 0 | 0 | 0 | 0 |
| 228T | 128T | 126 | 1446 | .02 | 0 | 7 | 0 | 0 |
| 229 | 129 | 329 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 429O | 129O | 128T | 226 | .045 | 5 | 0 | 0 | 0 |
| 230T | 130T | 120T | 1799 | .045 | 0 | 0 | 0 | 0 |
| 231 | 131 | 331 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 231O | 131O | 130 | 3121 | .045 | 0 | 0 | 0 | 0 |
| 232 | 132 | 132T | 631 | .02 | 0 | 0 | 0 | 0 |
| 232T | 132T | 131 | 785 | .045 | 0 | 0 | 0 | 0 |
| 233 | 133 | 132T | 429 | .02 | 0 | 0 | 0 | 0 |
| 235 | 135 | 135T | 1627 | .02 | 0 | 0 | 0 | 0 |
| 235T | 135T | 134 | 1287 | .045 | 0 | 0 | 0 | 0 |
| 236 | 136 | 135T | 1834 | .02 | 0 | 0 | 0 | 0 |
| 238 | 138 | 138T | 1380 | .045 | 0 | 0 | 0 | 0 |
| 238T | 138T | 137 | 1890 | .045 | 0 | 0 | 0 | 0 |
| 439O | 139O | 138 | 684 | .045 | 7.62 | 0 | 0 | 0 |
| 240O | 140O | 139 | 1481 | .045 | 0 | 0 | 0 | 0 |
| 241 | 141 | 138T | 1783 | .045 | 0 | 0 | 0 | 0 |
| 246 | 146 | 142 | 1755 | .045 | 0 | 0 | 0 | 0 |
| 247 | 147 | 146 | 2433 | .045 | 0 | 0 | 0 | 0 |
| 248 | 148 | 147 | 1725 | .045 | 0 | 0 | 0 | 0 |
| 249 | 149 | 148 | 2811 | .045 | 0 | 0 | 0 | 0 |
| 250 | 150 | 150T | 1231 | .045 | 0 | 0 | 0 | 0 |
| 250T | 150T | 147 | 1828 | .045 | 0 | 0 | 0 | 0 |
| 251 | 151 | 150 | 296 | .045 | 0 | 0 | 0 | 0 |
| 252 | 152 | 151 | 2626 | .045 | 0 | 0 | 0 | 0 |
| 253 | 153 | 150T | 1794 | .045 | 0 | 0 | 0 | 0 |
| 254 | 154 | 150T | 2092 | .045 | 0 | 0 | 0 | 0 |
| 229O | 129O | 126 | 1661 | .01875 | 0 | 0 | 0 | 0 |
| 227O | 127O | 126O | 623 | .01875 | 0 | 0 | 0 | 0 |
| 226O | 126O | 120 | 2226 | .01875 | 0 | 0 | 0 | 0 |
| 202O | 102O | 102T | 2852 | .02 | 0 | 9 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 202 | 102 | 302 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 210T | 110T | 105 | 2333 | 0.045 | 0 | 0 | 0 | 0 |
| 245 | 145 | 143T | 2703 | .045 | 0 | 0 | 0 | 0 |
| 243T | 143T | 143 | 638 | .045 | 0 | 0 | 0 | 0 |
| 244 | 144 | 143T | 903 | .045 | 0 | 0 | 0 | 0 |
| 243 | 143 | 155 | 3359 | .045 | 0 | 0 | 0 | 0 |
| 234 | 134 | 130T | 40 | .045 | 0 | 0 | 0 | 0 |
| 230 | 130 | 130T | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 221 | 121 | 321N | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 207 | 107 | 307 | 1 | 0.01 | 0 | 0 | 0 | 0 |
| 240 | 140 | 340 | 1 | 0.01 | 0 | 0 | 0 | 0 |
| 239 | 139 | 339 | 1 | 0.01 | 0 | 0 | 0 | 0 |
| 207O | 107O | 106 | 2603 | 0.01875 | 0 | 0 | 0 | 0 |
| 206 | 106 | 105 | 1274 | 0.01875 | 0 | 12 | 0 | 0 |
| 239O | 139O | 138T | 1916 | 0.01875 | 0 | 0 | 0 | 0 |
| 204 | 104 | 100 | 523 | .045 | 0 | 2 | 0 | 0 |
| 202T | 102T | 101 | 1337 | 0.012 | 0 | 0 | 0 | 0 |
| 201 | 101 | 104 | 351 | 0.015 | 11.5 | 0 | 0 | 0 |

[OUTLETS]

| ;;Name | From Node | To Node | Offset | Type | QTable/Qcoeff | Qexpon | Gated |
|---|---|---|---|---|---|---|---|
| 502 | 302 | 102O | 0 | TABULAR/DEPTH | 502Outlet | | NO |
| 507 | 307 | 107O | 0 | TABULAR/DEPTH | 507Outlet | | NO |
| 516 | 316 | 116O | 0 | TABULAR/DEPTH | 516Outlet | | NO |
| 521S | 321S | 121O | 0 | TABULAR/DEPTH | 521SOutlet | | NO |
| 522 | 322 | 122O | 0 | TABULAR/DEPTH | 522Outlet | | NO |
| 526 | 326 | 126O | 0 | TABULAR/DEPTH | 526Outlet | | NO |
| 527 | 327 | 127O | 0 | TABULAR/DEPTH | 527Outlet | | NO |
| 529 | 329 | 129O | 0 | TABULAR/DEPTH | 529Outlet | | NO |
| 531 | 331 | 131O | 0 | TABULAR/DEPTH | 531Outlet | | NO |
| 539 | 339 | 139O | 0 | TABULAR/DEPTH | 539Outlet | | NO |
| 540 | 340 | 140O | 0 | TABULAR/DEPTH | 540Outlet | | NO |
| 521N | 321N | 321S | 0 | TABULAR/DEPTH | 521NOutlet | | NO |

[XSECTIONS]

| ;;Link | Shape | Geom1 | Geom2 | Geom3 | Geom4 | Barrels | Culvert |
|---|---|---|---|---|---|---|---|
| 203 | TRAPEZOIDAL | 7 | 3 | 2 | 4 | 1 | |
| 205 | TRAPEZOIDAL | 6 | 40 | 6 | 8 | 1 | |
| 406 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 | |
| 407O | TRAPEZOIDAL | 2 | 30 | 7 | 50 | 1 | |
| 208 | TRAPEZOIDAL | 5 | 12 | 3 | 2 | 1 | |





| | | | | | | |
|---|---|---|---|---|---|---|
| 209 | TRAPEZOIDAL | 3 | 6 | 5 | 5 | 1 |
| 210 | TRAPEZOIDAL | 10 | 6 | 5 | 3 | 1 |
| 211 | TRAPEZOIDAL | 1 | 166 | 26 | 29 | 1 |
| 212 | TRAPEZOIDAL | 2 | 54 | 5 | 56 | 1 |
| 212T | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 213 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 214 | TRAPEZOIDAL | 10 | 5 | 3 | 2 | 1 |
| 215 | TRAPEZOIDAL | 8 | 5 | 3 | 3 | 1 |
| 216 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 216O | TRAPEZOIDAL | 8 | 5 | 3 | 2 | 1 |
| 217 | TRAPEZOIDAL | 7 | 6 | 2 | 10 | 1 |
| 218 | TRAPEZOIDAL | 2 | 30 | 15 | 15 | 1 |
| 218T | TRAPEZOIDAL | 5 | 76 | 20 | 20 | 1 |
| 219 | TRAPEZOIDAL | 1 | 130 | 35 | 20 | 1 |
| 220 | TRAPEZOIDAL | 5 | 5 | 2 | 3 | 1 |
| 220T | TRAPEZOIDAL | 5 | 55 | 2 | 13 | 1 |
| 221O | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 222 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 222O | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 223 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 224 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 224T | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 225 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 226 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 426O | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 227 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 427O | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 228 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 228T | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 229 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 429O | TRAPEZOIDAL | 1 | 6 | 18 | 13 | 1 |
| 230T | TRAPEZOIDAL | 5 | 80 | 3 | 5 | 1 |
| 231 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 231O | TRAPEZOIDAL | 15 | 30 | 3 | 3 | 1 |
| 232 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 232T | TRAPEZOIDAL | 10 | 16 | 4 | 4 | 1 |
| 233 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 235 | TRAPEZOIDAL | 5 | 1 | 5 | 5 | 1 |
| 235T | TRAPEZOIDAL | 5 | 60 | 4 | 6 | 1 |
| 236 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 238 | TRAPEZOIDAL | 5 | 315 | 5 | 3 | 1 |
| 238T | TRAPEZOIDAL | 1 | 951 | 4 | 4 | 1 |
| 439O | TRAPEZOIDAL | 3 | 6 | 10 | 10 | 1 |
| 240O | TRAPEZOIDAL | 1 | 180 | 14 | 92 | 1 |
| 241 | TRAPEZOIDAL | 1 | 16 | 57 | 35 | 1 |
| 246 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 247 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 248 | TRAPEZOIDAL | 1 | 120 | 30 | 200 | 1 |
| 249 | TRAPEZOIDAL | 1 | 120 | 30 | 200 | 1 |
| 250 | TRAPEZOIDAL | 9 | 1050 | 9 | 5 | 1 |
| 250T | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 251 | TRAPEZOIDAL | 9 | 54 | 4 | 4 | 1 |
| 252 | TRAPEZOIDAL | 4 | 25 | 9 | 3 | 1 |
| 253 | TRAPEZOIDAL | 9 | 1050 | 9 | 5 | 1 |
| 254 | TRAPEZOIDAL | 9 | 1050 | 9 | 5 | 1 |
| 229O | CIRCULAR | 1.75 | 0 | 0 | 0 | 1 |
| 227O | CIRCULAR | 2 | 0 | 0 | 0 | 1 |
| 226O | CIRCULAR | 3 | 0 | 0 | 0 | 1 |
| 202O | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 202 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 210T | TRAPEZOIDAL | 10 | 6 | 3 | 2 | 1 |
| 245 | TRAPEZOIDAL | 2 | 127 | 7 | 3.3 | 1 |
| 243T | TRAPEZOIDAL | 4 | 600 | 3 | 3 | 1 |
| 244 | TRAPEZOIDAL | 2 | 30 | 20 | 20 | 1 |
| 243 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 234 | TRAPEZOIDAL | 5 | 60 | 4 | 6 | 1 |
| 230 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 221 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 207 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 240 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 239 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 207O | CIRCULAR | 3 | 0 | 0 | 0 | 1 |
| 206 | CIRCULAR | 3 | 0 | 0 | 0 | 1 |
| 239O | CIRCULAR | 3 | 0 | 0 | 0 | 1 |
| 204 | TRAPEZOIDAL | 10 | 10 | 2 | 1 | 1 |

```
202T             CIRCULAR     7                0          0          0          1
201              RECT_OPEN    5                9          0          0          1

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
;Stage-Discrhage from Merrick 2-20-15 Memo
502Outlet        Rating     0.00       0.00
502Outlet                   1.31       25.00
502Outlet                   1.91       50.00
502Outlet                   2.31       75.00
502Outlet                   4.21       100.00
502Outlet                   4.41       102.00
502Outlet                   5.51       191.00
502Outlet                   8.61       351.00
502Outlet                   9.11       369
502Outlet                   9.15       371
502Outlet                   10.11      407
502Outlet                   11         500
;
;Storage-Discharge Curve from 2002 OSP
504Outlet        Rating     0          0.00
504Outlet                   1.00       114.00
504Outlet                   4.50       228.00
504Outlet                   10.40      342.00
504Outlet                   18.30      484.00
504Outlet                   23.80      541.00
504Outlet                   26.60      1160.00
504Outlet                   29.40      2272.00
;
;Storage-Discharge Curve from 2002 OSP
507Outlet        Rating     0          0.00
507Outlet                   0.70       5.00
507Outlet                   1.70       8.00
507Outlet                   2.60       275.00
507Outlet                   2.80       325.00
507Outlet                   2.90       390.00
507Outlet                   3.10       450.00
507Outlet                   3.20       500.00
507Outlet                   3.30       600.00
507Outlet                   3.4        1000
;
;Storage-Discharge Curve from 2002 OSP
516Outlet        Rating     0          0.00
516Outlet                   0.7        0.70
516Outlet                   1.7        2.23
516Outlet                   2.7        4.24
516Outlet                   3.7        6.75
516Outlet                   4.7        15.29
516Outlet                   5.7        54.93
516Outlet                   6.7        109.45
516Outlet                   7.7        135.07
516Outlet                   8.7        143.96
516Outlet                   9.7        152.34
516Outlet                   10.7       160.29
516Outlet                   11.7       167.85
516Outlet                   12.7       175.09
516Outlet                   13.7       182.05
516Outlet                   14.7       188.74
;
;Storage-Discharge Curve from 2002 OSP
518Outlet        Rating     0.00       9.60
518Outlet                   0.20       35.00
518Outlet                   1.50       62.00
518Outlet                   3.90       95.00
;
;Storage-Discharge Curve from 2002 OSP
522Outlet        Rating     0          0.00
522Outlet                   0.70       6.40
522Outlet                   3.60       24.00
522Outlet                   7.00       38.00
522Outlet                   8.30       39.00
522Outlet                   12.20      500.00
;
;Storage-Discharge Curve from 2002 OSP
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526Outlet        Rating     0          0.00
526Outlet                   0.20       35.00
526Outlet                   0.70       58.00
526Outlet                   1.70       89.00
526Outlet                   2.80       140.00
526Outlet                   3.50       375.00
526Outlet                   4.20       750.00
;
;Storage-Discharge Curve from 2002 OSP
527Outlet        Rating     0          0.00
527Outlet                   0.30       8.00
527Outlet                   0.90       24.00
527Outlet                   1.70       100.00
527Outlet                   1.80       200.00
527Outlet                   1.90       500.00
;
;Storage-Discharge Curve from 2002 OSP
529Outlet        Rating     0          0.00
529Outlet                   0.10       21.00
529Outlet                   0.80       28.00
529Outlet                   1.00       36.00
529Outlet                   1.1        100
;
;Storage-Discharge Curve from 2002 OSP
531Outlet        Rating     0          0.00
531Outlet                   0.10       9.30
531Outlet                   0.70       28.00
531Outlet                   2.20       40.00
531Outlet                   4.30       40.00
531Outlet                   5.60       74.60
531Outlet                   6.90       200.00
531Outlet                   8.40       850.00
;
;Calculated in UD-Detention 3.07 using Cherrylane Subdivision Pond Details, 11/11/2015
539Outlet        Rating     0          0.00
539Outlet                   0.62       0.13
539Outlet                   1.62       0.47
539Outlet                   2.62       0.92
539Outlet                   3.62       1.46
539Outlet                   4.62       2.06
539Outlet                   5.62       8.32
539Outlet                   6.62       34.29
539Outlet                   7.62       50.13
539Outlet                   8.62       63.79
539Outlet                   9.62       165.92
539Outlet                   10.62      356.5
;
;Storage-Discharge Curve from 2002 OSP
545Outlet        Rating     0          12.00
545Outlet                   2.70       18.00
545Outlet                   2.90       27.00
545Outlet                   3.70       90.00
545Outlet                   5.30       98.00
545Outlet                   5.40       200.00
545Outlet                   5.5        500
;
;Storage-Discharge Curve from 2002 OSP
550Outlet        Rating     0          0.00
550Outlet                   0.20       1.10
550Outlet                   0.90       3.20
550Outlet                   1.90       5.30
550Outlet                   3.50       11.00
550Outlet                   5.30       11.00
550Outlet                   5.60       150.00
550Outlet                   6.00       500.00
550Outlet                   6.1        600
;
;Developed Using UD-Detention 3.07 and Thornton Survey
521SOutlet       Rating     0          0.00
521SOutlet                  0.63       1.87
521SOutlet                  1.63       10.45
521SOutlet                  2.63       19.31
521SOutlet                  3.63       24.53
521SOutlet                  4.63       28.82
521SOutlet                  5.63       155.55
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521SOutlet                  6.63       723.20
;
;Calculated in UD-Detention 3.07 using As-Builts
540Outlet        Rating     0          0.00
540Outlet                   2.2        10.21
540Outlet                   3.2        13.29
540Outlet                   4.2        15.78
540Outlet                   5.2        17.93
540Outlet                   6.2        19.85
540Outlet                   7.2        1084.25
540Outlet                   8.2        3417.34
;
;Developed Using UD-Detention_v3.07 and survey provided by Thornton
Outlet321N       Rating     0          0
Outlet321N                  0.83       28
Outlet321N                  1.83       417
Outlet321N                  2.83       2018
Outlet321N                  3.83       5778
Outlet321N                  4.83       13210
Outlet321N                  5.83       28187
Outlet321N                  6.83       56426
Outlet321N                  7.83       104919
;
;DEveloped from UD-Detention 3.07 and Thornton Survey
521NOutlet       Rating     0          0.00
521NOutlet                  0.83       3.01
521NOutlet                  1.83       12.75
521NOutlet                  2.83       20.41
521NOutlet                  3.83       25.40
521NOutlet                  4.83       29.56
521NOutlet                  5.83       33.24
521NOutlet                  6.48       35.41
521NOutlet                  6.83       139.39
521NOutlet                  7.83       894.08
;
;Stage-Area from Merrick 2-20-15 Memo
302Pond          Storage    0          0
302Pond                     1.11       131.17
302Pond                     2.11       724.28
302Pond                     3.11       1554.49
302Pond                     4.11       2768.68
302Pond                     5.11       5388.16
302Pond                     6.11       9693.27
302Pond                     7.11       19727.44
302Pond                     8.11       31642.7
302Pond                     9.11       61944.65
302Pond                     10.11      99022.90
302Pond                     11         99022.9
;
;Villages North Subdivision Filing No. 5 Pond 301 Construction Plans - Developed Info
316Pond          Storage    0          22000
316Pond                     0.7        59012
316Pond                     1.7        111281
316Pond                     2.7        251085
316Pond                     3.7        375069
316Pond                     4.7        447885
316Pond                     5.7        505814
316Pond                     6.7        542816
316Pond                     7.7        590463
316Pond                     8.7        618714
316Pond                     9.7        650622
316Pond                     10.7       700403
316Pond                     11.7       759679
316Pond                     12.7       854831
316Pond                     13.7       940000
316Pond                     14.7       1029979.768
;
;Calculated in UD-Detention 3.07 using LiDAR
Pond340          Storage    0          0
Pond340                     2.2        6514
Pond340                     3.2        40684
Pond340                     4.2        66995
Pond340                     5.2        89247
Pond340                     6.2        103191
Pond340                     7.2        114771
```





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Pond340                     8.2        120029
;
;Cherrylane Pond A - From Final Drainage Report Cherrylane Subdivision - March 2, 2012
Pond339          Storage    0          0
Pond339                     0.62       4674
Pond339                     1.62       19677
Pond339                     2.62       24349
Pond339                     3.62       27372
Pond339                     4.62       30874
Pond339                     5.62       34392
Pond339                     6.62       38240
Pond339                     7.62       42540
Pond339                     8.62       46952
Pond339                     9.62       51487
Pond339                     10.62      89765
;
;Developed Using LiDAR
Pond321N         Storage    0          0
Pond321N                    0.83       70
Pond321N                    1.83       721
Pond321N                    2.83       2466
Pond321N                    3.83       5053
Pond321N                    4.83       9812
Pond321N                    5.83       20142
Pond321N                    6.48       30668
Pond321N                    6.83       36336
Pond321N                    7.83       60650
;
;Developed from LiDAR and survey provided by Thornton
Pond321S         Storage    0          0
Pond321S                    0.63       20
Pond321S                    1.63       359
Pond321S                    2.63       5354
Pond321S                    3.63       15802
Pond321S                    4.63       23544
Pond321S                    5.63       30671
Pond321S                    6.63       39344

[REPORT]
;;Reporting Options
INPUT      NO
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS -2727.273 0.000 12727.273 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
102              2326.301           937.302
102O             2549.487           891.237
103              2355.675           1032.767
104              5281.076           1061.645
105              5051.857           1303.598
108              4375.127           4954.176
109              4947.917           6099.756
110              4411.845           2450.055
110T             4544.027           2450.055
111              4147.480           2567.551
112              3391.103           2530.833
112T             4080.787           2444.925
113              2913.778           2134.286
114              4499.966           2538.177
115              4096.076           3492.827
116              3617.973           3830.071
116O             3731.018           3707.371
117              3501.255           3375.332
118T             3405.790           4139.052
119              3280.951           4425.447
```

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120             2796.283          4469.508
120T            3229.547          4014.213
121             2707.257          5335.091
122             2399.944          6348.263
122O            2406.248          6227.161
123             2739.160          4534.291
124             1371.651          6268.656
124T            1430.399          4968.863
125             394.971           6275.999
126             1276.186          5079.015
127             1305.560          5453.532
128             446.375           5380.097
128T            439.031           5306.662
129             336.223           5416.814
131             142.061           5012.906
131O            288.826           4961.431
130T            2016.662          3915.474
132             -662.488          5314.006
132T            -333.490          5210.420
133             -493.588          5027.611
135             130.606           3456.110
135T            1268.843          3558.918
136             145.293           3250.493
138             6578.166          3096.280
138T            6952.683          2501.460
139             6870.727          3651.946
140             6776.439          4491.538
141             5968.659          2097.569
143             10133.472         7229.480
144             9611.016          7531.731
145             8885.450          6377.502
146             11535.003         6364.121
147             9914.494          6308.128
148             8715.114          6246.625
149             6864.561          6298.030
150             8642.264          5110.258
150T            9526.909          5080.321
151             8633.684          5313.334
152             6849.874          5372.753
153             8597.618          4410.760
154             8590.275          3735.161
118             3561.664          4497.215
107             5093.178          4360.765
143T            9782.077          7036.641
134             1929.754          3911.404
130             1988.692          3927.550
121O            2837.107          5106.543
140O            6819.915          4420.143
102T            4370.734          688.780
101             5181.614          989.255
100             5571.651          1054.699
137             7459.381          1664.305
142             12372.158         7237.993
155             12430.906         7737.348
129O            394.041           5334.485
127O            1319.012          5341.119
126O            1344.007          4988.087
139O            6834.331          3563.411
107O            5139.616          4220.793
106             5065.413          2640.985
316             3659.180          3779.209
302             2445.437          937.481
322             2404.147          6283.901
331             214.654           4978.744
327             1305.450          5403.159
326             1316.336          5033.744
329             370.348           5385.662
321S            2781.835          5192.826
307             5112.626          4314.404
340             6802.208          4455.556
339             6861.461          3615.285
321N            2720.356          5286.438

[VERTICES]
;;Link          X-Coord           Y-Coord
```





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;;-------------- ----------------- -----------------
205             5050.876          1252.727
205             5067.795          1237.218
205             5236.984          1223.119
205             5244.033          1196.330
205             5239.803          1149.804
205             5260.952          1114.556
205             5266.592          1091.998
406             5060.186          2474.274
406             5071.028          2428.197
406             5073.738          2184.262
406             5095.421          1536.479
406             5087.290          1338.620
407O            5119.936          4261.760
407O            5066.420          3354.662
407O            5063.744          3274.388
208             4463.859          4860.978
208             4482.476          4818.424
208             4509.072          4805.127
208             4908.008          4794.488
208             4945.242          4738.637
209             5044.893          5993.266
209             5044.893          5757.576
209             5044.893          5465.769
209             5078.563          4769.921
211             4209.124          2539.323
211             4230.807          2506.798
211             4355.485          2452.591
212             3470.559          2506.696
212             3614.693          2497.337
212             3725.133          2487.978
212             3818.726          2497.337
212             3944.141          2491.721
212T            4324.129          2437.437
213             3156.086          2006.909
213             3232.833          2006.909
213             3288.989          1975.087
213             3361.991          1975.087
213             3395.685          2010.652
213             3487.406          2025.627
213             3762.570          2413.103
213             3800.007          2443.053
215             4192.861          3218.284
215             4228.096          3147.813
215             4222.676          3069.212
215             4263.332          2819.856
215             4282.304          2730.413
215             4333.802          2646.391
215             4382.589          2611.156
215             4412.403          2584.052
215             4474.742          2570.500
216O            3867.615          3627.552
216O            3973.320          3548.951
217             3599.314          3558.905
217             3592.131          3594.824
217             3594.525          3652.295
217             3640.023          3709.766
218             3563.445          4429.537
218             3531.387          4374.327
218             3524.263          4336.926
218             3510.015          4328.021
218             3426.308          4320.897
218             3417.403          4299.525
218T            3461.056          4080.188
218T            3539.657          3936.537
218T            3569.472          3914.854
219             3352.641          4400.014
219             3371.613          4348.516
219             3349.930          4294.308
219             3352.641          4234.680
220             2862.060          4351.227
220             2948.792          4313.281
220             2992.159          4253.653
220             3062.629          4185.893
220             3143.941          4080.188
```

| | | |
|---|---|---|
| 220 | 3165.624 | 4072.056 |
| 220T | 3409.559 | 3931.116 |
| 220T | 3466.477 | 3904.012 |
| 220T | 3496.291 | 3860.646 |
| 220T | 3561.341 | 3852.515 |
| 221O | 2859.350 | 5061.349 |
| 221O | 2951.503 | 4874.332 |
| 221O | 2956.924 | 4730.681 |
| 221O | 2900.005 | 4608.714 |
| 222O | 2435.669 | 5869.131 |
| 222O | 2479.799 | 5801.884 |
| 222O | 2553.350 | 5761.956 |
| 222O | 2622.698 | 5740.942 |
| 222O | 2658.423 | 5709.420 |
| 222O | 2671.032 | 5675.797 |
| 222O | 2673.133 | 5631.666 |
| 222O | 2645.814 | 5574.927 |
| 222O | 2620.597 | 5539.202 |
| 222O | 2626.901 | 5467.752 |
| 222O | 2677.336 | 5408.912 |
| 224 | 1409.291 | 6210.554 |
| 224 | 1414.712 | 5020.693 |
| 224T | 2703.851 | 4617.082 |
| 225 | 1276.482 | 6278.314 |
| 427O | 1377.770 | 5287.099 |
| 427O | 1380.242 | 5082.360 |
| 427O | 1339.783 | 5087.177 |
| 427O | 1307.031 | 5091.030 |
| 228T | 438.971 | 5204.999 |
| 228T | 463.365 | 5188.737 |
| 228T | 569.070 | 5137.240 |
| 228T | 840.109 | 5085.742 |
| 228T | 1146.383 | 5069.480 |
| 228T | 1216.853 | 5072.190 |
| 230T | 2349.796 | 3876.908 |
| 230T | 2482.605 | 3874.198 |
| 230T | 2544.944 | 3898.591 |
| 230T | 2661.491 | 3912.143 |
| 230T | 2745.513 | 3933.827 |
| 230T | 2916.268 | 3941.958 |
| 230T | 3016.552 | 3977.193 |
| 230T | 3149.361 | 4009.717 |
| 231O | 319.714 | 4947.512 |
| 231O | 349.529 | 4901.436 |
| 231O | 772.349 | 4546.375 |
| 231O | 807.584 | 4467.773 |
| 231O | 829.268 | 4484.036 |
| 231O | 934.973 | 4465.063 |
| 231O | 972.918 | 4446.090 |
| 231O | 1016.284 | 4446.090 |
| 231O | 1054.230 | 4435.249 |
| 231O | 1108.438 | 4381.041 |
| 231O | 1143.673 | 4324.123 |
| 231O | 1222.274 | 4305.150 |
| 231O | 1246.668 | 4288.888 |
| 231O | 1279.192 | 4280.756 |
| 231O | 1845.664 | 3982.614 |
| 232 | -612.660 | 5283.601 |
| 232 | -588.266 | 5270.049 |
| 232 | -574.714 | 5237.524 |
| 232 | -553.031 | 5226.682 |
| 232 | -536.769 | 5251.076 |
| 232 | -496.113 | 5297.153 |
| 232 | -447.326 | 5297.153 |
| 232 | -384.987 | 5275.470 |
| 233 | -393.118 | 5039.666 |
| 233 | -398.539 | 5158.923 |
| 233 | -382.277 | 5191.447 |
| 235 | 409.157 | 3437.825 |
| 235 | 577.201 | 3478.481 |
| 235 | 680.196 | 3516.426 |
| 235 | 937.683 | 3562.503 |
| 235 | 1162.646 | 3570.634 |
| 235T | 1284.613 | 3719.706 |
| 235T | 1346.952 | 3760.362 |





| | | |
|---|---|---|
| 235T | 1406.581 | 3749.520 |
| 235T | 1523.127 | 3754.941 |
| 235T | 1636.964 | 3830.832 |
| 235T | 1742.669 | 3830.832 |
| 235T | 1802.298 | 3879.619 |
| 235T | 1880.899 | 3887.750 |
| 236 | 487.758 | 3223.704 |
| 236 | 829.268 | 3329.410 |
| 236 | 1056.940 | 3383.617 |
| 236 | 1206.012 | 3372.776 |
| 238 | 6610.529 | 3055.660 |
| 238 | 6629.502 | 3042.108 |
| 238 | 6645.764 | 3036.687 |
| 238 | 6686.420 | 3006.873 |
| 238 | 6824.650 | 3071.923 |
| 238 | 6924.934 | 3055.660 |
| 238 | 6935.776 | 2912.010 |
| 238 | 6962.880 | 2860.512 |
| 238 | 6957.459 | 2825.277 |
| 238 | 6976.432 | 2741.255 |
| 238 | 6946.617 | 2668.074 |
| 238 | 6924.934 | 2573.211 |
| 238 | 6922.224 | 2532.555 |
| 238T | 6987.273 | 2548.817 |
| 238T | 7038.771 | 2589.473 |
| 238T | 7147.186 | 2489.189 |
| 238T | 7220.367 | 2356.380 |
| 238T | 7149.897 | 2101.603 |
| 238T | 7163.449 | 2066.368 |
| 238T | 7125.503 | 1882.061 |
| 238T | 7193.263 | 1792.619 |
| 238T | 7364.018 | 1749.252 |
| 439O | 6754.852 | 3426.909 |
| 240O | 6824.650 | 4364.779 |
| 240O | 6849.043 | 4337.675 |
| 240O | 6857.175 | 3914.854 |
| 240O | 6859.885 | 3860.646 |
| 240O | 6881.568 | 3817.280 |
| 241 | 6022.375 | 2077.209 |
| 241 | 6090.134 | 2199.177 |
| 241 | 6239.206 | 2139.548 |
| 241 | 6298.834 | 2144.969 |
| 241 | 6325.938 | 2185.625 |
| 241 | 6344.911 | 2215.439 |
| 241 | 6396.408 | 2234.412 |
| 241 | 6420.802 | 2261.516 |
| 241 | 6464.168 | 2280.489 |
| 241 | 6534.638 | 2345.538 |
| 241 | 6618.660 | 2359.090 |
| 241 | 6697.262 | 2394.325 |
| 241 | 6708.103 | 2459.374 |
| 241 | 6748.759 | 2502.741 |
| 241 | 6762.311 | 2556.948 |
| 246 | 11538.018 | 6424.675 |
| 247 | 9944.309 | 6362.336 |
| 247 | 9965.992 | 6367.757 |
| 247 | 10098.801 | 6321.680 |
| 247 | 10139.457 | 6324.390 |
| 247 | 10171.981 | 6286.445 |
| 247 | 11413.340 | 6286.445 |
| 248 | 8797.814 | 6245.789 |
| 248 | 8889.967 | 6272.893 |
| 248 | 8949.596 | 6270.183 |
| 248 | 8982.120 | 6294.576 |
| 248 | 9171.848 | 6289.155 |
| 248 | 9364.285 | 6272.893 |
| 248 | 9475.411 | 6278.314 |
| 249 | 6919.514 | 6270.183 |
| 249 | 6989.984 | 6234.948 |
| 249 | 7033.350 | 6232.237 |
| 249 | 7168.869 | 6256.631 |
| 249 | 7469.723 | 6264.762 |
| 249 | 7602.532 | 6226.816 |
| 249 | 7843.757 | 6205.133 |
| 249 | 7906.096 | 6188.871 |

| | | |
|---|---|---|
| 249 | 8047.036 | 6194.292 |
| 249 | 8217.790 | 6161.767 |
| 249 | 8290.971 | 6186.161 |
| 249 | 8350.599 | 6175.319 |
| 249 | 8410.228 | 6112.980 |
| 249 | 8453.594 | 6096.718 |
| 249 | 8597.245 | 6118.401 |
| 250 | 8903.519 | 5053.218 |
| 252 | 6930.355 | 5294.442 |
| 252 | 7242.050 | 5291.732 |
| 252 | 7448.040 | 5294.442 |
| 252 | 7691.975 | 5299.863 |
| 252 | 7794.970 | 5305.284 |
| 252 | 8009.090 | 5299.863 |
| 252 | 8122.927 | 5286.311 |
| 252 | 8307.233 | 5286.311 |
| 252 | 8396.676 | 5294.442 |
| 252 | 8421.070 | 5310.705 |
| 253 | 8742.170 | 4446.078 |
| 253 | 8785.175 | 4492.155 |
| 253 | 8797.462 | 4529.016 |
| 253 | 8825.108 | 4562.806 |
| 253 | 8831.251 | 4648.816 |
| 253 | 8861.969 | 4716.395 |
| 253 | 8935.692 | 4719.467 |
| 253 | 9393.388 | 4879.199 |
| 253 | 9503.972 | 4989.784 |
| 254 | 9458.465 | 4879.075 |
| 2290 | 412.222 | 5339.144 |
| 2290 | 440.348 | 5350.132 |
| 2290 | 499.854 | 5287.792 |
| 2290 | 508.355 | 5219.785 |
| 2290 | 1216.760 | 5109.274 |
| 2270 | 1394.363 | 5323.874 |
| 2270 | 1393.373 | 5050.216 |
| 2260 | 1397.887 | 5012.595 |
| 2260 | 1466.037 | 4992.342 |
| 2260 | 2684.493 | 4725.982 |
| 2020 | 2566.828 | 868.115 |
| 2020 | 2641.975 | 801.638 |
| 2020 | 2795.160 | 714.930 |
| 2020 | 3699.816 | 691.808 |
| 210T | 4580.478 | 2358.835 |
| 210T | 4622.410 | 2379.801 |
| 210T | 4664.343 | 2379.801 |
| 210T | 4701.033 | 2316.902 |
| 210T | 4732.482 | 2285.453 |
| 210T | 4737.724 | 2212.072 |
| 210T | 4779.656 | 2175.381 |
| 210T | 4858.279 | 2122.966 |
| 210T | 4936.902 | 2028.618 |
| 210T | 4931.661 | 1944.754 |
| 210T | 4926.419 | 1871.372 |
| 210T | 4973.593 | 1792.749 |
| 210T | 5015.525 | 1719.368 |
| 245 | 9152.137 | 6398.130 |
| 245 | 9593.523 | 6410.986 |
| 245 | 9859.213 | 6419.556 |
| 245 | 9910.636 | 6462.409 |
| 245 | 9782.077 | 6655.248 |
| 245 | 9747.795 | 6723.813 |
| 245 | 9756.365 | 6848.087 |
| 245 | 9777.792 | 6950.935 |
| 243T | 9824.930 | 7092.350 |
| 243T | 9953.489 | 7165.200 |
| 244 | 9632.091 | 7310.901 |
| 244 | 9623.521 | 7139.488 |
| 244 | 9627.806 | 7066.638 |
| 244 | 9653.518 | 7032.355 |
| 244 | 9692.086 | 7023.785 |
| 243 | 10206.323 | 7298.045 |
| 207O | 5155.858 | 4201.364 |
| 207O | 5117.541 | 2680.183 |
| 206 | 5125.205 | 2572.895 |
| 206 | 5113.710 | 1316.101 |





| | | |
|---|---|---|
| 239O | 7038.845 | 2990.441 |
| 204 | 5313.532 | 1014.113 |
| 204 | 5339.477 | 991.984 |
| 204 | 5391.367 | 985.116 |
| 204 | 5432.573 | 1038.532 |
| 204 | 5503.540 | 1031.664 |
| 204 | 5527.195 | 1062.187 |
| 202T | 4754.477 | 688.780 |
| 202T | 4910.469 | 810.454 |
| 202T | 4907.350 | 885.331 |
| 202T | 4963.507 | 932.129 |
| 202T | 5022.784 | 941.488 |
| 202T | 5057.103 | 922.769 |

# EPA SWMM 5.1

# 100-YEAR FUTURE CONDITIONS OUTPUT

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)
--------------------------------------------------------------

WARNING 04: minimum elevation drop used for Conduit 216
WARNING 04: minimum elevation drop used for Conduit 222
WARNING 04: minimum elevation drop used for Conduit 223
WARNING 04: minimum elevation drop used for Conduit 226
WARNING 04: minimum elevation drop used for Conduit 227
WARNING 04: minimum elevation drop used for Conduit 229
WARNING 04: minimum elevation drop used for Conduit 231
WARNING 04: minimum elevation drop used for Conduit 250T
WARNING 04: minimum elevation drop used for Conduit 202
WARNING 04: minimum elevation drop used for Conduit 230
WARNING 04: minimum elevation drop used for Conduit 221
WARNING 04: minimum elevation drop used for Conduit 207
WARNING 08: elevation drop exceeds length for Conduit 240
WARNING 08: elevation drop exceeds length for Conduit 239

***********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
***********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Flow Routing Method ...... KINWAVE
Starting Date ............ 01/01/2005 00:00:00
Ending Date .............. 01/01/2005 06:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Routing Time Step ........ 5.00 sec


*************************        Volume        Volume
Flow Routing Continuity       acre-feet      10^6 gal
*************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.000         0.000
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........       479.926       156.391
External Outflow .........       397.644       129.578
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......        94.625        30.835
Continuity Error (%) .....        -2.572


*********************************
Highest Flow Instability Indexes
*********************************
Link 202O (14)
Link 502 (13)
Link 202T (13)
Link 201 (12)
Link 204 (10)


*************************
Routing Time Step Summary
*************************
```





```
Minimum Time Step           :     5.00 sec
Average Time Step           :     5.00 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00
Percent Not Converging      :     0.00


******************
Node Depth Summary
******************
```

| Node | Type | Average Depth Feet | Maximum Depth Feet | Maximum HGL Feet | Time of Max Occurrence days hr:min | Reported Max Depth Feet |
|---|---|---|---|---|---|---|
| 102 | JUNCTION | 0.65 | 2.16 | 5151.05 | 0 00:45 | 2.16 |
| 102O | JUNCTION | 0.51 | 1.44 | 5150.33 | 0 00:57 | 1.44 |
| 103 | JUNCTION | 0.65 | 2.16 | 5153.16 | 0 00:45 | 2.16 |
| 104 | JUNCTION | 2.81 | 6.00 | 5086.00 | 0 00:53 | 5.99 |
| 105 | JUNCTION | 13.50 | 15.00 | 5100.00 | 0 00:26 | 15.00 |
| 108 | JUNCTION | 0.29 | 1.17 | 5180.17 | 0 00:45 | 1.17 |
| 109 | JUNCTION | 0.28 | 1.27 | 5195.27 | 0 00:40 | 1.27 |
| 110 | JUNCTION | 0.47 | 2.08 | 5122.08 | 0 00:42 | 2.07 |
| 110T | JUNCTION | 10.46 | 12.08 | 5116.08 | 0 00:43 | 12.07 |
| 111 | JUNCTION | 0.04 | 0.26 | 5123.26 | 0 00:35 | 0.26 |
| 112 | JUNCTION | 0.03 | 0.14 | 5164.14 | 0 00:35 | 0.14 |
| 112T | JUNCTION | 16.20 | 16.89 | 5139.89 | 0 00:42 | 16.88 |
| 113 | JUNCTION | 0.19 | 0.91 | 5166.91 | 0 00:35 | 0.90 |
| 114 | JUNCTION | 8.28 | 8.58 | 5113.58 | 0 02:03 | 8.58 |
| 115 | JUNCTION | 6.03 | 6.45 | 5138.45 | 0 02:39 | 6.45 |
| 116 | JUNCTION | 0.92 | 2.64 | 5154.94 | 0 01:04 | 2.64 |
| 116O | JUNCTION | 2.05 | 2.45 | 5154.75 | 0 02:37 | 2.45 |
| 117 | JUNCTION | 0.49 | 1.88 | 5163.88 | 0 00:45 | 1.88 |
| 118T | JUNCTION | 8.04 | 8.13 | 5166.13 | 0 00:48 | 8.13 |
| 119 | JUNCTION | 0.04 | 0.14 | 5172.14 | 0 00:40 | 0.14 |
| 120 | JUNCTION | 1.55 | 3.61 | 5180.61 | 0 00:56 | 3.61 |
| 120T | JUNCTION | 1.51 | 3.61 | 5161.61 | 0 00:57 | 3.61 |
| 121 | JUNCTION | 0.35 | 0.50 | 5216.67 | 0 01:39 | 0.50 |
| 122 | JUNCTION | 0.00 | 0.00 | 5259.00 | 0 00:00 | 0.00 |
| 122O | JUNCTION | 10.93 | 11.07 | 5270.07 | 0 01:36 | 11.07 |
| 123 | JUNCTION | 0.28 | 1.02 | 5178.02 | 0 01:05 | 1.02 |
| 124 | JUNCTION | 0.19 | 0.68 | 5286.68 | 0 00:39 | 0.68 |
| 124T | JUNCTION | 0.32 | 1.35 | 5223.35 | 0 01:05 | 1.35 |
| 125 | JUNCTION | 0.14 | 0.44 | 5316.44 | 0 00:45 | 0.44 |
| 126 | JUNCTION | 7.15 | 7.60 | 5220.60 | 0 00:56 | 7.59 |
| 127 | JUNCTION | 0.00 | 0.00 | 5241.00 | 0 00:00 | 0.00 |
| 128 | JUNCTION | 0.12 | 0.39 | 5266.39 | 0 00:40 | 0.39 |
| 128T | JUNCTION | 0.15 | 0.66 | 5264.66 | 0 00:52 | 0.65 |
| 129 | JUNCTION | 0.00 | 0.00 | 5267.00 | 0 00:00 | 0.00 |
| 131 | JUNCTION | 0.34 | 1.75 | 5251.75 | 0 00:41 | 1.74 |
| 131O | JUNCTION | 0.38 | 1.45 | 5251.45 | 0 00:53 | 1.44 |
| 130T | JUNCTION | 0.43 | 1.49 | 5184.49 | 0 00:59 | 1.49 |
| 132 | JUNCTION | 0.30 | 1.33 | 5287.33 | 0 00:35 | 1.32 |
| 132T | JUNCTION | 0.35 | 1.75 | 5280.75 | 0 00:40 | 1.74 |
| 133 | JUNCTION | 0.20 | 0.76 | 5293.76 | 0 00:40 | 0.76 |
| 135 | JUNCTION | 0.32 | 1.42 | 5274.42 | 0 00:35 | 1.42 |
| 135T | JUNCTION | 0.35 | 1.42 | 5237.42 | 0 00:40 | 1.41 |
| 136 | JUNCTION | 0.19 | 0.54 | 5276.54 | 0 00:45 | 0.54 |
| 138 | JUNCTION | 0.50 | 1.38 | 5080.38 | 0 01:46 | 1.37 |
| 138T | JUNCTION | 2.26 | 3.00 | 5076.00 | 0 00:52 | 3.00 |
| 139 | JUNCTION | 0.21 | 0.45 | 5087.45 | 0 01:45 | 0.45 |
| 140 | JUNCTION | 0.00 | 0.00 | 5092.00 | 0 00:00 | 0.00 |
| 141 | JUNCTION | 0.19 | 0.69 | 5093.69 | 0 00:45 | 0.69 |
| 143 | JUNCTION | 0.18 | 0.60 | 5054.60 | 0 01:07 | 0.60 |
| 144 | JUNCTION | 0.25 | 0.81 | 5075.81 | 0 00:50 | 0.81 |
| 145 | JUNCTION | 0.19 | 0.95 | 5067.95 | 0 00:40 | 0.94 |
| 146 | JUNCTION | 0.00 | 0.00 | 5054.00 | 0 00:00 | 0.00 |
| 147 | JUNCTION | 0.15 | 0.43 | 5055.43 | 0 01:12 | 0.42 |
| 148 | JUNCTION | 0.14 | 0.43 | 5073.43 | 0 00:59 | 0.43 |
| 149 | JUNCTION | 0.07 | 0.28 | 5115.28 | 0 00:45 | 0.28 |
| 150 | JUNCTION | 0.23 | 0.97 | 5056.97 | 0 00:48 | 0.97 |
| 150T | JUNCTION | 0.16 | 0.47 | 5055.47 | 0 01:17 | 0.47 |
| 151 | JUNCTION | 0.27 | 1.19 | 5062.19 | 0 00:48 | 1.19 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 152 | JUNCTION | 0.24 | 1.23 | 5101.23 | 0 | 00:40 | 1.23 |
| 153 | JUNCTION | 0.02 | 0.07 | 5063.07 | 0 | 00:45 | 0.07 |
| 154 | JUNCTION | 0.02 | 0.06 | 5069.06 | 0 | 00:55 | 0.06 |
| 118 | JUNCTION | 3.12 | 3.59 | 5176.59 | 0 | 00:40 | 3.59 |
| 107 | JUNCTION | 20.30 | 21.17 | 5159.17 | 0 | 00:47 | 21.17 |
| 143T | JUNCTION | 0.26 | 0.85 | 5055.85 | 0 | 00:59 | 0.85 |
| 134 | JUNCTION | 0.20 | 0.83 | 5184.83 | 0 | 00:45 | 0.83 |
| 130 | JUNCTION | 0.39 | 1.37 | 5184.37 | 0 | 01:01 | 1.36 |
| 121O | JUNCTION | 6.08 | 6.28 | 5204.65 | 0 | 01:29 | 6.28 |
| 140O | JUNCTION | 0.23 | 0.54 | 5090.34 | 0 | 01:17 | 0.53 |
| 102T | JUNCTION | 9.53 | 10.44 | 5107.44 | 0 | 01:02 | 10.44 |
| 101 | JUNCTION | 12.07 | 13.65 | 5098.00 | 0 | 00:49 | 13.65 |
| 100 | OUTFALL | 4.80 | 8.00 | 5075.00 | 0 | 00:54 | 7.99 |
| 137 | OUTFALL | 0.14 | 0.27 | 5069.27 | 0 | 02:10 | 0.27 |
| 142 | OUTFALL | 0.00 | 0.00 | 5051.00 | 0 | 00:00 | 0.00 |
| 155 | OUTFALL | 0.00 | 0.00 | 5046.00 | 0 | 00:00 | 0.00 |
| 129O | DIVIDER | 5.10 | 5.66 | 5272.66 | 0 | 00:52 | 5.64 |
| 127O | DIVIDER | 7.06 | 7.57 | 5248.57 | 0 | 00:47 | 7.57 |
| 126O | DIVIDER | 9.75 | 10.85 | 5223.85 | 0 | 01:04 | 10.85 |
| 139O | DIVIDER | 8.09 | 9.00 | 5088.38 | 0 | 01:43 | 9.00 |
| 107O | DIVIDER | 7.15 | 8.03 | 5146.03 | 0 | 00:48 | 8.03 |
| 106 | DIVIDER | 6.35 | 7.47 | 5117.47 | 0 | 00:58 | 7.47 |
| 316 | STORAGE | 8.66 | 10.94 | 5163.24 | 0 | 02:37 | 10.94 |
| 302 | STORAGE | 2.09 | 7.98 | 5156.87 | 0 | 00:57 | 7.97 |
| 322 | STORAGE | 2.66 | 5.75 | 5264.75 | 0 | 01:36 | 5.75 |
| 331 | STORAGE | 2.25 | 7.09 | 5257.09 | 0 | 00:53 | 7.08 |
| 327 | STORAGE | 0.31 | 1.48 | 5242.48 | 0 | 00:47 | 1.48 |
| 326 | STORAGE | 0.42 | 2.56 | 5215.56 | 0 | 01:04 | 2.56 |
| 329 | STORAGE | 0.21 | 1.03 | 5268.03 | 0 | 00:52 | 1.03 |
| 321S | STORAGE | 3.21 | 4.78 | 5203.15 | 0 | 01:29 | 4.78 |
| 307 | STORAGE | 1.27 | 2.40 | 5140.40 | 0 | 00:48 | 2.40 |
| 340 | STORAGE | 5.02 | 6.27 | 5096.07 | 0 | 01:17 | 6.27 |
| 339 | STORAGE | 6.59 | 9.08 | 5088.46 | 0 | 01:43 | 9.08 |
| 321N | STORAGE | 3.74 | 6.54 | 5222.71 | 0 | 01:16 | 6.54 |

**********
Node Inflow Summary
**********

| Node | Type | Maximum Lateral Inflow CFS | Maximum Total Inflow CFS | Time of Max Occurrence days hr:min | | Lateral Inflow Volume 10^6 gal | Total Inflow Volume 10^6 gal | Flow Balance Error Percent |
|---|---|---|---|---|---|---|---|---|
| 102 | JUNCTION | 159.01 | 334.90 | 0 | 00:50 | 5.55 | 11.3 | 0.000 |
| 102O | JUNCTION | 0.00 | 318.52 | 0 | 00:57 | 0 | 11.3 | 0.000 |
| 103 | JUNCTION | 176.35 | 176.35 | 0 | 00:45 | 5.75 | 5.75 | 0.000 |
| 104 | JUNCTION | 70.89 | 1274.23 | 0 | 00:53 | 1.77 | 60.2 | 0.000 |
| 105 | JUNCTION | 159.61 | 703.47 | 0 | 00:55 | 4.46 | 41 | 0.000 |
| 108 | JUNCTION | 68.87 | 68.87 | 0 | 00:45 | 2.04 | 2.04 | 0.000 |
| 109 | JUNCTION | 65.48 | 65.48 | 0 | 00:40 | 1.6 | 1.6 | 0.000 |
| 110 | JUNCTION | 47.67 | 194.07 | 0 | 00:42 | 1.32 | 4.39 | 0.000 |
| 110T | JUNCTION | 0.00 | 300.30 | 0 | 00:42 | 0 | 27 | 0.000 |
| 111 | JUNCTION | 50.46 | 50.46 | 0 | 00:35 | 0.994 | 0.994 | 0.000 |
| 112 | JUNCTION | 15.33 | 15.33 | 0 | 00:35 | 0.359 | 0.359 | 0.000 |
| 112T | JUNCTION | 0.00 | 99.57 | 0 | 00:42 | 0 | 2.08 | 0.000 |
| 113 | JUNCTION | 89.28 | 89.28 | 0 | 00:35 | 1.71 | 1.71 | 0.000 |
| 114 | JUNCTION | 6.58 | 168.33 | 0 | 02:02 | 0.357 | 22.6 | 0.000 |
| 115 | JUNCTION | 106.96 | 164.78 | 0 | 02:00 | 1.82 | 22.6 | -0.000 |
| 116 | JUNCTION | 185.99 | 1316.32 | 0 | 01:03 | 4.43 | 46.4 | 0.000 |
| 116O | JUNCTION | 0.00 | 162.09 | 0 | 02:37 | 0 | 21 | 0.000 |
| 117 | JUNCTION | 134.66 | 134.66 | 0 | 00:45 | 3.81 | 3.81 | 0.000 |
| 118T | JUNCTION | 0.00 | 87.63 | 0 | 00:43 | 0 | 2.28 | 0.000 |
| 119 | JUNCTION | 17.46 | 17.46 | 0 | 00:40 | 0.558 | 0.558 | 0.000 |
| 120 | JUNCTION | 34.28 | 390.98 | 0 | 00:56 | 0.883 | 16.3 | 0.000 |
| 120T | JUNCTION | 0.00 | 1001.32 | 0 | 01:03 | 0 | 35.9 | 0.000 |
| 121 | JUNCTION | 35.07 | 54.64 | 0 | 01:05 | 0.986 | 3.76 | 0.000 |
| 122 | JUNCTION | 121.69 | 121.69 | 0 | 00:40 | 2.95 | 2.95 | 0.000 |
| 122O | JUNCTION | 0.00 | 32.84 | 0 | 01:36 | 0 | 2.78 | 0.000 |
| 123 | JUNCTION | 156.02 | 282.03 | 0 | 00:58 | 4.62 | 8.53 | 0.000 |
| 124 | JUNCTION | 53.95 | 67.52 | 0 | 00:39 | 1.04 | 1.63 | 0.000 |
| 124T | JUNCTION | 0.00 | 151.28 | 0 | 01:01 | 0 | 3.91 | 0.000 |
| 125 | JUNCTION | 18.26 | 18.26 | 0 | 00:45 | 0.59 | 0.59 | 0.000 |





| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 126 | JUNCTION | 85.78 | 158.86 | 0 | 00:54 | 1.55 | 4.11 | 0.000 |
| 127 | JUNCTION | 101.60 | 101.60 | 0 | 00:35 | 1.9 | 1.9 | 0.000 |
| 128 | JUNCTION | 12.50 | 12.50 | 0 | 00:40 | 0.385 | 0.385 | 0.000 |
| 128T | JUNCTION | 0.00 | 47.65 | 0 | 00:52 | 0 | 0.96 | 0.000 |
| 129 | JUNCTION | 64.10 | 64.10 | 0 | 00:40 | 1.59 | 1.59 | 0.000 |
| 131 | JUNCTION | 33.39 | 339.70 | 0 | 00:41 | 0.842 | 7.52 | 0.000 |
| 131O | JUNCTION | 0.00 | 282.93 | 0 | 00:53 | 0 | 7.51 | 0.000 |
| 130T | JUNCTION | 0.00 | 619.23 | 0 | 00:59 | 0 | 19.6 | 0.000 |
| 132 | JUNCTION | 219.28 | 219.28 | 0 | 00:35 | 4.51 | 4.51 | 0.000 |
| 132T | JUNCTION | 0.00 | 306.70 | 0 | 00:40 | 0 | 6.67 | 0.000 |
| 133 | JUNCTION | 89.01 | 89.01 | 0 | 00:40 | 2.16 | 2.16 | 0.000 |
| 135 | JUNCTION | 105.41 | 105.41 | 0 | 00:35 | 2.31 | 2.31 | 0.000 |
| 135T | JUNCTION | 0.00 | 130.66 | 0 | 00:42 | 0 | 3.37 | 0.000 |
| 136 | JUNCTION | 30.08 | 30.08 | 0 | 00:45 | 1.06 | 1.06 | 0.000 |
| 138 | JUNCTION | 73.87 | 129.19 | 0 | 01:13 | 2.24 | 5.66 | 0.000 |
| 138T | JUNCTION | 0.00 | 193.65 | 0 | 01:21 | 0 | 11.1 | 0.000 |
| 139 | JUNCTION | 157.91 | 158.63 | 0 | 00:40 | 4.07 | 7.83 | 0.000 |
| 140 | JUNCTION | 129.28 | 129.28 | 0 | 00:50 | 4.54 | 4.54 | 0.000 |
| 141 | JUNCTION | 63.72 | 63.72 | 0 | 00:45 | 1.92 | 1.92 | 0.000 |
| 143 | JUNCTION | 136.26 | 433.38 | 0 | 01:04 | 3.5 | 14.8 | 0.000 |
| 144 | JUNCTION | 131.46 | 131.46 | 0 | 00:50 | 4.72 | 4.72 | 0.000 |
| 145 | JUNCTION | 257.76 | 257.76 | 0 | 00:40 | 6.17 | 6.17 | 0.000 |
| 146 | JUNCTION | 99.25 | 638.79 | 0 | 01:11 | 3 | 27.3 | 0.000 |
| 147 | JUNCTION | 184.64 | 568.78 | 0 | 01:13 | 6.15 | 24.3 | 0.000 |
| 148 | JUNCTION | 90.30 | 118.41 | 0 | 00:59 | 2.44 | 4.49 | 0.000 |
| 149 | JUNCTION | 63.55 | 63.55 | 0 | 00:45 | 1.9 | 1.9 | 0.000 |
| 150 | JUNCTION | 129.47 | 353.70 | 0 | 00:47 | 3.95 | 10.2 | 0.000 |
| 150T | JUNCTION | 0.00 | 314.57 | 0 | 01:19 | 0 | 13.6 | 0.000 |
| 151 | JUNCTION | 77.01 | 226.79 | 0 | 00:48 | 2.56 | 6.21 | 0.000 |
| 152 | JUNCTION | 160.01 | 160.01 | 0 | 00:40 | 3.6 | 3.6 | 0.000 |
| 153 | JUNCTION | 30.06 | 30.06 | 0 | 00:45 | 0.991 | 0.991 | -0.000 |
| 154 | JUNCTION | 29.49 | 29.49 | 0 | 00:55 | 1.29 | 1.29 | 0.000 |
| 118 | JUNCTION | 72.04 | 72.04 | 0 | 00:40 | 1.72 | 1.72 | 0.000 |
| 107 | JUNCTION | 96.79 | 217.89 | 0 | 00:45 | 2.28 | 5.93 | 0.000 |
| 143T | JUNCTION | 0.00 | 341.63 | 0 | 00:58 | 0 | 11.2 | 0.000 |
| 134 | JUNCTION | 104.54 | 233.92 | 0 | 00:45 | 3.06 | 6.44 | 0.000 |
| 130 | JUNCTION | 186.15 | 418.35 | 0 | 01:00 | 5.61 | 13.2 | 0.000 |
| 121O | JUNCTION | 0.00 | 48.14 | 0 | 01:29 | 0 | 3.76 | 0.000 |
| 140O | JUNCTION | 0.00 | 97.70 | 0 | 01:17 | 0 | 4.03 | 0.000 |
| 102T | JUNCTION | 283.60 | 488.35 | 0 | 00:48 | 5.27 | 16.6 | 0.000 |
| 101 | JUNCTION | 37.25 | 522.75 | 0 | 00:49 | 0.992 | 17.6 | 0.000 |
| 100 | OUTFALL | 18.51 | 1287.97 | 0 | 00:54 | 0.432 | 60.5 | 0.000 |
| 137 | OUTFALL | 69.34 | 204.14 | 0 | 01:51 | 3.73 | 14.6 | 0.000 |
| 142 | OUTFALL | 142.10 | 756.04 | 0 | 01:09 | 4.93 | 32.2 | 0.000 |
| 155 | OUTFALL | 388.76 | 635.72 | 0 | 00:58 | 7.41 | 22.2 | 0.000 |
| 129O | DIVIDER | 0.00 | 55.96 | 0 | 00:52 | 0 | 1.59 | -0.000 |
| 127O | DIVIDER | 0.00 | 79.27 | 0 | 00:47 | 0 | 1.9 | 0.000 |
| 126O | DIVIDER | 0.00 | 162.26 | 0 | 01:04 | 0 | 5.42 | 0.000 |
| 139O | DIVIDER | 0.00 | 110.91 | 0 | 01:43 | 0 | 6.82 | 0.000 |
| 107O | DIVIDER | 0.00 | 215.11 | 0 | 00:48 | 0 | 5.8 | 0.000 |
| 106 | DIVIDER | 173.13 | 312.90 | 0 | 00:58 | 4.01 | 10.1 | 0.000 |
| 316 | STORAGE | 0.00 | 1316.32 | 0 | 01:03 | 0 | 46.4 | -0.002 |
| 302 | STORAGE | 0.00 | 334.90 | 0 | 00:50 | 0 | 11.3 | 0.037 |
| 322 | STORAGE | 0.00 | 121.69 | 0 | 00:40 | 0 | 2.95 | 0.009 |
| 331 | STORAGE | 0.00 | 339.70 | 0 | 00:41 | 0 | 7.52 | 0.047 |
| 327 | STORAGE | 0.00 | 101.60 | 0 | 00:35 | 0 | 1.9 | 0.026 |
| 326 | STORAGE | 0.00 | 158.86 | 0 | 00:54 | 0 | 4.11 | 0.017 |
| 329 | STORAGE | 0.00 | 64.10 | 0 | 00:40 | 0 | 1.59 | 0.000 |
| 321S | STORAGE | 0.00 | 52.27 | 0 | 01:16 | 0 | 3.76 | 0.003 |
| 307 | STORAGE | 0.00 | 217.89 | 0 | 00:45 | 0 | 5.93 | 0.033 |
| 340 | STORAGE | 0.00 | 129.28 | 0 | 00:50 | 0 | 4.54 | -0.001 |
| 339 | STORAGE | 0.00 | 158.63 | 0 | 00:40 | 0 | 7.83 | 0.009 |
| 321N | STORAGE | 0.00 | 54.64 | 0 | 01:05 | 0 | 3.76 | 0.006 |

**********
Node Flooding Summary
**********

No nodes were flooded.

**********
Storage Volume Summary
**********

| Storage Unit | Average Volume 1000 ft3 | Avg Pcnt Full | Evap Pcnt Loss | Exfil Pcnt Loss | Maximum Volume 1000 ft3 | Max Pcnt Full | Time of Max Occurrence days hr:min | Maximum Outflow CFS |
|---|---|---|---|---|---|---|---|---|
| 316 | 3434.637 | 43 | 0 | 0 | 4670.472 | 59 | 0 02:37 | 162.09 |
| 302 | 6.496 | 2 | 0 | 0 | 51.827 | 19 | 0 00:56 | 318.52 |
| 322 | 115.833 | 22 | 0 | 0 | 250.370 | 47 | 0 01:36 | 32.84 |
| 331 | 98.058 | 27 | 0 | 0 | 308.903 | 84 | 0 00:53 | 282.93 |
| 327 | 13.382 | 16 | 0 | 0 | 64.547 | 78 | 0 00:47 | 79.27 |
| 326 | 18.069 | 10 | 0 | 0 | 111.626 | 61 | 0 01:04 | 128.99 |
| 329 | 8.958 | 19 | 0 | 0 | 44.919 | 94 | 0 00:51 | 55.96 |
| 321S | 17.794 | 19 | 0 | 0 | 36.976 | 39 | 0 01:29 | 48.14 |
| 307 | 55.383 | 37 | 0 | 0 | 104.463 | 71 | 0 00:48 | 215.11 |
| 340 | 173.456 | 36 | 0 | 0 | 266.523 | 55 | 0 01:17 | 97.70 |
| 339 | 168.431 | 46 | 0 | 0 | 266.851 | 73 | 0 01:43 | 110.91 |
| 321N | 17.287 | 16 | 0 | 0 | 46.467 | 44 | 0 01:16 | 52.27 |

**********
Outfall Loading Summary
**********

| Outfall Node | Flow Freq Pcnt | Avg Flow CFS | Max Flow CFS | Total Volume 10^6 gal |
|---|---|---|---|---|
| 100 | 97.20 | 385.23 | 1287.97 | 60.494 |
| 137 | 97.20 | 92.95 | 204.14 | 14.596 |
| 142 | 97.20 | 205.26 | 756.04 | 32.234 |
| 155 | 98.59 | 139.65 | 635.72 | 22.244 |
| System | 97.55 | 823.08 | 2697.37 | 129.569 |

**********
Link Flow Summary
**********

| Link | Type | Maximum \|Flow\| CFS | Time of Max Occurrence days hr:min | Maximum \|Veloc\| ft/sec | Max/ Full Flow | Max/ Full Depth |
|---|---|---|---|---|---|---|
| 203 | CONDUIT | 176.34 | 0 00:45 | 8.58 | 0.06 | 0.31 |
| 205 | CONDUIT | 703.21 | 0 00:56 | 4.98 | 0.18 | 0.41 |
| 406 | CONDUIT | 264.59 | 0 01:03 | 11.80 | 0.04 | 0.29 |
| 407O | CONDUIT | 146.98 | 0 01:03 | 4.12 | 0.21 | 0.48 |
| 208 | CONDUIT | 68.37 | 0 00:47 | 3.95 | 0.06 | 0.23 |
| 209 | CONDUIT | 62.40 | 0 00:48 | 4.22 | 0.15 | 0.41 |
| 210 | CONDUIT | 194.05 | 0 00:43 | 6.51 | 0.03 | 0.21 |
| 211 | CONDUIT | 48.62 | 0 00:40 | 1.12 | 0.10 | 0.25 |
| 212 | CONDUIT | 14.75 | 0 00:45 | 1.82 | 0.01 | 0.07 |
| 212T | CONDUIT | 99.41 | 0 00:43 | 4.09 | 0.02 | 0.22 |
| 213 | CONDUIT | 85.01 | 0 00:42 | 5.22 | 0.01 | 0.18 |
| 214 | CONDUIT | 168.32 | 0 02:03 | 4.23 | 0.07 | 0.31 |
| 215 | CONDUIT | 164.51 | 0 02:03 | 5.02 | 0.07 | 0.32 |
| 216 | DUMMY | 1316.32 | 0 01:03 | | | |
| 216O | CONDUIT | 162.09 | 0 02:39 | 5.94 | 0.07 | 0.31 |
| 217 | CONDUIT | 134.71 | 0 00:45 | 4.15 | 0.04 | 0.27 |
| 218 | CONDUIT | 71.26 | 0 00:42 | 3.14 | 0.10 | 0.29 |
| 218T | CONDUIT | 87.07 | 0 00:47 | 1.96 | 0.01 | 0.10 |
| 219 | CONDUIT | 17.19 | 0 00:48 | 0.97 | 0.03 | 0.13 |
| 220 | CONDUIT | 390.94 | 0 00:57 | 7.73 | 0.48 | 0.72 |
| 220T | CONDUIT | 1000.58 | 0 01:04 | 5.08 | 0.30 | 0.53 |
| 221O | CONDUIT | 47.92 | 0 01:32 | 5.36 | 0.00 | 0.13 |
| 222 | DUMMY | 121.69 | 0 00:40 | | | |
| 222O | CONDUIT | 32.84 | 0 01:39 | 6.06 | 0.00 | 0.10 |
| 223 | DUMMY | 282.03 | 0 00:58 | | | |
| 224 | CONDUIT | 67.06 | 0 00:42 | 6.93 | 0.01 | 0.13 |
| 224T | CONDUIT | 150.88 | 0 01:05 | 7.05 | 0.02 | 0.20 |
| 225 | CONDUIT | 18.15 | 0 00:47 | 4.19 | 0.00 | 0.09 |
| 226 | DUMMY | 158.86 | 0 00:54 | | | |





| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 426O | CONDUIT | 103.42 | 0 | 01:05 | 4.10 | 0.03 | 0.27 |
| 227 | DUMMY | 101.60 | 0 | 00:35 | | | |
| 427O | CONDUIT | 45.93 | 0 | 00:49 | 12.34 | 0.00 | 0.11 |
| 228 | CONDUIT | 12.49 | 0 | 00:40 | 3.72 | 0.00 | 0.08 |
| 228T | CONDUIT | 45.67 | 0 | 00:56 | 6.03 | 0.00 | 0.12 |
| 229 | DUMMY | 64.10 | 0 | 00:40 | | | |
| 429O | CONDUIT | 36.01 | 0 | 00:52 | 3.85 | 0.39 | 0.66 |
| 230T | CONDUIT | 612.72 | 0 | 01:03 | 4.87 | 0.12 | 0.30 |
| 231 | DUMMY | 339.70 | 0 | 00:41 | | | |
| 231O | CONDUIT | 256.53 | 0 | 01:01 | 5.63 | 0.01 | 0.09 |
| 232 | CONDUIT | 218.18 | 0 | 00:38 | 6.04 | 0.03 | 0.26 |
| 232T | CONDUIT | 306.57 | 0 | 00:41 | 7.66 | 0.03 | 0.17 |
| 233 | CONDUIT | 88.83 | 0 | 00:40 | 7.21 | 0.01 | 0.15 |
| 235 | CONDUIT | 104.92 | 0 | 00:40 | 9.24 | 0.04 | 0.28 |
| 235T | CONDUIT | 129.51 | 0 | 00:46 | 4.12 | 0.02 | 0.10 |
| 236 | CONDUIT | 29.75 | 0 | 00:51 | 4.74 | 0.00 | 0.11 |
| 238 | CONDUIT | 119.41 | 0 | 01:23 | 1.11 | 0.01 | 0.07 |
| 238T | CONDUIT | 164.14 | 0 | 02:10 | 0.70 | 0.11 | 0.27 |
| 439O | CONDUIT | 84.12 | 0 | 01:46 | 3.11 | 0.16 | 0.46 |
| 240O | CONDUIT | 70.88 | 0 | 01:45 | 0.84 | 0.24 | 0.44 |
| 241 | CONDUIT | 59.34 | 0 | 00:58 | 1.99 | 0.40 | 0.66 |
| 246 | DUMMY | 638.79 | 0 | 01:11 | | | |
| 247 | DUMMY | 568.78 | 0 | 01:13 | | | |
| 248 | CONDUIT | 115.91 | 0 | 01:12 | 1.68 | 0.19 | 0.42 |
| 249 | CONDUIT | 52.97 | 0 | 01:13 | 1.58 | 0.07 | 0.25 |
| 250 | CONDUIT | 285.73 | 0 | 01:17 | 0.62 | 0.01 | 0.05 |
| 250T | DUMMY | 314.57 | 0 | 01:19 | | | |
| 251 | CONDUIT | 226.75 | 0 | 00:48 | 4.03 | 0.02 | 0.11 |
| 252 | CONDUIT | 150.26 | 0 | 00:48 | 4.05 | 0.10 | 0.30 |
| 253 | CONDUIT | 19.17 | 0 | 01:45 | 0.41 | 0.00 | 0.01 |
| 254 | CONDUIT | 19.72 | 0 | 01:52 | 0.43 | 0.00 | 0.01 |
| 229O | CONDUIT | 21.44 | 0 | 00:35 | 11.17 | 1.08 | 1.00 |
| 227O | CONDUIT | 35.98 | 0 | 00:35 | 12.61 | 1.08 | 1.00 |
| 226O | CONDUIT | 63.61 | 0 | 02:04 | 10.08 | 1.08 | 1.00 |
| 202O | CONDUIT | 317.57 | 0 | 01:02 | 7.45 | 0.04 | 0.29 |
| 202 | DUMMY | 334.90 | 0 | 00:50 | | | |
| 210T | CONDUIT | 288.88 | 0 | 00:49 | 5.16 | 0.10 | 0.37 |
| 245 | CONDUIT | 214.27 | 0 | 00:59 | 2.04 | 0.23 | 0.42 |
| 243T | CONDUIT | 334.19 | 0 | 01:07 | 0.94 | 0.04 | 0.15 |
| 244 | CONDUIT | 130.74 | 0 | 00:52 | 3.51 | 0.16 | 0.40 |
| 243 | DUMMY | 433.38 | 0 | 01:04 | | | |
| 234 | CONDUIT | 233.90 | 0 | 00:45 | 4.41 | 0.04 | 0.17 |
| 230 | DUMMY | 418.35 | 0 | 01:00 | | | |
| 221 | DUMMY | 54.64 | 0 | 01:05 | | | |
| 207 | DUMMY | 217.89 | 0 | 00:45 | | | |
| 240 | DUMMY | 129.28 | 0 | 00:50 | | | |
| 239 | DUMMY | 158.63 | 0 | 00:40 | | | |
| 207O | CONDUIT | 51.88 | 0 | 01:59 | 8.30 | 1.08 | 1.00 |
| 206 | CONDUIT | 50.51 | 0 | 00:26 | 8.06 | 1.08 | 1.00 |
| 239O | CONDUIT | 28.87 | 0 | 03:57 | 4.55 | 1.08 | 1.00 |
| 204 | CONDUIT | 1274.17 | 0 | 00:54 | 11.19 | 0.35 | 0.60 |
| 202T | CONDUIT | 488.26 | 0 | 00:49 | 19.08 | 0.73 | 0.63 |
| 201 | CONDUIT | 522.75 | 0 | 00:49 | 27.04 | 0.31 | 0.43 |
| 502 | DUMMY | 318.52 | 0 | 00:57 | | | |
| 507 | DUMMY | 215.11 | 0 | 00:48 | | | |
| 516 | DUMMY | 162.09 | 0 | 02:37 | | | |
| 521S | DUMMY | 48.14 | 0 | 01:29 | | | |
| 522 | DUMMY | 32.84 | 0 | 01:36 | | | |
| 526 | DUMMY | 128.99 | 0 | 01:04 | | | |
| 527 | DUMMY | 79.27 | 0 | 00:47 | | | |
| 529 | DUMMY | 55.96 | 0 | 00:52 | | | |
| 531 | DUMMY | 282.93 | 0 | 00:53 | | | |
| 539 | DUMMY | 110.91 | 0 | 01:43 | | | |
| 540 | DUMMY | 97.70 | 0 | 01:17 | | | |
| 521N | DUMMY | 52.27 | 0 | 01:16 | | | |

**********
Conduit Surcharge Summary
**********

| Conduit | Hours Full Both Ends | Hours Full Upstream | Hours Full Dnstream | Hours Above Full Normal Flow | Hours Capacity Limited |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 229O | 1.70 | 1.70 | 1.70 | 1.68 | 1.70 |
| 227O | 0.78 | 0.78 | 0.78 | 0.80 | 0.78 |
| 226O | 1.51 | 1.51 | 1.51 | 0.09 | 1.51 |
| 207O | 1.31 | 1.31 | 1.31 | 0.08 | 1.31 |
| 206 | 1.85 | 1.85 | 1.85 | 1.87 | 1.85 |
| 239O | 3.11 | 3.11 | 3.11 | 0.15 | 3.11 |

Analysis begun on:  Thu Nov 01 12:32:41 2018
Analysis ended on:  Thu Nov 01 12:32:42 2018
Total elapsed time: 00:00:01

## Table B-3 - Baseline Peak Flows

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Peak Flow (cfs) | | | | | | | Future Conditions Peak Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 100 | 1691 | 2.6 | 39 | 46 | 128 | 218 | 332 | 634 | 827 | 1,086 | 1,666 | 213 | 330 | 462 | 805 | 1,016 | 1,288 | 1,881 |
| 101 | 317 | 0.5 | 35 | 51 | 57 | 98 | 151 | 280 | 358 | 453 | 617 | 99 | 149 | 203 | 344 | 425 | 523 | 717 |
| 102O | 215 | 0.3 | 42 | 42 | 49 | 79 | 116 | 203 | 256 | 319 | 429 | 49 | 79 | 116 | 203 | 256 | 319 | 429 |
| 302 | 215 | 0.3 | 42 | 42 | 49 | 79 | 116 | 204 | 261 | 335 | 503 | 49 | 79 | 116 | 204 | 261 | 335 | 503 |
| 102 | 215 | 0.3 | 42 | 42 | 49 | 79 | 116 | 204 | 261 | 335 | 503 | 49 | 79 | 116 | 204 | 261 | 335 | 503 |
| 103 | 111 | 0.2 | 39 | 39 | 24 | 40 | 60 | 107 | 138 | 176 | 267 | 24 | 40 | 60 | 107 | 138 | 176 | 267 |
| 102T | 298 | 0.5 | 34 | 51 | 52 | 91 | 140 | 261 | 334 | 423 | 577 | 94 | 140 | 192 | 323 | 399 | 488 | 663 |
| 104 | 1684 | 2.6 | 39 | 46 | 126 | 216 | 329 | 630 | 822 | 1,079 | 1,655 | 209 | 325 | 456 | 796 | 1,005 | 1,274 | 1,861 |
| 105 | 1333 | 2.1 | 40 | 45 | 68 | 114 | 171 | 333 | 441 | 606 | 980 | 106 | 166 | 236 | 421 | 541 | 703 | 1,086 |
| 106 | 173 | 0.3 | 37 | 58 | 15 | 39 | 78 | 141 | 189 | 257 | 406 | 41 | 75 | 106 | 183 | 238 | 313 | 480 |
| 107 | 107 | 0.2 | 38 | 52 | 23 | 39 | 60 | 111 | 144 | 187 | 286 | 37 | 57 | 80 | 135 | 171 | 218 | 326 |
| 307 | 107 | 0.2 | 38 | 52 | 23 | 39 | 60 | 111 | 144 | 187 | 286 | 37 | 57 | 80 | 135 | 171 | 218 | 326 |
| 107O | 107 | 0.2 | 38 | 52 | 7 | 27 | 50 | 107 | 141 | 185 | 282 | 22 | 46 | 72 | 132 | 168 | 215 | 321 |
| 108 | 42 | 0.1 | 32 | 32 | 8 | 13 | 21 | 40 | 53 | 69 | 106 | 8 | 13 | 21 | 40 | 53 | 69 | 106 |
| 109 | 30 | 0.0 | 38 | 46 | 8 | 13 | 19 | 35 | 45 | 57 | 87 | 11 | 17 | 24 | 41 | 52 | 65 | 98 |
| 110 | 81 | 0.1 | 42 | 49 | 26 | 42 | 63 | 109 | 140 | 178 | 268 | 31 | 50 | 71 | 120 | 153 | 194 | 291 |
| 110T | 1077 | 1.7 | 41 | 43 | 43 | 69 | 100 | 170 | 218 | 276 | 415 | 52 | 81 | 114 | 188 | 239 | 300 | 448 |
| 111 | 18 | 0.0 | 54 | 54 | 10 | 15 | 20 | 32 | 40 | 50 | 74 | 10 | 15 | 20 | 32 | 40 | 50 | 74 |
| 112 | 7 | 0.0 | 42 | 52 | 2 | 3 | 5 | 8 | 11 | 13 | 20 | 3 | 4 | 6 | 10 | 12 | 15 | 23 |
| 112T | 40 | 0.1 | 42 | 43 | 14 | 23 | 34 | 59 | 77 | 97 | 147 | 15 | 24 | 35 | 61 | 78 | 100 | 150 |
| 113 | 33 | 0.1 | 42 | 42 | 14 | 22 | 33 | 54 | 70 | 89 | 134 | 14 | 22 | 33 | 54 | 70 | 89 | 134 |
| 114 | 996 | 1.6 | 41 | 43 | 17 | 38 | 72 | 135 | 151 | 167 | 218 | 22 | 40 | 75 | 137 | 153 | 168 | 216 |
| 115 | 988 | 1.5 | 41 | 43 | 19 | 37 | 71 | 134 | 149 | 163 | 209 | 24 | 40 | 74 | 135 | 150 | 165 | 206 |
| 116O | 957 | 1.5 | 41 | 42 | 13 | 37 | 71 | 134 | 147 | 162 | 187 | 14 | 40 | 74 | 135 | 147 | 162 | 187 |
| 316 | 957 | 1.5 | 41 | 42 | 174 | 271 | 387 | 714 | 915 | 1,292 | 2,253 | 181 | 280 | 397 | 726 | 929 | 1,316 | 2,292 |
| 116 | 957 | 1.5 | 41 | 42 | 174 | 271 | 387 | 714 | 915 | 1,292 | 2,253 | 181 | 280 | 397 | 726 | 929 | 1,316 | 2,292 |
| 117 | 72 | 0.1 | 40 | 43 | 19 | 31 | 45 | 79 | 101 | 129 | 195 | 21 | 34 | 49 | 83 | 106 | 135 | 202 |
| 118T | 56 | 0.1 | 40 | 40 | 12 | 18 | 23 | 47 | 64 | 88 | 143 | 12 | 18 | 23 | 47 | 64 | 88 | 143 |
| 118 | 43 | 0.1 | 36 | 36 | 9 | 14 | 19 | 39 | 53 | 72 | 117 | 9 | 14 | 19 | 39 | 53 | 72 | 117 |
| 119 | 14 | 0.0 | 50 | 50 | 4 | 5 | 6 | 9 | 13 | 17 | 28 | 4 | 5 | 6 | 9 | 13 | 17 | 28 |
| 120 | 343 | 0.5 | 42 | 43 | 73 | 110 | 146 | 249 | 308 | 390 | 706 | 74 | 112 | 148 | 249 | 308 | 391 | 713 |
| 120T | 733 | 1.1 | 42 | 43 | 137 | 209 | 294 | 516 | 681 | 987 | 1,726 | 139 | 212 | 298 | 516 | 691 | 1,001 | 1,745 |
| 121 | 86 | 0.1 | 31 | 34 | 7 | 11 | 16 | 29 | 38 | 53 | 87 | 8 | 12 | 17 | 30 | 40 | 55 | 104 |
| 321N | 86 | 0.1 | 31 | 34 | 7 | 11 | 16 | 29 | 38 | 53 | 87 | 8 | 12 | 17 | 30 | 40 | 55 | 104 |
| 321S | 86 | 0.1 | 31 | 34 | 7 | 11 | 15 | 27 | 33 | 50 | 87 | 8 | 12 | 17 | 28 | 34 | 52 | 103 |
| 121O | 86 | 0.1 | 31 | 34 | 7 | 11 | 15 | 25 | 32 | 46 | 85 | 8 | 12 | 16 | 26 | 33 | 48 | 101 |
| 122O | 58 | 0.1 | 33 | 37 | 5 | 8 | 12 | 20 | 26 | 32 | 64 | 6 | 9 | 13 | 22 | 27 | 33 | 75 |
| 322 | 58 | 0.1 | 33 | 37 | 13 | 23 | 36 | 66 | 87 | 111 | 170 | 16 | 27 | 41 | 74 | 95 | 122 | 184 |
| 122 | 58 | 0.1 | 33 | 37 | 13 | 23 | 36 | 66 | 87 | 111 | 170 | 16 | 27 | 41 | 74 | 95 | 122 | 184 |
| 123 | 232 | 0.4 | 46 | 46 | 32 | 49 | 68 | 156 | 207 | 281 | 573 | 32 | 49 | 68 | 156 | 207 | 282 | 580 |
| 124 | 30 | 0.0 | 47 | 47 | 11 | 17 | 25 | 42 | 53 | 68 | 101 | 11 | 17 | 25 | 42 | 53 | 68 | 101 |
| 124T | 135 | 0.2 | 47 | 48 | 11 | 17 | 24 | 74 | 100 | 148 | 354 | 11 | 17 | 25 | 74 | 101 | 151 | 361 |
| 125 | 11 | 0.0 | 47 | 47 | 3 | 5 | 7 | 11 | 14 | 18 | 27 | 3 | 5 | 7 | 11 | 14 | 18 | 27 |
| 126O | 104 | 0.2 | 47 | 48 | 31 | 47 | 62 | 99 | 117 | 159 | 321 | 32 | 48 | 63 | 99 | 118 | 162 | 327 |
| 326 | 70 | 0.1 | 44 | 46 | 22 | 34 | 47 | 78 | 110 | 152 | 303 | 23 | 36 | 48 | 78 | 111 | 159 | 312 |
| 126 | 70 | 0.1 | 44 | 46 | 22 | 34 | 47 | 78 | 110 | 152 | 303 | 23 | 36 | 48 | 78 | 111 | 159 | 312 |
| 127O | 34 | 0.1 | 53 | 53 | 10 | 16 | 21 | 46 | 61 | 79 | 140 | 10 | 16 | 21 | 46 | 61 | 79 | 140 |
| 327 | 34 | 0.1 | 53 | 53 | 20 | 30 | 41 | 64 | 81 | 102 | 150 | 20 | 30 | 41 | 64 | 81 | 102 | 150 |
| 127 | 34 | 0.1 | 53 | 53 | 20 | 30 | 41 | 64 | 81 | 102 | 150 | 20 | 30 | 41 | 64 | 81 | 102 | 150 |

## Table B-3 - Baseline Peak Flows

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Peak Flow (cfs) | | | | | | | Future Conditions Peak Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 128 | 7 | 0.0 | 50 | 50 | 2 | 3 | 5 | 8 | 10 | 13 | 19 | 2 | 3 | 5 | 8 | 10 | 13 | 19 |
| 128T | 37 | 0.1 | 41 | 43 | 2 | 3 | 5 | 12 | 18 | 44 | 88 | 2 | 3 | 6 | 12 | 20 | 48 | 93 |
| 129O | 30 | 0.0 | 39 | 42 | 8 | 14 | 20 | 25 | 30 | 52 | 90 | 9 | 15 | 21 | 26 | 32 | 56 | 94 |
| 329 | 30 | 0.0 | 39 | 42 | 9 | 14 | 21 | 37 | 48 | 61 | 92 | 10 | 16 | 23 | 40 | 51 | 64 | 96 |
| 129 | 30 | 0.0 | 39 | 42 | 9 | 14 | 21 | 37 | 48 | 61 | 92 | 10 | 16 | 23 | 40 | 51 | 64 | 96 |
| 130T | 391 | 0.6 | 43 | 44 | 73 | 107 | 152 | 273 | 402 | 609 | 1,037 | 74 | 108 | 153 | 274 | 410 | 619 | 1,049 |
| 130 | 269 | 0.4 | 43 | 44 | 47 | 61 | 79 | 171 | 266 | 410 | 709 | 47 | 62 | 80 | 177 | 272 | 418 | 719 |
| 131O | 149 | 0.2 | 48 | 49 | 31 | 38 | 40 | 108 | 170 | 275 | 476 | 32 | 39 | 40 | 112 | 175 | 283 | 486 |
| 331 | 149 | 0.2 | 48 | 49 | 56 | 81 | 114 | 200 | 259 | 332 | 504 | 59 | 86 | 119 | 206 | 265 | 340 | 514 |
| 131 | 149 | 0.2 | 48 | 49 | 56 | 81 | 114 | 200 | 259 | 332 | 504 | 59 | 86 | 119 | 206 | 265 | 340 | 514 |
| 132 | 86 | 0.1 | 48 | 50 | 35 | 52 | 76 | 129 | 166 | 210 | 317 | 39 | 57 | 81 | 135 | 173 | 219 | 330 |
| 132T | 127 | 0.2 | 50 | 52 | 52 | 76 | 106 | 183 | 235 | 299 | 450 | 55 | 80 | 112 | 189 | 241 | 307 | 459 |
| 133 | 42 | 0.1 | 56 | 56 | 17 | 25 | 31 | 54 | 70 | 89 | 134 | 17 | 25 | 31 | 54 | 70 | 89 | 134 |
| 134 | 122 | 0.2 | 43 | 43 | 33 | 55 | 81 | 142 | 183 | 234 | 352 | 33 | 55 | 81 | 142 | 183 | 234 | 352 |
| 135 | 43 | 0.1 | 45 | 45 | 17 | 28 | 40 | 65 | 83 | 105 | 158 | 17 | 28 | 40 | 65 | 83 | 105 | 158 |
| 135T | 63 | 0.1 | 45 | 45 | 21 | 33 | 48 | 81 | 103 | 131 | 196 | 21 | 33 | 48 | 81 | 103 | 131 | 196 |
| 136 | 20 | 0.0 | 45 | 45 | 5 | 7 | 11 | 18 | 24 | 30 | 45 | 5 | 7 | 11 | 18 | 24 | 30 | 45 |
| 137 | 364 | 0.6 | 24 | 30 | 10 | 18 | 37 | 82 | 117 | 172 | 382 | 12 | 28 | 51 | 96 | 135 | 204 | 440 |
| 138 | 215 | 0.3 | 27 | 35 | 9 | 16 | 24 | 44 | 57 | 90 | 259 | 9 | 16 | 24 | 45 | 68 | 129 | 299 |
| 138T | 252 | 0.4 | 28 | 36 | 13 | 23 | 37 | 85 | 114 | 149 | 331 | 14 | 31 | 54 | 96 | 127 | 194 | 386 |
| 139 | 170 | 0.3 | 25 | 36 | 11 | 19 | 31 | 62 | 81 | 107 | 239 | 24 | 39 | 57 | 98 | 125 | 159 | 267 |
| 339 | 170 | 0.3 | 25 | 36 | 11 | 19 | 31 | 62 | 81 | 107 | 239 | 24 | 39 | 57 | 98 | 125 | 159 | 267 |
| 139O | 170 | 0.3 | 25 | 36 | 2 | 11 | 21 | 38 | 49 | 97 | 232 | 7 | 18 | 29 | 48 | 61 | 111 | 259 |
| 140 | 93 | 0.1 | 25 | 29 | 11 | 20 | 34 | 67 | 88 | 116 | 179 | 13 | 24 | 39 | 75 | 99 | 129 | 199 |
| 340 | 93 | 0.1 | 25 | 29 | 11 | 20 | 34 | 67 | 88 | 116 | 179 | 13 | 24 | 39 | 75 | 99 | 129 | 199 |
| 140O | 93 | 0.1 | 25 | 29 | 9 | 13 | 15 | 18 | 30 | 83 | 167 | 11 | 13 | 16 | 19 | 45 | 98 | 184 |
| 141 | 37 | 0.1 | 38 | 38 | 8 | 14 | 22 | 38 | 50 | 64 | 96 | 8 | 14 | 22 | 38 | 50 | 64 | 96 |
| 142 | 623 | 1.0 | 42 | 52 | 84 | 118 | 175 | 331 | 450 | 627 | 1,029 | 112 | 171 | 239 | 424 | 559 | 756 | 1,198 |
| 143 | 263 | 0.4 | 20 | 50 | 13 | 29 | 58 | 134 | 187 | 263 | 428 | 56 | 92 | 137 | 251 | 328 | 433 | 668 |
| 143T | 199 | 0.3 | 19 | 50 | 11 | 24 | 46 | 108 | 148 | 206 | 329 | 49 | 78 | 113 | 205 | 264 | 342 | 522 |
| 144 | 89 | 0.1 | 8 | 44 | 2 | 6 | 14 | 36 | 50 | 71 | 114 | 20 | 30 | 45 | 80 | 102 | 131 | 198 |
| 145 | 109 | 0.2 | 27 | 54 | 14 | 26 | 44 | 87 | 115 | 152 | 235 | 48 | 73 | 101 | 164 | 206 | 258 | 381 |
| 146 | 535 | 0.8 | 37 | 49 | 53 | 88 | 136 | 268 | 369 | 519 | 861 | 89 | 138 | 197 | 355 | 470 | 639 | 1,018 |
| 147 | 481 | 0.8 | 34 | 47 | 42 | 72 | 115 | 233 | 324 | 458 | 763 | 76 | 119 | 171 | 314 | 418 | 569 | 908 |
| 148 | 77 | 0.1 | 30 | 61 | 8 | 14 | 22 | 46 | 63 | 86 | 136 | 22 | 32 | 41 | 71 | 91 | 118 | 180 |
| 149 | 38 | 0.1 | 45 | 46 | 10 | 14 | 20 | 37 | 48 | 62 | 95 | 10 | 15 | 21 | 38 | 49 | 64 | 96 |
| 150 | 191 | 0.3 | 31 | 48 | 29 | 47 | 77 | 155 | 205 | 271 | 422 | 55 | 83 | 121 | 215 | 276 | 354 | 535 |
| 150T | 293 | 0.5 | 27 | 38 | 20 | 34 | 58 | 125 | 178 | 258 | 441 | 36 | 58 | 87 | 167 | 226 | 315 | 514 |
| 151 | 119 | 0.2 | 21 | 44 | 13 | 23 | 41 | 90 | 120 | 160 | 252 | 33 | 51 | 76 | 136 | 176 | 227 | 345 |
| 152 | 65 | 0.1 | 33 | 50 | 14 | 25 | 40 | 72 | 94 | 120 | 184 | 28 | 44 | 62 | 101 | 127 | 160 | 237 |
| 153 | 41 | 0.1 | 22 | 22 | 2 | 4 | 5 | 10 | 19 | 30 | 58 | 2 | 4 | 5 | 10 | 19 | 30 | 58 |
| 154 | 61 | 0.1 | 14 | 14 | 1 | 2 | 3 | 8 | 17 | 29 | 61 | 1 | 2 | 3 | 8 | 17 | 29 | 61 |
| 155 | 388 | 0.6 | 36 | 56 | 97 | 139 | 184 | 287 | 361 | 451 | 681 | 113 | 162 | 214 | 360 | 473 | 636 | 995 |

## Table B-4 - Baseline Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Runoff Volume (acre-feet) | | | | | | | Future Condtions Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 100 | 1691 | 2.6 | 39 | 46 | 20 | 36 | 59 | 110 | 140 | 174 | 247 | 29 | 48 | 72 | 122 | 153 | 186 | 260 |
| 101 | 317 | 0.5 | 35 | 51 | 7 | 11 | 17 | 29 | 37 | 49 | 75 | 10 | 16 | 22 | 34 | 43 | 54 | 81 |
| 102O | 215 | 0.3 | 42 | 42 | 6 | 9 | 13 | 21 | 27 | 35 | 53 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |
| 302 | 215 | 0.3 | 42 | 42 | 6 | 9 | 13 | 21 | 27 | 35 | 53 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |
| 102 | 215 | 0.3 | 42 | 42 | 6 | 9 | 13 | 21 | 27 | 35 | 53 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |
| 103 | 111 | 0.2 | 39 | 39 | 3 | 4 | 6 | 11 | 14 | 18 | 27 | 3 | 4 | 6 | 11 | 14 | 18 | 27 |
| 102T | 298 | 0.5 | 34 | 51 | 6 | 10 | 16 | 27 | 35 | 46 | 71 | 10 | 15 | 21 | 32 | 41 | 51 | 76 |
| 104 | 1684 | 2.6 | 39 | 46 | 20 | 36 | 59 | 109 | 140 | 173 | 246 | 28 | 47 | 72 | 122 | 152 | 185 | 258 |
| 105 | 1333 | 2.1 | 40 | 45 | 13 | 24 | 41 | 79 | 100 | 120 | 164 | 17 | 30 | 48 | 85 | 106 | 126 | 170 |
| 106 | 173 | 0.3 | 37 | 58 | 4 | 6 | 9 | 16 | 21 | 27 | 42 | 6 | 9 | 13 | 20 | 25 | 31 | 46 |
| 107 | 107 | 0.2 | 38 | 52 | 3 | 4 | 6 | 10 | 13 | 17 | 26 | 4 | 5 | 7 | 11 | 14 | 18 | 27 |
| 307 | 107 | 0.2 | 38 | 52 | 3 | 4 | 6 | 10 | 13 | 17 | 26 | 4 | 5 | 7 | 11 | 14 | 18 | 27 |
| 107O | 107 | 0.2 | 38 | 52 | 2 | 4 | 6 | 10 | 13 | 16 | 25 | 3 | 5 | 7 | 11 | 14 | 18 | 27 |
| 108 | 42 | 0.1 | 32 | 32 | 1 | 1 | 2 | 4 | 5 | 6 | 10 | 1 | 1 | 2 | 4 | 5 | 6 | 10 |
| 109 | 30 | 0.0 | 38 | 46 | 1 | 1 | 2 | 3 | 4 | 5 | 7 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |
| 110 | 81 | 0.1 | 42 | 49 | 2 | 3 | 5 | 8 | 10 | 13 | 20 | 3 | 4 | 5 | 8 | 11 | 13 | 20 |
| 110T | 1077 | 1.7 | 41 | 43 | 8 | 16 | 28 | 56 | 70 | 82 | 104 | 9 | 17 | 30 | 58 | 71 | 83 | 105 |
| 111 | 18 | 0.0 | 54 | 54 | 1 | 1 | 1 | 2 | 2 | 3 | 5 | 1 | 1 | 1 | 2 | 2 | 3 | 5 |
| 112 | 7 | 0.0 | 42 | 52 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | 1 | 2 |
| 112T | 40 | 0.1 | 42 | 43 | 1 | 2 | 2 | 4 | 5 | 6 | 10 | 1 | 2 | 2 | 4 | 5 | 6 | 10 |
| 113 | 33 | 0.1 | 42 | 42 | 1 | 1 | 2 | 3 | 4 | 5 | 8 | 1 | 1 | 2 | 3 | 4 | 5 | 8 |
| 114 | 996 | 1.6 | 41 | 43 | 6 | 12 | 23 | 48 | 60 | 69 | 84 | 6 | 13 | 24 | 49 | 61 | 69 | 85 |
| 115 | 988 | 1.5 | 41 | 43 | 6 | 12 | 23 | 48 | 60 | 69 | 84 | 6 | 13 | 24 | 49 | 61 | 69 | 84 |
| 116O | 957 | 1.5 | 41 | 42 | 5 | 11 | 21 | 45 | 56 | 64 | 76 | 5 | 12 | 22 | 46 | 57 | 64 | 77 |
| 316 | 957 | 1.5 | 41 | 42 | 24 | 36 | 50 | 83 | 108 | 141 | 219 | 24 | 37 | 51 | 84 | 109 | 142 | 221 |
| 116 | 957 | 1.5 | 41 | 42 | 24 | 36 | 50 | 83 | 108 | 141 | 219 | 24 | 37 | 51 | 84 | 109 | 142 | 221 |
| 117 | 72 | 0.1 | 40 | 43 | 2 | 3 | 4 | 7 | 9 | 12 | 18 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 118T | 56 | 0.1 | 40 | 40 | 1 | 2 | 2 | 4 | 5 | 7 | 11 | 1 | 2 | 2 | 4 | 5 | 7 | 11 |
| 118 | 43 | 0.1 | 36 | 36 | 1 | 1 | 2 | 3 | 4 | 5 | 9 | 1 | 1 | 2 | 3 | 4 | 5 | 9 |
| 119 | 14 | 0.0 | 50 | 50 | 0 | 1 | 1 | 1 | 1 | 2 | 3 | 0 | 1 | 1 | 1 | 1 | 2 | 3 |
| 120 | 343 | 0.5 | 42 | 43 | 9 | 13 | 18 | 29 | 38 | 50 | 77 | 9 | 13 | 18 | 30 | 38 | 50 | 77 |
| 120T | 733 | 1.1 | 42 | 43 | 19 | 28 | 40 | 65 | 84 | 110 | 169 | 19 | 29 | 40 | 65 | 85 | 110 | 170 |
| 121 | 86 | 0.1 | 31 | 34 | 1 | 2 | 4 | 6 | 8 | 11 | 18 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 321N | 86 | 0.1 | 31 | 34 | 1 | 2 | 4 | 6 | 8 | 11 | 18 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 321S | 86 | 0.1 | 31 | 34 | 1 | 2 | 4 | 6 | 8 | 11 | 18 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 121O | 86 | 0.1 | 31 | 34 | 1 | 2 | 4 | 6 | 8 | 11 | 18 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 122O | 58 | 0.1 | 33 | 37 | 1 | 2 | 3 | 5 | 6 | 8 | 13 | 1 | 2 | 3 | 5 | 7 | 9 | 13 |
| 322 | 58 | 0.1 | 33 | 37 | 1 | 2 | 3 | 5 | 7 | 9 | 14 | 1 | 2 | 3 | 5 | 7 | 9 | 14 |
| 122 | 58 | 0.1 | 33 | 37 | 1 | 2 | 3 | 5 | 7 | 9 | 14 | 1 | 2 | 3 | 5 | 7 | 9 | 14 |
| 123 | 232 | 0.4 | 46 | 46 | 3 | 5 | 7 | 13 | 19 | 26 | 44 | 3 | 5 | 7 | 13 | 19 | 26 | 44 |
| 124 | 30 | 0.0 | 47 | 47 | 1 | 1 | 2 | 3 | 4 | 5 | 8 | 1 | 1 | 2 | 3 | 4 | 5 | 8 |
| 124T | 135 | 0.2 | 47 | 48 | 1 | 1 | 2 | 5 | 8 | 12 | 22 | 1 | 1 | 2 | 5 | 8 | 12 | 22 |
| 125 | 11 | 0.0 | 47 | 47 | 0 | 1 | 1 | 1 | 1 | 2 | 3 | 0 | 1 | 1 | 1 | 1 | 2 | 3 |
| 126O | 104 | 0.2 | 47 | 48 | 3 | 5 | 6 | 10 | 13 | 17 | 25 | 3 | 5 | 6 | 10 | 13 | 17 | 25 |
| 326 | 70 | 0.1 | 44 | 46 | 2 | 3 | 4 | 7 | 9 | 13 | 21 | 2 | 3 | 4 | 7 | 9 | 13 | 21 |
| 126 | 70 | 0.1 | 44 | 46 | 2 | 3 | 4 | 7 | 9 | 13 | 21 | 2 | 3 | 4 | 7 | 9 | 13 | 21 |
| 127O | 34 | 0.1 | 53 | 53 | 1 | 2 | 2 | 4 | 5 | 6 | 9 | 1 | 2 | 2 | 4 | 5 | 6 | 9 |
| 327 | 34 | 0.1 | 53 | 53 | 1 | 2 | 2 | 4 | 5 | 6 | 9 | 1 | 2 | 2 | 4 | 5 | 6 | 9 |
| 127 | 34 | 0.1 | 53 | 53 | 1 | 2 | 2 | 4 | 5 | 6 | 9 | 1 | 2 | 2 | 4 | 5 | 6 | 9 |

## Table B-4 - Baseline Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Runoff Volume (acre-feet) | | | | | | | Future Condtions Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 128 | 7 | 0.0 | 50 | 50 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | 1 | 2 |
| 128T | 37 | 0.1 | 41 | 43 | 0 | 0 | 0 | 1 | 2 | 3 | 6 | 0 | 0 | 1 | 1 | 2 | 3 | 6 |
| 129O | 30 | 0.0 | 39 | 42 | 1 | 1 | 2 | 3 | 4 | 5 | 7 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |
| 329 | 30 | 0.0 | 39 | 42 | 1 | 1 | 2 | 3 | 4 | 5 | 7 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |
| 129 | 30 | 0.0 | 39 | 42 | 1 | 1 | 2 | 3 | 4 | 5 | 7 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |
| 130T | 391 | 0.6 | 43 | 44 | 10 | 15 | 22 | 36 | 46 | 60 | 92 | 11 | 16 | 22 | 36 | 46 | 60 | 93 |
| 130 | 269 | 0.4 | 43 | 44 | 7 | 10 | 14 | 24 | 31 | 40 | 62 | 7 | 10 | 14 | 24 | 31 | 41 | 63 |
| 131O | 149 | 0.2 | 48 | 49 | 4 | 6 | 9 | 14 | 18 | 23 | 35 | 4 | 6 | 9 | 14 | 18 | 23 | 35 |
| 331 | 149 | 0.2 | 48 | 49 | 4 | 6 | 9 | 14 | 18 | 23 | 35 | 4 | 6 | 9 | 14 | 18 | 23 | 35 |
| 131 | 149 | 0.2 | 48 | 49 | 4 | 6 | 9 | 14 | 18 | 23 | 35 | 4 | 6 | 9 | 14 | 18 | 23 | 35 |
| 132 | 86 | 0.1 | 48 | 50 | 3 | 4 | 5 | 8 | 11 | 14 | 21 | 3 | 4 | 5 | 9 | 11 | 14 | 21 |
| 132T | 127 | 0.2 | 50 | 52 | 4 | 6 | 8 | 12 | 16 | 20 | 31 | 4 | 6 | 8 | 13 | 16 | 20 | 31 |
| 133 | 42 | 0.1 | 56 | 56 | 1 | 2 | 3 | 4 | 5 | 7 | 10 | 1 | 2 | 3 | 4 | 5 | 7 | 10 |
| 134 | 122 | 0.2 | 43 | 43 | 3 | 5 | 7 | 12 | 15 | 20 | 30 | 3 | 5 | 7 | 12 | 15 | 20 | 30 |
| 135 | 43 | 0.1 | 45 | 45 | 1 | 2 | 3 | 4 | 6 | 7 | 11 | 1 | 2 | 3 | 4 | 6 | 7 | 11 |
| 135T | 63 | 0.1 | 45 | 45 | 2 | 3 | 4 | 6 | 8 | 10 | 16 | 2 | 3 | 4 | 6 | 8 | 10 | 16 |
| 136 | 20 | 0.0 | 45 | 45 | 1 | 1 | 1 | 2 | 3 | 3 | 5 | 1 | 1 | 1 | 2 | 3 | 3 | 5 |
| 137 | 364 | 0.6 | 24 | 30 | 3 | 6 | 11 | 21 | 29 | 42 | 73 | 4 | 8 | 12 | 23 | 32 | 45 | 76 |
| 138 | 215 | 0.3 | 27 | 35 | 1 | 2 | 2 | 5 | 8 | 15 | 33 | 1 | 2 | 2 | 6 | 10 | 17 | 36 |
| 138T | 252 | 0.4 | 28 | 36 | 3 | 6 | 10 | 18 | 23 | 32 | 53 | 4 | 7 | 12 | 19 | 25 | 34 | 56 |
| 139 | 170 | 0.3 | 25 | 36 | 2 | 5 | 8 | 13 | 16 | 22 | 37 | 4 | 6 | 9 | 14 | 18 | 24 | 39 |
| 339 | 170 | 0.3 | 25 | 36 | 2 | 5 | 8 | 13 | 16 | 22 | 37 | 4 | 6 | 9 | 14 | 18 | 24 | 39 |
| 139O | 170 | 0.3 | 25 | 36 | 1 | 2 | 5 | 10 | 13 | 19 | 33 | 2 | 4 | 7 | 11 | 15 | 21 | 36 |
| 140 | 93 | 0.1 | 25 | 29 | 1 | 2 | 4 | 8 | 10 | 14 | 21 | 2 | 3 | 5 | 8 | 11 | 14 | 22 |
| 340 | 93 | 0.1 | 25 | 29 | 1 | 2 | 4 | 8 | 10 | 14 | 21 | 2 | 3 | 5 | 8 | 11 | 14 | 22 |
| 140O | 93 | 0.1 | 25 | 29 | 1 | 2 | 4 | 7 | 9 | 12 | 19 | 2 | 3 | 5 | 8 | 9 | 12 | 20 |
| 141 | 37 | 0.1 | 38 | 38 | 1 | 1 | 2 | 3 | 5 | 6 | 9 | 1 | 1 | 2 | 3 | 5 | 6 | 9 |
| 142 | 623 | 1.0 | 42 | 52 | 16 | 23 | 33 | 53 | 70 | 92 | 144 | 21 | 30 | 40 | 60 | 77 | 99 | 151 |
| 143 | 263 | 0.4 | 20 | 50 | 3 | 6 | 10 | 21 | 28 | 37 | 60 | 9 | 13 | 19 | 29 | 36 | 45 | 68 |
| 143T | 199 | 0.3 | 19 | 50 | 2 | 4 | 8 | 15 | 21 | 28 | 45 | 7 | 10 | 14 | 22 | 27 | 34 | 52 |
| 144 | 89 | 0.1 | 8 | 44 | 0 | 1 | 2 | 6 | 8 | 11 | 19 | 2 | 4 | 5 | 9 | 11 | 14 | 22 |
| 145 | 109 | 0.2 | 27 | 54 | 2 | 3 | 5 | 9 | 12 | 16 | 25 | 4 | 6 | 8 | 12 | 15 | 19 | 28 |
| 146 | 535 | 0.8 | 37 | 49 | 12 | 18 | 26 | 44 | 58 | 77 | 122 | 17 | 25 | 33 | 51 | 65 | 84 | 129 |
| 147 | 481 | 0.8 | 34 | 47 | 10 | 15 | 22 | 38 | 51 | 68 | 108 | 15 | 21 | 29 | 44 | 58 | 75 | 115 |
| 148 | 77 | 0.1 | 30 | 61 | 1 | 2 | 4 | 7 | 9 | 12 | 18 | 3 | 4 | 6 | 9 | 11 | 14 | 20 |
| 149 | 38 | 0.1 | 45 | 46 | 1 | 1 | 2 | 3 | 4 | 6 | 9 | 1 | 2 | 2 | 3 | 5 | 6 | 9 |
| 150 | 191 | 0.3 | 31 | 48 | 4 | 6 | 9 | 16 | 21 | 28 | 44 | 6 | 9 | 12 | 19 | 24 | 31 | 47 |
| 150T | 293 | 0.5 | 27 | 38 | 5 | 7 | 11 | 20 | 28 | 38 | 62 | 7 | 11 | 15 | 24 | 32 | 42 | 66 |
| 151 | 119 | 0.2 | 21 | 44 | 2 | 3 | 4 | 9 | 12 | 16 | 26 | 3 | 5 | 7 | 12 | 15 | 19 | 29 |
| 152 | 65 | 0.1 | 33 | 50 | 1 | 2 | 3 | 6 | 8 | 10 | 15 | 2 | 3 | 4 | 7 | 9 | 11 | 17 |
| 153 | 41 | 0.1 | 22 | 22 | 0 | 0 | 1 | 1 | 2 | 3 | 6 | 0 | 0 | 1 | 1 | 2 | 3 | 6 |
| 154 | 61 | 0.1 | 14 | 14 | 0 | 0 | 1 | 1 | 2 | 4 | 8 | 0 | 0 | 1 | 1 | 2 | 4 | 8 |
| 155 | 388 | 0.6 | 36 | 56 | 9 | 14 | 21 | 36 | 46 | 60 | 93 | 15 | 21 | 29 | 43 | 55 | 68 | 101 |

## Table B-5 - Baseline Peak Flows Along 4100 Drainageway

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 100 | --- | South Platte River | 1,691 | 2.6 | 0 | 0 | 128 | 218 | 332 | 634 | 827 | 1,086 | 1,666 | 213 | 330 | 462 | 805 | 1,016 | 1,288 | 1,881 |
| 104 | 204 | | 1,684 | 2.6 | 523 | 523 | 126 | 216 | 329 | 630 | 822 | 1,079 | 1,655 | 209 | 325 | 456 | 796 | 1,005 | 1,274 | 1,861 |
| 105 | 205 | | 1,333 | 2.1 | 514 | 1,037 | 68 | 114 | 171 | 333 | 441 | 606 | 980 | 106 | 166 | 236 | 421 | 541 | 703 | 1,086 |
| 110T | 210T | | 1,077 | 1.7 | 2,333 | 3,370 | 43 | 69 | 100 | 170 | 218 | 276 | 415 | 52 | 81 | 114 | 188 | 239 | 300 | 448 |
| 114 | 214 | | 996 | 1.6 | 136 | 3,506 | 17 | 38 | 72 | 135 | 151 | 167 | 218 | 22 | 40 | 75 | 137 | 153 | 168 | 216 |
| 115 | 215 | Welby Road | 988 | 1.5 | 1,625 | 5,131 | 19 | 37 | 71 | 134 | 149 | 163 | 209 | 24 | 40 | 74 | 135 | 150 | 165 | 206 |
| 116O | 216O | | 957 | 1.5 | 864 | 5,995 | 13 | 37 | 71 | 134 | 147 | 162 | 187 | 14 | 40 | 74 | 135 | 147 | 162 | 187 |
| 116 | 216 | H Tributary Confluence | 957 | 1.5 | 0 | 5,995 | 174 | 271 | 387 | 714 | 915 | 1,292 | 2,253 | 181 | 280 | 397 | 726 | 929 | 1,316 | 2,292 |
| 120T | 220T | | 733 | 1.1 | 636 | 6,631 | 137 | 209 | 294 | 516 | 681 | 987 | 1,726 | 139 | 212 | 298 | 516 | 691 | 1,001 | 1,745 |
| 130T | 230T | D Tributary Confluence | 391 | 0.6 | 1,799 | 8,430 | 73 | 107 | 152 | 273 | 402 | 609 | 1,037 | 74 | 108 | 153 | 274 | 410 | 619 | 1,049 |
| 130 | 230 | | 269 | 0.4 | 0 | 8,430 | 47 | 61 | 79 | 171 | 266 | 410 | 709 | 47 | 62 | 80 | 177 | 272 | 418 | 719 |
| 131O | 231O | | 149 | 0.2 | 3,121 | 11,551 | 31 | 38 | 40 | 108 | 170 | 275 | 476 | 32 | 39 | 40 | 112 | 175 | 283 | 486 |
| 131 | 231 | | 149 | 0.2 | 0 | 11,551 | 56 | 81 | 114 | 200 | 259 | 332 | 504 | 59 | 86 | 119 | 206 | 265 | 340 | 514 |
| 132T | 232T | | 127 | 0.2 | 785 | 12,336 | 52 | 76 | 106 | 183 | 235 | 299 | 450 | 55 | 80 | 112 | 189 | 241 | 307 | 459 |
| 132 | 232 | | 86 | 0.1 | 631 | 12,967 | 35 | 52 | 76 | 129 | 166 | 210 | 317 | 39 | 57 | 81 | 135 | 173 | 219 | 330 |

## Table B-6 - Baseline Runoff Volumes Along 4100 Drainageway

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 100 | --- | South Platte River | 1,691 | 2.6 | 0 | 0 | 20 | 36 | 59 | 110 | 140 | 174 | 247 | 29 | 48 | 72 | 122 | 153 | 186 | 260 |
| 104 | 204 | | 1,684 | 2.6 | 523 | 523 | 20 | 36 | 59 | 109 | 140 | 173 | 246 | 28 | 47 | 72 | 122 | 152 | 185 | 258 |
| 105 | 205 | | 1,333 | 2.1 | 514 | 1,037 | 13 | 24 | 41 | 79 | 100 | 120 | 164 | 17 | 30 | 48 | 85 | 106 | 126 | 170 |
| 110T | 210T | | 1,077 | 1.7 | 2,333 | 3,370 | 8 | 16 | 28 | 56 | 70 | 82 | 104 | 9 | 17 | 30 | 58 | 71 | 83 | 105 |
| 114 | 214 | | 996 | 1.6 | 136 | 3,506 | 6 | 12 | 23 | 48 | 60 | 69 | 84 | 6 | 13 | 24 | 49 | 61 | 69 | 85 |
| 115 | 215 | | 988 | 1.5 | 1,625 | 5,131 | 6 | 12 | 23 | 48 | 60 | 69 | 84 | 6 | 13 | 24 | 49 | 61 | 69 | 84 |
| 116O | 216O | Welby Road | 957 | 1.5 | 864 | 5,995 | 5 | 11 | 21 | 45 | 56 | 64 | 76 | 5 | 12 | 22 | 46 | 57 | 64 | 77 |
| 116 | 216 | | 957 | 1.5 | 0 | 5,995 | 24 | 36 | 50 | 83 | 108 | 141 | 219 | 24 | 37 | 51 | 84 | 109 | 142 | 221 |
| 120T | 220T | H Tributary Confluence | 733 | 1.1 | 636 | 6,631 | 19 | 28 | 40 | 65 | 84 | 110 | 169 | 19 | 29 | 40 | 65 | 85 | 110 | 170 |
| 130T | 230T | | 391 | 0.6 | 1,799 | 8,430 | 10 | 15 | 22 | 36 | 46 | 60 | 92 | 11 | 16 | 22 | 36 | 46 | 60 | 93 |
| 130 | 230 | | 269 | 0.4 | 0 | 8,430 | 7 | 10 | 14 | 24 | 31 | 40 | 62 | 7 | 10 | 14 | 24 | 31 | 41 | 63 |
| 131O | 231O | D Tributary Confluence | 149 | 0.2 | 3,121 | 11,551 | 4 | 6 | 9 | 14 | 18 | 23 | 35 | 4 | 6 | 9 | 14 | 18 | 23 | 35 |
| 131 | 231 | | 149 | 0.2 | 0 | 11,551 | 4 | 6 | 9 | 14 | 18 | 23 | 35 | 4 | 6 | 9 | 14 | 18 | 23 | 35 |
| 132T | 232T | | 127 | 0.2 | 785 | 12,336 | 4 | 6 | 8 | 12 | 16 | 20 | 31 | 4 | 6 | 8 | 13 | 16 | 20 | 31 |
| 132 | 232 | | 86 | 0.1 | 631 | 12,967 | 3 | 4 | 5 | 8 | 11 | 14 | 21 | 3 | 4 | 5 | 9 | 11 | 14 | 21 |

## Table B-7 - Baseline Peak Flows Along School Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 101 | 201 | Colorado Boulevard | 317 | 0.5 | 0 | 0 | 57 | 98 | 151 | 280 | 358 | 453 | 617 | 99 | 149 | 203 | 344 | 425 | 523 | 717 |
| 102T | 202T | | 298 | 0.5 | 1,337 | 1,337 | 52 | 91 | 140 | 261 | 334 | 423 | 577 | 94 | 140 | 192 | 323 | 399 | 488 | 663 |
| 102O | 202O | Old Welby Road | 215 | 0.3 | 2,852 | 4,189 | 49 | 79 | 116 | 203 | 256 | 319 | 429 | 49 | 79 | 116 | 203 | 256 | 319 | 429 |
| 102 | 202 | | 215 | 0.3 | 0 | 4,189 | 49 | 79 | 116 | 204 | 261 | 335 | 503 | 49 | 79 | 116 | 204 | 261 | 335 | 503 |

## Table B-8 - Baseline Runoff Volumes Along School Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 101 | 201 | Colorado Boulevard | 317 | 0.5 | 0 | 0 | 7 | 11 | 17 | 29 | 37 | 49 | 75 | 10 | 16 | 22 | 34 | 43 | 54 | 81 |
| 102T | 202T | | 298 | 0.5 | 1,337 | 1,337 | 6 | 10 | 16 | 27 | 35 | 46 | 71 | 10 | 15 | 21 | 32 | 41 | 51 | 76 |
| 102O | 202O | Old Welby Road | 215 | 0.3 | 2,852 | 4,189 | 6 | 9 | 13 | 21 | 27 | 35 | 53 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |
| 102 | 202 | | 215 | 0.3 | 0 | 4,189 | 6 | 9 | 13 | 21 | 27 | 35 | 53 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |

## Table B-9 - Baseline Peak Flows Along B Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 110T | 210T | Drainageway 4100 Confluence | 1,077 | 1.7 | 0 | 0 | 43 | 69 | 100 | 170 | 218 | 276 | 415 | 52 | 81 | 114 | 188 | 239 | 300 | 448 |
| 110 | 210 | | 81 | 0.1 | 216 | 216 | 26 | 42 | 63 | 109 | 140 | 178 | 268 | 31 | 50 | 71 | 120 | 153 | 194 | 291 |
| 112T | 212T | | 40 | 0.1 | 450 | 666 | 14 | 23 | 34 | 59 | 77 | 97 | 147 | 15 | 24 | 35 | 61 | 78 | 100 | 150 |
| 113 | 213 | RTD NMRL | 33 | 0.1 | 2,015 | 2,681 | 14 | 22 | 33 | 54 | 70 | 89 | 134 | 14 | 22 | 33 | 54 | 70 | 89 | 134 |

## Table B-10 - Baseline Runoff Volumes Along B Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 110T | 210T | Drainageway 4100 Confluence | 1,077 | 1.7 | 0 | 0 | 8 | 16 | 28 | 56 | 70 | 82 | 104 | 9 | 17 | 30 | 58 | 71 | 83 | 105 |
| 110 | 210 | | 81 | 0.1 | 216 | 216 | 2 | 3 | 5 | 8 | 10 | 13 | 20 | 3 | 4 | 5 | 8 | 11 | 13 | 20 |
| 112T | 212T | | 40 | 0.1 | 450 | 666 | 1 | 2 | 2 | 4 | 5 | 6 | 10 | 1 | 2 | 2 | 4 | 5 | 6 | 10 |
| 113 | 213 | RTD NMRL | 33 | 0.1 | 2,015 | 2,681 | 1 | 1 | 2 | 3 | 4 | 5 | 8 | 1 | 1 | 2 | 3 | 4 | 5 | 8 |

## Table B-11 - Baseline Peak Flows Along D Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 130T | 230T | Drainageway 4100 Confluence | 391 | 0.6 | 0 | 0 | 73 | 107 | 152 | 273 | 402 | 609 | 1,037 | 74 | 108 | 153 | 274 | 410 | 619 | 1,049 |
| 134 | 234 | | 122 | 0.2 | 40 | 40 | 33 | 55 | 81 | 142 | 183 | 234 | 352 | 33 | 55 | 81 | 142 | 183 | 234 | 352 |
| 135T | 235T | | 63 | 0.1 | 1,287 | 1,327 | 21 | 33 | 48 | 81 | 103 | 131 | 196 | 21 | 33 | 48 | 81 | 103 | 131 | 196 |
| 136 | 236 | | 20 | 0.0 | 1,834 | 3,161 | 5 | 7 | 11 | 18 | 24 | 30 | 45 | 5 | 7 | 11 | 18 | 24 | 30 | 45 |

## Table B-12 - Baseline Runoff Volumes Along D Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 130T | 230T | 4100 Drainageway Confluence | 391 | 0.6 | 0 | 0 | 10 | 15 | 22 | 36 | 46 | 60 | 92 | 11 | 16 | 22 | 36 | 46 | 60 | 93 |
| 134 | 234 | | 122 | 0.2 | 40 | 40 | 3 | 5 | 7 | 12 | 15 | 20 | 30 | 3 | 5 | 7 | 12 | 15 | 20 | 30 |
| 135T | 235T | | 63 | 0.1 | 1,287 | 1,327 | 2 | 3 | 4 | 6 | 8 | 10 | 16 | 2 | 3 | 4 | 6 | 8 | 10 | 16 |
| 136 | 236 | | 20 | 0.0 | 1,834 | 3,161 | 1 | 1 | 1 | 2 | 3 | 3 | 5 | 1 | 1 | 1 | 2 | 3 | 3 | 5 |

## Table B-13 - Baseline Peak Flows Along West G Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 120T | 220T | 4100 Drainageway Confluence | 733 | 1.1 | 0 | 0 | 137 | 209 | 294 | 516 | 681 | 987 | 1,726 | 139 | 212 | 298 | 516 | 691 | 1,001 | 1,745 |
| 120 | 220 | | 343 | 0.5 | 0 | 0 | 73 | 110 | 146 | 249 | 308 | 390 | 706 | 74 | 112 | 148 | 249 | 308 | 391 | 713 |
| 123 | 223 | | 232 | 0.4 | 0 | 0 | 32 | 49 | 68 | 156 | 207 | 281 | 573 | 32 | 49 | 68 | 156 | 207 | 282 | 580 |
| 124T | 224T | | 135 | 0.2 | 2,136 | 2,136 | 11 | 17 | 24 | 74 | 100 | 148 | 354 | 11 | 17 | 25 | 74 | 101 | 151 | 361 |
| 126O | 226O | | 104 | 0.2 | 2,226 | 4,362 | 31 | 47 | 62 | 99 | 117 | 159 | 321 | 32 | 48 | 63 | 99 | 118 | 162 | 327 |
| 126 | 226 | York Street | 70 | 0.1 | 0 | 4,362 | 22 | 34 | 47 | 78 | 110 | 152 | 303 | 23 | 36 | 48 | 78 | 111 | 159 | 312 |
| 128T | 228T | | 37 | 0.1 | 1,446 | 5,808 | 2 | 3 | 5 | 12 | 18 | 44 | 88 | 2 | 3 | 6 | 12 | 20 | 48 | 93 |
| 129O | 229O | | 30 | 0.0 | 1,661 | 7,469 | 8 | 14 | 20 | 25 | 30 | 52 | 90 | 9 | 15 | 21 | 26 | 32 | 56 | 94 |
| 129 | 229 | | 30 | 0.0 | 0 | 7,469 | 9 | 14 | 21 | 37 | 48 | 61 | 92 | 10 | 16 | 23 | 40 | 51 | 64 | 96 |

## Table B-14 - Baseline Runoff Volumes Along West G Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 120T | 220T | North G Confluence | 733 | 1.1 | 0 | 0 | 19 | 28 | 40 | 65 | 84 | 110 | 169 | 19 | 29 | 40 | 65 | 85 | 110 | 170 |
| 120 | 220 | | 343 | 0.5 | 0 | 0 | 9 | 13 | 18 | 29 | 38 | 50 | 77 | 9 | 13 | 18 | 30 | 38 | 50 | 77 |
| 123 | 223 | | 232 | 0.4 | 0 | 0 | 3 | 5 | 7 | 13 | 19 | 26 | 44 | 3 | 5 | 7 | 13 | 19 | 26 | 44 |
| 124T | 224T | | 135 | 0.2 | 2,136 | 2,136 | 1 | 1 | 2 | 5 | 8 | 12 | 22 | 1 | 1 | 2 | 5 | 8 | 12 | 22 |
| 126O | 226O | | 104 | 0.2 | 2,226 | 4,362 | 3 | 5 | 6 | 10 | 13 | 17 | 25 | 3 | 5 | 6 | 10 | 13 | 17 | 25 |
| 126 | 226 | York Street | 70 | 0.1 | 0 | 4,362 | 2 | 3 | 4 | 7 | 9 | 13 | 21 | 2 | 3 | 4 | 7 | 9 | 13 | 21 |
| 128T | 228T | | 37 | 0.1 | 1,446 | 5,808 | 0 | 0 | 0 | 1 | 2 | 3 | 6 | 0 | 0 | 1 | 1 | 2 | 3 | 6 |
| 129O | 229O | | 30 | 0.0 | 1,661 | 7,469 | 1 | 1 | 2 | 3 | 4 | 5 | 7 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |
| 129 | 229 | | 30 | 0.0 | 0 | 7,469 | 1 | 1 | 2 | 3 | 4 | 5 | 7 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |

## Table B-15 - Baseline Peak Flows Along North G Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 120 | 220 | West G Confluence | 343 | 0.5 | 0 | 0 | 73 | 110 | 146 | 249 | 308 | 390 | 706 | 74 | 112 | 148 | 249 | 308 | 391 | 713 |
| 121O | 221O | | 86 | 0.1 | 1,215 | 1,215 | 7 | 11 | 15 | 25 | 32 | 46 | 85 | 8 | 12 | 16 | 26 | 33 | 48 | 101 |
| 121 | 221 | Yorkborough Park | 86 | 0.1 | 0 | 1,215 | 7 | 11 | 16 | 29 | 38 | 53 | 87 | 8 | 12 | 17 | 30 | 40 | 55 | 104 |
| 122O | 222O | | 58 | 0.1 | 1,335 | 2,550 | 5 | 8 | 12 | 20 | 26 | 32 | 64 | 6 | 9 | 13 | 22 | 27 | 33 | 75 |
| 122 | 226O | | 58 | 0.1 | 2,226 | 4,776 | 13 | 23 | 36 | 66 | 87 | 111 | 170 | 16 | 27 | 41 | 74 | 95 | 122 | 184 |

## Table B-16 - Baseline Runoff Volumes Along North G Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 120 | 220 | West G Confluence | 343 | 0.5 | 0 | 0 | 9 | 13 | 18 | 29 | 38 | 50 | 77 | 9 | 13 | 18 | 30 | 38 | 50 | 77 |
| 121O | 221O | | 86 | 0.1 | 1,215 | 1,215 | 1 | 2 | 4 | 6 | 8 | 11 | 18 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 121O | 221O | | 86 | 0.1 | 1,215 | 2,430 | 1 | 2 | 4 | 6 | 8 | 11 | 18 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 122O | 222O | | 58 | 0.1 | 1,335 | 2,550 | 1 | 2 | 3 | 5 | 6 | 8 | 13 | 1 | 2 | 3 | 5 | 7 | 9 | 13 |
| 122 | 226O | | 58 | 0.1 | 2,226 | 4,776 | 1 | 2 | 3 | 5 | 7 | 9 | 14 | 1 | 2 | 3 | 5 | 7 | 9 | 14 |

## Table B-17 - Baseline Peak Flows Along H Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 116 | 216 | 4100 Drainageway Confluence | 957 | 1.5 | 0 | 0 | 174 | 271 | 387 | 714 | 915 | 1,292 | 2,253 | 181 | 280 | 397 | 726 | 929 | 1,316 | 2,292 |
| 118T | 218T | | 56 | 0.1 | 583 | 583 | 12 | 18 | 23 | 47 | 64 | 88 | 143 | 12 | 18 | 23 | 47 | 64 | 88 | 143 |
| 118 | 218 | Thornton Parkway | 43 | 0.1 | 750 | 1,333 | 9 | 14 | 19 | 39 | 53 | 72 | 117 | 9 | 14 | 19 | 39 | 53 | 72 | 117 |

## Table B-18 - Baseline Runoff Volumes Along H Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 116 | 216 | 4100 Drainageway Confluence | 957 | 1.5 | 0 | 0 | 24 | 36 | 50 | 83 | 108 | 141 | 219 | 24 | 37 | 51 | 84 | 109 | 142 | 221 |
| 118T | 218T | | 56 | 0.1 | 583 | 583 | 1 | 2 | 2 | 4 | 5 | 7 | 11 | 1 | 2 | 2 | 4 | 5 | 7 | 11 |
| 118 | 218 | Thornton Parkway | 43 | 0.1 | 750 | 1,333 | 1 | 1 | 2 | 3 | 4 | 5 | 9 | 1 | 1 | 2 | 3 | 4 | 5 | 9 |

## Table B-19 - Baseline Peak Flows Along J Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 137 | 237 | South Platte Confluence | 364 | 0.6 | 0 | 0 | 10 | 18 | 37 | 82 | 117 | 172 | 382 | 12 | 28 | 51 | 96 | 135 | 204 | 440 |
| 138T | 238T | | 252 | 0.4 | 1,890 | 1,890 | 13 | 23 | 37 | 85 | 114 | 149 | 331 | 14 | 31 | 54 | 96 | 127 | 194 | 386 |
| 138 | 238 | Riverdale Road | 215 | 0.3 | 1,380 | 3,270 | 9 | 16 | 24 | 44 | 57 | 90 | 259 | 9 | 16 | 24 | 45 | 68 | 129 | 299 |
| 139O | 239O | | 170 | 0.3 | 1,916 | 5,186 | 2 | 11 | 21 | 38 | 49 | 97 | 232 | 7 | 18 | 29 | 48 | 61 | 111 | 259 |
| 139 | 239 | | 170 | 0.3 | 0 | 5,186 | 11 | 19 | 31 | 62 | 81 | 107 | 239 | 24 | 39 | 57 | 98 | 125 | 159 | 267 |
| 140O | 240O | Thornton Parkway | 93 | 0.1 | 1,481 | 6,667 | 9 | 13 | 15 | 18 | 30 | 83 | 167 | 11 | 13 | 16 | 19 | 45 | 98 | 184 |
| 140 | 240 | Thornton Parkway | 93 | 0.1 | 0 | 6,667 | 11 | 20 | 34 | 67 | 88 | 116 | 179 | 13 | 24 | 39 | 75 | 99 | 129 | 199 |

## Table B-20 - Baseline Runoff Volumes Along J Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 137 | 237 | South Platte Confluence | 364 | 0.6 | 0 | 0 | 3 | 6 | 11 | 21 | 29 | 42 | 73 | 4 | 8 | 12 | 23 | 32 | 45 | 76 |
| 138T | 238T | | 252 | 0.4 | 1,890 | 1,890 | 3 | 6 | 10 | 18 | 23 | 32 | 53 | 4 | 7 | 12 | 19 | 25 | 34 | 56 |
| 138 | 238 | Riverdale Road | 215 | 0.3 | 1,380 | 3,270 | 1 | 2 | 2 | 5 | 8 | 15 | 33 | 1 | 2 | 2 | 6 | 10 | 17 | 36 |
| 139O | 239O | | 170 | 0.3 | 1,916 | 5,186 | 1 | 2 | 5 | 10 | 13 | 19 | 33 | 2 | 4 | 7 | 11 | 15 | 21 | 36 |
| 139 | 239 | | 170 | 0.3 | 0 | 5,186 | 2 | 5 | 8 | 13 | 16 | 22 | 37 | 4 | 6 | 9 | 14 | 18 | 24 | 39 |
| 140O | 240O | Thornton Parkway | 93 | 0.1 | 1,481 | 6,667 | 1 | 2 | 4 | 7 | 9 | 12 | 19 | 2 | 3 | 5 | 8 | 9 | 12 | 20 |
| 140 | 240 | Thornton Parkway | 93 | 0.1 | 0 | 6,667 | 1 | 2 | 4 | 8 | 10 | 14 | 21 | 2 | 3 | 5 | 8 | 11 | 14 | 22 |

## Table B-21 - Baseline Peak Flows Along North K Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 143 | 247 | Confluence with Reservoir | 263 | 0.4 | 0 | 0 | 13 | 29 | 58 | 134 | 187 | 263 | 428 | 56 | 92 | 137 | 251 | 328 | 433 | 668 |
| 143T | 248 | | 199 | 0.3 | 1,725 | 1,725 | 11 | 24 | 46 | 108 | 148 | 206 | 329 | 49 | 78 | 113 | 205 | 264 | 342 | 522 |
| 145 | 249 | | 109 | 0.2 | 2,811 | 4,536 | 14 | 26 | 44 | 87 | 115 | 152 | 235 | 48 | 73 | 101 | 164 | 206 | 258 | 381 |

## Table B-22 - Baseline Runoff Volumes Along North K Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 143 | 247 | Confluence with Reservoir | 263 | 0.4 | 0 | 0 | 3 | 6 | 10 | 21 | 28 | 37 | 60 | 9 | 13 | 19 | 29 | 36 | 45 | 68 |
| 143T | 248 | | 199 | 0.3 | 1,725 | 1,725 | 2 | 4 | 8 | 15 | 21 | 28 | 45 | 7 | 10 | 14 | 22 | 27 | 34 | 52 |
| 145 | 249 | | 109 | 0.2 | 2,811 | 4,536 | 2 | 3 | 5 | 9 | 12 | 16 | 25 | 4 | 6 | 8 | 12 | 15 | 19 | 28 |

## Table B-23 - Baseline Peak Flows Along South K Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 150T | 250T | Confluence with Reservoir | 293 | 0.5 | 0 | 0 | 20 | 34 | 58 | 125 | 178 | 258 | 441 | 36 | 58 | 87 | 167 | 226 | 315 | 514 |
| 150 | 250 | | 191 | 0.3 | 1,231 | 1,231 | 29 | 47 | 77 | 155 | 205 | 271 | 422 | 55 | 83 | 121 | 215 | 276 | 354 | 535 |
| 151 | 251 | | 119 | 0.2 | 296 | 1,527 | 13 | 23 | 41 | 90 | 120 | 160 | 252 | 33 | 51 | 76 | 136 | 176 | 227 | 345 |
| 152 | 252 | Riverdale Road | 65 | 0.1 | 2,626 | 4,153 | 14 | 25 | 40 | 72 | 94 | 120 | 184 | 28 | 44 | 62 | 101 | 127 | 160 | 237 |

## Table B-24 - Baseline Runoff Volumes Along South K Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 150T | 250T | Confluence with Reservoir | 293 | 0.5 | 0 | 0 | 5 | 7 | 11 | 20 | 28 | 38 | 62 | 7 | 11 | 15 | 24 | 32 | 42 | 66 |
| 150 | 250 | | 191 | 0.3 | 1,231 | 1,231 | 4 | 6 | 9 | 16 | 21 | 28 | 44 | 6 | 9 | 12 | 19 | 24 | 31 | 47 |
| 151 | 251 | | 119 | 0.2 | 1,828 | 3,059 | 2 | 3 | 4 | 9 | 12 | 16 | 26 | 3 | 5 | 7 | 12 | 15 | 19 | 29 |
| 152 | 252 | Riverdale Road | 65 | 0.1 | 2,626 | 5,685 | 1 | 2 | 3 | 6 | 8 | 10 | 15 | 2 | 3 | 4 | 7 | 9 | 11 | 17 |

## Table B-25 - Baseline Peak Flows Along Colorado Boulevard

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 105 | 205 | Confluence with Drainageway 4100 | 1,333 | 2.1 | 0 | 0 | 68 | 114 | 171 | 333 | 441 | 606 | 980 | 106 | 166 | 236 | 421 | 541 | 703 | 1,086 |
| 106 | 206 | | 173 | 0.3 | 1,274 | 1,274 | 15 | 39 | 78 | 141 | 189 | 257 | 406 | 41 | 75 | 106 | 183 | 238 | 313 | 480 |
| 107O | 207O | Thornton Parkway | 107 | 0.2 | 2,603 | 3,877 | 7 | 27 | 50 | 107 | 141 | 185 | 282 | 22 | 46 | 72 | 132 | 168 | 215 | 321 |
| 107 | 207 | | 107 | 0.2 | 0 | 3,877 | 23 | 39 | 60 | 111 | 144 | 187 | 286 | 37 | 57 | 80 | 135 | 171 | 218 | 326 |
| 109 | 209 | | 30 | 0.0 | 2,407 | 6,284 | 8 | 13 | 19 | 35 | 45 | 57 | 87 | 11 | 17 | 24 | 41 | 52 | 65 | 98 |

## Table B-26 - Baseline Runoff Volumes Along Colorado Boulevard

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 105 | 205 | Confluence with Drainageway 4100 | 1,333 | 2.1 | 0 | 0 | 13 | 24 | 41 | 79 | 100 | 120 | 164 | 17 | 30 | 48 | 85 | 106 | 126 | 170 |
| 106 | 206 | | 173 | 0.3 | 1,274 | 1,274 | 4 | 6 | 9 | 16 | 21 | 27 | 42 | 6 | 9 | 13 | 20 | 25 | 31 | 46 |
| 107O | 207O | Thornton Parkway | 107 | 0.2 | 2,603 | 3,877 | 2 | 4 | 6 | 10 | 13 | 16 | 25 | 3 | 5 | 7 | 11 | 14 | 18 | 27 |
| 107 | 207 | | 107 | 0.2 | 0 | 3,877 | 3 | 4 | 6 | 10 | 13 | 17 | 26 | 4 | 5 | 7 | 11 | 14 | 18 | 27 |
| 109 | 209 | | 30 | 0.0 | 2,407 | 6,284 | 1 | 1 | 2 | 3 | 4 | 5 | 7 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |

## Table B-27 - Baseline Peak Flows Along Thornton Parkway

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 107 | 207 | Thornton Parkway | 107 | 0.2 | 0 | 0 | 23 | 39 | 60 | 111 | 144 | 187 | 286 | 37 | 57 | 80 | 135 | 171 | 218 | 326 |
| 108 | 208 | | 42 | 0.1 | 1,396 | 1,396 | 8 | 13 | 21 | 40 | 53 | 69 | 106 | 8 | 13 | 21 | 40 | 53 | 69 | 106 |

## Table B-28 - Baseline Runoff Volumes Along Thornton Parkway

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 107 | 207 | Thornton Parkway | 107 | 0.2 | 0 | 0 | 3 | 4 | 6 | 10 | 13 | 17 | 26 | 4 | 5 | 7 | 11 | 14 | 18 | 27 |
| 108 | 208 | | 42 | 0.1 | 1,396 | 1,396 | 1 | 1 | 2 | 4 | 5 | 6 | 10 | 1 | 1 | 2 | 4 | 5 | 6 | 10 |

**Figure B-3**
**4100 Drainageway**
**Baseline Peak Discharge vs. Drainageway Station**

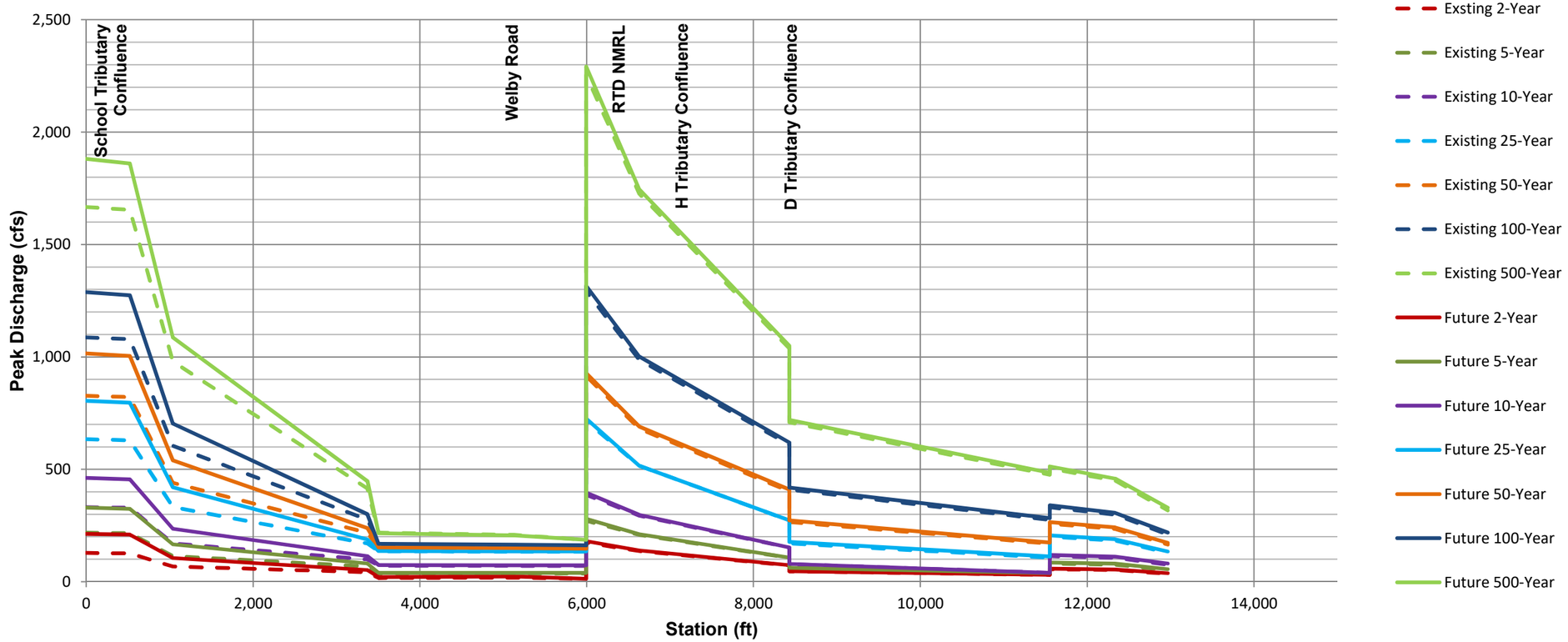


**Figure B-4**
**School Tributary**
**Baseline Peak Discharge vs. Drainageway Station**

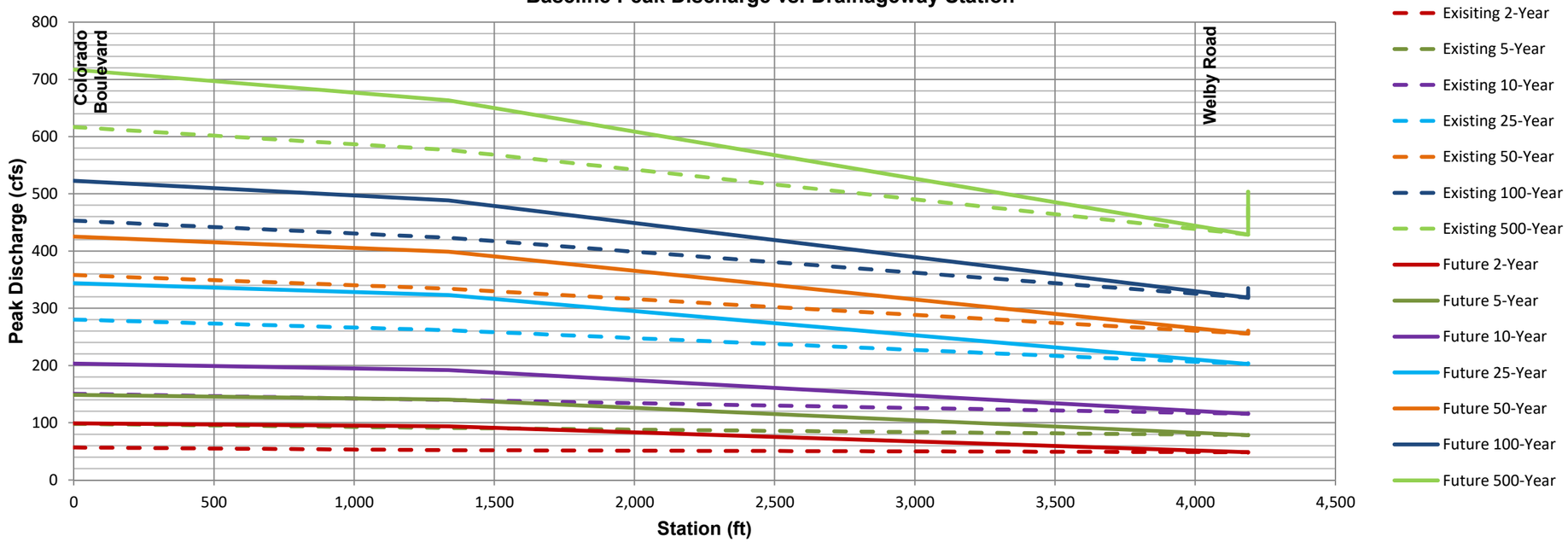


**Figure B-5**
**B Tributary**
**Baseline Peak Discharge vs. Drainageway Station**

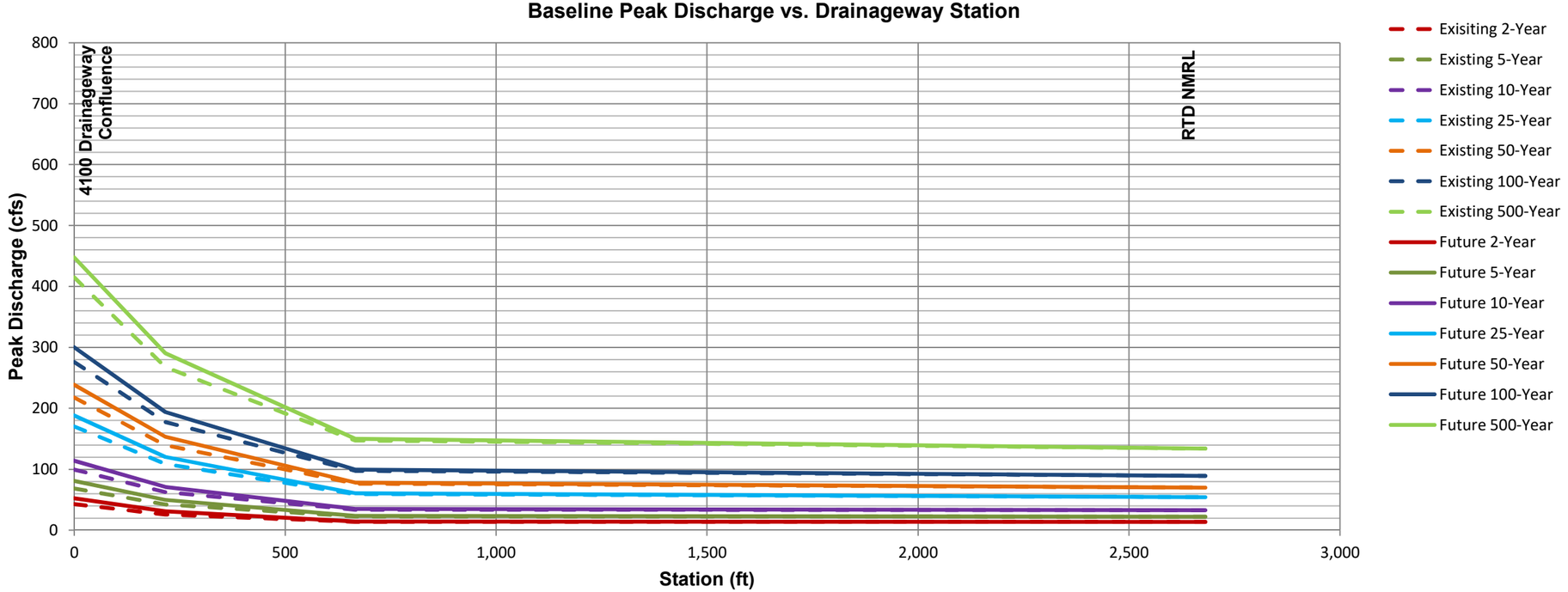


**Figure B-6**
**D Tributary**
**Baseline Peak Discharge vs. Drainageway Station**

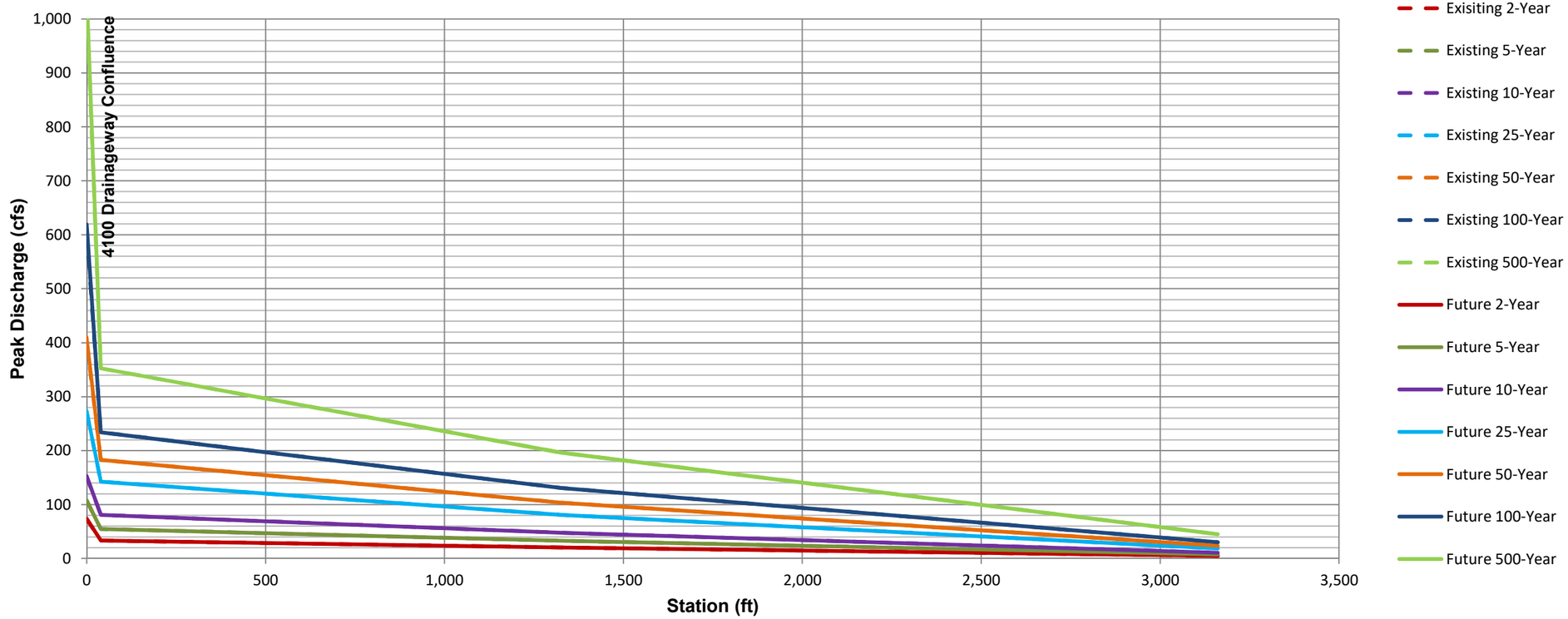


**Figure B-7**
**West G Tributary**
**Baseline Peak Discharge vs. Drainageway Station**

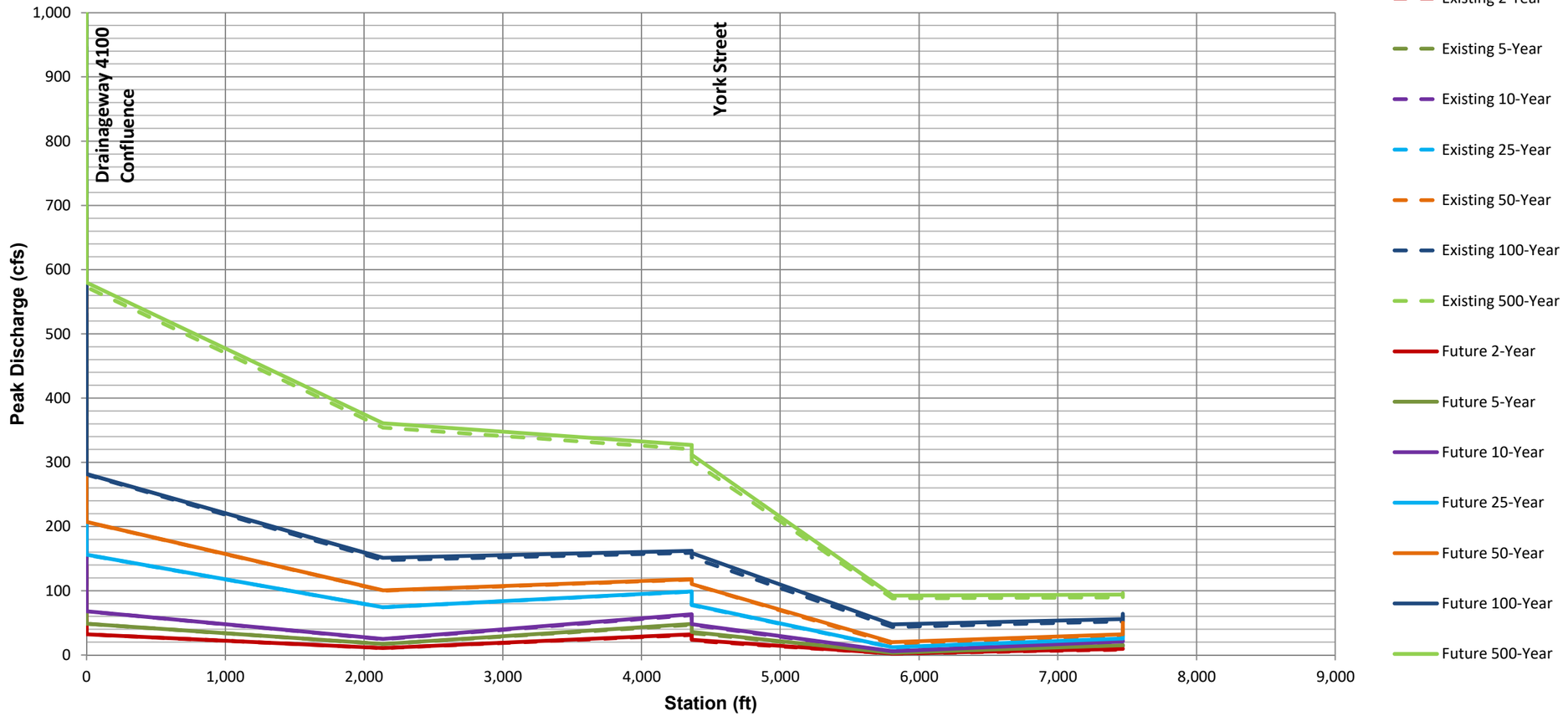


**Figure B-8**
**North G Tributary**
**Baseline Peak Discharge vs. Drainageway Station**

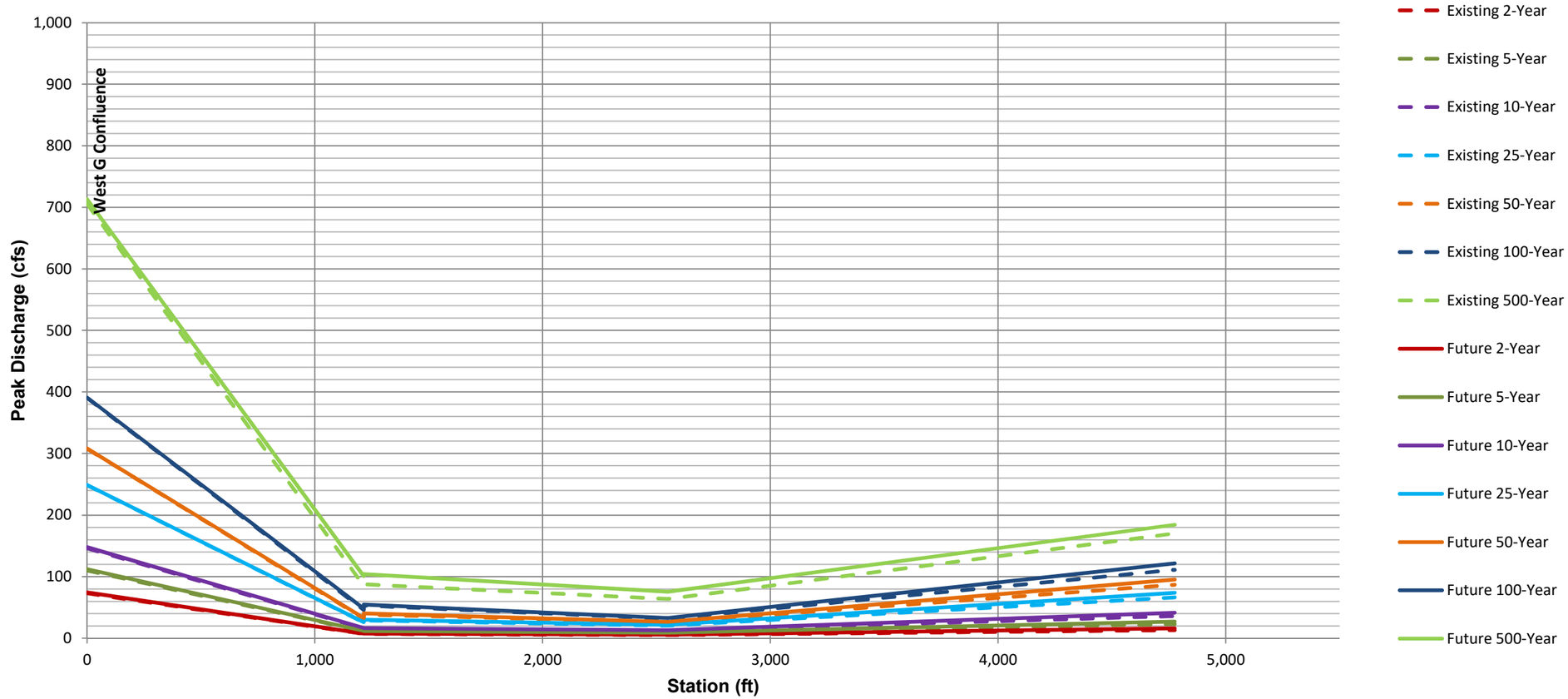


**Figure B-9**
**H Tributary**
**Baseline Peak Discharge vs. Drainageway Station**

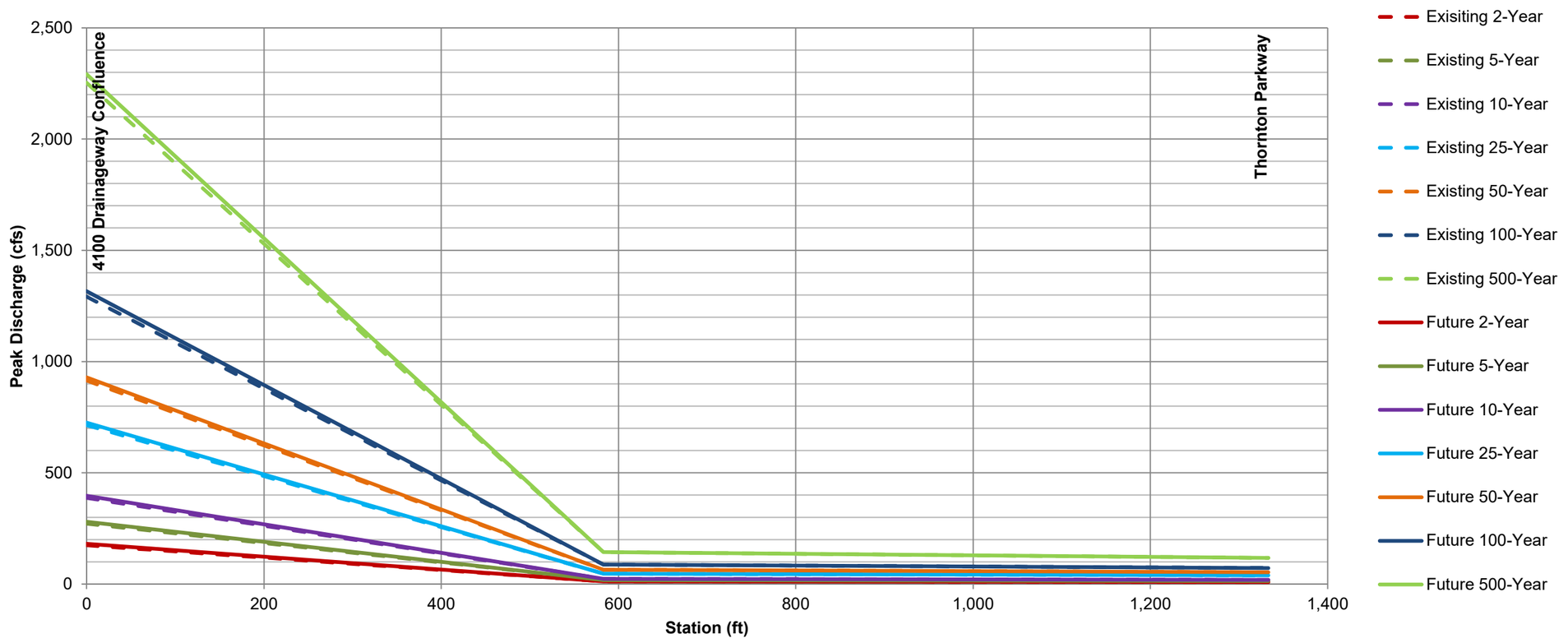


**Figure B-10**
**J Tributary**
**Baseline Peak Discharge vs. Drainageway Station**

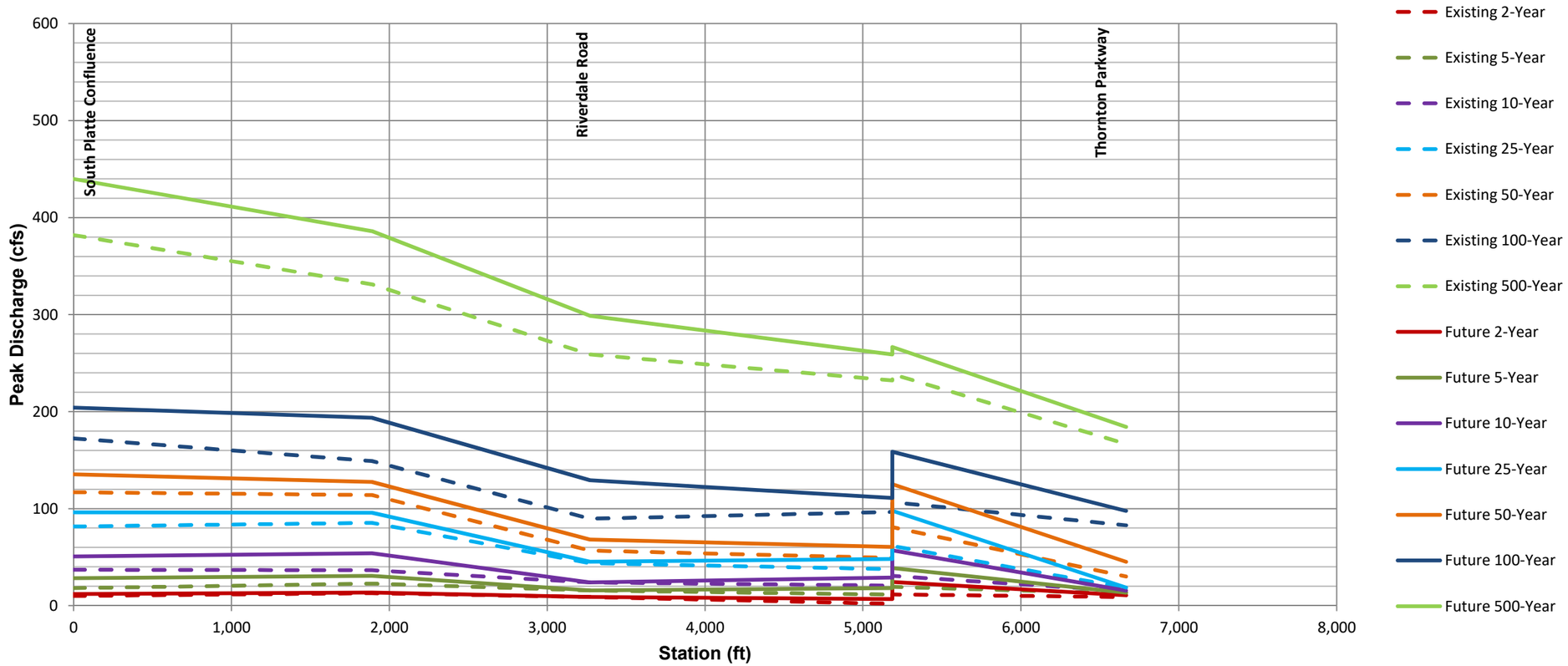


**Figure B-11**
**North K Tributary**
**Baseline Peak Discharge vs. Drainageway Station**

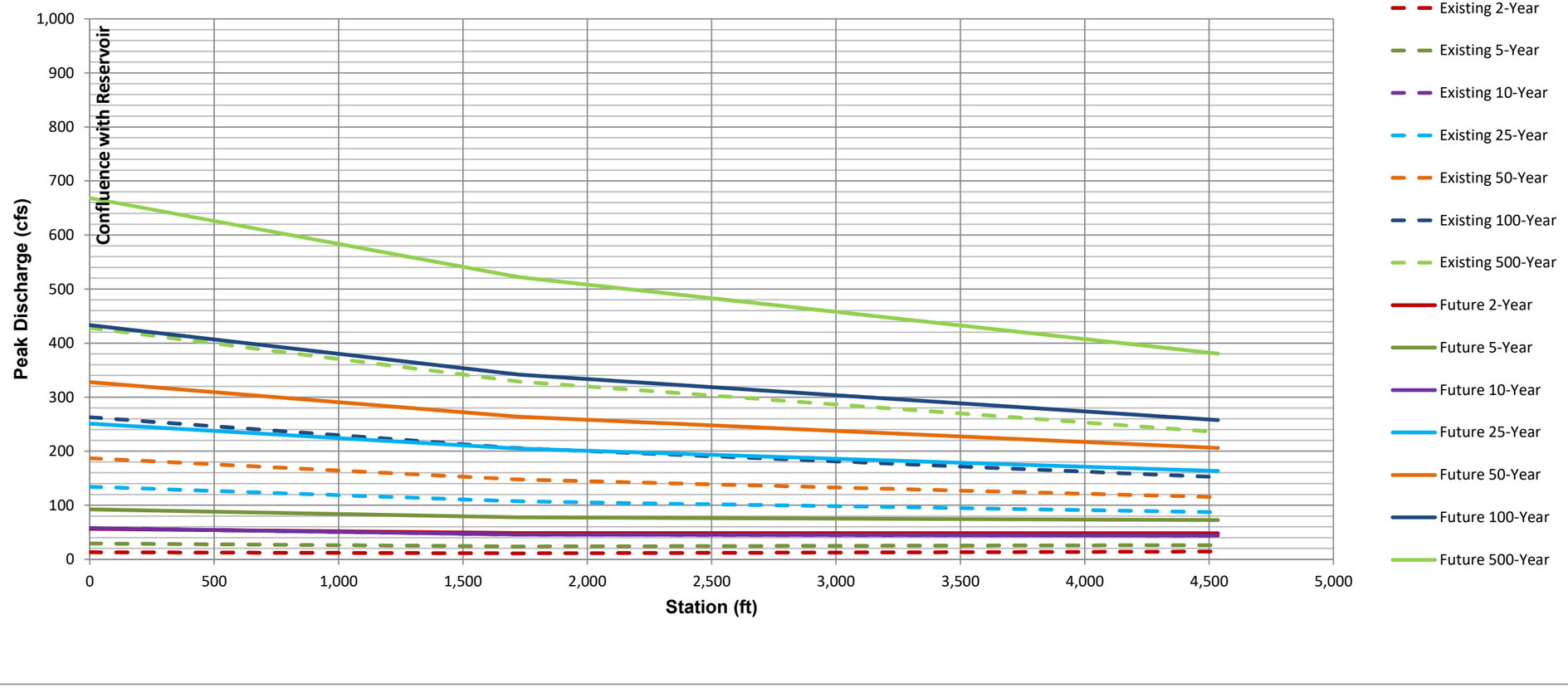


**Figure B-12**
**South K Tributary**
**Baseline Peak Discharge vs. Drainageway Station**

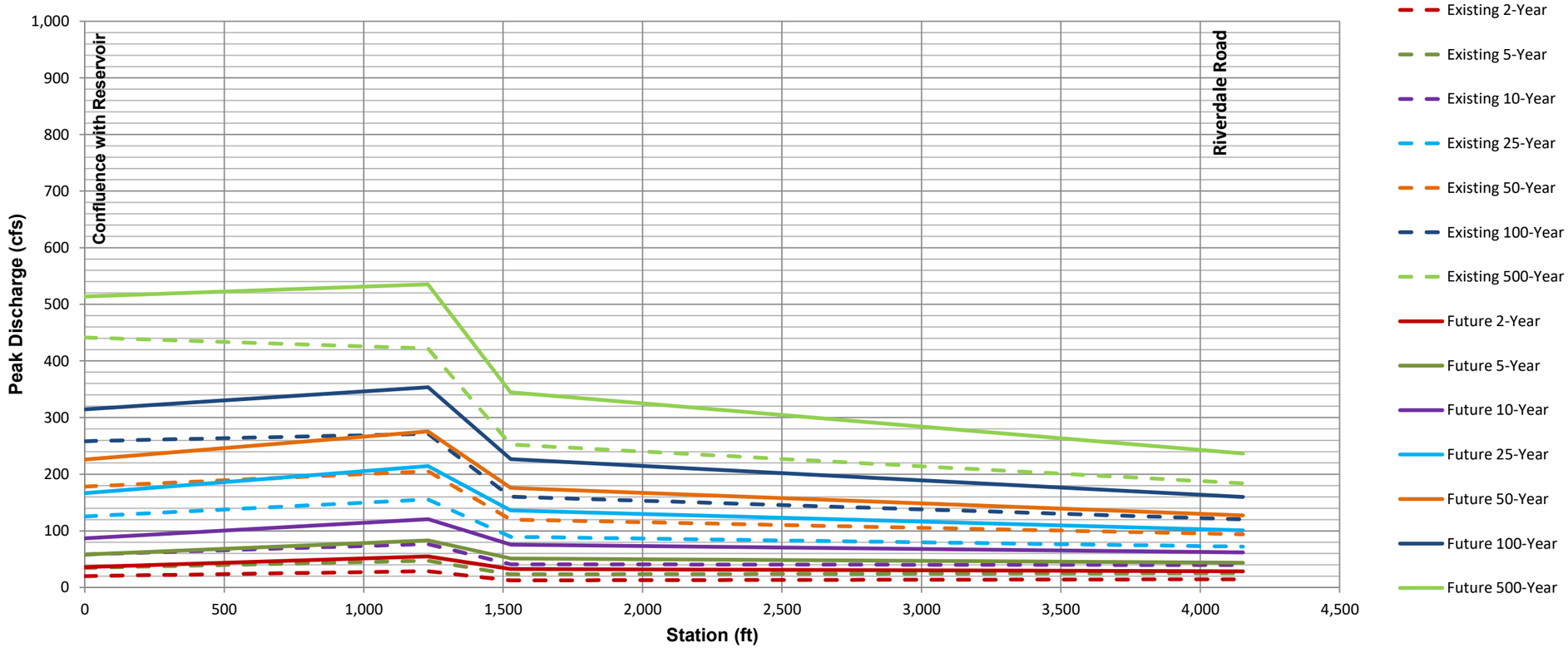


**Figure B-13**
**Colorado Boulevard**
**Baseline Peak Discharge vs. Drainageway Station**

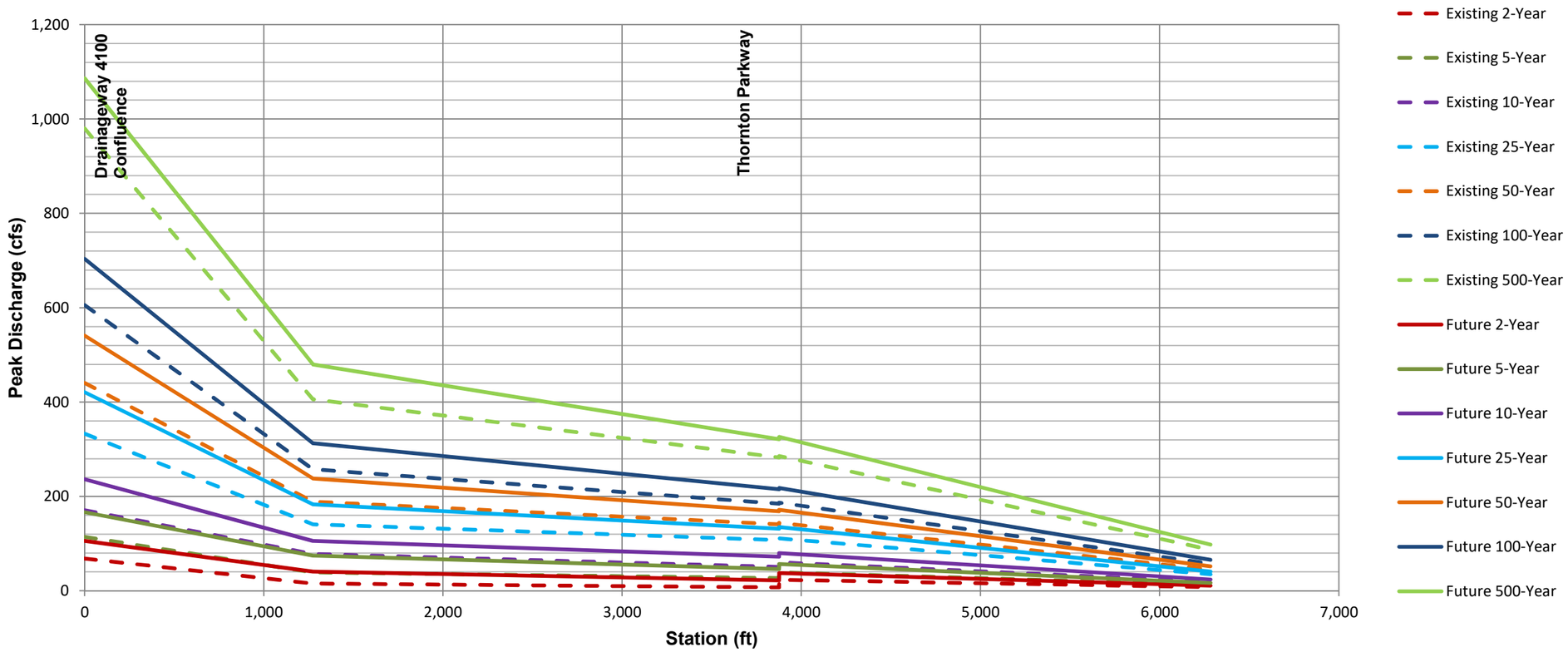
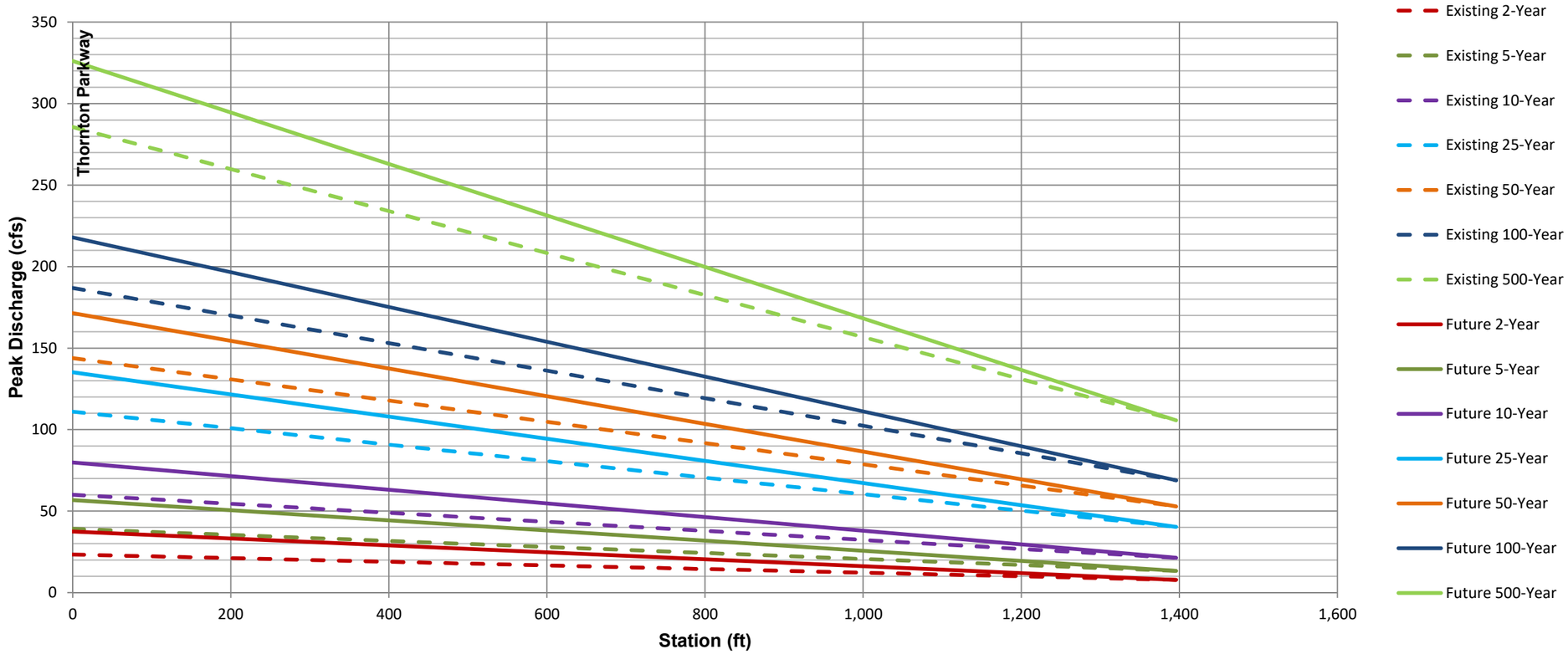
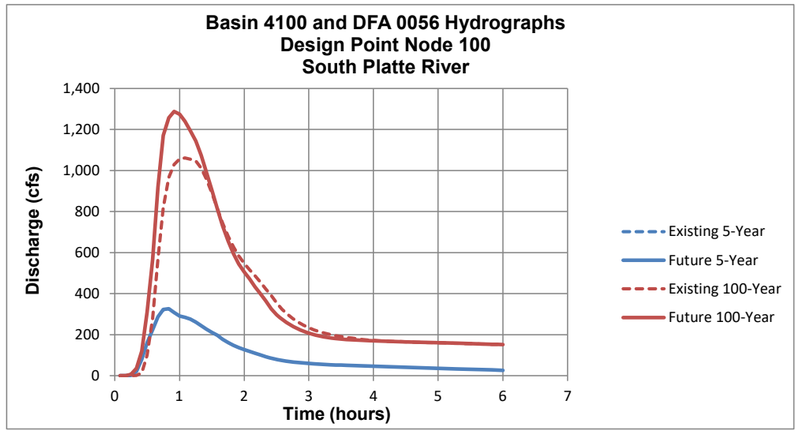
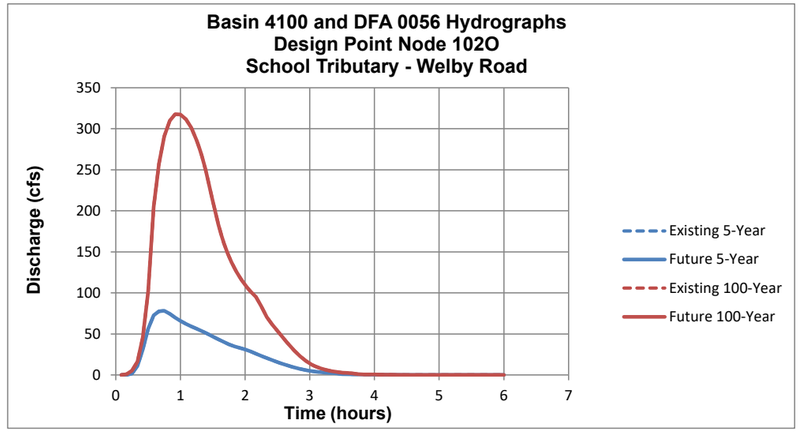


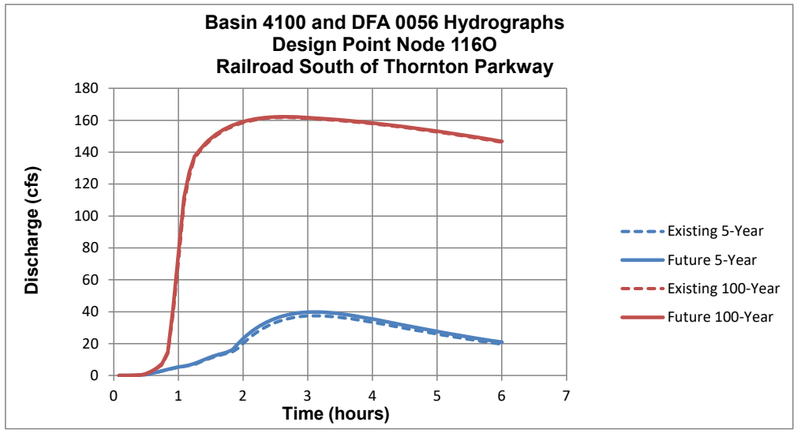
**Figure B-14**
**Thornton Parkway**
**Baseline Peak Discharge vs. Drainageway Station**

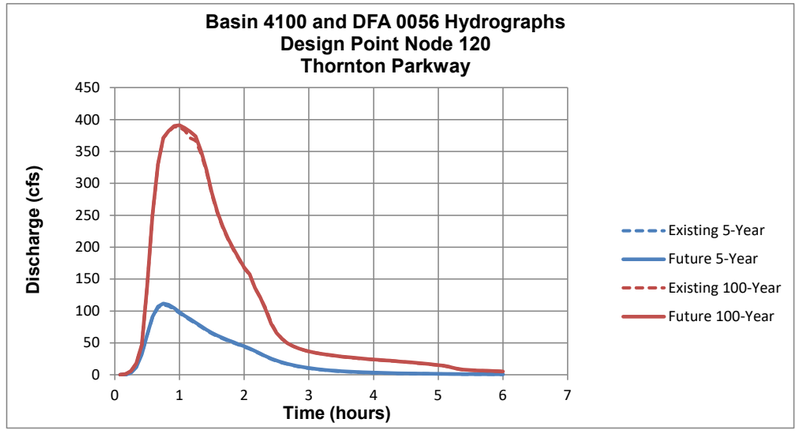


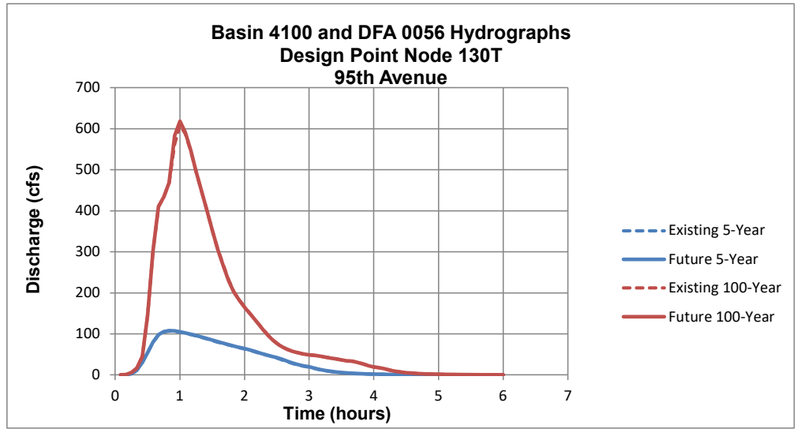
## Figure B-15 - Baseline Hydrographs



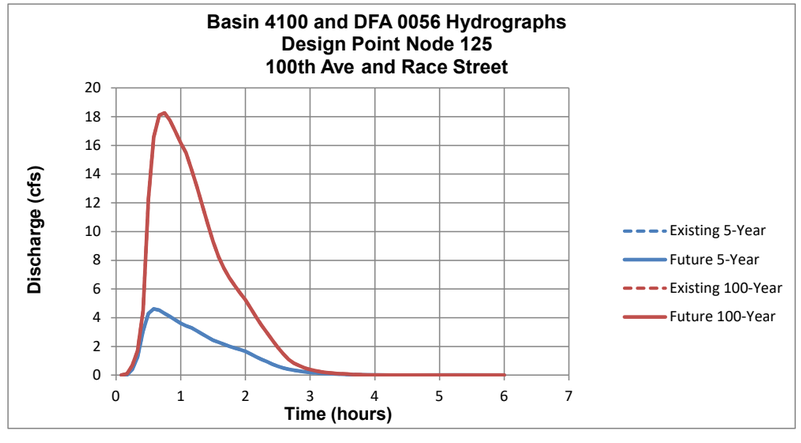
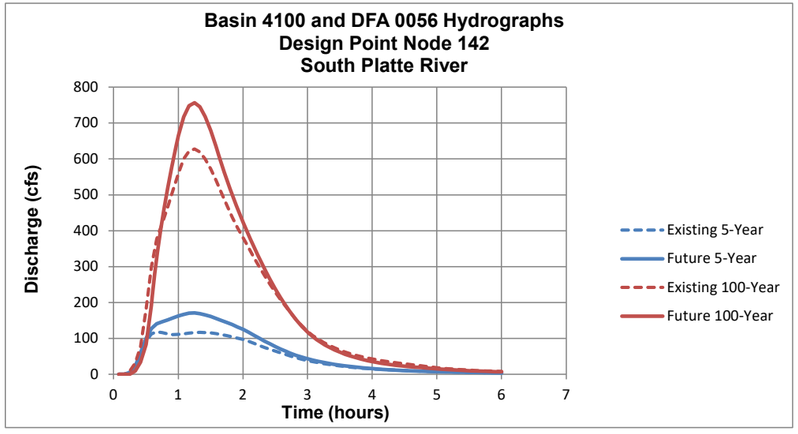



**Figure B-15 - Baseline Hydrographs**



# APPENDIX C

# HYDRAULIC ANALYSIS

# NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole- foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

**Coastal Base Flood Elevations** shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures.** Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum.** For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC- 3, #9202
1315 East- West Highway
Silver Spring, MD 20910- 3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242,** or visit its website at http://www.ngs.noaa.gov/.

**Base map** information shown on this FIRM was provided by the Adams County and Commerce City GIS departments. The coordinate system used for the production of the digital FIRM is Universe Transverse Mercator, Zone 13N, referenced to North American Datum of 1983 and the GRS 80 spheroid, Western Hemisphere.

This map reflects more detailed and up- to- date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data)* may reflect stream channel distances that differ from what is shown on this map.

**Corporate limits** shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de- annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

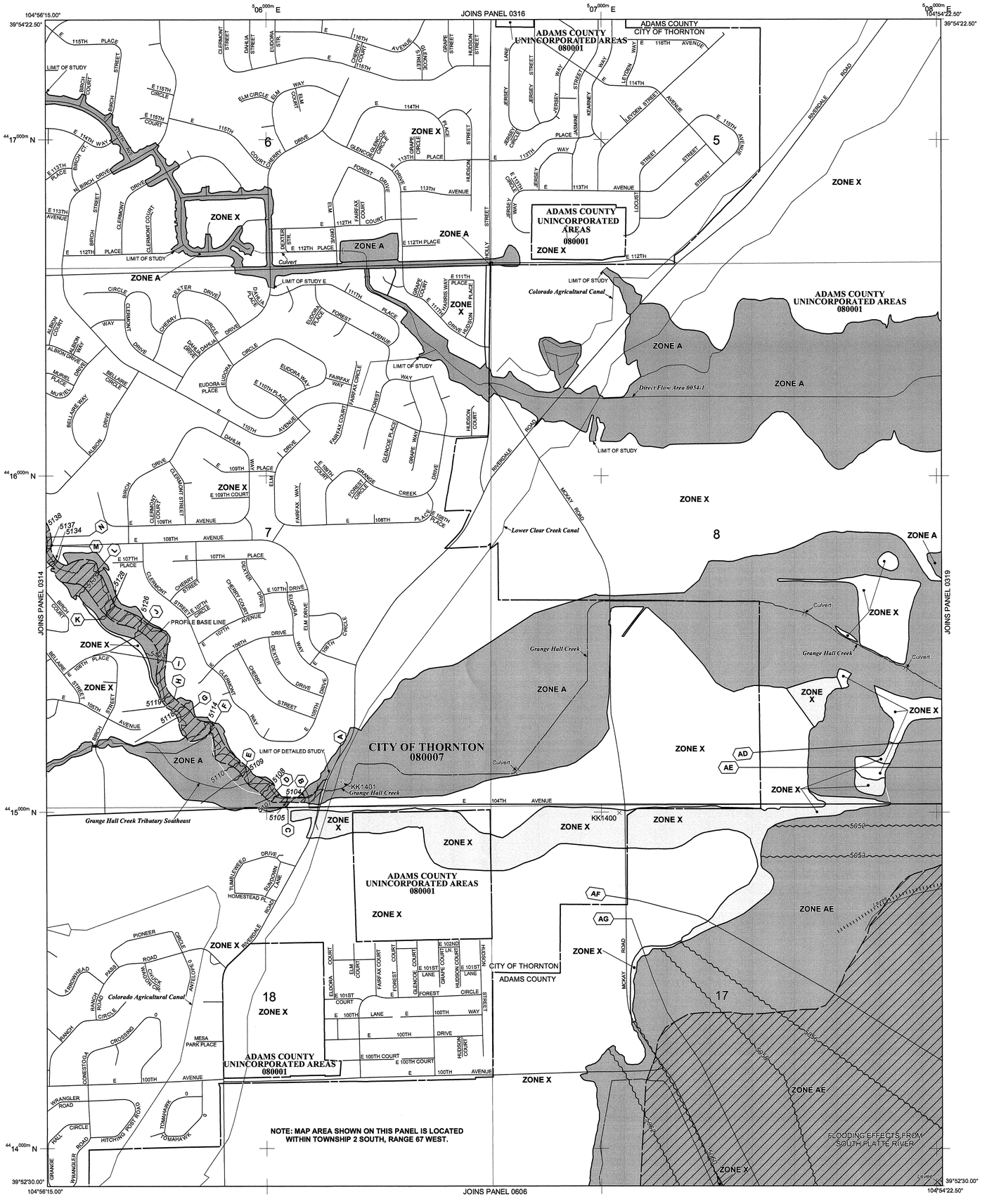
Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1- 800- 358- 9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report,* and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1- 800- 358- 9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1- 877- FEMA MAP** (1- 877- 336- 2627) or visit the FEMA website at http://www.fema.gov/.

This digital Flood Insurance Rate Map (FIRM) was produced through a cooperative partnership between the State of Colorado Water Conservation Board, the Urban Drainage and Flood Control District, and the Federal Emergency Management Agency (FEMA). The State of Colorado Water Conservation Board and the Urban Drainage and Flood Control District have implemented a long-term approach of floodplain management to reduce the costs associated with flooding. As part of this effort, both the State of Colorado and the Urban Drainage and Flood Control District have joined in Cooperating Technical Partner agreements with FEMA to produce this digital FIRM.

Additional flood hazard information and resources are available from local communities, the Colorado Water Conservation Board, and the Urban Drainage and Flood Control District.




# LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

**ZONE A** No Base Flood Elevations determined.

**ZONE AE** Base Flood Elevations determined.

**ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

**ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

**ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

**ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

**ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

**ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

**ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

**ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.

**ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- A–A — Cross section line
- 23–23 — Transect line
- 97°07'30", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 4275000mN — 1000-meter Universal Transverse Mercator grid ticks, zone 13
- 6000000 M — 5000-foot grid ticks: Alabama State Plane coordinate system, east zone (FIPSZONE 0101), Transverse Mercator
- DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
August 16, 1995
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
March 5, 2007 - to update map format.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1- 800- 638- 6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0318H

# FIRM
## FLOOD INSURANCE RATE MAP
## ADAMS COUNTY, COLORADO
## AND INCORPORATED AREAS

**PANEL 318 OF 1150**
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| ADAMS COUNTY | 080001 | 0318 | H |
| THORNTON, CITY OF | 080007 | 0318 | H |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER**
**08001C0318H**

**MAP REVISED**
**MARCH 5, 2007**

Federal Emergency Management Agency

# NOTES TO USERS

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The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
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1315 East- West Highway
Silver Spring, MD 20910- 3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242,** or visit its website at http://www.ngs.noaa.gov/.

**Base map** information shown on this FIRM was provided by the Adams County and Commerce City GIS departments. The coordinate system used for the production of the digital FIRM is Universe Transverse Mercator, Zone 13N, referenced to North American Datum of 1983 and the GRS 80 spheroid, Western Hemisphere.

This map reflects more detailed and up- to- date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data)* may reflect stream channel distances that differ from what is shown on this map.

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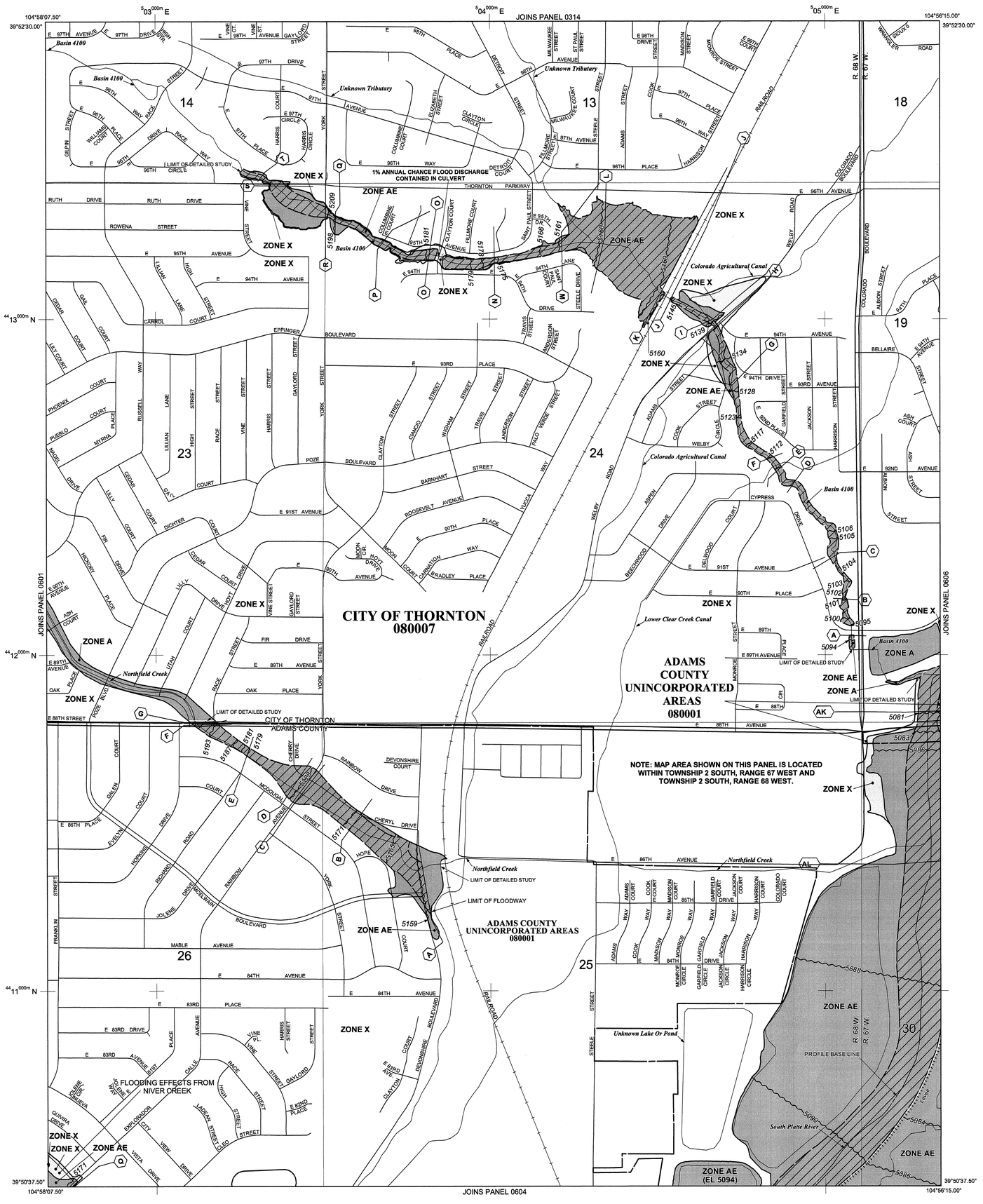
Contact the **FEMA Map Service Center** at 1- 800- 358- 9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1- 800- 358- 9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1- 877- FEMA MAP** (1- 877- 336- 2627) or visit the FEMA website at http://www.fema.gov/.

This digital Flood Insurance Rate Map (FIRM) was produced through a cooperative partnership between the State of Colorado Water Conservation Board, the Urban Drainage and Flood Control District, and the Federal Emergency Management Agency (FEMA). The State of Colorado Water Conservation Board and the Urban Drainage and Flood Control District have implemented a long-term approach of floodplain management to reduce the costs associated with flooding. As part of this effort, both the State of Colorado and the Urban Drainage and Flood Control District have joined in Cooperating Technical Partner agreements with FEMA to produce this digital FIRM.

Additional flood hazard information and resources are available from local communities, the Colorado Water Conservation Board, and the Urban Drainage and Flood Control District.




# LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

**ZONE A** No Base Flood Elevations determined.

**ZONE AE** Base Flood Elevations determined.

**ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

**ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

**ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

**ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

**ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

**ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

**ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

**ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.

**ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- A — A — Cross section line
- 23 — 23 — Transect line
- 97°07'30", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 4275000mN — 1000-meter Universal Transverse Mercator grid ticks, zone 13
- 6000000 M — 5000-foot grid ticks: Alabama State Plane coordinate system, east zone (FIPSZONE 0101), Transverse Mercator
- DX5510 × — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
August 16, 1995
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
March 5, 2007 - to update map format.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1- 800- 638- 6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

**PANEL 0602H**

# FIRM
## FLOOD INSURANCE RATE MAP
## ADAMS COUNTY, COLORADO
## AND INCORPORATED AREAS

**PANEL 602 OF 1150**
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| ADAMS COUNTY | 080001 | 0602 | H |
| THORNTON, CITY OF | 080007 | 0602 | H |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER**
**08001C0602H**

**MAP REVISED**
**MARCH 5, 2007**

Federal Emergency Management Agency

# NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole- foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

**Coastal Base Flood Elevations** shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures.** Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum.** For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC- 3, #9202
1315 East- West Highway
Silver Spring, MD 20910- 3282

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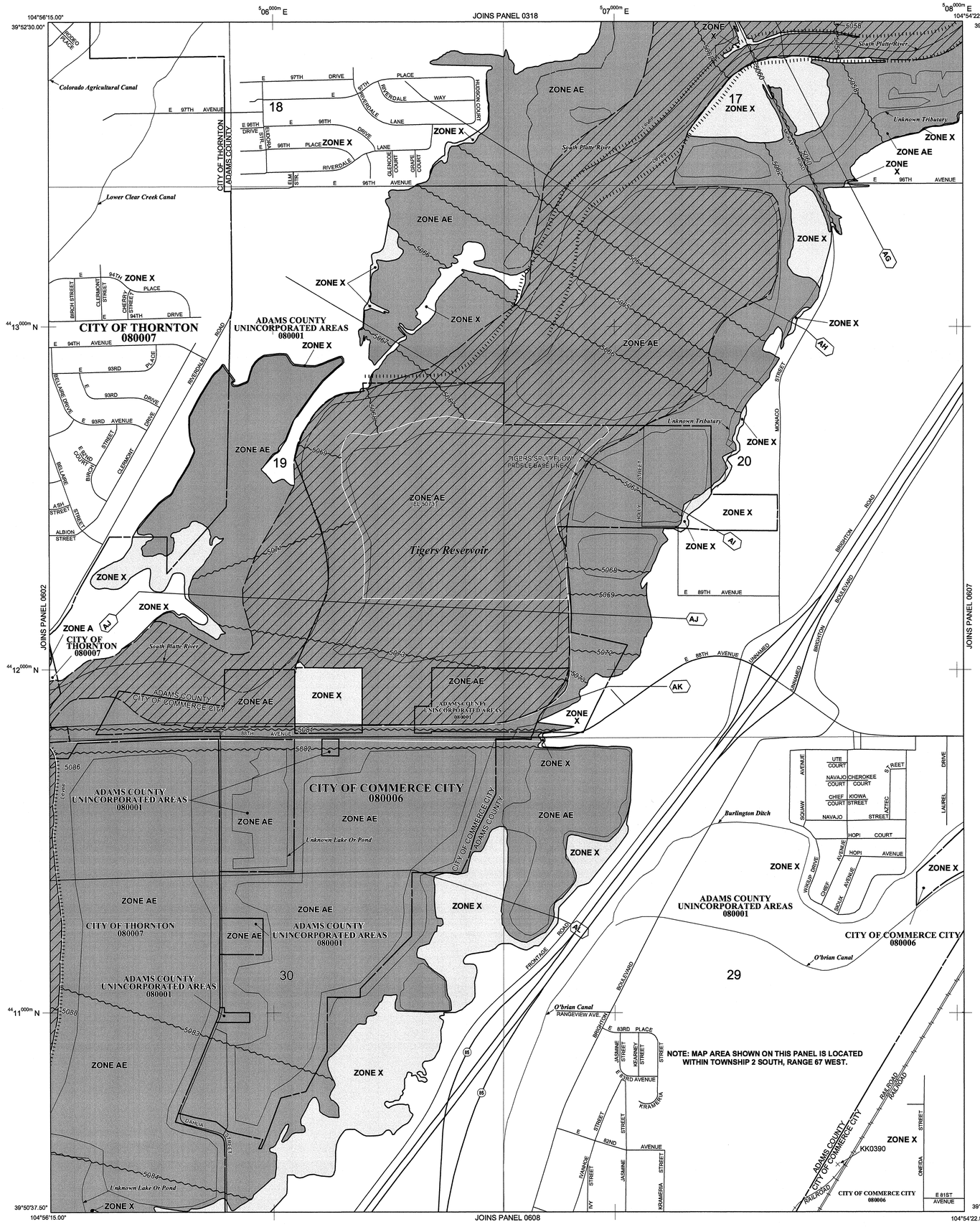


# LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

| | |
|---|---|
| **ZONE A** | No Base Flood Elevations determined. |
| **ZONE AE** | Base Flood Elevations determined. |
| **ZONE AH** | Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined. |
| **ZONE AO** | Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined. |
| **ZONE AR** | Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood. |
| **ZONE A99** | Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined. |
| **ZONE V** | Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined. |
| **ZONE VE** | Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined. |

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

| | |
|---|---|
| **ZONE X** | Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood. |

OTHER AREAS

| | |
|---|---|
| **ZONE X** | Areas determined to be outside the 0.2% annual chance floodplain. |
| **ZONE D** | Areas in which flood hazards are undetermined, but possible. |

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

| | |
|---|---|
| | Floodplain boundary |
| | Floodway boundary |
| | Zone D boundary |
| | CBRS and OPA boundary |
| | Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities. |
| 513 | Base Flood Elevation line and value; elevation in feet* |
| (EL 987) | Base Flood Elevation value where uniform within zone; elevation in feet* |

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

| | |
|---|---|
| A — A | Cross section line |
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| 4275,000mN | 1000-meter Universal Transverse Mercator grid ticks, zone 13 |
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| DX5510 × | Bench mark (see explanation in Notes to Users section of this FIRM panel) |
| M1.5 | River Mile |

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 16, 1995
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
March 5, 2007 - to update map format.

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MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

**PANEL 0606H**

# FIRM
## FLOOD INSURANCE RATE MAP
## ADAMS COUNTY, COLORADO
## AND INCORPORATED AREAS

**PANEL 606 OF 1150**
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| ADAMS COUNTY | 080001 | 0606 | H |
| COMMERCE CITY, CITY OF | 080006 | 0606 | H |
| THORNTON, CITY OF | 080007 | 0606 | H |

Notice to User: **The Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER**
**08001C0606H**

**MAP REVISED**
**MARCH 5, 2007**

Federal Emergency Management Agency

# NOTES TO USERS

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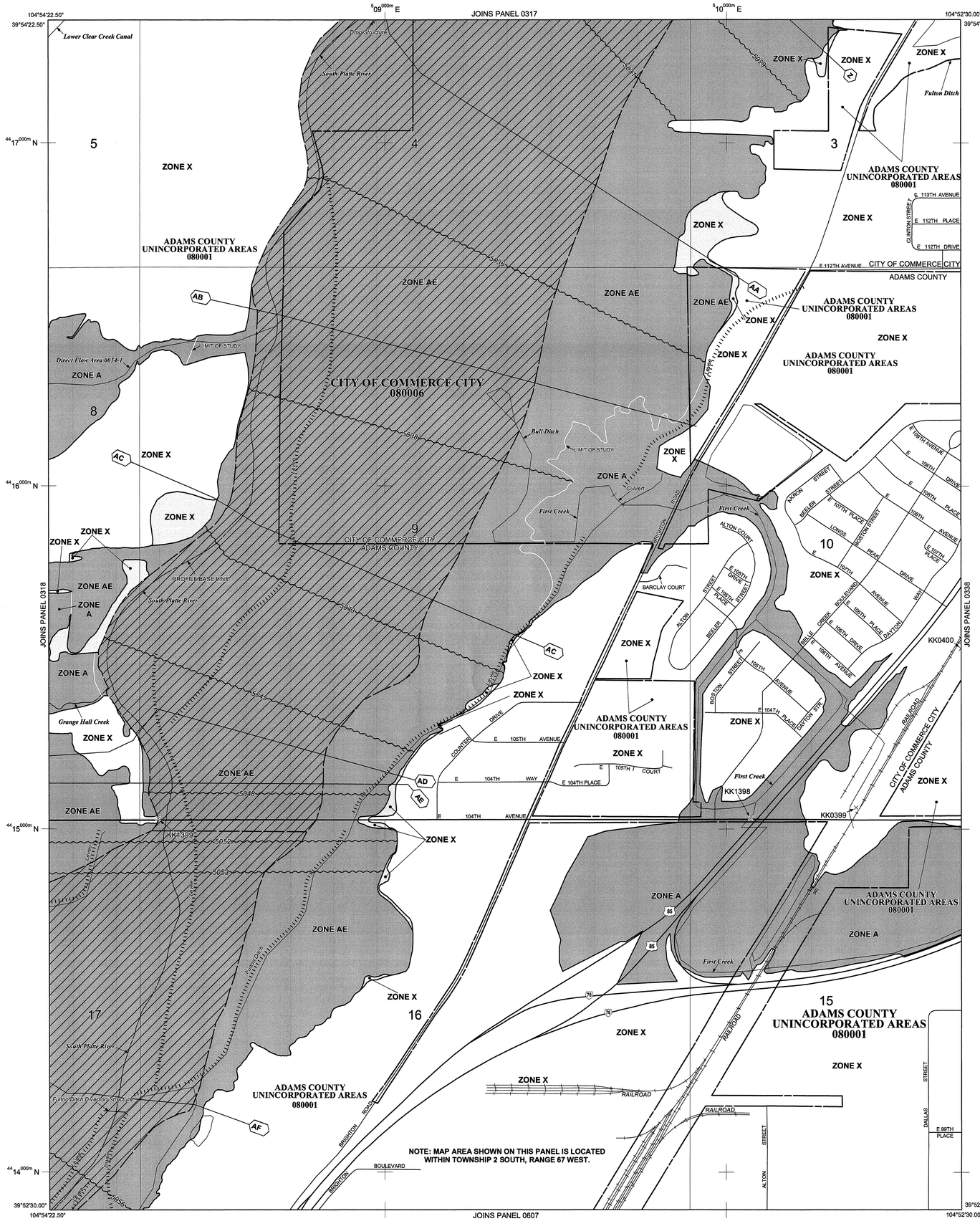


# LEGEND

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OTHER FLOOD AREAS

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OTHER AREAS

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- M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
August 16, 1995
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
March 5, 2007 - to update map format.

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MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0319H

# FIRM
## FLOOD INSURANCE RATE MAP
## ADAMS COUNTY, COLORADO
## AND INCORPORATED AREAS

**PANEL 319 OF 1150**
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| ADAMS COUNTY | 080001 | 0319 | H |
| COMMERCE CITY, CITY OF | 080006 | 0319 | H |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER**
**08001C0319H**
**MAP REVISED**
**MARCH 5, 2007**

Federal Emergency Management Agency

HEC-RAS Plan: Future Profile: 100-YR

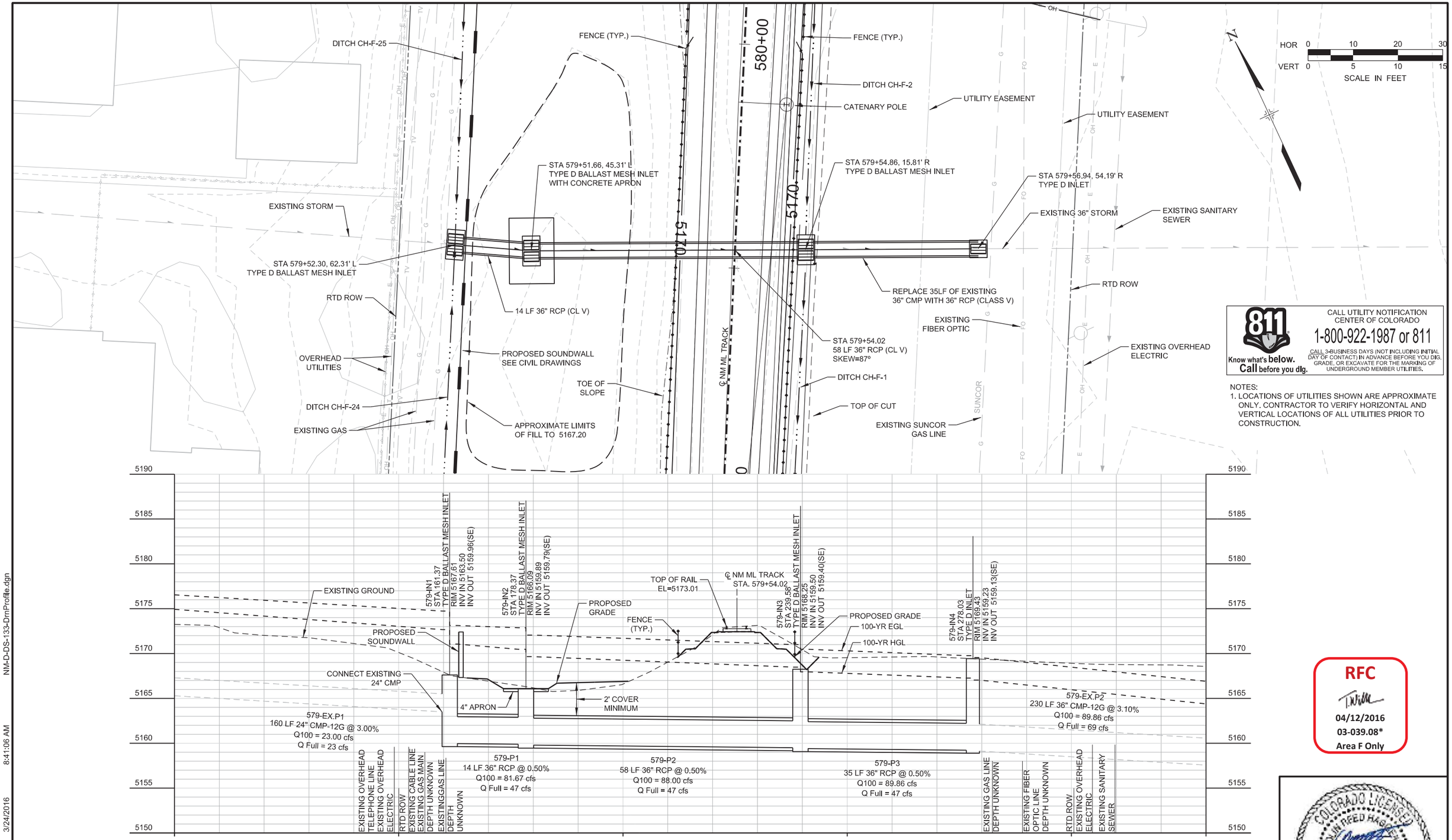
| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Thornton Pkway a | Thornton Parkway | 51209 | 100-YR | 69.00 | 5169.97 | 5170.83 | | 5170.99 | 0.015601 | 3.21 | 21.91 | 29.73 | 0.63 |
| Thornton Pkway a | Thornton Parkway | 51116 | 100-YR | 69.00 | 5167.17 | 5168.44 | 5168.44 | 5168.87 | 0.034990 | 5.31 | 13.46 | 16.87 | 0.96 |
| Thornton Pkway a | Thornton Parkway | 51090 | 100-YR | 69.00 | 5163.00 | 5165.92 | | 5165.95 | 0.001012 | 1.57 | 45.75 | 25.31 | 0.19 |
| Thornton Pkway a | Thornton Parkway | 51016 | 100-YR | 69.00 | 5162.84 | 5165.90 | | 5165.91 | 0.000305 | 0.92 | 75.83 | 34.66 | 0.10 |
| Thornton Pkway a | Thornton Parkway | 50986 | 100-YR | 69.00 | 5162.00 | 5165.72 | 5163.74 | 5165.88 | 0.002164 | 3.13 | 22.02 | 30.20 | 0.29 |
| Thornton Pkway a | Thornton Parkway | 50978 | | Culvert | | | | | | | | | |
| Thornton Pkway a | Thornton Parkway | 50879 | 100-YR | 69.00 | 5160.99 | 5162.62 | | 5162.84 | 0.010375 | 3.79 | 18.48 | 20.22 | 0.56 |
| Thornton Pkway a | Thornton Parkway | 50849 | 100-YR | 69.00 | 5160.87 | 5161.88 | 5161.86 | 5162.26 | 0.037138 | 4.96 | 13.95 | 17.81 | 0.97 |
| Thornton Pkway a | Thornton Parkway | 50804 | 100-YR | 69.00 | 5158.97 | 5160.14 | 5160.14 | 5160.56 | 0.038547 | 5.19 | 13.38 | 16.99 | 0.99 |
| Thornton Pkway a | Thornton Parkway | 50779 | 100-YR | 69.00 | 5154.00 | 5155.97 | | 5156.03 | 0.002035 | 1.86 | 37.97 | 25.84 | 0.25 |
| Thornton Pkway a | Thornton Parkway | 50659 | 100-YR | 69.00 | 5153.67 | 5154.95 | 5154.95 | 5155.35 | 0.036611 | 5.12 | 13.77 | 18.35 | 0.97 |
| Thornton Pkway a | Thornton Parkway | 50641 | 100-YR | 69.00 | 5149.00 | 5151.09 | | 5151.18 | 0.004408 | 2.46 | 28.06 | 20.03 | 0.36 |
| Thornton Pkway a | Thornton Parkway | 50380 | 100-YR | 69.00 | 5147.97 | 5149.32 | 5149.00 | 5149.46 | 0.011016 | 3.01 | 24.03 | 34.13 | 0.54 |
| North K Tributar | North K Trib | 71600 | 100-YR | 258.00 | 5056.00 | 5062.40 | | 5062.40 | 0.000007 | 0.26 | 636.91 | 130.27 | 0.02 |
| North K Tributar | North K Trib | 71233 | 100-YR | 433.00 | 5056.00 | 5062.37 | | 5062.39 | 0.000126 | 1.00 | 398.66 | 148.56 | 0.08 |
| North K Tributar | North K Trib | 71213 | 100-YR | 433.00 | 5056.00 | 5062.31 | 5059.51 | 5062.38 | 0.000764 | 2.06 | 221.36 | 146.10 | 0.18 |
| North K Tributar | North K Trib | 71208 | | Culvert | | | | | | | | | |
| North K Tributar | North K Trib | 71137 | 100-YR | 433.00 | 5056.00 | 5061.30 | 5059.89 | 5062.01 | 0.011706 | 7.08 | 79.41 | 97.15 | 0.68 |
| North K Tributar | North K Trib | 71117 | 100-YR | 433.00 | 5056.00 | 5061.61 | | 5061.65 | 0.000454 | 1.71 | 315.10 | 117.75 | 0.14 |
| North K Tributar | North K Trib | 70900 | 100-YR | 433.00 | 5055.98 | 5061.59 | | 5061.60 | 0.000100 | 0.84 | 562.18 | 162.88 | 0.07 |
| North K Tributar | North K Trib | 70450 | 100-YR | 433.00 | 5055.00 | 5061.58 | | 5061.59 | 0.000012 | 0.31 | 1461.97 | 371.69 | 0.02 |
| North K Tributar | North K Trib | 70180 | 100-YR | 433.00 | 5055.00 | 5061.58 | | 5061.58 | 0.000008 | 0.34 | 1549.44 | 390.27 | 0.02 |
| North K Tributar | North K Trib | 70160 | 100-YR | 433.00 | 5055.00 | 5061.58 | 5057.69 | 5061.58 | 0.000036 | 0.68 | 1092.53 | 390.27 | 0.05 |
| North K Tributar | North K Trib | 70140 | | Culvert | | | | | | | | | |
| North K Tributar | North K Trib | 70050 | 100-YR | 433.00 | 5049.96 | 5053.94 | 5053.94 | 5055.81 | 0.024069 | 10.98 | 39.43 | 49.66 | 1.00 |
| North K Tributar | North K Trib | 70030 | 100-YR | 433.00 | 5046.61 | 5050.73 | 5048.92 | 5050.85 | 0.001903 | 2.99 | 163.72 | 63.15 | 0.28 |
| North G Tributar | North G Trib | 40882 | 100-YR | 55.00 | 5223.98 | 5224.57 | 5224.57 | 5224.79 | 0.025387 | 3.85 | 15.57 | 40.34 | 0.94 |
| North G Tributar | North G Trib | 40566 | 100-YR | 55.00 | 5217.97 | 5222.71 | 5218.73 | 5222.71 | 0.000007 | 0.23 | 333.82 | 242.95 | 0.02 |
| North G Tributar | North G Trib | 40546 | 100-YR | 55.00 | 5216.17 | 5222.71 | | 5222.71 | 0.000011 | 0.29 | 217.30 | 231.30 | 0.03 |
| North G Tributar | North G Trib | 40524 | | Culvert | | | | | | | | | |
| North G Tributar | North G Trib | 40438 | 100-YR | 55.00 | 5211.00 | 5212.55 | 5212.55 | 5213.02 | 0.054519 | 5.48 | 10.04 | 79.24 | 1.01 |
| North G Tributar | North G Trib | 40418 | 100-YR | 55.00 | 5210.97 | 5211.43 | | 5211.49 | 0.021449 | 2.05 | 27.38 | 74.40 | 0.55 |
| North G Tributar | North G Trib | 40353 | 100-YR | 55.00 | 5208.56 | 5208.97 | 5208.97 | 5209.12 | 0.072782 | 3.09 | 17.93 | 60.43 | 0.97 |
| North G Tributar | North G Trib | 40056 | 100-YR | 55.00 | 5200.63 | 5203.15 | | 5203.15 | 0.000012 | 0.16 | 314.06 | 169.57 | 0.02 |
| North G Tributar | North G Trib | 40026 | 100-YR | 55.00 | 5198.37 | 5203.15 | | 5203.15 | 0.000023 | 0.28 | 169.31 | 164.23 | 0.03 |
| North G Tributar | North G Trib | 40000 | | Culvert | | | | | | | | | |
| North G Tributar | North G Trib | 38639 | 100-YR | 391.00 | 5165.96 | 5171.20 | 5171.20 | 5173.53 | 0.038861 | 12.26 | 31.90 | 256.23 | 1.01 |
| North G Tributar | North G Trib | 38609 | 100-YR | 391.00 | 5165.60 | 5170.41 | 5170.41 | 5171.69 | 0.045325 | 9.09 | 43.17 | 17.01 | 0.97 |
| North G Tributar | North G Trib | 38474 | 100-YR | 391.00 | 5164.00 | 5166.98 | 5166.77 | 5167.20 | 0.011868 | 4.49 | 106.07 | 116.28 | 0.52 |
| North G Tributar | North G Trib | 38343 | 100-YR | 391.00 | 5162.00 | 5164.77 | 5164.77 | 5165.16 | 0.021371 | 6.29 | 82.48 | 98.55 | 0.71 |
| Drainageway 4100 | 4100_US | 21886 | 100-YR | 340.00 | 5259.00 | 5261.87 | | 5262.03 | 0.013121 | 1.96 | 128.89 | 63.68 | 0.22 |
| Drainageway 4100 | 4100_US | 21737 | 100-YR | 340.00 | 5255.59 | 5261.94 | | 5261.95 | 0.000078 | 0.27 | 767.05 | 170.20 | 0.02 |
| Drainageway 4100 | 4100_US | 21628 | 100-YR | 340.00 | 5250.81 | 5261.94 | | 5261.94 | 0.000026 | 0.19 | 1599.91 | 255.40 | 0.01 |
| Drainageway 4100 | 4100_US | 21598 | 100-YR | 283.00 | 5248.75 | 5261.93 | 5253.44 | 5261.94 | 0.000203 | 0.49 | 571.86 | 265.81 | 0.03 |
| Drainageway 4100 | 4100_US | 21579 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_US | 21394 | 100-YR | 283.00 | 5243.00 | 5247.21 | 5245.93 | 5248.03 | 0.034697 | 4.22 | 53.49 | 72.05 | 0.38 |
| Drainageway 4100 | 4100_US | 21357 | 100-YR | 283.00 | 5242.20 | 5245.24 | | 5245.47 | 0.130021 | 3.85 | 73.58 | 60.04 | 0.60 |
| Drainageway 4100 | 4100_US | 20987 | 100-YR | 283.00 | 5233.96 | 5237.23 | 5235.49 | 5237.28 | 0.008689 | 1.68 | 158.12 | 69.54 | 0.18 |
| Drainageway 4100 | 4100_US | 20587 | 100-YR | 283.00 | 5224.98 | 5226.45 | 5226.45 | 5226.99 | 0.319868 | 5.89 | 48.02 | 45.24 | 0.95 |
| Drainageway 4100 | 4100_US | 20324 | 100-YR | 283.00 | 5220.01 | 5224.54 | | 5224.57 | 0.000758 | 0.67 | 255.80 | 94.05 | 0.06 |
| Drainageway 4100 | 4100_US | 20294 | 100-YR | 283.00 | 5213.86 | 5224.55 | | 5224.56 | 0.000069 | 0.36 | 578.17 | 94.29 | 0.02 |

HEC-RAS Plan: Future Profile: 100-YR (Continued)

| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Drainageway 4100 | 4100_US | 20234 | 100-YR | 283.00 | 5213.98 | 5224.55 | | 5224.56 | 0.000032 | 0.24 | 605.58 | 92.54 | 0.01 |
| Drainageway 4100 | 4100_US | 20204 | 100-YR | 283.00 | 5211.28 | 5224.55 | 5214.41 | 5224.55 | 0.000092 | 0.42 | 562.34 | 96.05 | 0.02 |
| Drainageway 4100 | 4100_US | 20176 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18947 | 100-YR | 418.00 | 5189.02 | 5194.68 | 5194.06 | 5195.62 | 0.081301 | 7.78 | 53.70 | 48.73 | 0.74 |
| Drainageway 4100 | 4100_US | 18917 | 100-YR | 418.00 | 5188.73 | 5193.76 | | 5194.01 | 0.025788 | 4.08 | 103.60 | 49.97 | 0.46 |
| Drainageway 4100 | 4100_US | 18819 | 100-YR | 418.00 | 5187.76 | 5192.83 | | 5192.92 | 0.005844 | 2.37 | 177.62 | 70.46 | 0.24 |
| Drainageway 4100 | 4100_US | 18762 | 100-YR | 418.00 | 5187.21 | 5192.78 | | 5192.81 | 0.000757 | 1.23 | 302.29 | 85.61 | 0.09 |
| Drainageway 4100 | 4100_US | 18732 | 100-YR | 418.00 | 5187.00 | 5192.73 | 5188.77 | 5192.77 | 0.001458 | 1.18 | 300.11 | 158.45 | 0.12 |
| Drainageway 4100 | 4100_US | 18716 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18649 | 100-YR | 418.00 | 5186.00 | 5189.52 | 5189.38 | 5191.06 | 0.086157 | 9.97 | 41.92 | 81.42 | 0.95 |
| Drainageway 4100 | 4100_US | 18600 | 100-YR | 418.00 | 5185.95 | 5188.01 | 5187.31 | 5188.22 | 0.026584 | 3.65 | 115.82 | 71.46 | 0.47 |
| Drainageway 4100 | 4100_US | 18545 | 100-YR | 418.00 | 5182.00 | 5186.38 | | 5186.56 | 0.034725 | 3.43 | 122.41 | 91.71 | 0.51 |
| Drainageway 4100 | 4100_US | 18247 | 100-YR | 619.00 | 5180.00 | 5184.47 | 5181.99 | 5184.53 | 0.003514 | 1.91 | 323.46 | 100.16 | 0.19 |
| Drainageway 4100 | 4100_US | 18226 | 100-YR | 619.00 | 5178.55 | 5184.09 | 5181.60 | 5184.39 | 0.011352 | 4.33 | 142.89 | 79.90 | 0.34 |
| Drainageway 4100 | 4100_US | 18210 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18113 | 100-YR | 619.00 | 5178.14 | 5181.99 | 5181.58 | 5183.32 | 0.079019 | 9.25 | 66.92 | 44.67 | 0.84 |
| Drainageway 4100 | 4100_US | 18083 | 100-YR | 619.00 | 5177.74 | 5181.39 | | 5181.60 | 0.022693 | 3.92 | 175.31 | 97.81 | 0.45 |
| Drainageway 4100 | 4100_US | 17660 | 100-YR | 619.00 | 5172.12 | 5175.55 | 5174.09 | 5175.67 | 0.009423 | 2.88 | 231.81 | 102.08 | 0.30 |
| Drainageway 4100 | 4100_US | 17210 | 100-YR | 619.00 | 5166.00 | 5167.98 | | 5168.23 | 0.036144 | 4.04 | 154.86 | 96.90 | 0.54 |
| Drainageway 4100 | 4100_US | 16910 | 100-YR | 619.00 | 5161.93 | 5164.52 | | 5164.59 | 0.005858 | 2.08 | 299.74 | 145.11 | 0.23 |
| Drainageway 4100 | 4100_US | 16789 | 100-YR | 619.00 | 5160.00 | 5163.87 | 5163.00 | 5163.95 | 0.004689 | 2.11 | 268.30 | 168.14 | 0.21 |
| Drainageway 4100 | 4100_US | 16777 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_US | 16764 | 100-YR | 619.00 | 5159.90 | 5163.25 | | 5163.46 | 0.017134 | 4.12 | 176.26 | 174.13 | 0.40 |
| Drainageway 4100 | 4100_DS | 16734 | 100-YR | 1001.00 | 5160.00 | 5163.22 | | 5163.29 | 0.001863 | 1.32 | 494.59 | 239.90 | 0.13 |
| Drainageway 4100 | 4100_DS | 16310 | 100-YR | 1316.00 | 5155.99 | 5163.24 | | 5163.24 | 0.000023 | 0.25 | 5300.37 | 841.22 | 0.02 |
| Drainageway 4100 | 4100_DS | 15853 | 100-YR | 1316.00 | 5153.00 | 5163.24 | | 5163.24 | 0.000007 | 0.17 | 7867.93 | 988.99 | 0.01 |
| Drainageway 4100 | 4100_DS | 15823 | 100-YR | 168.00 | 5153.00 | 5163.24 | | 5163.24 | 0.000011 | 0.22 | 773.41 | 1000.53 | 0.01 |
| Drainageway 4100 | 4100_DS | 15787 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 15543 | 100-YR | 168.00 | 5142.00 | 5144.90 | | 5145.10 | 0.017027 | 3.53 | 46.56 | 153.60 | 0.39 |
| Drainageway 4100 | 4100_DS | 15496 | 100-YR | 168.00 | 5140.12 | 5144.07 | 5143.02 | 5144.30 | 0.020870 | 3.84 | 45.59 | 142.56 | 0.42 |
| Drainageway 4100 | 4100_DS | 15412 | 100-YR | 168.00 | 5140.98 | 5143.71 | | 5143.74 | 0.002690 | 1.41 | 131.59 | 107.30 | 0.16 |
| Drainageway 4100 | 4100_DS | 15381 | 100-YR | 168.00 | 5139.17 | 5143.58 | 5141.65 | 5143.63 | 0.004808 | 2.10 | 128.91 | 132.75 | 0.20 |
| Drainageway 4100 | 4100_DS | 15376 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 15294 | 100-YR | 168.00 | 5135.05 | 5139.24 | | 5139.57 | 0.022421 | 4.64 | 36.21 | 23.86 | 0.42 |
| Drainageway 4100 | 4100_DS | 15264 | 100-YR | 168.00 | 5134.47 | 5138.76 | | 5138.92 | 0.015740 | 3.23 | 52.04 | 21.44 | 0.36 |
| Drainageway 4100 | 4100_DS | 15133 | 100-YR | 168.00 | 5132.18 | 5134.38 | | 5134.84 | 0.086086 | 5.42 | 30.99 | 35.55 | 0.80 |
| Drainageway 4100 | 4100_DS | 15102 | 100-YR | 168.00 | 5131.02 | 5133.44 | 5132.34 | 5133.58 | 0.021134 | 2.99 | 56.20 | 31.96 | 0.40 |
| Drainageway 4100 | 4100_DS | 15091 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 14964 | 100-YR | 168.00 | 5127.13 | 5129.22 | | 5129.50 | 0.021954 | 4.21 | 39.94 | 36.64 | 0.59 |
| Drainageway 4100 | 4100_DS | 14934 | 100-YR | 168.00 | 5127.00 | 5128.66 | | 5128.85 | 0.018832 | 3.61 | 49.06 | 48.04 | 0.54 |
| Drainageway 4100 | 4100_DS | 14570 | 100-YR | 168.00 | 5122.03 | 5125.94 | | 5126.04 | 0.004123 | 2.52 | 67.91 | 30.33 | 0.28 |
| Drainageway 4100 | 4100_DS | 14171 | 100-YR | 168.00 | 5118.63 | 5121.08 | 5121.08 | 5121.94 | 0.052311 | 7.58 | 23.10 | 13.93 | 0.93 |
| Drainageway 4100 | 4100_DS | 13510 | 100-YR | 300.00 | 5105.98 | 5110.68 | | 5110.79 | 0.002637 | 2.75 | 117.04 | 40.09 | 0.24 |
| Drainageway 4100 | 4100_DS | 13478 | 100-YR | 300.00 | 5105.00 | 5110.66 | 5107.14 | 5110.72 | 0.001067 | 2.01 | 149.19 | 52.34 | 0.16 |
| Drainageway 4100 | 4100_DS | 13472 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 13367 | 100-YR | 300.00 | 5105.41 | 5107.99 | | 5108.39 | 0.019936 | 5.08 | 59.11 | 94.17 | 0.60 |
| Drainageway 4100 | 4100_DS | 13337 | 100-YR | 300.00 | 5104.99 | 5108.01 | | 5108.06 | 0.002210 | 1.92 | 169.92 | 86.29 | 0.21 |
| Drainageway 4100 | 4100_DS | 12821 | 100-YR | 300.00 | 5100.51 | 5107.01 | 5102.86 | 5107.04 | 0.001835 | 1.23 | 220.78 | 50.98 | 0.09 |
| Drainageway 4100 | 4100_DS | 12221 | 100-YR | 703.00 | 5098.00 | 5099.96 | 5099.96 | 5100.73 | 0.075992 | 3.63 | 122.76 | 82.20 | 0.49 |
| Drainageway 4100 | 4100_DS | 11321 | 100-YR | 703.00 | 5088.00 | 5094.58 | | 5094.62 | 0.001380 | 1.09 | 500.96 | 128.31 | 0.08 |
| Drainageway 4100 | 4100_DS | 11277 | 100-YR | 703.00 | 5087.28 | 5094.37 | 5090.22 | 5094.49 | 0.008145 | 2.67 | 258.20 | 79.98 | 0.19 |

HEC-RAS Plan: Future Profile: 100-YR (Continued)

| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Drainageway 4100 | 4100_DS | 11260 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 11158 | 100-YR | 703.00 | 5085.00 | 5093.04 | | 5093.34 | 0.020594 | 4.38 | 160.60 | 41.10 | 0.30 |
| Drainageway 4100 | 4100_DS | 11128 | 100-YR | 703.00 | 5084.82 | 5092.48 | | 5092.67 | 0.019784 | 3.51 | 201.34 | 50.40 | 0.29 |
| Drainageway 4100 | 4100_DS | 11071 | 100-YR | 703.00 | 5084.47 | 5091.04 | | 5091.32 | 0.028750 | 4.27 | 164.79 | 44.21 | 0.35 |
| Drainageway 4100 | 4100_DS | 11051 | 100-YR | 703.00 | 5084.35 | 5089.39 | 5087.83 | 5090.20 | 0.127463 | 7.23 | 97.42 | 23.23 | 0.60 |
| Drainageway 4100 | 4100_DS | 11039 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 10834 | 100-YR | 1288.00 | 5082.50 | 5087.52 | | 5088.65 | 0.170165 | 8.55 | 150.70 | 335.65 | 0.79 |
| Drainageway 4100 | 4100_DS | 10803 | 100-YR | 1288.00 | 5082.18 | 5088.07 | 5086.27 | 5088.08 | 0.000126 | 0.24 | 1525.85 | 369.69 | 0.02 |
| Drainageway 4100 | 4100_DS | 10621 | 100-YR | 1288.00 | 5079.96 | 5088.07 | | 5088.07 | 0.000006 | 0.07 | 5743.09 | 997.64 | 0.01 |
| Drainageway 4100 | 4100_DS | 10599 | 100-YR | 1288.00 | 5079.95 | 5088.05 | 5082.75 | 5088.07 | 0.000329 | 0.58 | 1595.63 | 956.18 | 0.04 |
| Drainageway 4100 | 4100_DS | 10512 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 10435 | 100-YR | 1288.00 | 5075.96 | 5082.94 | 5082.94 | 5086.44 | 0.198232 | 15.01 | 85.80 | 53.51 | 1.00 |
| Drainageway 4100 | 4100_DS | 10378 | 100-YR | 1288.00 | 5072.01 | 5083.55 | | 5083.67 | 0.003555 | 2.48 | 479.52 | 75.83 | 0.14 |
| Drainageway 4100 | 4100_DS | 10147 | 100-YR | 1288.00 | 5071.00 | 5083.00 | 5075.98 | 5083.07 | 0.001903 | 1.92 | 613.45 | 120.28 | 0.10 |
| Colorado Bouleva | Colorado Bouleva | 61506 | 100-YR | 65.00 | 5176.85 | 5177.65 | 5177.65 | 5177.90 | 0.022023 | 4.11 | 17.29 | 70.71 | 0.90 |
| Colorado Bouleva | Colorado Bouleva | 61358 | 100-YR | 65.00 | 5173.96 | 5174.46 | 5174.46 | 5174.64 | 0.021924 | 2.91 | 20.14 | 72.05 | 0.83 |
| Colorado Bouleva | Colorado Bouleva | 61224 | 100-YR | 65.00 | 5171.91 | 5173.37 | 5172.94 | 5173.42 | 0.001638 | 1.60 | 38.35 | 86.78 | 0.27 |
| Colorado Bouleva | Colorado Bouleva | 61204 | 100-YR | 65.00 | 5170.06 | 5173.35 | 5172.12 | 5173.39 | 0.000981 | 1.58 | 43.57 | 85.18 | 0.21 |
| Colorado Bouleva | Colorado Bouleva | 61196 | | Culvert | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 60700 | 100-YR | 65.00 | 5161.85 | 5163.29 | 5163.29 | 5163.87 | 0.023466 | 6.13 | 10.61 | 11.52 | 1.00 |
| Colorado Bouleva | Colorado Bouleva | 60680 | 100-YR | 65.00 | 5161.10 | 5162.69 | 5162.69 | 5163.17 | 0.022205 | 5.60 | 11.94 | 13.75 | 0.96 |
| Colorado Bouleva | Colorado Bouleva | 60636 | 100-YR | 65.00 | 5158.98 | 5160.30 | 5160.30 | 5160.75 | 0.023027 | 5.40 | 12.29 | 14.91 | 0.97 |
| Colorado Bouleva | Colorado Bouleva | 60438 | 100-YR | 65.00 | 5151.98 | 5153.44 | 5153.44 | 5153.87 | 0.019808 | 5.31 | 13.09 | 17.21 | 0.92 |
| Colorado Bouleva | Colorado Bouleva | 60316 | 100-YR | 65.00 | 5148.12 | 5152.17 | 5150.38 | 5152.19 | 0.000768 | 1.33 | 50.54 | 56.11 | 0.18 |
| Colorado Bouleva | Colorado Bouleva | 60295 | | Culvert | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 60149 | 100-YR | 65.00 | 5147.11 | 5149.03 | 5148.94 | 5149.37 | 0.021333 | 4.70 | 13.84 | 20.67 | 0.87 |
| Colorado Bouleva | Colorado Bouleva | 60139 | 100-YR | 65.00 | 5147.02 | 5148.98 | | 5149.16 | 0.008692 | 3.37 | 19.49 | 22.37 | 0.60 |
| Colorado Bouleva | Colorado Bouleva | 60023 | 100-YR | 65.00 | 5145.96 | 5147.14 | 5147.14 | 5147.54 | 0.024774 | 5.11 | 12.79 | 16.74 | 0.99 |
| Colorado Bouleva | Colorado Bouleva | 60013 | 100-YR | 65.00 | 5144.98 | 5146.83 | 5146.57 | 5147.10 | 0.011011 | 4.19 | 15.70 | 15.42 | 0.69 |




CALL UTILITY NOTIFICATION CENTER OF COLORADO
**1-800-922-1987 or 811**
CALL 3-BUSINESS DAYS (NOT INCLUDING INITIAL DAY OF CONTACT) IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.
Know what's below. Call before you dig.

NOTES:
1. LOCATIONS OF UTILITIES SHOWN ARE APPROXIMATE ONLY. CONTRACTOR TO VERIFY HORIZONTAL AND VERTICAL LOCATIONS OF ALL UTILITIES PRIOR TO CONSTRUCTION.




RFC
T.N.Wilson
04/12/2016
03-039.08*
Area F Only

COLORADO LICENSED
COLLEEN REED HASTY
41104
3/23/16
PROFESSIONAL ENGINEER

DWG No. DS-133

| NO. | REVISIONS | BY | DATE |
|---|---|---|---|
| 0 | ISSUED FOR CONSTRUCTION | JSG | 03/24/2016 |

DESIGNED BY: CRH DATE: 07/01/2015
DRAWN BY: PEB DATE: 07/11/2015
CHECKED BY: JSG DATE: 12/07/2015
APPROVED BY: JSG DATE: 03/24/2016
HORZ. SCALE: 1"=20'
VERT. SCALE: 1"=10'

REGIONAL RAIL PARTNERS
A Balfour Beatty / GRAHAM JOINT VENTURE

Stantec
2000 SOUTH COLORADO BOULEVARD
SUITE 2-300
DENVER, COLORADO 80222
(303) 758-4058

RTD FasTracks
North Metro Rail Line
REGIONAL TRANSPORTATION DISTRICT
1600 BLAKE STREET
DENVER, COLORADO 80202
(303) 628-9000

# NORTH METRO RAIL LINE

## DRAINAGE STRUCTURES
## STORM SEWER PROFILES
## MINOR DRAINAGE - STA 579+54.02

USER: pbalasco
NM-D-DS-133-DrnProfile.dgn
3/24/2016 8:41:06 AM

**Cot PD Training Facility**

Cot PD Training Facility

Denver, CO 80229

Inquiry Number: 5507149.5

December 10, 2018

# The EDR Aerial Photo Decade Package

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

# EDR Aerial Photo Decade Package

12/10/18

**Site Name:**

Cot PD Training Facility
Cot PD Training Facility
Denver, CO 80229
EDR Inquiry # 5507149.5

**Client Name:**

ERO Resources
1842 Clarkson Street
Denver, CO 80218
Contact: Adam Backsmeier

Environmental Data Resources, Inc. (EDR) Aerial Photo Decade Package is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's professional researchers provide digitally reproduced historical aerial photographs, and when available, provide one photo per decade.

## *Search Results:*

| *Year* | *Scale* | *Details* | *Source* |
|---|---|---|---|
| 2017 | 1"=500' | Flight Year: 2017 | USDA/NAIP |
| 2013 | 1"=500' | Flight Year: 2013 | USDA/NAIP |
| 2009 | 1"=500' | Flight Year: 2009 | USDA/NAIP |
| 2006 | 1"=500' | Flight Year: 2006 | USDA/NAIP |
| 1999 | 1"=500' | Acquisition Date: October 04, 1999 | USGS/DOQQ |
| 1994 | 1"=500' | Flight Date: September 25, 1994 | EDR Proprietary Landiscor |
| 1991 | 1"=500' | Flight Date: June 11, 1991 | USGS |
| 1984 | 1"=500' | Flight Date: October 13, 1984 | USDA |
| 1979 | 1"=500' | Flight Date: June 21, 1979 | EDR Proprietary Landiscor |
| 1970 | 1"=500' | Flight Date: June 16, 1970 | USDA |
| 1963 | 1"=500' | Flight Date: May 18, 1963 | USGS |
| 1954 | 1"=500' | Flight Date: November 14, 1954 | Jack |
| 1950 | 1"=500' | Flight Date: June 21, 1950 | USDA |
| 1937 | 1"=500' | Flight Date: July 16, 1937 | USDA |

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INQUIRY #: 5507149.5
YEAR: 2017
= 500'
N
EDR

INQUIRY #: 5507149.5

YEAR: 2013

= 500'

N

EDR

INQUIRY #: 5507149.5
YEAR: 2009
= 500'
N
EDR

INQUIRY #: 5507149.5
YEAR: 2006
= 500'
N
EDR

INQUIRY #: 5507149.5

YEAR: 1999

= 500'

N

EDR

INQUIRY #: 5507149.5
YEAR: 1994
= 500'
N
EDR

INQUIRY #: 5507149.5
YEAR: 1991
= 500'
N
EDR

INQUIRY #: 5507149.5

YEAR: 1984

= 500'

N

EDR

INQUIRY #: 5507149.5
YEAR: 1979
= 500'
N
EDR

INQUIRY #: 5507149.5

YEAR: 1970

= 500'

N

EDR

INQUIRY #: 5507149.5
YEAR: 1963
= 500'
N
EDR

INQUIRY #: 5507149.5

YEAR: 1954

= 500'

N

EDR

INQUIRY #: 5507149.5

YEAR: 1950

= 500'

N

EDR

INQUIRY #: 5507149.5

YEAR: 1937

= 500'

N

EDR

Cot PD Training Facility

Cot PD Training Facility

Denver, CO 80229

Inquiry Number: 5507149.3

December 10, 2018

# Certified Sanborn® Map Report

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

# Certified Sanborn® Map Report

12/10/18

**Site Name:**

Cot PD Training Facility
Cot PD Training Facility
Denver, CO 80229
EDR Inquiry # 5507149.3

**Client Name:**

ERO Resources
1842 Clarkson Street
Denver, CO 80218
Contact: Adam Backsmeier

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The Sanborn Library is continually enhanced with newly identified map archives. This report accesses all maps in the collection as of the day this report was generated.

## *Certified Sanborn Results:*

**Certification #** B420-4643-9356

**PO #** NA

**Project** CoT PD Training Facility

### UNMAPPED PROPERTY

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Sanborn® Library search results

Certification #: B420-4643-9356

The Sanborn Library includes more than 1.2 million fire insurance maps from Sanborn, Bromley, Perris & Browne, Hopkins, Barlow and others which track historical property usage in approximately 12,000 American cities and towns. Collections searched:

- ☑ Library of Congress
- ☑ University Publications of America
- ☑ EDR Private Collection

*The Sanborn Library LLC Since 1866™*

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# APPENDIX D

# WETLAND AND RIPARIAN INVENTORY

**Legend**

- DFA 0056
- Basin 4100
- LAKES/RESERVOIRS/DETENTION BASINS
- FRESHWATER POND
- FRESHWATER FORESTED/SHRUB WETLAND
- FRESHWATER EMERGENT WETLAND
- RIVERINE/DRAINAGEWAY/CANAL
- ADAMS COUNTY
- Thornton City Boundary

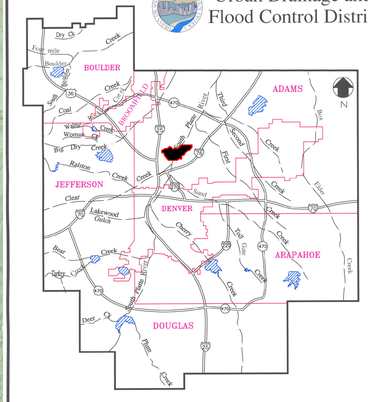
Note: This information was acquired through the U.S. Fish and Wildlife Service's National Wetlands Inventory.

N

0 370 740 1,480 Feet

100TH AVENUE
YORK STREET
North G Tributary
West G Tributary
4100 Drainageway
THORNTON PARKWAY
Thornton Parkway
H Tributary
Colorado Boulevard
COLORADO AGRICULTURAL DITCH
LOWER CLEAR CREEK CANAL
River Valley Village
Cherrylane
North K Tributary
MCKAY ROAD
West Sprat Platte Lake
South K Tributary
DFA 0056
ADAMS COUNTY 88TH AVENUE OPEN SPACE
RIVERDALE ROAD
J Tributary
D Tributary
EPPINGER BOULEVARD
BASIN 4100
RTD NMRL
B Tributary
School Tributary
88TH AVENUE

Urban Drainage and Flood Control District




February 2007

| | | | |
|---|---|---|---|
| PROJECT: 017-2321<br>DRAWN BY: HLP<br>DATE: 09-2020 | **MILE HIGH FLOOD DISTRICT**<br>**ADAMS COUNTY AND CITY OF THORNTON** | **BASIN 4100 AND DFA 0056 OSP**<br>**WETLAND INVENTORY** | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | FIGURE<br>D-1 |

# APPENDIX E

# ALTERNATIVE ANALYSIS

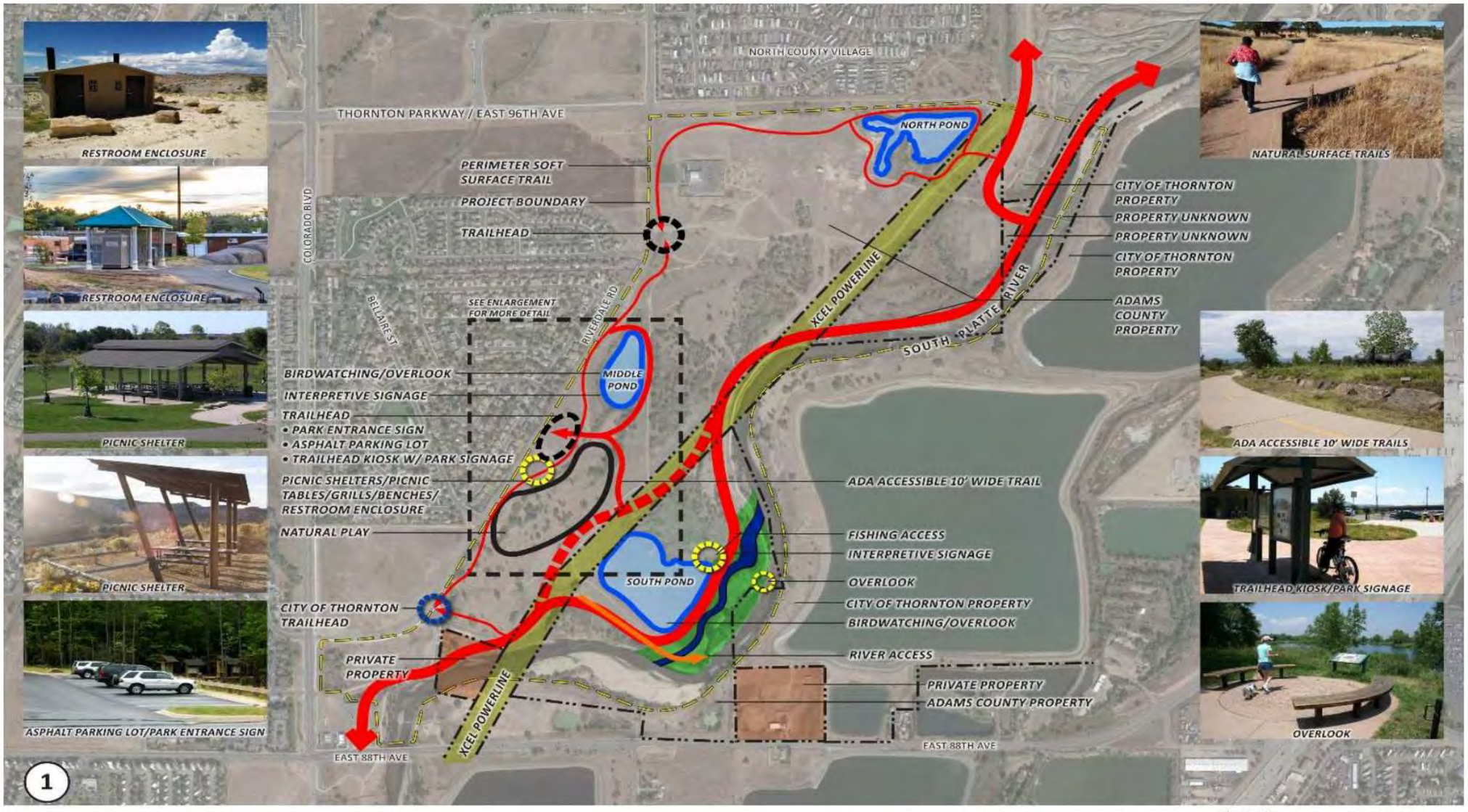



**Figure 3-1: Recreation and Public Access Improvements – Page 1**

# Channel Stabilization

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | 4100-1 | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/2/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| Reclamation & seeding (native grasses) | 6 | AC | $7,500 |
| Reclamation & seeding (native grasses) | 1 | AC | $1,250 |
| Check Structure (Concrete) | 1 | EA | $18,590 |
| Check Structure (Concrete) | 1 | EA | $18,590 |
| Check Structure (Concrete) | 4 | EA | $74,360 |
| Sloping Drop Structure | 1 | EA | $24,012 |
| Sloping Drop Structure | 1 | EA | $52,337 |
| Sloping Drop Structure | 1 | EA | $52,337 |
| Sloping Drop Structure | 1 | EA | $52,337 |
| Excavation, Mid Range | 2790 | CY | $83,700 |
| Excavation, Mid Range | 1450 | CY | $43,500 |
| Excavation, Mid Range | 2430 | CY | $72,900 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $0 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $292,563 |
| Channel Improvements | | | $200,100 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $0 |
| Landscaping and Maintenance Improvements | | | $8,750 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$501,413** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $6,003 |
| Mobilization | 5% | | $25,071 |
| Traffic Control | 5% | | $14,628 |
| Utility Coordination/Relocation | 5% | | $25,071 |
| Stormwater Management/Erosion Control | 5% | | $25,071 |
| **Subtotal Additional Capital Improvement Costs** | | | **$95,844** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $89,589 |
| Legal/Administrative | 5% | | $29,863 |
| Contract Admin/Construction Management | 10% | | $59,726 |
| Contingency | 25% | | $149,314 |
| **Subtotal Other Costs** | | | **$328,492** |
| **Totals** | | | **$925,749** |

# Structure Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | 4100-1 | | | | |
| | | ESTIMATED BY: | User | DATE: | 5/16/2019 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| (3) 8x6 Box | 69 | LF | $240,244 |
| (2) 42x42 Circular | 83 | LF | $30,478 |
| Removal of culvert pipe (D<48") | 166 | LF | $4,150 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $30,478 |
| Concrete Box Culverts | | | $240,244 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $4,150 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$274,872** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $13,744 |
| Traffic Control | 5% | | $13,536 |
| Utility Coordination/Relocation | 5% | | $13,744 |
| Stormwater Management/Erosion Control | 5% | | $13,744 |
| **Subtotal Additional Capital Improvement Costs** | | | **$54,768** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $49,446 |
| Legal/Administrative | 5% | | $16,482 |
| Contract Admin/Construction Management | 10% | | $32,964 |
| Contingency | 25% | | $82,410 |
| **Subtotal Other Costs** | | | **$181,302** |
| **Totals** | | | **$510,942** |

# Detention/Water Quality

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | 4100-1 | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| Cutoff Wall | 380 | LF | $126,540 |
| Spillway | 380 | LF | $47,017 |
| Detention Facility | 1 | EA | $417,810 |
| Soil Riprap, Type M | 3378 | CY | $297,264 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $0 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $297,264 |
| Detention/Water Quality Facilities | | | $417,810 |
| Removals | | | $0 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $173,557 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$888,631** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $21,452 |
| Mobilization | 5% | | $44,432 |
| Traffic Control | 5% | | $0 |
| Utility Coordination/Relocation | 5% | | $44,432 |
| Stormwater Management/Erosion Control | 5% | | $44,432 |
| **Subtotal Additional Capital Improvement Costs** | | | **$154,748** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $156,507 |
| Legal/Administrative | 5% | | $52,169 |
| Contract Admin/Construction Management | 10% | | $104,338 |
| Contingency | 25% | | $260,845 |
| **Subtotal Other Costs** | | | **$573,859** |
| **Totals** | | | **$1,617,238** |

# Channel Stabilization

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | 4100-2 | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/2/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| Remove Failed Drop | 1 | EA | $30,000 |
| Check Structure (Concrete) | 6 | EA | $111,540 |
| Check Structure (Concrete) | 1 | EA | $18,590 |
| Check Structure (Concrete) | 3 | EA | $55,770 |
| Sloping Drop Structure | 1 | EA | $48,970 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $0 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $234,870 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $30,000 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$264,870** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $13,244 |
| Traffic Control | 5% | | $11,744 |
| Utility Coordination/Relocation | 5% | | $13,244 |
| Stormwater Management/Erosion Control | 5% | | $13,244 |
| **Subtotal Additional Capital Improvement Costs** | | | **$51,476** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $47,452 |
| Legal/Administrative | 5% | | $15,817 |
| Contract Admin/Construction Management | 10% | | $31,635 |
| Contingency | 25% | | $79,086 |
| **Subtotal Other Costs** | | | **$173,990** |
| **Totals** | | | **$490,336** |

# Structure Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | 4100-2 | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 60x60 Circular | 166 | LF | $76,129 |
| 6x4 Box | 405 | LF | $298,520 |
| Pedestrian Bridge | 1 | LS | $150,000 |
| Removal of culvert pipe (D<48") | 50 | LF | $1,260 |
| Removal of culvert pipe (D<48") | 166 | LF | $4,160 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $76,129 |
| Concrete Box Culverts | | | $298,520 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $5,420 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $150,000 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$530,069** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $26,503 |
| Traffic Control | 5% | | $18,732 |
| Utility Coordination/Relocation | 5% | | $26,503 |
| Stormwater Management/Erosion Control | 5% | | $26,503 |
| **Subtotal Additional Capital Improvement Costs** | | | **$98,241** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $94,246 |
| Legal/Administrative | 5% | | $31,416 |
| Contract Admin/Construction Management | 10% | | $62,831 |
| Contingency | 25% | | $157,078 |
| **Subtotal Other Costs** | | | **$345,571** |
| **Totals** | | | **$973,881** |

# Storm Drain System Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | 4100-2 | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 42x42 Circular | 1211 | LF | $207,492 |
| Type "P" | 1 | EA | $18,750 |
| Type "B" | 1 | EA | $15,000 |
| Type "P" | 1 | EA | $18,750 |
| Type "B" | 1 | EA | $15,000 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $274,992 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $0 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$274,992** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $13,750 |
| Traffic Control | 5% | | $13,750 |
| Utility Coordination/Relocation | 5% | | $13,750 |
| Stormwater Management/Erosion Control | 5% | | $13,750 |
| **Subtotal Additional Capital Improvement Costs** | | | **$55,000** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $49,499 |
| Legal/Administrative | 5% | | $16,500 |
| Contract Admin/Construction Management | 10% | | $32,999 |
| Contingency | 25% | | $82,498 |
| **Subtotal Other Costs** | | | **$181,496** |
| **Totals** | | | **$511,488** |

# Detention/Water Quality

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | 4100-2 | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 40-ft x 10-ft Emergency Spillway Box | 1 | EA | $50,000 |
| 7.5-FT SSP, Jack and Bore | 195 | LF | $585,000 |
| 7.5-FT SSP, Jack and Bore | 181 | LF | $543,000 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $0 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $0 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $1,178,000 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$1,178,000** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $58,900 |
| Traffic Control | 5% | | $0 |
| Utility Coordination/Relocation | 5% | | $58,900 |
| Stormwater Management/Erosion Control | 5% | | $58,900 |
| **Subtotal Additional Capital Improvement Costs** | | | **$176,700** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $203,205 |
| Legal/Administrative | 5% | | $67,735 |
| Contract Admin/Construction Management | 10% | | $135,470 |
| Contingency | 25% | | $338,675 |
| **Subtotal Other Costs** | | | **$745,085** |
| **Totals** | | | **$2,099,785** |

# Channel Conveyance Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | School Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 5/20/2019 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 10x5 Box | 53 | LF | $86,793 |
| 10x5 Box | 60 | LF | $93,961 |
| Flume | 77 | LF | $93,940 |
| Removal of culvert pipe (D<48") | 258 | LF | $6,450 |
| Reclamation & seeding (native grasses) | 7 | AC | $8,750 |
| Sloping Drop Structure | 1 | EA | $50,947 |
| Sloping Drop Structure | 1 | EA | $50,947 |
| Sloping Drop Structure | 1 | EA | $50,947 |
| Sloping Drop Structure | 1 | EA | $50,947 |
| Sloping Drop Structure | 1 | EA | $50,947 |
| Sloping Drop Structure | 1 | EA | $50,947 |
| Sloping Drop Structure | 1 | EA | $50,947 |
| Sloping Drop Structure | 1 | EA | $50,947 |
| Sloping Drop Structure | 1 | EA | $50,947 |
| Sloping Drop Structure | 1 | EA | $50,947 |
| Sloping Drop Structure | 1 | EA | $82,960 |
| Sloping Drop Structure | 1 | EA | $50,947 |
| Sloping Drop Structure | 1 | EA | $50,947 |
| Excavation, Mid Range | 27570 | CY | $827,100 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $0 |
| Concrete Box Culverts | | | $180,754 |
| Hydraulic Structures | | | $643,377 |
| Channel Improvements | | | $827,100 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $6,450 |
| Landscaping and Maintenance Improvements | | | $8,750 |
| Special Items (User Defined) | | | $93,940 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$1,760,371** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $24,813 |
| Mobilization | 5% | | $88,019 |
| Traffic Control | 5% | | $41,207 |
| Utility Coordination/Relocation | 5% | | $88,019 |
| Stormwater Management/Erosion Control | 5% | | $88,019 |
| **Subtotal Additional Capital Improvement Costs** | | | **$330,077** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $313,567 |

# Channel Conveyance Improvements

| Master Plan Cost Estimator | | | |
|---|---|---|---|
| Legal/Administrative | 5% | | $104,522 |
| Contract Admin/Construction Management | 10% | | $209,045 |
| Contingency | 25% | | $522,612 |
| **Subtotal Other Costs** | | | **$1,149,746** |
| **Totals** | | | **$3,240,194** |

# Storm Drain System Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | School Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 5/20/2019 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 84x84 Circular | 538 | LF | $304,017 |
| 84x84 Circular | 500 | LF | $284,067 |
| 4x84 Circular | 433 | LF | $248,892 |
| 84x84 Circular | 500 | LF | $284,067 |
| 84x84 Circular | 500 | LF | $284,067 |
| 84x84 Circular | 253 | LF | $132,825 |
| MODIFY MANHOLE | 1 | EA | $1,500 |
| Removal of culvert pipe (D<48") | 258 | LF | $6,450 |
| Removal of culvert pipe (D<48") | 129 | LF | $3,225 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $1,706,685 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $9,675 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $1,500 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$1,717,860** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $85,893 |
| Traffic Control | 5% | | $85,334 |
| Utility Coordination/Relocation | 5% | | $85,893 |
| Stormwater Management/Erosion Control | 5% | | $85,893 |
| **Subtotal Additional Capital Improvement Costs** | | | **$343,013** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $309,131 |

# Storm Drain System Improvements

| Master Plan Cost Estimator | | | |
|---|---|---|---|
| Legal/Administrative | 5% | | $103,044 |
| Contract Admin/Construction Management | 10% | | $206,087 |
| Contingency | 25% | | $515,218 |
| **Subtotal Other Costs** | | | **$1,133,480** |
| **Totals** | | | **$3,194,353** |

# Detention/Water Quality

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | School Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| Detention Facility | 1 | EA | $62,700 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $0 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $62,700 |
| Removals | | | $0 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$62,700** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $1,881 |
| Mobilization | 5% | | $3,135 |
| Traffic Control | 5% | | $0 |
| Utility Coordination/Relocation | 5% | | $3,135 |
| Stormwater Management/Erosion Control | 5% | | $3,135 |
| **Subtotal Additional Capital Improvement Costs** | | | **$11,286** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $11,098 |
| Legal/Administrative | 5% | | $3,699 |
| Contract Admin/Construction Management | 10% | | $7,399 |
| Contingency | 25% | | $18,496 |
| **Subtotal Other Costs** | | | **$40,692** |
| **Totals** | | | **$114,678** |

# Storm Drain System Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | B Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 48x48 Circular | 500 | LF | $95,150 |
| 48x48 Circular | 500 | LF | $95,150 |
| 48x48 Circular | 500 | LF | $95,150 |
| 48x48 Circular | 500 | LF | $95,150 |
| 48x48 Circular | 434 | LF | $83,270 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |

| **Master Plan Improvement Cost Summary** | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $501,495 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $0 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$501,495** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $25,075 |
| Traffic Control | 5% | | $25,075 |
| Utility Coordination/Relocation | 5% | | $25,075 |
| Stormwater Management/Erosion Control | 5% | | $25,075 |
| **Subtotal Additional Capital Improvement Costs** | | | **$100,300** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $90,269 |
| Legal/Administrative | 5% | | $30,090 |
| Contract Admin/Construction Management | 10% | | $60,180 |
| Contingency | 25% | | $150,449 |
| **Subtotal Other Costs** | | | **$330,988** |
| **Totals** | | | **$932,783** |

# Storm Drain System Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | D Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 42x42 Circular | 260 | LF | $43,205 |
| Modify Manhole | 1 | EA | $1,500 |
| Removal of culvert pipe (D<48") | 260 | LF | $6,500 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $43,205 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $6,500 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $1,500 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$51,205** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $2,560 |
| Traffic Control | 5% | | $2,160 |
| Utility Coordination/Relocation | 5% | | $2,560 |
| Stormwater Management/Erosion Control | 5% | | $2,560 |
| **Subtotal Additional Capital Improvement Costs** | | | **$9,840** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $9,157 |
| Legal/Administrative | 5% | | $3,052 |
| Contract Admin/Construction Management | 10% | | $6,104 |
| Contingency | 25% | | $15,261 |
| **Subtotal Other Costs** | | | **$33,574** |
| **Totals** | | | **$94,619** |

# Channel Stabilization

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | West G Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/2/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| Check Structure (Concrete) | 1 | EA | $5,070 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $0 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $5,070 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $0 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$5,070** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $254 |
| Traffic Control | 5% | | $254 |
| Utility Coordination/Relocation | 5% | | $254 |
| Stormwater Management/Erosion Control | 5% | | $254 |
| **Subtotal Additional Capital Improvement Costs** | | | **$1,016** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $913 |
| Legal/Administrative | 5% | | $304 |
| Contract Admin/Construction Management | 10% | | $609 |
| Contingency | 25% | | $1,522 |
| **Subtotal Other Costs** | | | **$3,348** |
| **Totals** | | | **$9,434** |

# Storm Drain System Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | West G Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 60x60 Circular | 215 | LF | $64,500 |
| 30x30 Circular | 623 | LF | $71,738 |
| 42x42 Circular | 1960 | LF | $309,680 |
| 66x66 Circular | 251 | LF | $82,830 |
| Remove Manhole | 13 | EA | $13,000 |
| Removal of culvert pipe (D<48") | 2583 | LF | $64,575 |
| Removal of culvert pipe (48"<D<84") | 466 | LF | $28,892 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |

| **Master Plan Improvement Cost Summary** | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $622,498 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $93,467 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $13,000 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$728,965** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $36,448 |
| Traffic Control | 5% | | $31,125 |
| Utility Coordination/Relocation | 5% | | $36,448 |
| Stormwater Management/Erosion Control | 5% | | $36,448 |
| **Subtotal Additional Capital Improvement Costs** | | | **$140,469** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |

| Master Plan Cost Estimator | | | |
|---|---|---|---|
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $130,415 |
| Legal/Administrative | 5% | | $43,472 |
| Contract Admin/Construction Management | 10% | | $86,943 |
| Contingency | 25% | | $217,358 |
| **Subtotal Other Costs** | | | **$478,188** |
| **Totals** | | | **$1,347,622** |

# Storm Drain System Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | H Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 36x36 Circular | 224 | LF | $30,240 |
| Remove Manhole | 2 | EA | $13,000 |
| Removal of culvert pipe (D<48") | 224 | LF | $5,600 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $39,990 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $5,600 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $13,000 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$58,590** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $2,930 |
| Traffic Control | 5% | | $2,000 |
| Utility Coordination/Relocation | 5% | | $2,930 |
| Stormwater Management/Erosion Control | 5% | | $2,930 |
| **Subtotal Additional Capital Improvement Costs** | | | **$10,790** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $10,407 |
| Legal/Administrative | 5% | | $3,469 |
| Contract Admin/Construction Management | 10% | | $6,938 |
| Contingency | 25% | | $17,345 |
| **Subtotal Other Costs** | | | **$38,159** |
| **Totals** | | | **$107,539** |

# Structure Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | DFA 0056 | | | | |
| REACH: | J Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 36x36 Circular | 26 | LF | $7,534 |
| Removal of culvert pipe (D<48") | 26 | LF | $650 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $7,534 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $650 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$8,184** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $409 |
| Traffic Control | 5% | | $377 |
| Utility Coordination/Relocation | 5% | | $409 |
| Stormwater Management/Erosion Control | 5% | | $409 |
| **Subtotal Additional Capital Improvement Costs** | | | **$1,604** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $1,468 |
| Legal/Administrative | 5% | | $489 |
| Contract Admin/Construction Management | 10% | | $979 |
| Contingency | 25% | | $2,447 |
| **Subtotal Other Costs** | | | **$5,383** |
| **Totals** | | | **$15,171** |

# Detention/Water Quality

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | DFA 0056 | | | | |
| REACH: | J Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 5/16/2019 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 36x36 Circular | 210 | LF | $32,374 |
| 48x48 Circular | 800 | LF | $146,575 |
| Install Outlet Structure | 1 | EA | $15,000 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $178,949 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $0 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $15,000 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$193,949** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $9,697 |
| Traffic Control | 5% | | $8,947 |
| Utility Coordination/Relocation | 5% | | $9,697 |
| Stormwater Management/Erosion Control | 5% | | $9,697 |
| **Subtotal Additional Capital Improvement Costs** | | | **$38,038** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $34,798 |
| Legal/Administrative | 5% | | $11,599 |
| Contract Admin/Construction Management | 10% | | $23,199 |
| Contingency | 25% | | $57,997 |
| **Subtotal Other Costs** | | | **$127,593** |
| **Totals** | | | **$359,580** |

# Channel Conveyance Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | DFA 0056 | | | | |
| REACH: | North K Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/7/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 12x4 Box | 78 | LF | $109,812 |
| 7x4 Box | 94 | LF | $92,370 |
| 12x4 Box | 61 | LF | $92,200 |
| Removal of culvert pipe (D<48") | 188 | LF | $4,700 |
| Removal of culvert pipe (D<48") | 61 | LF | $1,525 |
| Removal of culvert pipe (D<48") | 78 | LF | $1,950 |
| Reclamation & seeding (native grasses) | 1 | AC | $1,250 |
| Reclamation & seeding (native grasses) | 2 | AC | $2,500 |
| Excavation, Mid Range | 1150 | CY | $34,500 |
| Excavation, Mid Range | 2250 | CY | $67,500 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $0 |
| Concrete Box Culverts | | | $294,382 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $102,000 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $8,175 |
| Landscaping and Maintenance Improvements | | | $3,750 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$408,307** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $3,060 |
| Mobilization | 5% | | $20,415 |
| Traffic Control | 5% | | $14,719 |
| Utility Coordination/Relocation | 5% | | $20,415 |
| Stormwater Management/Erosion Control | 5% | | $20,415 |
| **Subtotal Additional Capital Improvement Costs** | | | **$79,024** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $73,100 |
| Legal/Administrative | 5% | | $24,367 |
| Contract Admin/Construction Management | 10% | | $48,733 |
| Contingency | 25% | | $121,833 |
| **Subtotal Other Costs** | | | **$268,033** |
| **Totals** | | | **$755,364** |

# Storm Drain System Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | DFA 0056 | | | | |
| REACH: | North K Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 48x48 Circular | 460 | LF | $82,800 |
| 48x48 Circular | 500 | LF | $92,575 |
| 48x48 Circular | 235 | LF | $42,300 |
| 48x48 Circular | 409 | LF | $76,195 |
| 48x48 Circular | 153 | LF | $27,540 |
| 48x48 Circular | 153 | LF | $27,540 |
| 48x48 Circular | 500 | LF | $92,575 |
| 48x48 Circular | 500 | LF | $92,575 |
| 48x48 Circular | 500 | LF | $92,575 |
| 48x48 Circular | 500 | LF | $92,575 |
| 48x48 Circular | 500 | LF | $92,575 |
| 48x48 Circular | 192 | LF | $37,135 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $913,460 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $0 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$913,460** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $45,673 |
| Traffic Control | 5% | | $45,673 |
| Utility Coordination/Relocation | 5% | | $45,673 |

| Master Plan Cost Estimator | | | |
|---|---|---|---|
| Stormwater Management/Erosion Control | 5% | | $45,673 |
| **Subtotal Additional Capital Improvement Costs** | | | **$182,692** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $164,423 |
| Legal/Administrative | 5% | | $54,808 |
| Contract Admin/Construction Management | 10% | | $109,615 |
| Contingency | 25% | | $274,038 |
| **Subtotal Other Costs** | | | **$602,884** |
| **Totals** | | | **$1,699,036** |

# Detention/Water Quality

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | DFA 0056 | | | | |
| REACH: | South K Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 18x18 Circular | 587 | LF | $42,216 |
| 36x36 Circular | 485 | LF | $69,499 |
| 42x42 Circular | 288 | LF | $49,754 |
| Detention Facility | 1 | EA | $666,900 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $161,469 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $666,900 |
| Removals | | | $0 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$828,369** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $20,007 |
| Mobilization | 5% | | $41,418 |
| Traffic Control | 5% | | $8,073 |
| Utility Coordination/Relocation | 5% | | $41,418 |
| Stormwater Management/Erosion Control | 5% | | $41,418 |
| **Subtotal Additional Capital Improvement Costs** | | | **$152,334** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $147,105 |
| Legal/Administrative | 5% | | $49,035 |
| Contract Admin/Construction Management | 10% | | $98,070 |
| Contingency | 25% | | $245,176 |
| **Subtotal Other Costs** | | | **$539,386** |
| **Totals** | | | **$1,520,089** |

# Channel Conveyance Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | Colorado Boulevard | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/2/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| Reclamation & seeding (native grasses) | 1 | AC | $1,250 |
| Sloping Drop Structure | 1 | EA | $47,361 |
| Excavation, Mid Range | 200 | CY | $6,000 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $0 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $47,361 |
| Channel Improvements | | | $6,000 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $0 |
| Landscaping and Maintenance Improvements | | | $1,250 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$54,611** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $180 |
| Mobilization | 5% | | $2,731 |
| Traffic Control | 5% | | $2,368 |
| Utility Coordination/Relocation | 5% | | $2,731 |
| Stormwater Management/Erosion Control | 5% | | $2,731 |
| **Subtotal Additional Capital Improvement Costs** | | | **$10,741** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $9,803 |
| Legal/Administrative | 5% | | $3,268 |
| Contract Admin/Construction Management | 10% | | $6,535 |
| Contingency | 25% | | $16,338 |
| **Subtotal Other Costs** | | | **$35,944** |
| **Totals** | | | **$101,296** |

# Structure Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | Colorado Boulevard | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 30x30 Circular | 128 | LF | $18,260 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $18,260 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $0 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$18,260** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $913 |
| Traffic Control | 5% | | $913 |
| Utility Coordination/Relocation | 5% | | $913 |
| Stormwater Management/Erosion Control | 5% | | $913 |
| **Subtotal Additional Capital Improvement Costs** | | | **$3,652** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $3,287 |
| Legal/Administrative | 5% | | $1,096 |
| Contract Admin/Construction Management | 10% | | $2,191 |
| Contingency | 25% | | $5,478 |
| **Subtotal Other Costs** | | | **$12,052** |
| **Totals** | | | **$33,964** |

# Storm Drain System Improvements

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | Colorado Boulevard | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/6/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 42x42 Circular | 488 | LF | $81,354 |
| 48x48 Circular | 655 | LF | $127,478 |
| 60x60 Circular | 637 | LF | $191,100 |
| 72x72 Circular | 2582 | LF | $1,161,900 |
| Remove Manhole | 7 | EA | $7,000 |
| Remove Manhole | 1 | EA | $1,000 |
| Removal of culvert pipe (D<48") | 3874 | LF | $96,850 |
| Removal of culvert pipe (D<48") | 488 | LF | $12,200 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $1,672,207 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $109,050 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $8,000 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$1,789,257** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $89,463 |
| Traffic Control | 5% | | $83,610 |
| Utility Coordination/Relocation | 5% | | $89,463 |
| Stormwater Management/Erosion Control | 5% | | $89,463 |
| **Subtotal Additional Capital Improvement Costs** | | | **$351,999** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $321,188 |
| Legal/Administrative | 5% | | $107,063 |
| Contract Admin/Construction Management | 10% | | $214,126 |

| Master Plan Cost Estimator | | | |
|---|---|---|---|
| Contingency | 25% | | $535,314 |
| **Subtotal Other Costs** | | | **$1,177,691** |
| **Totals** | | | **$3,318,947** |

# Recommended Plan

| Master Plan Cost Estimator |
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| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | 4100-1 | | | | |
| | | ESTIMATED BY: | User | DATE: | 5/16/2019 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| (3) 8x6 Box | 69 | LF | $240,244 |
| (2) 42x42 Circular | 83 | LF | $30,478 |
| Removal of culvert pipe (D<48") | 166 | LF | $4,150 |
| Reclamation & seeding (native grasses) | 6 | AC | $7,500 |
| Reclamation & seeding (native grasses) | 1 | AC | $1,250 |
| Check Structure (Concrete) | 1 | EA | $18,590 |
| Check Structure (Concrete) | 1 | EA | $18,590 |
| Check Structure (Concrete) | 4 | EA | $74,360 |
| Sloping Drop Structure | 1 | EA | $24,012 |
| Sloping Drop Structure | 1 | EA | $52,337 |
| Sloping Drop Structure | 1 | EA | $52,337 |
| Sloping Drop Structure | 1 | EA | $52,337 |
| Excavation, Mid Range | 2790 | CY | $83,700 |
| Excavation, Mid Range | 1450 | CY | $43,500 |
| Excavation, Mid Range | 2430 | CY | $72,900 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $30,478 |
| Concrete Box Culverts | | | $240,244 |
| Hydraulic Structures | | | $292,563 |
| Channel Improvements | | | $200,100 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $4,150 |
| Landscaping and Maintenance Improvements | | | $8,750 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$776,285** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $6,003 |
| Mobilization | 5% | | $38,814 |
| Traffic Control | 5% | | $28,164 |
| Utility Coordination/Relocation | 5% | | $38,814 |
| Stormwater Management/Erosion Control | 5% | | $38,814 |
| **Subtotal Additional Capital Improvement Costs** | | | **$150,609** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $139,034 |
| Legal/Administrative | 5% | | $46,345 |
| Contract Admin/Construction Management | 10% | | $92,689 |
| Contingency | 25% | | $231,724 |

# Recommended Plan

| Master Plan Cost Estimator | |
|---|---|
| **Subtotal Other Costs** | **$509,792** |
| **Totals** | **$1,436,686** |

# Recommended Plan

| Master Plan Cost Estimator |
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| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | 4100-2 | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/7/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 60x60 Circular | 166 | LF | $76,129 |
| 42x42 Circular | 1211 | LF | $207,492 |
| Pedestrian Bridge | 1 | LS | $150,000 |
| 40-ft x 10-ft Emergency Spillway Box | 1 | EA | $50,000 |
| 7.5-FT SSP, Jack and Bore | 195 | LF | $585,000 |
| 7.5-FT SSP, Jack and Bore | 181 | LF | $543,000 |
| Removal of culvert pipe (D<48") | 50 | LF | $1,260 |
| Removal of culvert pipe (D<48") | 166 | LF | $4,160 |
| Remove Failed Drop | 1 | EA | $30,000 |
| Type "P" | 1 | EA | $18,750 |
| Type "B" | 1 | EA | $15,000 |
| Type "P" | 1 | EA | $18,750 |
| Type "B" | 1 | EA | $15,000 |
| Check Structure (Concrete) | 6 | EA | $111,540 |
| Check Structure (Concrete) | 1 | EA | $18,590 |
| Check Structure (Concrete) | 3 | EA | $55,770 |
| Sloping Drop Structure | 1 | EA | $48,970 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $351,121 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $234,870 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $35,420 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $1,328,000 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$1,949,411** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $97,471 |
| Traffic Control | 5% | | $29,300 |
| Utility Coordination/Relocation | 5% | | $97,471 |
| Stormwater Management/Erosion Control | 5% | | $97,471 |
| **Subtotal Additional Capital Improvement Costs** | | | **$321,713** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $340,669 |
| Legal/Administrative | 5% | | $113,556 |

# Recommended Plan

| Master Plan Cost Estimator | | | |
|---|---|---|---|
| Contract Admin/Construction Management | 10% | | $227,112 |
| Contingency | 25% | | $567,781 |
| **Subtotal Other Costs** | | | **$1,249,118** |
| **Totals** | | | **$3,520,242** |

# Recommended Plan

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | School Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 5/20/2019 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 84x84 Circular | 538 | LF | $304,017 |
| 84x84 Circular | 500 | LF | $284,067 |
| 84x84 Circular | 433 | LF | $248,892 |
| 84x84 Circular | 500 | LF | $284,067 |
| 84x84 Circular | 500 | LF | $284,067 |
| 84x84 Circular | 253 | LF | $132,825 |
| Modify Manhole | 1 | EA | $1,500 |
| Removal of culvert pipe (D<48") | 258 | LF | $6,450 |
| Removal of culvert pipe (D<48") | 129 | LF | $3,225 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Type "P" | 1 | EA | $18,750 |
| Detention Facility | 1 | EA | $62,700 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $1,706,685 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $62,700 |
| Removals | | | $9,675 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $1,500 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$1,780,560** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $1,881 |
| Mobilization | 5% | | $89,028 |
| Traffic Control | 5% | | $85,334 |
| Utility Coordination/Relocation | 5% | | $89,028 |
| Stormwater Management/Erosion Control | 5% | | $89,028 |
| **Subtotal Additional Capital Improvement Costs** | | | **$354,299** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |

# Recommended Plan

| Master Plan Cost Estimator | | | |
|---|---|---|---|
| Engineering | 15% | | $320,229 |
| Legal/Administrative | 5% | | $106,743 |
| Contract Admin/Construction Management | 10% | | $213,486 |
| Contingency | 25% | | $533,715 |
| **Subtotal Other Costs** | | | **$1,174,173** |
| **Totals** | | | **$3,309,032** |

# Recommended Plan

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | B Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/7/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 48x48 Circular | 500 | LF | $95,150 |
| 48x48 Circular | 500 | LF | $95,150 |
| 48x48 Circular | 500 | LF | $95,150 |
| 48x48 Circular | 500 | LF | $95,150 |
| 48x48 Circular | 434 | LF | $83,270 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $501,495 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $0 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$501,495** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $25,075 |
| Traffic Control | 5% | | $25,075 |
| Utility Coordination/Relocation | 5% | | $25,075 |
| Stormwater Management/Erosion Control | 5% | | $25,075 |
| **Subtotal Additional Capital Improvement Costs** | | | **$100,300** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $90,269 |
| Legal/Administrative | 5% | | $30,090 |
| Contract Admin/Construction Management | 10% | | $60,180 |
| Contingency | 25% | | $150,449 |
| **Subtotal Other Costs** | | | **$330,988** |
| **Totals** | | | **$932,783** |

# Recommended Plan

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | D Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/7/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 42x42 Circular | 260 | LF | $43,205 |
| Modify Manhole | 1 | EA | $1,500 |
| Removal of culvert pipe (D<48") | 260 | LF | $6,500 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $43,205 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $6,500 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $1,500 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$51,205** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $2,560 |
| Traffic Control | 5% | | $2,160 |
| Utility Coordination/Relocation | 5% | | $2,560 |
| Stormwater Management/Erosion Control | 5% | | $2,560 |
| **Subtotal Additional Capital Improvement Costs** | | | **$9,840** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $9,157 |
| Legal/Administrative | 5% | | $3,052 |
| Contract Admin/Construction Management | 10% | | $6,104 |
| Contingency | 25% | | $15,261 |
| **Subtotal Other Costs** | | | **$33,574** |
| **Totals** | | | **$94,619** |

# Recommended Plan

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | West G Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/7/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 60x60 Circular | 215 | LF | $64,500 |
| 30x30 Circular | 623 | LF | $71,738 |
| 42x42 Circular | 1960 | LF | $309,680 |
| 66x66 Circular | 251 | LF | $82,830 |
| Remove Manhole | 13 | EA | $13,000 |
| Removal of culvert pipe (D<48") | 2583 | LF | $64,575 |
| Removal of culvert pipe (48"<D<84") | 466 | LF | $28,892 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| 5-Foot Diameter | 1 | EA | $4,875 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Check Structure (Concrete) | 1 | EA | $5,070 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $622,498 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $5,070 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $93,467 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $13,000 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$734,035** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $36,702 |
| Traffic Control | 5% | | $31,378 |
| Utility Coordination/Relocation | 5% | | $36,702 |
| Stormwater Management/Erosion Control | 5% | | $36,702 |
| **Subtotal Additional Capital Improvement Costs** | | | **$141,484** |
| **Land Acquisition** | | | |

# Recommended Plan

| Master Plan Cost Estimator | | | |
|---|---|---|---|
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $131,328 |
| Legal/Administrative | 5% | | $43,776 |
| Contract Admin/Construction Management | 10% | | $87,552 |
| Contingency | 25% | | $218,880 |
| **Subtotal Other Costs** | | | **$481,536** |
| **Totals** | | | **$1,357,055** |

# Recommended Plan

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | DFA 0056 | | | | |
| REACH: | J Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/7/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 36x36 Circular | 26 | LF | $7,534 |
| Removal of culvert pipe (D<48") | 26 | LF | $650 |

| Master Plan Improvement Cost Summary | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $7,534 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $0 |
| Channel Improvements | | | $0 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $650 |
| Landscaping and Maintenance Improvements | | | $0 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$8,184** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $0 |
| Mobilization | 5% | | $409 |
| Traffic Control | 5% | | $377 |
| Utility Coordination/Relocation | 5% | | $409 |
| Stormwater Management/Erosion Control | 5% | | $409 |
| **Subtotal Additional Capital Improvement Costs** | | | **$1,604** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $1,468 |
| Legal/Administrative | 5% | | $489 |
| Contract Admin/Construction Management | 10% | | $979 |
| Contingency | 25% | | $2,447 |
| **Subtotal Other Costs** | | | **$5,383** |
| **Totals** | | | **$15,171** |

# Recommended Plan

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | DFA 0056 | | | | |
| REACH: | North K Tributary | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/7/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 12x4 Box | 78 | LF | $109,812 |
| 7x4 Box | 94 | LF | $92,370 |
| 12x4 Box | 61 | LF | $92,200 |
| 48x48 Circular | 460 | LF | $82,800 |
| 48x48 Circular | 500 | LF | $92,575 |
| 48x48 Circular | 235 | LF | $42,300 |
| 48x48 Circular | 409 | LF | $76,195 |
| 48x48 Circular | 153 | LF | $27,540 |
| 48x48 Circular | 153 | LF | $27,540 |
| 48x48 Circular | 500 | LF | $92,575 |
| 48x48 Circular | 500 | LF | $92,575 |
| 48x48 Circular | 500 | LF | $92,575 |
| 48x48 Circular | 500 | LF | $92,575 |
| 48x48 Circular | 500 | LF | $92,575 |
| 48x48 Circular | 192 | LF | $37,135 |
| Removal of culvert pipe (D<48") | 188 | LF | $4,700 |
| Removal of culvert pipe (D<48") | 61 | LF | $1,525 |
| Removal of culvert pipe (D<48") | 78 | LF | $1,950 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| Reclamation & seeding (native grasses) | 1 | AC | $1,250 |
| Reclamation & seeding (native grasses) | 2 | AC | $2,500 |
| Excavation, Mid Range | 1150 | CY | $34,500 |
| Excavation, Mid Range | 2250 | CY | $67,500 |

| Master Plan Improvement Cost Summary | |
|---|---|
| **Capital Improvement Costs** | |
| Pipe Culverts and Storm Drains | $913,460 |
| Concrete Box Culverts | $294,382 |
| Hydraulic Structures | $0 |
| Channel Improvements | $102,000 |
| Detention/Water Quality Facilities | $0 |

# Recommended Plan

| Master Plan Cost Estimator | | | |
|---|---|---|---|
| Removals | | | $8,175 |
| Landscaping and Maintenance Improvements | | | $3,750 |
| Special Items (User Defined) | | | $0 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$1,321,767** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $3,060 |
| Mobilization | 5% | | $66,088 |
| Traffic Control | 5% | | $60,392 |
| Utility Coordination/Relocation | 5% | | $66,088 |
| Stormwater Management/Erosion Control | 5% | | $66,088 |
| **Subtotal Additional Capital Improvement Costs** | | | **$261,716** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $237,522 |
| Legal/Administrative | 5% | | $79,174 |
| Contract Admin/Construction Management | 10% | | $158,348 |
| Contingency | 25% | | $395,871 |
| **Subtotal Other Costs** | | | **$870,915** |
| **Totals** | | | **$2,454,398** |

# Recommended Plan

| Master Plan Cost Estimator |
|---|

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Master Plan | | | | |
| DRAINAGEWAY: | Basin 4100 | | | | |
| REACH: | Colorado Boulevard | | | | |
| | | ESTIMATED BY: | User | DATE: | 11/7/2018 |

| DESCRIPTION | QUANTITY | UNIT | TOTAL COST |
|---|---|---|---|
| 30x30 Circular | 128 | LF | $18,260 |
| 42x42 Circular | 488 | LF | $81,354 |
| 48x48 Circular | 655 | LF | $127,478 |
| 60x60 Circular | 637 | LF | $191,100 |
| 72x72 Circular | 2582 | LF | $1,161,900 |
| Remove Manhole | 1 | EA | $1,000 |
| Remove Manhole | 7 | EA | $7,000 |
| Removal of culvert pipe (D<48") | 3874 | LF | $96,850 |
| Removal of culvert pipe (D<48") | 488 | LF | $12,200 |
| 6-Foot Diameter | 1 | EA | $5,375 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Type "B" | 1 | EA | $15,000 |
| Reclamation & seeding (native grasses) | 1 | AC | $1,250 |
| Sloping Drop Structure | 1 | EA | $47,361 |
| Excavation, Mid Range | 200 | CY | $6,000 |

| **Master Plan Improvement Cost Summary** | | | |
|---|---|---|---|
| **Capital Improvement Costs** | | | |
| Pipe Culverts and Storm Drains | | | $1,690,467 |
| Concrete Box Culverts | | | $0 |
| Hydraulic Structures | | | $47,361 |
| Channel Improvements | | | $6,000 |
| Detention/Water Quality Facilities | | | $0 |
| Removals | | | $109,050 |
| Landscaping and Maintenance Improvements | | | $1,250 |
| Special Items (User Defined) | | | $8,000 |
| ROW/Easements | | | $0 |
| **Subtotal Capital Improvement Costs** | | | **$1,862,128** |
| **Additional Capital Improvement Costs** | | | |
| Dewatering | 3% | | $180 |
| Mobilization | 5% | | $93,106 |
| Traffic Control | 5% | | $86,891 |
| Utility Coordination/Relocation | 5% | | $93,106 |
| Stormwater Management/Erosion Control | 5% | | $93,106 |
| **Subtotal Additional Capital Improvement Costs** | | | **$366,389** |
| **Land Acquisition** | | | |
| ROW/Easements | | | $0 |

# Recommended Plan

| Master Plan Cost Estimator | | | |
|---|---|---|---|
| **Other Costs (percentage of Capital Improvement Costs)** | | | |
| Engineering | 15% | | $334,278 |
| Legal/Administrative | 5% | | $111,426 |
| Contract Admin/Construction Management | 10% | | $222,852 |
| Contingency | 25% | | $557,129 |
| **Subtotal Other Costs** | | | **$1,225,685** |
| **Totals** | | | **$3,454,202** |

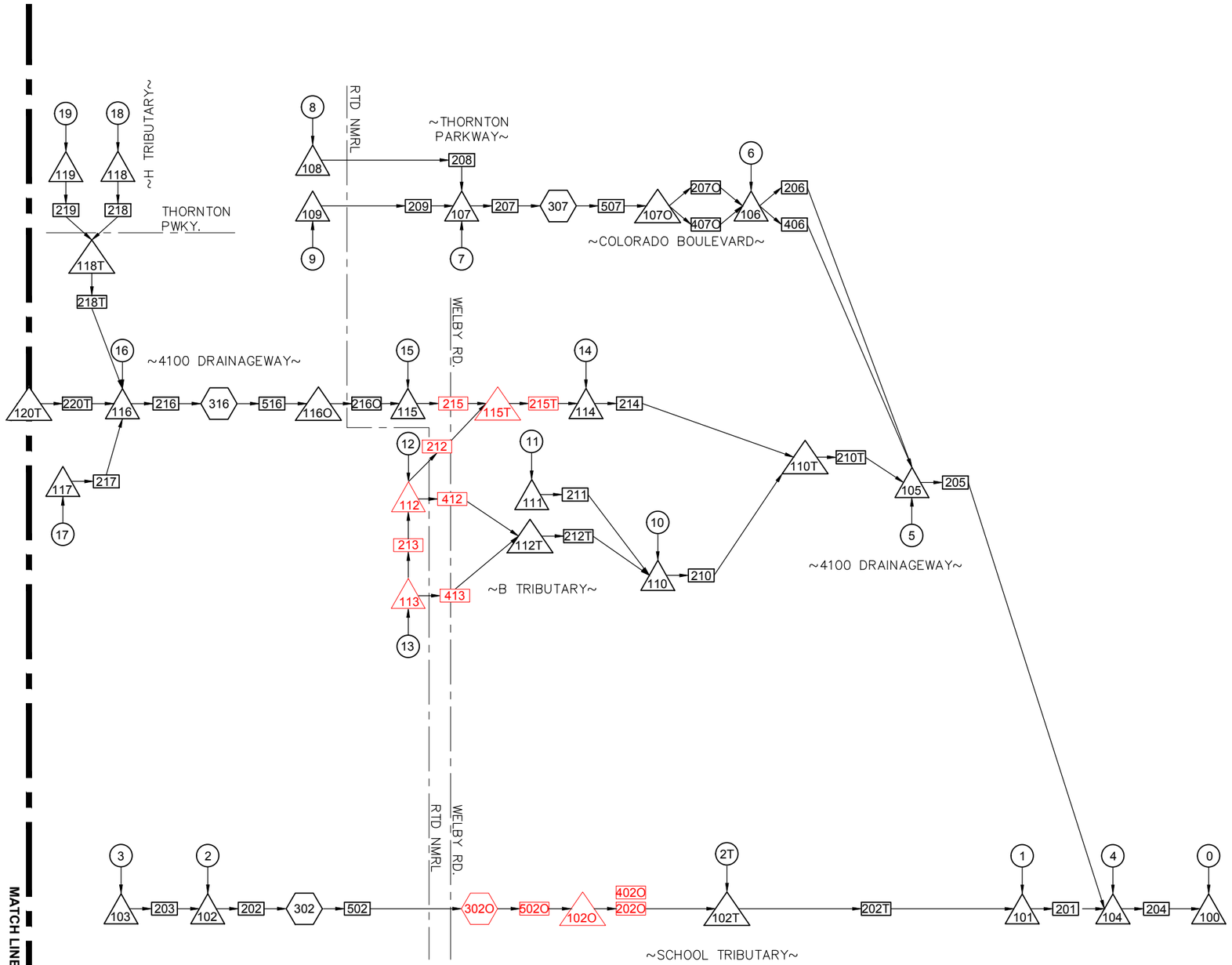
# APPENDIX F

# CONCEPTUAL DESIGN INFORMATION

LEGEND

- XX — SUBWATERSHED ID
- 1XX — DESIGN POINT ID
- 2XX — CONVEYANCE ELEMENT ID
- 3XX — DETENTION BASIN ID
- 4XX — OVERFLOW CONVEYANCE ELEMENT ID
- 5XX — POND OUTLET ID

RED TEXT INDICATES CHANGES TO BASELINE HYDROLOGY FOR MASTER PLAN IMPROVEMENTS




| REV NO. | DATE | REVISIONS DESCRIPTION |
|---|---|---|
| | | |

REVISIONS


olsson
1525 Raleigh Street
Suite 400
Denver, CO 80204
TEL 303.237.2072
FAX 303.237.2659


designed by: AG
drawn by: JH
checked by: DO/DK
project no.: 017-2321
date: 6/2020

MILE HIGH FLOOD DISTRICT, CITY OF THORNTON AND ADAMS COUNTY

BASIN 4100 AND DFA 0056

MASTER PLAN
SWMM ROUTING

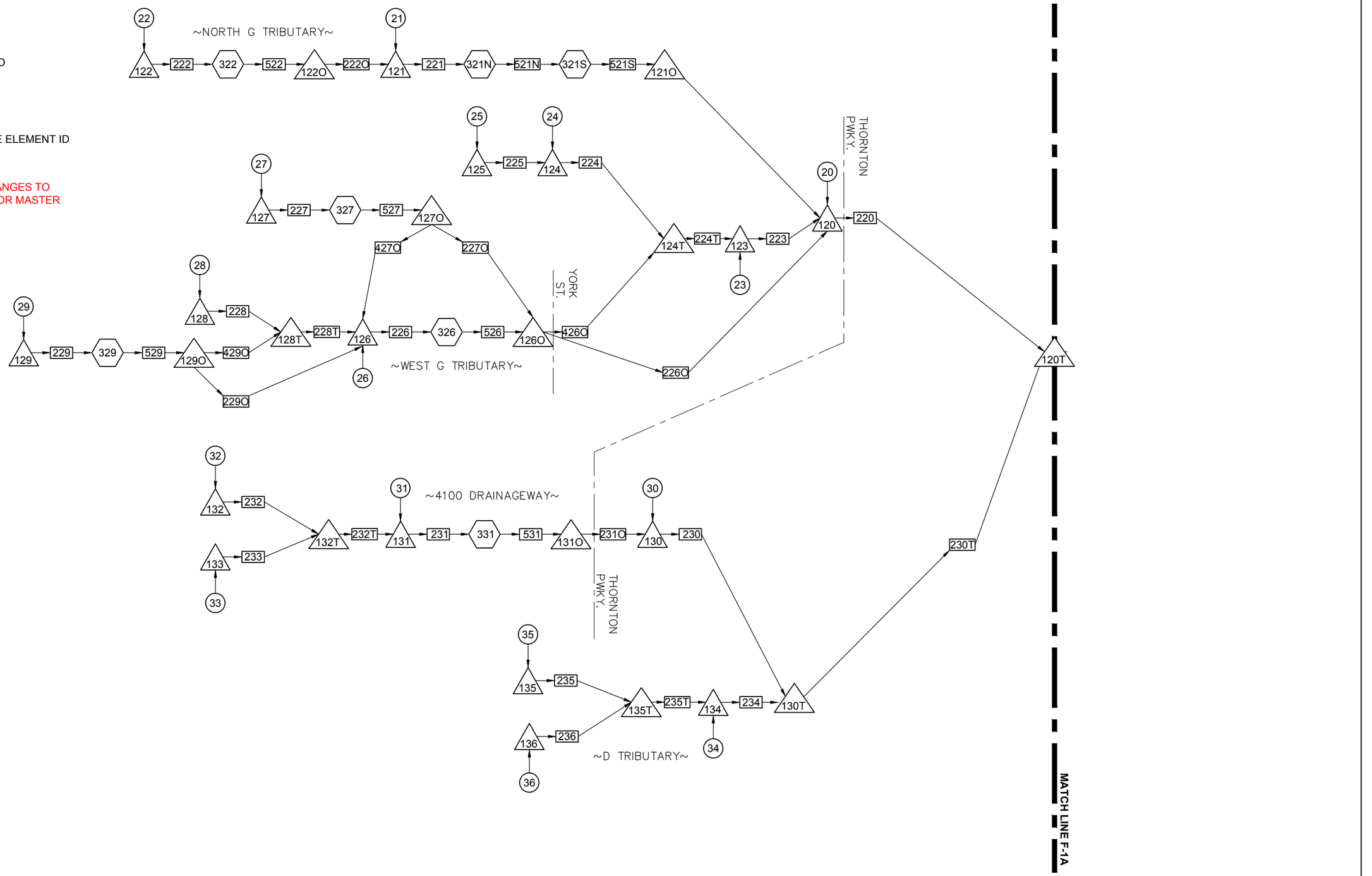
FIGURE
F-1A

DWG: C:\Temp\AcPublish_4468\W_ROUT_MASTERPLAN_72321.dwg USER: mstewart
DATE: Jun 08, 2020 11:07am XREFS: W_TBLK_72321

LEGEND

- XX — SUBWATERSHED ID
- 1XX — DESIGN POINT ID
- 2XX — CONVEYANCE ELEMENT ID
- 3XX — DETENTION BASIN ID
- 4XX — OVERFLOW CONVEYANCE ELEMENT ID
- 5XX — POND OUTLET ID

RED TEXT INDICATES CHANGES TO BASELINE HYDROLOGY FOR MASTER PLAN IMPROVEMENTS




| REV NO. | DATE | REVISIONS DESCRIPTION |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

REVISIONS


olsson
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Suite 400
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TEL 303.237.2072
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designed by: AG
drawn by: JH
checked by: DO/DK
project no.: 017-2321
date: 6/2020

MILE HIGH FLOOD DISTRICT, CITY OF THORNTON AND ADAMS COUNTY

BASIN 4100 AND DFA 0056

MASTER PLAN
SWMM ROUTING

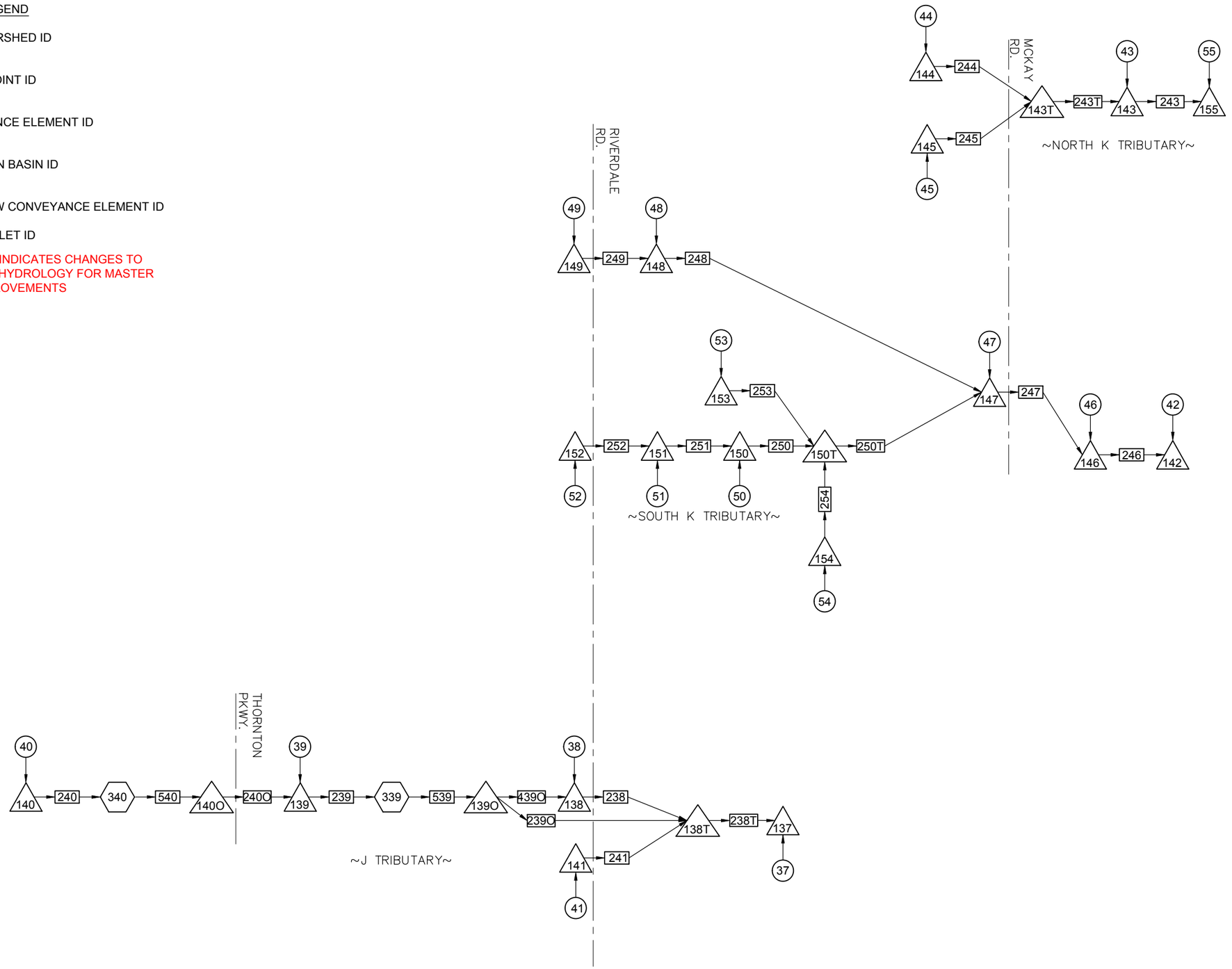
FIGURE
F-1B

DWG: C:\Temp\AcPublish_4468\W_ROUT_MASTERPLAN_72321.dwg USER: mstewart
DATE: Jun 08, 2020 11:07am XREFS: W_TBLK_72321

LEGEND

- XX — SUBWATERSHED ID
- 1XX — DESIGN POINT ID
- 2XX — CONVEYANCE ELEMENT ID
- 3XX — DETENTION BASIN ID
- 4XX — OVERFLOW CONVEYANCE ELEMENT ID
- 5XX — POND OUTLET ID

RED TEXT INDICATES CHANGES TO BASELINE HYDROLOGY FOR MASTER PLAN IMPROVEMENTS




| REV NO. | DATE | REVISIONS DESCRIPTION |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

REVISIONS


olsson

1525 Raleigh Street
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TEL 303.237.2072
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designed by: AG
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date: 6/2020

MILE HIGH FLOOD DISTRICT, CITY OF THORNTON AND ADAMS COUNTY

BASIN 4100 AND DFA 0056

MASTER PLAN
SWMM ROUTING

FIGURE
F-1C

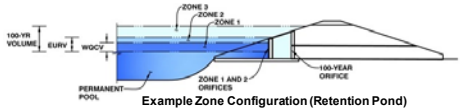
DWG: C:\Temp\AcPublish_4468\W_ROUT_MASTERPLAN_72321.dwg
DATE: Jun 08, 2020 11:07am
USER: mstewart
XREFS: W_TBLK_72321

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.03 (May 2020)*

**Project:** Basin 4100 and DFA 0056 OSP

**Basin ID:** School Tributary Proposed Detention Basin 302O




**Example Zone Configuration (Retention Pond)**

## Watershed Information

| | | |
|---|---|---|
| Selected BMP Type = | EDB | |
| Watershed Area = | 214.96 | acres |
| Watershed Length = | 5,682 | ft |
| Watershed Length to Centroid = | 3,078 | ft |
| Watershed Slope = | 0.016 | ft/ft |
| Watershed Imperviousness = | 41.59% | 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 = | Denver - Capitol Building | |

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) = | 3.297 | acre-feet | | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 8.334 | acre-feet | | acre-feet |
| 2-yr Runoff Volume (P1 = 0.83 in.) = | 5.492 | acre-feet | 0.83 | inches |
| 5-yr Runoff Volume (P1 = 1.11 in.) = | 8.783 | acre-feet | 1.11 | inches |
| 10-yr Runoff Volume (P1 = 1.37 in.) = | 12.844 | acre-feet | 1.37 | inches |
| 25-yr Runoff Volume (P1 = 1.77 in.) = | 20.863 | acre-feet | 1.77 | inches |
| 50-yr Runoff Volume (P1 = 2.1 in.) = | 26.917 | acre-feet | 2.10 | inches |
| 100-yr Runoff Volume (P1 = 2.47 in.) = | 34.550 | acre-feet | 2.47 | inches |
| 500-yr Runoff Volume (P1 = 3.43 in.) = | 52.664 | acre-feet | 3.43 | inches |
| Approximate 2-yr Detention Volume = | 5.080 | acre-feet | | |
| Approximate 5-yr Detention Volume = | 8.350 | acre-feet | | |
| Approximate 10-yr Detention Volume = | 10.097 | acre-feet | | |
| Approximate 25-yr Detention Volume = | 12.508 | acre-feet | | |
| Approximate 50-yr Detention Volume = | 13.721 | acre-feet | | |
| Approximate 100-yr Detention Volume = | 16.851 | acre-feet | | |

## Define Zones and Basin Geometry

| | | | |
|---|---|---|---|
| Zone 1 Volume (User Defined) = | 3.430 | acre-feet | **WQCV not provided!** |
| Select Zone 2 Storage Volume (Optional) = | | acre-feet | |
| Select Zone 3 Storage Volume (Optional) = | | acre-feet | **Total detention volume is less than 100-year volume.** |
| Total Detention Basin Volume = | 3.430 | 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 ($R_{LW}$) = | user | | |

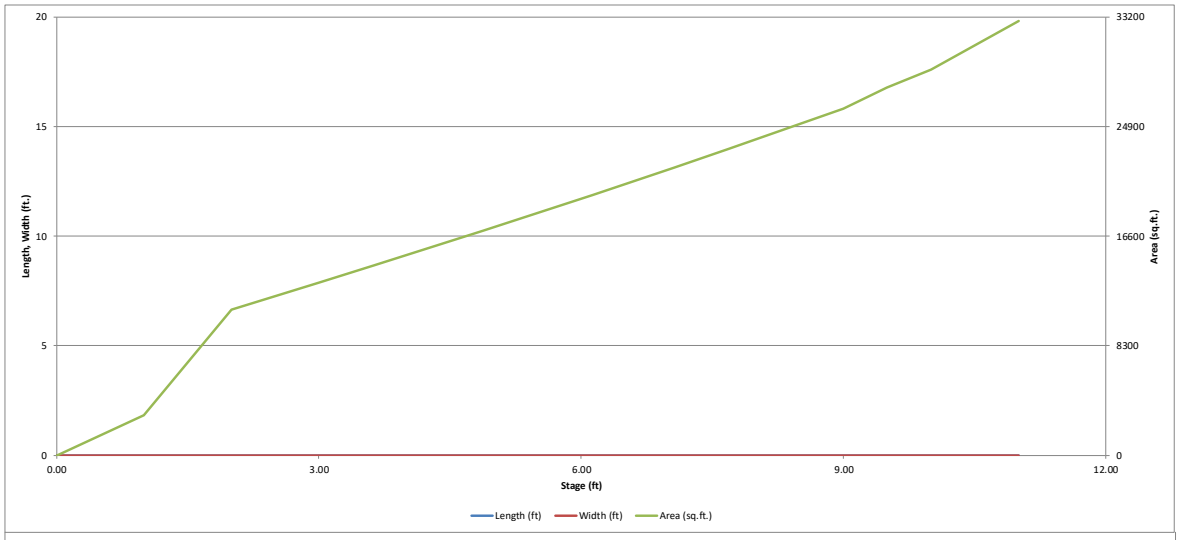
| | | |
|---|---|---|
| Initial Surcharge Area ($A_{ISV}$) = | user | $ft^2$ |
| Surcharge Volume Length ($L_{ISV}$) = | user | ft |
| Surcharge Volume Width ($W_{ISV}$) = | user | ft |
| Depth of Basin Floor ($H_{FLOOR}$) = | user | ft |
| Length of Basin Floor ($L_{FLOOR}$) = | user | ft |
| Width 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 |

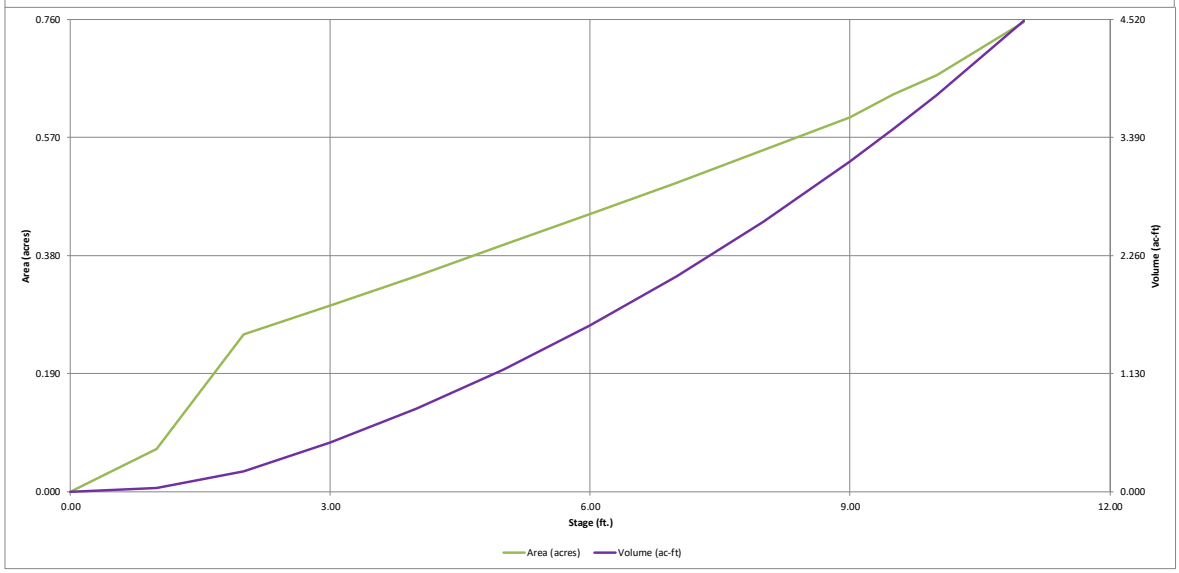
Depth Increment = ft

| 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 | -- | -- | -- | 0 | 0.000 | | |
| **5141** | -- | 1.00 | -- | -- | -- | 3,018 | 0.069 | 1,509 | 0.035 |
| **5142** | -- | 2.00 | -- | -- | -- | 11,026 | 0.253 | 8,531 | 0.196 |
| **5143** | -- | 3.00 | -- | -- | -- | 13,057 | 0.300 | 20,572 | 0.472 |
| **5144** | -- | 4.00 | -- | -- | -- | 15,131 | 0.347 | 34,666 | 0.796 |
| **5145** | -- | 5.00 | -- | -- | -- | 17,296 | 0.397 | 50,880 | 1.168 |
| **5146** | -- | 6.00 | -- | -- | -- | 19,438 | 0.446 | 69,247 | 1.590 |
| **5147** | -- | 7.00 | -- | -- | -- | 21,654 | 0.497 | 89,793 | 2.061 |
| **5148** | -- | 8.00 | -- | -- | -- | 23,925 | 0.549 | 112,583 | 2.585 |
| **5149** | -- | 9.00 | -- | -- | -- | 26,244 | 0.602 | 137,667 | 3.160 |
| **5149.5** | -- | 9.50 | -- | -- | -- | 27,838 | 0.639 | 151,187 | 3.471 |
| **5150** | -- | 10.00 | -- | -- | -- | 29,214 | 0.671 | 165,450 | 3.798 |
| **5151 - Not Closed** | -- | 11.00 | -- | -- | -- | 32,917 | 0.756 | 196,516 | 4.511 |

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.03 (May 2020)*



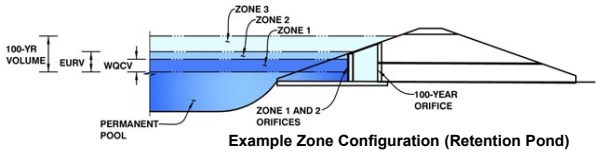



# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.03 (May 2020)*

**Project: Basin 4100 and DFA 0056 OSP**

**Basin ID: School Tributary Proposed Detention Basin 302O**




**Example Zone Configuration (Retention Pond)**

| | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (User) | 9.44 | 3.430 | Circular Orifice |
| Zone 2 | | | |
| Zone 3 | | | |
| Total (all zones) | | 3.430 | |

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 | ft² |
| 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)

| | | | | | |
|---|---|---|---|---|---|
| Invert of Lowest Orifice = | N/A | ft (relative to basin bottom at Stage = 0 ft) | WQ Orifice Area per Row = | N/A | ft² |
| Depth at top of Zone using Orifice Plate = | N/A | ft (relative to basin bottom at Stage = 0 ft) | Elliptical Half-Width = | N/A | feet |
| Orifice Plate: Orifice Vertical Spacing = | N/A | inches | Elliptical Slot Centroid = | N/A | feet |
| Orifice Plate: Orifice Area per Row = | N/A | inches | Elliptical Slot Area = | N/A | ft² |

Calculated Parameters for Plate

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

| | Row 1 (optional) | 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) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

| | 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) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

User Input: Vertical Orifice (Circular or Rectangular)

| | Zone 1 Circular | Not Selected | | | Zone 1 Circular | Not Selected | |
|---|---|---|---|---|---|---|---|
| Invert of Vertical Orifice = | 0.00 | | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Area = | 22.34 | | ft² |
| Depth at top of Zone using Vertical Orifice = | 10.00 | | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Centroid = | 2.67 | | feet |
| Vertical Orifice Diameter = | 64.00 | | inches | | | | |

Calculated Parameters for Vertical Orifice

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

| | Not Selected | Not Selected | | | Not Selected | Not Selected | |
|---|---|---|---|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | | | ft (relative to basin bottom at Stage = 0 ft) | Height of Grate Upper Edge, $H_t$ = | | | feet |
| Overflow Weir Front Edge Length = | | | feet | Overflow Weir Slope Length = | | | feet |
| Overflow Weir Grate Slope = | | | H:V | Grate Open Area / 100-yr Orifice Area = | | | |
| Horiz. Length of Weir Sides = | | | feet | Overflow Grate Open Area w/o Debris = | | | ft² |
| Overflow Grate Open Area % = | | | %, grate open area/total area | Overflow Grate Open Area w/ Debris = | | | ft² |
| Debris Clogging % = | | | % | | | | |

Calculated Parameters for Overflow Weir

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

| | Not Selected | Not Selected | | | Not Selected | Not Selected | |
|---|---|---|---|---|---|---|---|
| Depth to Invert of Outlet Pipe = | | | ft (distance below basin bottom at Stage = 0 ft) | Outlet Orifice Area = | | | ft² |
| Circular Orifice Diameter = | | | inches | Outlet Orifice Centroid = | | | feet |
| | | | | Half-Central Angle of Restrictor Plate on Pipe = | N/A | N/A | radians |

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

| | | | | | |
|---|---|---|---|---|---|
| Spillway Invert Stage= | 10.00 | ft (relative to basin bottom at Stage = 0 ft) | Spillway Design Flow Depth= | 0.75 | feet |
| Spillway Crest Length = | 155.00 | feet | Stage at Top of Freeboard = | 11.75 | feet |
| Spillway End Slopes = | 10.00 | H:V | Basin Area at Top of Freeboard = | 0.76 | acres |
| Freeboard above Max Water Surface = | 1.00 | feet | Basin Volume at Top of Freeboard = | 4.51 | acre-ft |

Calculated Parameters for Spillway

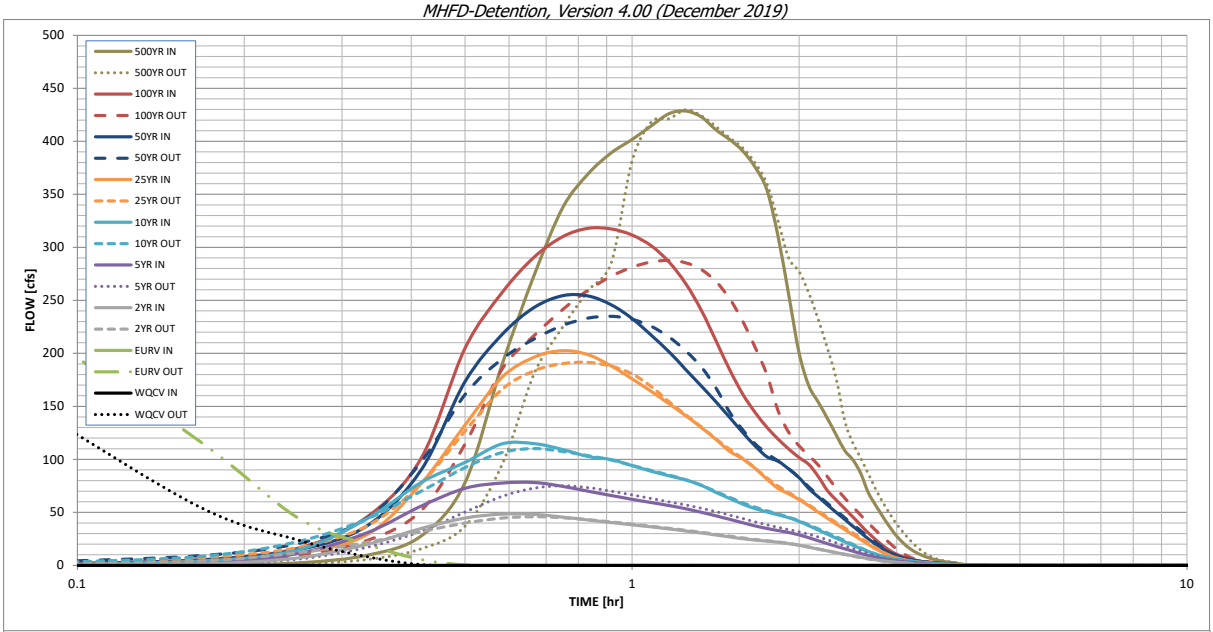
Routed Hydrograph Results

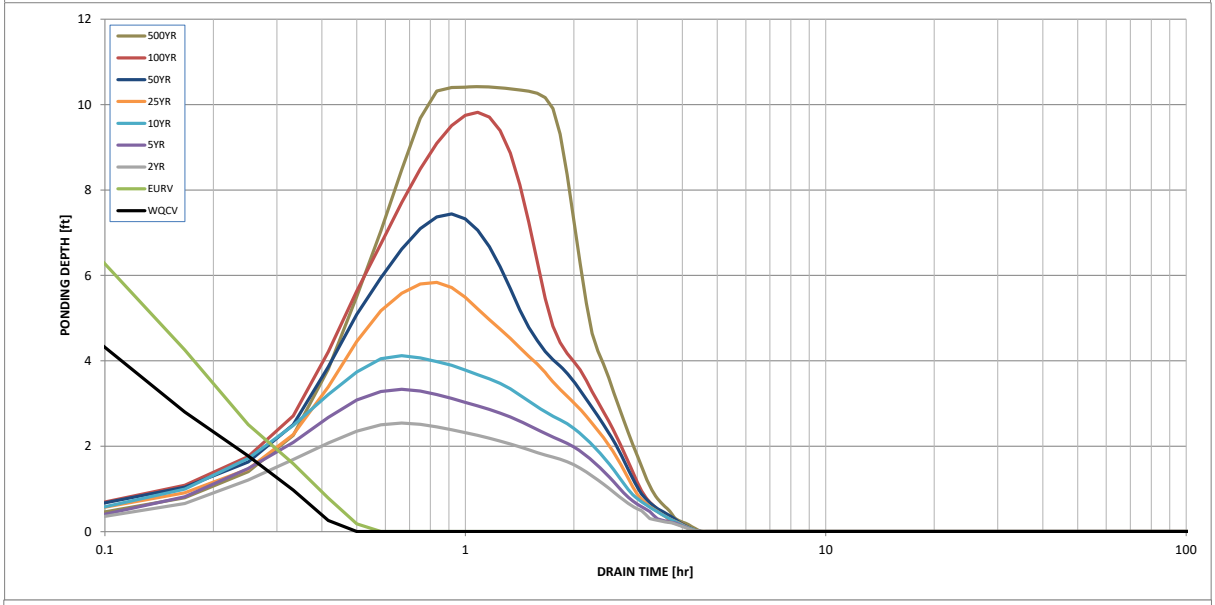
*The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

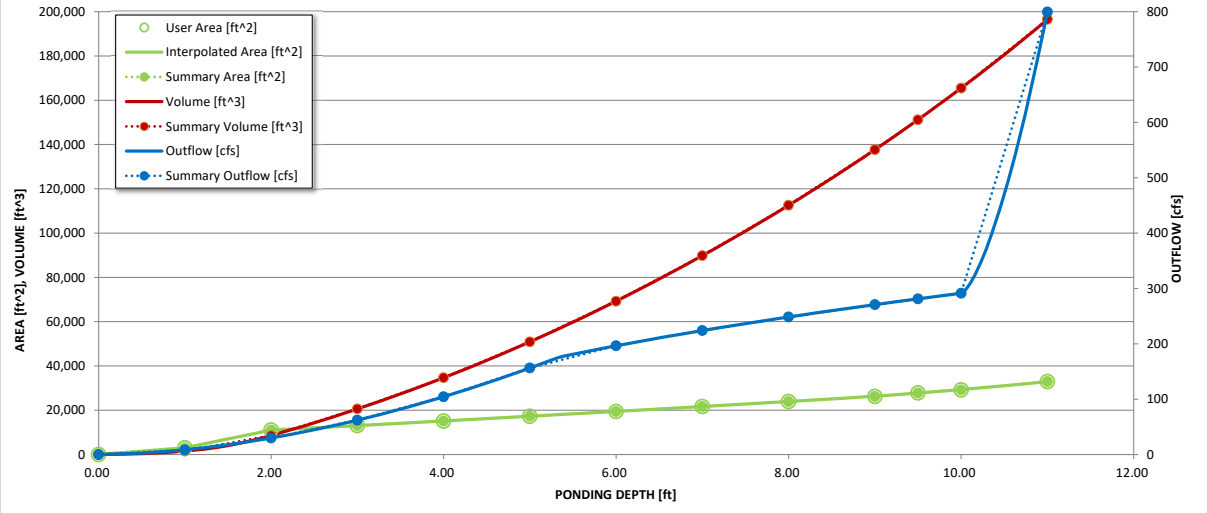
| Design Storm Return Period = | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|---|---|---|---|---|---|---|---|---|
| One-Hour Rainfall Depth (in) = | N/A | N/A | 0.83 | 1.11 | 1.37 | 1.77 | 2.10 | 2.47 | 3.43 |
| CUHP Runoff Volume (acre-ft) = | 3.297 | 8.334 | 5.492 | 8.783 | 12.844 | 20.863 | 26.917 | 34.550 | 52.664 |
| User Override Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 5.592 | 8.886 | 12.961 | 20.992 | 26.979 | 34.531 | 52.823 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | 1.4 | 14.2 | 40.4 | 107.4 | 149.7 | 207.8 | 335.4 |
| 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 | 0.19 | 0.50 | 0.70 | 0.97 | 1.56 |
| Peak Inflow Q (cfs) = | N/A | N/A | 48.3 | 78.2 | 114.8 | 202.5 | 254.4 | 317.9 | 428.5 |
| Peak Outflow Q (cfs) = | 243.0 | 799.5 | 45.9 | 75.0 | 110.0 | 191.5 | 234.9 | 287.6 | 429.8 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 5.3 | 2.7 | 1.8 | 1.6 | 1.4 | 1.3 |
| Structure Controlling Flow = | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Spillway |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 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) = | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Time to Drain 99% of Inflow Volume (hours) = | **0** | 0 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| Maximum Ponding Depth (ft) = | 9.23 | 6.99 | 2.54 | 3.33 | 4.12 | 5.84 | 7.44 | 9.82 | 10.42 |
| Area at Maximum Ponding Depth (acres) = | 0.62 | 0.50 | 0.28 | 0.32 | 0.35 | 0.44 | 0.52 | 0.66 | 0.71 |
| Maximum Volume Stored (acre-ft) = | 3.301 | 2.056 | 0.337 | 0.574 | 0.834 | 1.515 | 2.280 | 3.672 | 4.087 |

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.00 (December 2019)*




| S-A-V-D Chart Axis Override | X-axis | Left Y-Axis | Right Y-Axis |
|---|---|---|---|
| minimum bound | | | |
| maximum bound | | | |

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*Outflow Hydrograph Workbook Filename:*

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

| | SOURCE | CUHP | CUHP | USER | USER | USER | USER | USER | USER | USER |
|---|---|---|---|---|---|---|---|---|---|---|
| Time Interval | TIME | WQCV [cfs] | EURV [cfs] | 2 Year [cfs] | 5 Year [cfs] | 10 Year [cfs] | 25 Year [cfs] | 50 Year [cfs] | 100 Year [cfs] | 500 Year [cfs] |
| 5.00 min | 0:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0:05:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.71 | 0.77 | 0.00 |
| | 0:10:00 | 0.00 | 0.00 | 1.31 | 1.43 | 3.71 | 3.96 | 5.10 | 5.28 | 2.39 |
| | 0:15:00 | 0.00 | 0.00 | 7.09 | 11.20 | 14.65 | 11.43 | 14.79 | 16.30 | 9.53 |
| | 0:20:00 | 0.00 | 0.00 | 19.91 | 30.95 | 44.30 | 29.29 | 37.52 | 45.98 | 27.76 |
| | 0:25:00 | 0.00 | 0.00 | 34.87 | 55.96 | 78.31 | 77.21 | 90.11 | 101.09 | 78.14 |
| | 0:30:00 | 0.00 | 0.00 | 44.63 | 72.73 | 97.08 | 132.46 | 173.31 | 204.84 | 189.77 |
| | 0:35:00 | 0.00 | 0.00 | 48.34 | 77.62 | 114.71 | 177.50 | 217.84 | 257.41 | 274.18 |
| | 0:40:00 | 0.00 | 0.00 | 48.02 | 78.16 | 114.79 | 196.44 | 243.35 | 290.96 | 337.57 |
| | 0:45:00 | 0.00 | 0.00 | 45.56 | 74.55 | 109.26 | 202.49 | 254.38 | 310.06 | 369.20 |
| | 0:50:00 | 0.00 | 0.00 | 42.85 | 69.95 | 102.68 | 198.64 | 254.14 | 317.94 | 388.97 |
| | 0:55:00 | 0.00 | 0.00 | 40.43 | 65.96 | 99.79 | 188.09 | 245.83 | 317.39 | 401.68 |
| | 1:00:00 | 0.00 | 0.00 | 38.28 | 62.28 | 94.13 | 175.91 | 232.82 | 311.58 | 414.72 |
| | 1:05:00 | 0.00 | 0.00 | 36.29 | 59.21 | 88.74 | 164.04 | 216.99 | 301.33 | 426.18 |
| | 1:10:00 | 0.00 | 0.00 | 34.34 | 56.42 | 84.48 | 152.28 | 201.33 | 285.94 | 428.49 |
| | 1:15:00 | 0.00 | 0.00 | 32.43 | 53.38 | 80.54 | 141.10 | 184.51 | 265.54 | 422.89 |
| | 1:20:00 | 0.00 | 0.00 | 30.54 | 50.06 | 75.58 | 129.95 | 169.09 | 240.51 | 410.67 |
| | 1:25:00 | 0.00 | 0.00 | 28.65 | 46.70 | 68.83 | 118.66 | 154.13 | 211.72 | 401.48 |
| | 1:30:00 | 0.00 | 0.00 | 26.81 | 43.39 | 63.04 | 107.44 | 139.37 | 184.20 | 390.89 |
| | 1:35:00 | 0.00 | 0.00 | 25.13 | 40.17 | 57.81 | 100.42 | 125.18 | 161.44 | 375.64 |
| | 1:40:00 | 0.00 | 0.00 | 23.81 | 37.23 | 53.54 | 91.53 | 112.71 | 144.25 | 353.96 |
| | 1:45:00 | 0.00 | 0.00 | 22.81 | 34.84 | 50.35 | 81.29 | 102.40 | 130.24 | 309.93 |
| | 1:50:00 | 0.00 | 0.00 | 21.77 | 32.86 | 47.68 | 72.48 | 98.24 | 119.07 | 254.34 |
| | 1:55:00 | 0.00 | 0.00 | 20.53 | 31.01 | 44.92 | 67.37 | 90.78 | 109.64 | 200.19 |
| | 2:00:00 | 0.00 | 0.00 | 18.98 | 28.74 | 41.48 | 61.99 | 82.64 | 101.68 | 169.21 |
| | 2:05:00 | 0.00 | 0.00 | 17.16 | 25.99 | 37.43 | 56.03 | 72.37 | 95.11 | 153.92 |
| | 2:10:00 | 0.00 | 0.00 | 15.33 | 23.23 | 33.29 | 50.08 | 64.53 | 83.73 | 138.44 |
| | 2:15:00 | 0.00 | 0.00 | 13.60 | 20.49 | 29.31 | 44.41 | 57.03 | 70.40 | 122.99 |
| | 2:20:00 | 0.00 | 0.00 | 11.98 | 17.95 | 25.58 | 38.95 | 49.96 | 61.67 | 108.30 |
| | 2:25:00 | 0.00 | 0.00 | 10.47 | 15.59 | 22.16 | 33.81 | 43.37 | 53.48 | 99.53 |
| | 2:30:00 | 0.00 | 0.00 | 9.05 | 13.35 | 18.88 | 28.87 | 36.96 | 45.65 | 86.80 |
| | 2:35:00 | 0.00 | 0.00 | 7.69 | 11.23 | 15.83 | 24.24 | 30.83 | 37.95 | 68.39 |
| | 2:40:00 | 0.00 | 0.00 | 6.42 | 9.28 | 13.00 | 19.67 | 25.00 | 30.59 | 56.59 |
| | 2:45:00 | 0.00 | 0.00 | 5.28 | 7.56 | 10.58 | 15.47 | 19.72 | 24.12 | 45.64 |
| | 2:50:00 | 0.00 | 0.00 | 4.30 | 6.13 | 8.57 | 12.09 | 15.43 | 18.55 | 35.80 |
| | 2:55:00 | 0.00 | 0.00 | 3.50 | 4.95 | 6.89 | 9.27 | 11.83 | 13.96 | 27.63 |
| | 3:00:00 | 0.00 | 0.00 | 2.88 | 4.06 | 5.66 | 7.04 | 9.04 | 10.46 | 20.95 |
| | 3:05:00 | 0.00 | 0.00 | 2.48 | 3.39 | 4.72 | 5.49 | 7.08 | 7.97 | 15.87 |
| | 3:10:00 | 0.00 | 0.00 | 2.10 | 2.84 | 3.95 | 4.36 | 5.64 | 6.13 | 12.20 |
| | 3:15:00 | 0.00 | 0.00 | 1.03 | 2.39 | 3.30 | 3.50 | 4.51 | 4.73 | 9.43 |
| | 3:20:00 | 0.00 | 0.00 | 0.92 | 1.83 | 2.74 | 2.82 | 3.63 | 3.67 | 7.29 |
| | 3:25:00 | 0.00 | 0.00 | 0.81 | 0.99 | 2.31 | 2.35 | 2.92 | 2.88 | 5.68 |
| | 3:30:00 | 0.00 | 0.00 | 0.71 | 0.86 | 1.83 | 1.87 | 2.40 | 2.31 | 4.44 |
| | 3:35:00 | 0.00 | 0.00 | 0.62 | 0.74 | 1.45 | 1.46 | 2.07 | 1.80 | 3.47 |
| | 3:40:00 | 0.00 | 0.00 | 0.52 | 0.62 | 1.15 | 1.15 | 1.73 | 0.89 | 2.75 |
| | 3:45:00 | 0.00 | 0.00 | 0.54 | 0.52 | 0.89 | 0.90 | 1.32 | 0.74 | 2.16 |
| | 3:50:00 | 0.00 | 0.00 | 0.42 | 0.51 | 0.67 | 0.68 | 0.97 | 0.61 | 1.01 |
| | 3:55:00 | 0.00 | 0.00 | 0.31 | 0.37 | 0.49 | 0.54 | 0.68 | 0.45 | 0.83 |
| | 4:00:00 | 0.00 | 0.00 | 0.22 | 0.26 | 0.34 | 0.38 | 0.44 | 0.43 | 0.66 |
| | 4:05:00 | 0.00 | 0.00 | 0.14 | 0.17 | 0.22 | 0.24 | 0.28 | 0.28 | 0.49 |
| | 4:10:00 | 0.00 | 0.00 | 0.10 | 0.11 | 0.13 | 0.14 | 0.17 | 0.16 | 0.40 |
| | 4:15:00 | 0.00 | 0.00 | 0.05 | 0.04 | 0.08 | 0.07 | 0.09 | 0.05 | 0.23 |
| | 4:20:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.03 | 0.03 | 0.03 | 0.03 | 0.12 |
| | 4:25:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.05 |
| | 4:30:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| | 4:35:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 4:40:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 4:45:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 4:50:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 4:55:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 5:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 5:05:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 5:10:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 5:15:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 5:20:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 5:25:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 5:30:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 5:35:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 5:40:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 5:45:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 5:50:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 5:55:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 6:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.03 (May 2020)*

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

| Stage - Storage Description | Stage [ft] | Area [ft$^2$] | Area [acres] | Volume [ft$^3$] | Volume [ac-ft] | Total Outflow [cfs] |
|---|---|---|---|---|---|---|
| 5140 | 0.00 | 0 | 0.000 | 0 | 0.000 | 0.00 |
| 5141 | 1.00 | 3018 | 0.069 | 1,509 | 0.035 | 8.49 |
| 5142 | 2.00 | 11026 | 0.253 | 8,531 | 0.196 | 29.76 |
| 5143 | 3.00 | 13057 | 0.300 | 20,572 | 0.472 | 62.00 |
| 5144 | 4.00 | 15131 | 0.347 | 34,666 | 0.796 | 104.36 |
| 5145 | 5.00 | 17296 | 0.397 | 50,880 | 1.168 | 156.29 |
| 5146 | 6.00 | 19438 | 0.446 | 69,247 | 1.590 | 196.39 |
| 5147 | 7.00 | 21654 | 0.497 | 89,793 | 2.061 | 223.92 |
| 5148 | 8.00 | 23925 | 0.549 | 112,583 | 2.585 | 248.42 |
| 5149 | 9.00 | 26244 | 0.602 | 137,667 | 3.160 | 270.71 |
| 5149.5 | 9.50 | 27838 | 0.639 | 151,187 | 3.471 | 281.19 |
| 5150 | 10.00 | 29214 | 0.671 | 165,450 | 3.798 | 291.29 |
| 5151 | 11.00 | 32917 | 0.756 | 196,516 | 4.511 | 799.52 |

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

# MASTER PLAN CUHP INPUT/OUTPUT IS THE SAME AS THE BASELINE HYDROLOGY

## CUHP SUBCATCHMENTS

Columns with this color heading are for required user-input
Columns with this color heading are for optional override values
Columns with this color heading are for program-calculated values

| | | | | | | | | | Maximum Depression Storage (Watershed inches) | | Horton's Infiltration Parameters | | | DCIA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($mi^2$) | Length to Centroid (mi) | Length (mi) | Slope (ft/ft) | Existing Percent Imperviousness | Future Percent Imperviousness | Pervious | Impervious | Initial Rate (in/hr) | Decay Coefficient (1/seconds) | Final Rate (in/hr) | Level 0, 1, or 2 |
| 0 | 100 | Rainfall | 0.0105 | 0.1428 | 0.1996 | 0.0179 | 48.61 | 91.07 | 0.35 | 0.10 | 4.832 | 0.00079 | 0.958 | 0 |
| 1 | 101 | Rainfall | 0.0294 | 0.1554 | 0.2652 | 0.0086 | 45.78 | 45.78 | 0.35 | 0.07 | 3.172 | 0.00171 | 0.543 | 0 |
| 2T | 102T | Rainfall | 0.1298 | 0.2954 | 0.5277 | 0.0233 | 13.84 | 76.84 | 0.35 | 0.09 | 3.000 | 0.00180 | 0.500 | 0 |
| 2 | 102 | Rainfall | 0.1625 | 0.5829 | 1.0762 | 0.0160 | 44.10 | 44.10 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 3 | 103 | Rainfall | 0.1733 | 0.4995 | 1.0111 | 0.0199 | 39.24 | 39.24 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 4 | 104 | Rainfall | 0.0534 | 0.1834 | 0.3736 | 0.0108 | 16.10 | 45.72 | 0.35 | 0.08 | 3.294 | 0.00164 | 0.574 | 0 |
| 5 | 105 | Rainfall | 0.1292 | 0.3298 | 0.6996 | 0.0121 | 35.86 | 45.81 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 6 | 106 | Rainfall | 0.1032 | 0.2292 | 0.7773 | 0.0150 | 35.16 | 67.75 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 7 | 107 | Rainfall | 0.0552 | 0.2651 | 0.5356 | 0.0227 | 45.06 | 79.83 | 0.35 | 0.09 | 3.000 | 0.00180 | 0.500 | 0 |
| 8 | 108 | Rainfall | 0.0656 | 0.2206 | 0.5687 | 0.0270 | 32.42 | 32.42 | 0.36 | 0.08 | 3.095 | 0.00175 | 0.524 | 0 |
| 9 | 109 | Rainfall | 0.0468 | 0.1958 | 0.4797 | 0.0330 | 37.87 | 45.67 | 0.35 | 0.07 | 3.067 | 0.00176 | 0.517 | 0 |
| 10 | 110 | Rainfall | 0.0361 | 0.3042 | 0.3413 | 0.0182 | 34.57 | 55.79 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 11 | 111 | Rainfall | 0.0281 | 0.0980 | 0.2324 | 0.0126 | 53.70 | 53.70 | 0.36 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 12 | 112 | Rainfall | 0.0102 | 0.0773 | 0.1966 | 0.0150 | 42.31 | 51.81 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 13 | 113 | Rainfall | 0.0515 | 0.1223 | 0.3643 | 0.0336 | 41.63 | 41.63 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 14 | 114 | Rainfall | 0.0121 | 0.1597 | 0.3092 | 0.0079 | 23.67 | 23.67 | 0.39 | 0.09 | 3.000 | 0.00180 | 0.500 | 0 |
| 15 | 115 | Rainfall | 0.0490 | 0.0902 | 0.3001 | 0.0129 | 53.98 | 64.42 | 0.35 | 0.09 | 3.000 | 0.00180 | 0.500 | 0 |
| 16 | 116 | Rainfall | 0.1493 | 0.1546 | 0.7114 | 0.0104 | 31.40 | 35.43 | 0.37 | 0.08 | 3.505 | 0.00152 | 0.626 | 0 |
| 17 | 117 | Rainfall | 0.1122 | 0.3543 | 0.6577 | 0.0181 | 40.41 | 42.98 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 18 | 118 | Rainfall | 0.0668 | 0.2143 | 0.4625 | 0.0360 | 36.25 | 36.25 | 0.35 | 0.07 | 4.333 | 0.00107 | 0.833 | 0 |
| 19 | 119 | Rainfall | 0.0214 | 0.2499 | 0.5109 | 0.0400 | 50.16 | 50.16 | 0.35 | 0.07 | 5.000 | 0.00070 | 1.000 | 0 |
| 20 | 120 | Rainfall | 0.0380 | 0.1733 | 0.4779 | 0.0300 | 41.41 | 41.41 | 0.35 | 0.07 | 4.920 | 0.00074 | 0.980 | 0 |
| 21 | 121 | Rainfall | 0.0440 | 0.1446 | 0.4346 | 0.0278 | 28.34 | 28.34 | 0.35 | 0.08 | 4.429 | 0.00101 | 0.857 | 0 |
| 22 | 122 | Rainfall | 0.0905 | 0.1620 | 0.5273 | 0.0145 | 32.93 | 37.03 | 0.36 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 23 | 123 | Rainfall | 0.1521 | 0.5025 | 0.8766 | 0.0229 | 43.75 | 43.75 | 0.35 | 0.07 | 3.928 | 0.00129 | 0.732 | 0 |
| 24 | 124 | Rainfall | 0.0303 | 0.0920 | 0.3181 | 0.0284 | 47.40 | 47.40 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 25 | 125 | Rainfall | 0.0171 | 0.1177 | 0.4303 | 0.0112 | 47.24 | 47.24 | 0.37 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 26 | 126 | Rainfall | 0.0517 | 0.1012 | 0.4362 | 0.0312 | 47.99 | 47.99 | 0.35 | 0.07 | 4.176 | 0.00115 | 0.794 | 0 |
| 27 | 127 | Rainfall | 0.0531 | 0.1151 | 0.4413 | 0.0267 | 53.32 | 53.32 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 28 | 128 | Rainfall | 0.0109 | 0.1217 | 0.3552 | 0.0221 | 49.74 | 49.74 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 29 | 129 | Rainfall | 0.0475 | 0.1314 | 0.6069 | 0.0260 | 39.19 | 42.04 | 0.35 | 0.07 | 3.065 | 0.00176 | 0.516 | 0 |
| 30 | 130 | Rainfall | 0.1872 | 0.5029 | 1.0375 | 0.0307 | 37.15 | 37.34 | 0.35 | 0.08 | 3.617 | 0.00146 | 0.654 | 0 |
| 31 | 131 | Rainfall | 0.0338 | 0.1411 | 0.3240 | 0.0272 | 33.00 | 33.00 | 0.36 | 0.08 | 4.273 | 0.00110 | 0.818 | 0 |
| 32 | 132 | Rainfall | 0.1337 | 0.1771 | 0.8517 | 0.0259 | 47.55 | 50.00 | 0.35 | 0.08 | 3.395 | 0.00158 | 0.599 | 0 |
| 33 | 133 | Rainfall | 0.0651 | 0.3138 | 0.5855 | 0.0383 | 56.38 | 56.38 | 0.36 | 0.08 | 4.024 | 0.00124 | 0.756 | 0 |
| 34 | 134 | Rainfall | 0.0922 | 0.3604 | 0.6774 | 0.0285 | 40.12 | 40.12 | 0.35 | 0.08 | 3.034 | 0.00178 | 0.508 | 0 |
| 35 | 135 | Rainfall | 0.0675 | 0.2126 | 0.4426 | 0.0342 | 45.31 | 45.31 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 36 | 136 | Rainfall | 0.0309 | 0.1576 | 0.3133 | 0.0024 | 44.61 | 44.61 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 37 | 137 | Rainfall | 0.1741 | 0.4279 | 0.8340 | 0.0027 | 15.76 | 16.48 | 0.40 | 0.10 | 4.036 | 0.00123 | 0.759 | 0 |
| 38 | 138 | Rainfall | 0.0699 | 0.2366 | 0.4130 | 0.0107 | 33.99 | 33.99 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 39 | 139 | Rainfall | 0.1202 | 0.3042 | 0.6051 | 0.0160 | 24.47 | 43.62 | 0.36 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 40 | 140 | Rainfall | 0.1455 | 0.3087 | 0.9918 | 0.0175 | 25.05 | 29.42 | 0.35 | 0.07 | 3.000 | 0.00180 | 0.500 | 0 |
| 41 | 141 | Rainfall | 0.0585 | 0.2104 | 0.4337 | 0.0101 | 37.59 | 37.59 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 42 | 142 | Rainfall | 0.1367 | 0.3955 | 0.6979 | 0.0015 | 68.59 | 68.59 | 0.40 | 0.10 | 4.103 | 0.00119 | 0.776 | 0 |
| 43 | 143 | Rainfall | 0.0997 | 0.1745 | 0.6741 | 0.0061 | 25.66 | 51.09 | 0.35 | 0.10 | 3.063 | 0.00177 | 0.516 | 0 |
| 44 | 144 | Rainfall | 0.1394 | 0.3510 | 1.2356 | 0.0086 | 7.65 | 44.24 | 0.37 | 0.10 | 3.000 | 0.00180 | 0.500 | 0 |
| 45 | 145 | Rainfall | 0.1710 | 0.3452 | 0.6872 | 0.0113 | 27.39 | 54.35 | 0.36 | 0.09 | 3.018 | 0.00179 | 0.505 | 0 |
| 46 | 146 | Rainfall | 0.0840 | 0.2253 | 0.4103 | 0.0010 | 69.98 | 69.98 | 0.40 | 0.10 | 4.358 | 0.00105 | 0.840 | 0 |
| 47 | 147 | Rainfall | 0.1744 | 0.3492 | 0.6383 | 0.0010 | 54.26 | 60.34 | 0.40 | 0.10 | 3.614 | 0.00146 | 0.654 | 0 |
| 48 | 148 | Rainfall | 0.0608 | 0.2669 | 0.5360 | 0.0078 | 15.18 | 74.92 | 0.35 | 0.10 | 3.000 | 0.00180 | 0.500 | 0 |
| 49 | 149 | Rainfall | 0.0593 | 0.3611 | 0.5397 | 0.0237 | 44.73 | 46.06 | 0.35 | 0.07 | 3.632 | 0.00145 | 0.658 | 0 |
| 50 | 150 | Rainfall | 0.1128 | 0.3493 | 0.6277 | 0.0046 | 47.97 | 55.38 | 0.35 | 0.08 | 3.438 | 0.00156 | 0.610 | 0 |
| 51 | 151 | Rainfall | 0.0833 | 0.3270 | 0.5816 | 0.0123 | 6.75 | 36.91 | 0.40 | 0.10 | 3.264 | 0.00165 | 0.566 | 0 |
| 52 | 152 | Rainfall | 0.1022 | 0.2932 | 0.5829 | 0.0331 | 33.44 | 50.27 | 0.35 | 0.08 | 3.000 | 0.00180 | 0.500 | 0 |
| 53 | 153 | Rainfall | 0.0644 | 0.1169 | 0.3410 | 0.0024 | 21.99 | 21.99 | 0.40 | 0.10 | 4.878 | 0.00077 | 0.969 | 0 |
| 54 | 154 | Rainfall | 0.0949 | 0.3690 | 0.6387 | 0.0101 | 14.45 | 14.45 | 0.40 | 0.10 | 4.803 | 0.00081 | 0.951 | 0 |
| 55 | 155 | Rainfall | 0.1967 | 0.2777 | 0.5925 | 0.0126 | 69.70 | 69.70 | 0.37 | 0.09 | 3.675 | 0.00143 | 0.669 | 0 |

# EPA SWMM 5.1
# MASTER PLAN INPUT PARAMETERS

```
[TITLE]
;;Project Title/Notes

[OPTIONS]
;;Option             Value
FLOW_UNITS           CFS
INFILTRATION         HORTON
FLOW_ROUTING         KINWAVE
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
ALLOW_PONDING        NO
SKIP_STEADY_STATE    NO

START_DATE           01/01/2005
START_TIME           00:00:00
REPORT_START_DATE    01/01/2005
REPORT_START_TIME    00:00:00
END_DATE             01/01/2005
END_TIME             06:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:05:00
WET_STEP             00:05:00
DRY_STEP             01:00:00
ROUTING_STEP         0:00:05
RULE_STEP            00:00:00

INERTIAL_DAMPING     PARTIAL
NORMAL_FLOW_LIMITED  BOTH
FORCE_MAIN_EQUATION  H-W
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         12.557
MAX_TRIALS           8
HEAD_TOLERANCE       0.005
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[FILES]
;;Interfacing Files
USE INFLOWS "F:\2017\2001-2500\017-2321\40-Design\Calcs\WTRS\1 HYDROLOGY\Master Plan\CUHP 2.0.0\Output
Files\Future\13_Fut_100yr_0mi^2_.txt"

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
CONSTANT         0.0
DRY_ONLY         NO

[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
102              5148.89    0          0          0          0
103              5151       0          0          0          0
104              5080       0          0          0          0
105              5085       0          0          0          0
108              5179       0          0          0          0
109              5194       0          0          0          0
110              5120       0          0          0          0
110T             5104       0          0          0          0
111              5123       0          0          0          0
112T             5123       0          0          0          0
114              5105       0          0          0          0
115              5132       0          0          0          0
116              5152.3     0          0          0          0
116O             5152.3     0          0          0          0
117              5162       0          0          0          0
118T             5158       0          0          0          0
119              5172       0          0          0          0
120              5177       0          0          0          0
120T             5158       0          0          0          0
121              5216.17    0          0          0          0
122              5259       0          0          0          0
122O             5259       0          0          0          0
123              5177       0          0          0          0
124              5286       0          0          0          0
124T             5222       0          0          0          0
125              5316       0          0          0          0
126              5213       0          0          0          0
```





```
127              5241       0          0          0          0
128              5266       0          0          0          0
128T             5264       0          0          0          0
129              5267       0          0          0          0
131              5250       0          0          0          0
131O             5250       0          0          0          0
130T             5183       0          0          0          0
132              5286       0          0          0          0
132T             5279       0          0          0          0
133              5293       0          0          0          0
135              5273       0          0          0          0
135T             5236       0          0          0          0
136              5276       0          0          0          0
138              5079       0          0          0          0
138T             5073       0          0          0          0
139              5087       0          0          0          0
140              5092       0          0          0          0
141              5093       0          0          0          0
143              5054       0          0          0          0
144              5075       0          0          0          0
145              5067       0          0          0          0
146              5054       0          0          0          0
147              5055       0          0          0          0
148              5073       0          0          0          0
149              5115       0          0          0          0
150              5056       0          0          0          0
150T             5055       0          0          0          0
151              5061       0          0          0          0
152              5100       0          0          0          0
153              5063       0          0          0          0
154              5069       0          0          0          0
118              5173       0          0          0          0
107              5138       0          0          0          0
143T             5055       0          0          0          0
134              5184       0          0          0          0
130              5183       0          0          0          0
121O             5198.37    0          0          0          0
140O             5089.8     0          0          0          0
102T             5097       0          0          0          0
101              5084.35    0          0          0          0
115T             5132       0          0          0          0

[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
100              5067       FREE                        NO
137              5069       FREE                        NO
142              5051       FREE                        NO
155              5046       FREE                        NO

[DIVIDERS]
;;Name           Elevation  Diverted Link    Type       Parameters
;;-------------- ---------- ---------------- ---------- ----------
129O             5267       429O             OVERFLOW   0          0          0          0
127O             5241       427O             OVERFLOW   0          0          0          0
126O             5213       426O             OVERFLOW   0          0          0          0
139O             5079.38    439O             OVERFLOW   0          0          0          0
107O             5138       407O             OVERFLOW   0          0          0          0
106              5110       406              OVERFLOW   0          0          0          0
102O             5140.0     402O             OVERFLOW   0          0          0          0
113              5149.04    413              OVERFLOW   0          0          0          0
112              5142.5     412              OVERFLOW   0          0          0          0

[STORAGE]
;;Name           Elev.    MaxDepth   InitDepth  Shape      Curve Name/Params            N/A      Fevap
Psi      Ksat     IMD
;;-------------- -------- ---------- ---------- ---------- ---------------------------- -------- --------
       -------- --------
;OSP - 301
316              5152.3   14.7       0          TABULAR    316Pond                      0        0
302              5148.89  11         0          TABULAR    302Pond                      0        0
;OSP - 307
322              5259     12.2       0          FUNCTIONAL 0          0          43560    0        0
;OSP - 305
331              5250     8.4        0          FUNCTIONAL 0          0          43560    0        0
;OSP - 303
327              5241     1.9        0          FUNCTIONAL 0          0          43560    0        0
;OSP - 302
326              5213     4.2        0          FUNCTIONAL 0          0          43560    0        0
;OSP - 304
329              5267     1.1        0          FUNCTIONAL 0          0          43560    0        0
321S             5198.37  6.63       0          TABULAR    Pond321S                     0        0
```

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 307 | 5138 | 3.4 | 0 | FUNCTIONAL | 0 | 0 | 43560 | 0 | 0 |
| 340 | 5089.8 | 8.2 | 0 | TABULAR | Pond340 | | | 0 | 0 |
| 339 | 5079.38 | 10.62 | 0 | TABULAR | Pond339 | | | 0 | 0 |
| 321N | 5216.17 | 7.83 | 0 | TABULAR | Pond321N | | | 0 | 0 |
| 302O | 5140.00 | 11 | 0 | TABULAR | PRDet_School | | | 0 | 0 |

[CONDUITS]

| ;;Name | From Node | To Node | Length | Roughness | InOffset | OutOffset | InitFlow | MaxFlow |
|---|---|---|---|---|---|---|---|---|
| 203 | 103 | 102 | 41 | .045 | 0 | 0 | 0 | 0 |
| 205 | 105 | 104 | 514 | .045 | 0 | 0 | 0 | 0 |
| 406 | 106 | 105 | 1999 | .02 | 6 | 12 | 0 | 0 |
| 407O | 107O | 106 | 2603 | .045 | 7 | 6 | 0 | 0 |
| 208 | 108 | 107 | 1396 | .045 | 0 | 20 | 0 | 0 |
| 209 | 109 | 107 | 2407 | .045 | 0 | 7 | 0 | 0 |
| 210 | 110 | 110T | 216 | .045 | 0 | 10 | 0 | 0 |
| 211 | 111 | 110 | 407 | .045 | 0 | 0 | 0 | 0 |
| 412 | 112 | 112T | 939 | .045 | 21.5 | 0 | 0 | 0 |
| 212T | 112T | 110 | 450 | 0.02 | 0 | 0 | 0 | 0 |
| 413 | 113 | 112T | 2015 | .02 | 16.96 | 16 | 0 | 0 |
| 214 | 114 | 110T | 136 | .045 | 0 | 0 | 0 | 0 |
| 215T | 115T | 114 | 1625 | .045 | 0 | 6 | 0 | 0 |
| 216 | 116 | 316 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 216O | 116O | 115 | 864 | .045 | 0 | 4 | 0 | 0 |
| 217 | 117 | 116 | 720 | .045 | 0 | 0 | 0 | 0 |
| 218 | 118 | 118T | 750 | .045 | 3 | 0 | 0 | 0 |
| 218T | 118T | 116 | 583 | .045 | 0 | 0 | 0 | 0 |
| 219 | 119 | 118T | 474 | .045 | 0 | 8 | 0 | 0 |
| 220 | 120 | 120T | 913 | .045 | 0 | 0 | 0 | 0 |
| 220T | 120T | 116 | 636 | .045 | 0 | 0 | 0 | 0 |
| 221O | 121O | 120 | 1215 | .02 | 5.63 | 0 | 0 | 0 |
| 222 | 122 | 322 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 222O | 122O | 121 | 1335 | .02 | 10.57 | 0 | 0 | 0 |
| 223 | 123 | 120 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 224 | 124 | 124T | 1847 | .02 | 0 | 0 | 0 | 0 |
| 224T | 124T | 123 | 2136 | .02 | 0 | 0 | 0 | 0 |
| 225 | 125 | 124 | 1376 | .02 | 0 | 0 | 0 | 0 |
| 226 | 126 | 326 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 426O | 126O | 124T | 223 | 0.02 | 9.5 | 0 | 0 | 0 |
| 227 | 127 | 327 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 427O | 127O | 126 | 733 | 0.02 | 7 | 7 | 0 | 0 |
| 228 | 128 | 128T | 96 | .02 | 0 | 0 | 0 | 0 |
| 228T | 128T | 126 | 1446 | .02 | 0 | 7 | 0 | 0 |
| 229 | 129 | 329 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 429O | 129O | 128T | 226 | .045 | 5 | 0 | 0 | 0 |





| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 230T | 130T | 120T | 1799 | .045 | 0 | 0 | 0 | 0 |
| 231 | 131 | 331 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 231O | 131O | 130 | 3121 | .045 | 0 | 0 | 0 | 0 |
| 232 | 132 | 132T | 631 | .02 | 0 | 0 | 0 | 0 |
| 232T | 132T | 131 | 785 | .045 | 0 | 0 | 0 | 0 |
| 233 | 133 | 132T | 429 | .02 | 0 | 0 | 0 | 0 |
| 235 | 135 | 135T | 1627 | .02 | 0 | 0 | 0 | 0 |
| 235T | 135T | 134 | 1287 | .045 | 0 | 0 | 0 | 0 |
| 236 | 136 | 135T | 1834 | .02 | 0 | 0 | 0 | 0 |
| 238 | 138 | 138T | 1380 | .045 | 0 | 0 | 0 | 0 |
| 238T | 138T | 137 | 1890 | .045 | 0 | 0 | 0 | 0 |
| 439O | 139O | 138 | 684 | .045 | 7.62 | 0 | 0 | 0 |
| 240O | 140O | 139 | 1481 | .045 | 0 | 0 | 0 | 0 |
| 241 | 141 | 138T | 1783 | .045 | 0 | 0 | 0 | 0 |
| 246 | 146 | 142 | 1755 | .045 | 0 | 0 | 0 | 0 |
| 247 | 147 | 146 | 2433 | .045 | 0 | 0 | 0 | 0 |
| 248 | 148 | 147 | 1725 | .045 | 0 | 0 | 0 | 0 |
| 249 | 149 | 148 | 2811 | .045 | 0 | 0 | 0 | 0 |
| 250 | 150 | 150T | 1231 | .045 | 0 | 0 | 0 | 0 |
| 250T | 150T | 147 | 1828 | .045 | 0 | 0 | 0 | 0 |
| 251 | 151 | 150 | 296 | .045 | 0 | 0 | 0 | 0 |
| 252 | 152 | 151 | 2626 | .045 | 0 | 0 | 0 | 0 |
| 253 | 153 | 150T | 1794 | .045 | 0 | 0 | 0 | 0 |
| 254 | 154 | 150T | 2092 | .045 | 0 | 0 | 0 | 0 |
| 229O | 129O | 126 | 1661 | .01875 | 0 | 0 | 0 | 0 |
| 227O | 127O | 126O | 623 | .01875 | 0 | 0 | 0 | 0 |
| 226O | 126O | 120 | 2226 | .01875 | 0 | 0 | 0 | 0 |
| 202O | 102O | 102T | 2655 | 0.019 | 0 | 19.11 | 0 | 0 |
| 202 | 102 | 302 | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 210T | 110T | 105 | 2333 | 0.045 | 0 | 0 | 0 | 0 |
| 245 | 145 | 143T | 2703 | .045 | 0 | 0 | 0 | 0 |
| 243T | 143T | 143 | 638 | .045 | 0 | 0 | 0 | 0 |
| 244 | 144 | 143T | 903 | .045 | 0 | 0 | 0 | 0 |
| 243 | 143 | 155 | 3359 | .045 | 0 | 0 | 0 | 0 |
| 234 | 134 | 130T | 40 | .045 | 0 | 0 | 0 | 0 |
| 230 | 130 | 130T | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 221 | 121 | 321N | 400 | 0.01 | 0 | 0 | 0 | 0 |
| 207 | 107 | 307 | 1 | 0.01 | 0 | 0 | 0 | 0 |
| 240 | 140 | 340 | 1 | 0.01 | 0 | 0 | 0 | 0 |
| 239 | 139 | 339 | 1 | 0.01 | 0 | 0 | 0 | 0 |
| 207O | 107O | 106 | 2603 | 0.01875 | 0 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 206 | 106 | 105 | 1274 | 0.01875 | 0 | 12 | 0 | 0 |
| 239O | 139O | 138T | 1916 | 0.01875 | 0 | 0 | 0 | 0 |
| 204 | 104 | 100 | 523 | .045 | 0 | 2 | 0 | 0 |
| 202T | 102T | 101 | 1337 | 0.012 | 0 | 0 | 0 | 0 |
| 201 | 101 | 104 | 351 | 0.015 | 11.5 | 0 | 0 | 0 |
| 402O | 102O | 102T | 2655 | 0.02 | 0 | 0 | 0 | 0 |
| 98 | 115 | 115T | .1 | 0.01 | 0 | 0 | 0 | 0 |
| 213 | 113 | 112 | 933.63 | 0.013 | 0 | 0 | 0 | 0 |
| 212 | 112 | 115T | 1500 | .013 | 0 | 0 | 0 | 0 |

[OUTLETS]

| ;;Name | From Node | To Node | Offset | Type | QTable/Qcoeff | Qexpon | Gated |
|---|---|---|---|---|---|---|---|
| 502 | 302 | 302O | 0 | TABULAR/DEPTH | 502Outlet | | NO |
| 507 | 307 | 107O | 0 | TABULAR/DEPTH | 507Outlet | | NO |
| 516 | 316 | 116O | 0 | TABULAR/DEPTH | 516Outlet | | NO |
| 521S | 321S | 121O | 0 | TABULAR/DEPTH | 521SOutlet | | NO |
| 522 | 322 | 122O | 0 | TABULAR/DEPTH | 522Outlet | | NO |
| 526 | 326 | 126O | 0 | TABULAR/DEPTH | 526Outlet | | NO |
| 527 | 327 | 127O | 0 | TABULAR/DEPTH | 527Outlet | | NO |
| 529 | 329 | 129O | 0 | TABULAR/DEPTH | 529Outlet | | NO |
| 531 | 331 | 131O | 0 | TABULAR/DEPTH | 531Outlet | | NO |
| 539 | 339 | 139O | 0 | TABULAR/DEPTH | 539Outlet | | NO |
| 540 | 340 | 140O | 0 | TABULAR/DEPTH | 540Outlet | | NO |
| 521N | 321N | 321S | 0 | TABULAR/DEPTH | 521NOutlet | | NO |
| 502O | 302O | 102O | 0 | TABULAR/DEPTH | PRDet_School_Flow | | NO |

[XSECTIONS]

| ;;Link | Shape | Geom1 | Geom2 | Geom3 | Geom4 | Barrels | Culvert |
|---|---|---|---|---|---|---|---|
| 203 | TRAPEZOIDAL | 7 | 3 | 2 | 4 | 1 | |
| 205 | TRAPEZOIDAL | 6 | 40 | 6 | 8 | 1 | |
| 406 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 | |
| 407O | TRAPEZOIDAL | 2 | 30 | 7 | 50 | 1 | |
| 208 | TRAPEZOIDAL | 5 | 12 | 3 | 2 | 1 | |
| 209 | TRAPEZOIDAL | 3 | 6 | 5 | 5 | 1 | |
| 210 | TRAPEZOIDAL | 10 | 6 | 5 | 3 | 1 | |
| 211 | TRAPEZOIDAL | 1 | 166 | 26 | 29 | 1 | |
| 412 | TRAPEZOIDAL | 2 | 54 | 5 | 56 | 1 | |
| 212T | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 | |
| 413 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 | |
| 214 | TRAPEZOIDAL | 10 | 5 | 3 | 2 | 1 | |
| 215T | TRAPEZOIDAL | 8 | 5 | 3 | 3 | 1 | |
| 216 | DUMMY | 0 | 0 | 0 | 0 | 1 | |
| 216O | TRAPEZOIDAL | 8 | 5 | 3 | 2 | 1 | |
| 217 | TRAPEZOIDAL | 7 | 6 | 2 | 10 | 1 | |
| 218 | TRAPEZOIDAL | 2 | 30 | 15 | 15 | 1 | |
| 218T | TRAPEZOIDAL | 5 | 76 | 20 | 20 | 1 | |
| 219 | TRAPEZOIDAL | 1 | 130 | 35 | 20 | 1 | |
| 220 | TRAPEZOIDAL | 5 | 5 | 2 | 3 | 1 | |
| 220T | TRAPEZOIDAL | 5 | 55 | 2 | 13 | 1 | |
| 221O | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 | |
| 222 | DUMMY | 0 | 0 | 0 | 0 | 1 | |
| 222O | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 | |
| 223 | DUMMY | 0 | 0 | 0 | 0 | 1 | |
| 224 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 | |
| 224T | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 | |





| | | | | | | |
|---|---|---|---|---|---|---|
| 225 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 226 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 426O | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 227 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 427O | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 228 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 228T | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 229 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 429O | TRAPEZOIDAL | 1 | 6 | 18 | 13 | 1 |
| 230T | TRAPEZOIDAL | 5 | 80 | 3 | 5 | 1 |
| 231 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 231O | TRAPEZOIDAL | 15 | 30 | 3 | 3 | 1 |
| 232 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 232T | TRAPEZOIDAL | 10 | 16 | 4 | 4 | 1 |
| 233 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 235 | TRAPEZOIDAL | 5 | 1 | 5 | 5 | 1 |
| 235T | TRAPEZOIDAL | 5 | 60 | 4 | 6 | 1 |
| 236 | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 238 | TRAPEZOIDAL | 5 | 315 | 5 | 3 | 1 |
| 238T | TRAPEZOIDAL | 1 | 951 | 4 | 4 | 1 |
| 439O | TRAPEZOIDAL | 3 | 6 | 10 | 10 | 1 |
| 240O | TRAPEZOIDAL | 1 | 180 | 14 | 92 | 1 |
| 241 | TRAPEZOIDAL | 1 | 16 | 57 | 35 | 1 |
| 246 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 247 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 248 | TRAPEZOIDAL | 1 | 120 | 30 | 200 | 1 |
| 249 | TRAPEZOIDAL | 1 | 120 | 30 | 200 | 1 |
| 250 | TRAPEZOIDAL | 9 | 1050 | 9 | 5 | 1 |
| 250T | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 251 | TRAPEZOIDAL | 9 | 54 | 4 | 4 | 1 |
| 252 | TRAPEZOIDAL | 4 | 25 | 9 | 3 | 1 |
| 253 | TRAPEZOIDAL | 9 | 1050 | 9 | 5 | 1 |
| 254 | TRAPEZOIDAL | 9 | 1050 | 9 | 5 | 1 |
| 229O | CIRCULAR | 1.75 | 0 | 0 | 0 | 1 |
| 227O | CIRCULAR | 2 | 0 | 0 | 0 | 1 |
| 226O | CIRCULAR | 3 | 0 | 0 | 0 | 1 |
| 202O | CIRCULAR | 7 | 0 | 0 | 0 | 1 |
| 202 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 210T | TRAPEZOIDAL | 10 | 6 | 3 | 2 | 1 |
| 245 | TRAPEZOIDAL | 2 | 127 | 7 | 3.3 | 1 |
| 243T | TRAPEZOIDAL | 4 | 600 | 3 | 3 | 1 |
| 244 | TRAPEZOIDAL | 2 | 30 | 20 | 20 | 1 |
| 243 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 234 | TRAPEZOIDAL | 5 | 60 | 4 | 6 | 1 |
| 230 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 221 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 207 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 240 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 239 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 207O | CIRCULAR | 3 | 0 | 0 | 0 | 1 |
| 206 | CIRCULAR | 3 | 0 | 0 | 0 | 1 |
| 239O | CIRCULAR | 3 | 0 | 0 | 0 | 1 |
| 204 | TRAPEZOIDAL | 10 | 10 | 2 | 1 | 1 |
| 202T | CIRCULAR | 7 | 0 | 0 | 0 | 1 |
| 201 | RECT_OPEN | 5 | 9 | 0 | 0 | 1 |
| 402O | TRAPEZOIDAL | 5 | 1 | 20 | 20 | 1 |
| 98 | DUMMY | 0 | 0 | 0 | 0 | 1 |
| 213 | CIRCULAR | 4 | 0 | 0 | 0 | 1 |
| 212 | CIRCULAR | 4 | 0 | 0 | 0 | 1 |

[CURVES]

| ;;Name | Type | X-Value | Y-Value |
|---|---|---|---|
| ;Stage-Discrhage from Merrick 2-20-15 Memo | | | |
| 502Outlet | Rating | 0.00 | 0.00 |
| 502Outlet | | 1.31 | 25.00 |
| 502Outlet | | 1.91 | 50.00 |
| 502Outlet | | 2.31 | 75.00 |
| 502Outlet | | 4.21 | 100.00 |
| 502Outlet | | 4.41 | 102.00 |
| 502Outlet | | 5.51 | 191.00 |
| 502Outlet | | 8.61 | 351.00 |
| 502Outlet | | 9.11 | 369 |
| 502Outlet | | 9.15 | 371 |
| 502Outlet | | 10.11 | 407 |
| 502Outlet | | 11 | 500 |
| ; | | | |
| ;Storage-Discharge Curve from 2002 OSP | | | |
| 504Outlet | Rating | 0 | 0.00 |
| 504Outlet | | 1.00 | 114.00 |
| 504Outlet | | 4.50 | 228.00 |
| 504Outlet | | 10.40 | 342.00 |

```
504Outlet                  18.30      484.00
504Outlet                  23.80      541.00
504Outlet                  26.60      1160.00
504Outlet                  29.40      2272.00
;
;Storage-Discharge Curve from 2002 OSP
507Outlet        Rating    0          0.00
507Outlet                  0.70       5.00
507Outlet                  1.70       8.00
507Outlet                  2.60       275.00
507Outlet                  2.80       325.00
507Outlet                  2.90       390.00
507Outlet                  3.10       450.00
507Outlet                  3.20       500.00
507Outlet                  3.30       600.00
507Outlet                  3.4        1000
;
;Storage-Discharge Curve from 2002 OSP
516Outlet        Rating    0          0.00
516Outlet                  0.7        0.70
516Outlet                  1.7        2.23
516Outlet                  2.7        4.24
516Outlet                  3.7        6.75
516Outlet                  4.7        15.29
516Outlet                  5.7        54.93
516Outlet                  6.7        109.45
516Outlet                  7.7        135.07
516Outlet                  8.7        143.96
516Outlet                  9.7        152.34
516Outlet                  10.7       160.29
516Outlet                  11.7       167.85
516Outlet                  12.7       175.09
516Outlet                  13.7       182.05
516Outlet                  14.7       188.74
;
;Storage-Discharge Curve from 2002 OSP
518Outlet        Rating    0.00       9.60
518Outlet                  0.20       35.00
518Outlet                  1.50       62.00
518Outlet                  3.90       95.00
;
;Storage-Discharge Curve from 2002 OSP
522Outlet        Rating    0          0.00
522Outlet                  0.70       6.40
522Outlet                  3.60       24.00
522Outlet                  7.00       38.00
522Outlet                  8.30       39.00
522Outlet                  12.20      500.00
;
;Storage-Discharge Curve from 2002 OSP
526Outlet        Rating    0          0.00
526Outlet                  0.20       35.00
526Outlet                  0.70       58.00
526Outlet                  1.70       89.00
526Outlet                  2.80       140.00
526Outlet                  3.50       375.00
526Outlet                  4.20       750.00
;
;Storage-Discharge Curve from 2002 OSP
527Outlet        Rating    0          0.00
527Outlet                  0.30       8.00
527Outlet                  0.90       24.00
527Outlet                  1.70       100.00
527Outlet                  1.80       200.00
527Outlet                  1.90       500.00
;
;Storage-Discharge Curve from 2002 OSP
529Outlet        Rating    0          0.00
529Outlet                  0.10       21.00
529Outlet                  0.80       28.00
529Outlet                  1.00       36.00
529Outlet                  1.1        100
;
;Storage-Discharge Curve from 2002 OSP
531Outlet        Rating    0          0.00
531Outlet                  0.10       9.30
531Outlet                  0.70       28.00
531Outlet                  2.20       40.00
531Outlet                  4.30       40.00
531Outlet                  5.60       74.60
531Outlet                  6.90       200.00
531Outlet                  8.40       850.00
```





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;
;Calculated in UD-Detention 3.07 using Cherrylane Subdivision Pond Details, 11/11/2015
539Outlet        Rating    0          0.00
539Outlet                  0.62       0.13
539Outlet                  1.62       0.47
539Outlet                  2.62       0.92
539Outlet                  3.62       1.46
539Outlet                  4.62       2.06
539Outlet                  5.62       8.32
539Outlet                  6.62       34.29
539Outlet                  7.62       50.13
539Outlet                  8.62       63.79
539Outlet                  9.62       165.92
539Outlet                  10.62      356.5
;
;Storage-Discharge Curve from 2002 OSP
545Outlet        Rating    0          12.00
545Outlet                  2.70       18.00
545Outlet                  2.90       27.00
545Outlet                  3.70       90.00
545Outlet                  5.30       98.00
545Outlet                  5.40       200.00
545Outlet                  5.5        500
;
;Storage-Discharge Curve from 2002 OSP
550Outlet        Rating    0          0.00
550Outlet                  0.20       1.10
550Outlet                  0.90       3.20
550Outlet                  1.90       5.30
550Outlet                  3.50       11.00
550Outlet                  5.30       11.00
550Outlet                  5.60       150.00
550Outlet                  6.00       500.00
550Outlet                  6.1        600
;
;Developed Using UD-Detention 3.07 and Thornton Survey
521SOutlet       Rating    0          0.00
521SOutlet                 0.63       1.87
521SOutlet                 1.63       10.45
521SOutlet                 2.63       19.31
521SOutlet                 3.63       24.53
521SOutlet                 4.63       28.82
521SOutlet                 5.63       155.55
521SOutlet                 6.63       723.20
;
;Calculated in UD-Detention 3.07 using As-Builts
540Outlet        Rating    0          0.00
540Outlet                  2.2        10.21
540Outlet                  3.2        13.29
540Outlet                  4.2        15.78
540Outlet                  5.2        17.93
540Outlet                  6.2        19.85
540Outlet                  7.2        1084.25
540Outlet                  8.2        3417.34
;
;Developed Using UD-Detention_v3.07 and survey provided by Thornton
Outlet321N       Rating    0          0
Outlet321N                 0.83       28
Outlet321N                 1.83       417
Outlet321N                 2.83       2018
Outlet321N                 3.83       5778
Outlet321N                 4.83       13210
Outlet321N                 5.83       28187
Outlet321N                 6.83       56426
Outlet321N                 7.83       104919
;
;DEveloped from UD-Detention 3.07 and Thornton Survey
521NOutlet       Rating    0          0.00
521NOutlet                 0.83       3.01
521NOutlet                 1.83       12.75
521NOutlet                 2.83       20.41
521NOutlet                 3.83       25.40
521NOutlet                 4.83       29.56
521NOutlet                 5.83       33.24
521NOutlet                 6.48       35.41
521NOutlet                 6.83       139.39
521NOutlet                 7.83       894.08
;
PRDet_School_Flow Rating    0.00       0.00
PRDet_School_Flow           1.00       8.49
PRDet_School_Flow           2.00       29.76
PRDet_School_Flow           3.00       62.00
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PRDet_School_Flow            4.00       104.36
PRDet_School_Flow            5.00       156.29
PRDet_School_Flow            6.00       196.39
PRDet_School_Flow            7.00       223.92
PRDet_School_Flow            8.00       248.42
PRDet_School_Flow            9.00       270.71
PRDet_School_Flow            9.5        281.19
PRDet_School_Flow            10         291.29
PRDet_School_Flow            11.00      799.52
;
;Stage-Area from Merrick 2-20-15 Memo
302Pond          Storage     0          0
302Pond                      1.11       131.17
302Pond                      2.11       724.28
302Pond                      3.11       1554.49
302Pond                      4.11       2768.68
302Pond                      5.11       5388.16
302Pond                      6.11       9693.27
302Pond                      7.11       19727.44
302Pond                      8.11       31642.7
302Pond                      9.11       61944.65
302Pond                      10.11      99022.90
302Pond                      11         99022.9
;
;Villages North Subdivision Filing No. 5 Pond 301 Construction Plans - Developed Info
316Pond          Storage     0          22000
316Pond                      0.7        59012
316Pond                      1.7        111281
316Pond                      2.7        251085
316Pond                      3.7        375069
316Pond                      4.7        447885
316Pond                      5.7        505814
316Pond                      6.7        542816
316Pond                      7.7        590463
316Pond                      8.7        618714
316Pond                      9.7        650622
316Pond                      10.7       700403
316Pond                      11.7       759679
316Pond                      12.7       854831
316Pond                      13.7       940000
316Pond                      14.7       1029979.768
;
;Calculated in UD-Detention 3.07 using LiDAR
Pond340          Storage     0          0
Pond340                      2.2        6514
Pond340                      3.2        40684
Pond340                      4.2        66995
Pond340                      5.2        89247
Pond340                      6.2        103191
Pond340                      7.2        114771
Pond340                      8.2        120029
;
;Cherrylane Pond A - From Final Drainage Report Cherrylane Subdivision - March 2, 2012
Pond339          Storage     0          0
Pond339                      0.62       4674
Pond339                      1.62       19677
Pond339                      2.62       24349
Pond339                      3.62       27372
Pond339                      4.62       30874
Pond339                      5.62       34392
Pond339                      6.62       38240
Pond339                      7.62       42540
Pond339                      8.62       46952
Pond339                      9.62       51487
Pond339                      10.62      89765
;
;Developed Using LiDAR
Pond321N         Storage     0          0
Pond321N                     0.83       70
Pond321N                     1.83       721
Pond321N                     2.83       2466
Pond321N                     3.83       5053
Pond321N                     4.83       9812
Pond321N                     5.83       20142
Pond321N                     6.48       30668
Pond321N                     6.83       36336
Pond321N                     7.83       60650
;
;Developed from LiDAR and survey provided by Thornton
Pond321S         Storage     0          0
Pond321S                     0.63       20
Pond321S                     1.63       359
```





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Pond321S                     2.63       5354
Pond321S                     3.63       15802
Pond321S                     4.63       23544
Pond321S                     5.63       30671
Pond321S                     6.63       39344
;
PRDet_School     Storage     0          0
PRDet_School                 1          3018
PRDet_School                 2          11026
PRDet_School                 3          13057
PRDet_School                 4          15131
PRDet_School                 5          17296
PRDet_School                 6          19438
PRDet_School                 7          21654
PRDet_School                 8          23925
PRDet_School                 9          26244
PRDet_School                 9.5        27838
PRDet_School                 10         29214

[REPORT]
;;Reporting Options
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS -2727.273 0.000 12727.273 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
102              2326.301           937.302
103              2355.675           1032.767
104              5281.076           1061.645
105              5051.857           1303.598
108              4375.127           4954.176
109              4947.917           6099.756
110              4411.845           2450.055
110T             4544.027           2450.055
111              4147.480           2567.551
112T             4080.787           2444.925
114              4499.966           2538.177
115              4096.076           3492.827
116              3617.973           3830.071
116O             3731.018           3707.371
117              3501.255           3375.332
118T             3405.790           4139.052
119              3280.951           4425.447
120              2796.283           4469.508
120T             3229.547           4014.213
121              2707.257           5335.091
122              2399.944           6348.263
122O             2406.248           6227.161
123              2739.160           4534.291
124              1371.651           6268.656
124T             1430.399           4968.863
125              394.971            6275.999
126              1276.186           5079.015
127              1305.560           5453.532
128              446.375            5380.097
128T             439.031            5306.662
129              336.223            5416.814
131              142.061            5012.906
131O             288.826            4961.431
130T             2016.662           3915.474
132              -662.488           5314.006
132T             -333.490           5210.420
133              -493.588           5027.611
135              130.606            3456.110
135T             1268.843           3558.918
136              145.293            3250.493
138              6578.166           3096.280
138T             6952.683           2501.460
139              6870.727           3651.946
140              6776.439           4491.538
141              5968.659           2097.569
143              10133.472          7229.480
144              9611.016           7531.731
145              8885.450           6377.502
```

| | | |
|---|---|---|
| 146 | 11535.003 | 6364.121 |
| 147 | 9914.494 | 6308.128 |
| 148 | 8715.114 | 6246.625 |
| 149 | 6864.561 | 6298.030 |
| 150 | 8642.264 | 5110.258 |
| 150T | 9526.909 | 5080.321 |
| 151 | 8633.684 | 5313.334 |
| 152 | 6849.874 | 5372.753 |
| 153 | 8597.618 | 4410.760 |
| 154 | 8590.275 | 3735.161 |
| 118 | 3561.664 | 4497.215 |
| 107 | 5093.178 | 4360.765 |
| 143T | 9782.077 | 7036.641 |
| 134 | 1929.754 | 3911.404 |
| 130 | 1988.692 | 3927.550 |
| 121O | 2837.107 | 5106.543 |
| 140O | 6819.915 | 4420.143 |
| 102T | 4370.734 | 688.780 |
| 101 | 5181.614 | 989.255 |
| 115T | 4123.029 | 3423.586 |
| 100 | 5571.651 | 1054.699 |
| 137 | 7459.381 | 1664.305 |
| 142 | 12372.158 | 7237.993 |
| 155 | 12430.906 | 7737.348 |
| 129O | 394.041 | 5334.485 |
| 127O | 1319.012 | 5341.119 |
| 126O | 1344.007 | 4988.087 |
| 139O | 6834.331 | 3563.411 |
| 107O | 5139.616 | 4220.793 |
| 106 | 5065.413 | 2640.985 |
| 102O | 2549.487 | 891.237 |
| 113 | 2913.778 | 2134.286 |
| 112 | 3391.103 | 2530.833 |
| 316 | 3659.180 | 3779.209 |
| 302 | 2445.437 | 937.481 |
| 322 | 2404.147 | 6283.901 |
| 331 | 214.654 | 4978.744 |
| 327 | 1305.450 | 5403.159 |
| 326 | 1316.336 | 5033.744 |
| 329 | 370.348 | 5385.662 |
| 321S | 2781.835 | 5192.826 |
| 307 | 5112.626 | 4314.404 |
| 340 | 6802.208 | 4455.556 |
| 339 | 6861.461 | 3615.285 |
| 321N | 2720.356 | 5286.438 |
| 302O | 2506.534 | 912.159 |

[VERTICES]

| ;;Link | X-Coord | Y-Coord |
|---|---|---|
| 205 | 5050.876 | 1252.727 |
| 205 | 5067.795 | 1237.218 |
| 205 | 5236.984 | 1223.119 |
| 205 | 5244.033 | 1196.330 |
| 205 | 5239.803 | 1149.804 |
| 205 | 5260.952 | 1114.556 |
| 205 | 5266.592 | 1091.998 |
| 406 | 5060.186 | 2474.274 |
| 406 | 5071.028 | 2428.197 |
| 406 | 5073.738 | 2184.262 |
| 406 | 5095.421 | 1536.479 |
| 406 | 5087.290 | 1338.620 |
| 407O | 5119.936 | 4261.760 |
| 407O | 5066.420 | 3354.662 |
| 407O | 5063.744 | 3274.388 |
| 208 | 4463.859 | 4860.978 |
| 208 | 4482.476 | 4818.424 |
| 208 | 4509.072 | 4805.127 |
| 208 | 4908.008 | 4794.488 |
| 208 | 4945.242 | 4738.637 |
| 209 | 5044.893 | 5993.266 |
| 209 | 5044.893 | 5757.576 |
| 209 | 5044.893 | 5465.769 |
| 209 | 5078.563 | 4769.921 |
| 211 | 4209.124 | 2539.323 |
| 211 | 4230.807 | 2506.798 |
| 211 | 4355.485 | 2452.591 |
| 412 | 3470.559 | 2506.696 |
| 412 | 3614.693 | 2497.337 |
| 412 | 3725.133 | 2487.978 |
| 412 | 3818.726 | 2497.337 |
| 412 | 3944.141 | 2491.721 |





| | | |
|---|---|---|
| 212T | 4324.129 | 2437.437 |
| 413 | 3156.086 | 2006.909 |
| 413 | 3232.833 | 2006.909 |
| 413 | 3288.989 | 1975.087 |
| 413 | 3361.991 | 1975.087 |
| 413 | 3395.685 | 2010.652 |
| 413 | 3487.406 | 2025.627 |
| 413 | 3762.570 | 2413.103 |
| 413 | 3800.007 | 2443.053 |
| 215T | 4192.861 | 3218.284 |
| 215T | 4228.096 | 3147.813 |
| 215T | 4222.676 | 3069.212 |
| 215T | 4263.332 | 2819.856 |
| 215T | 4282.304 | 2730.413 |
| 215T | 4333.802 | 2646.391 |
| 215T | 4382.589 | 2611.156 |
| 215T | 4412.403 | 2584.052 |
| 215T | 4474.742 | 2570.500 |
| 216O | 3867.615 | 3627.552 |
| 216O | 3973.320 | 3548.951 |
| 217 | 3599.314 | 3558.905 |
| 217 | 3592.131 | 3594.824 |
| 217 | 3594.525 | 3652.295 |
| 217 | 3640.023 | 3709.766 |
| 218 | 3563.445 | 4429.537 |
| 218 | 3531.387 | 4374.327 |
| 218 | 3524.263 | 4336.926 |
| 218 | 3510.015 | 4328.021 |
| 218 | 3426.308 | 4320.897 |
| 218 | 3417.403 | 4299.525 |
| 218T | 3461.056 | 4080.188 |
| 218T | 3539.657 | 3936.537 |
| 218T | 3569.472 | 3914.854 |
| 219 | 3352.641 | 4400.014 |
| 219 | 3371.613 | 4348.516 |
| 219 | 3349.930 | 4294.308 |
| 219 | 3352.641 | 4234.680 |
| 220 | 2862.060 | 4351.227 |
| 220 | 2948.792 | 4313.281 |
| 220 | 2992.159 | 4253.653 |
| 220 | 3062.629 | 4185.893 |
| 220 | 3143.941 | 4080.188 |
| 220 | 3165.624 | 4072.056 |
| 220T | 3409.559 | 3931.116 |
| 220T | 3466.477 | 3904.012 |
| 220T | 3496.291 | 3860.646 |
| 220T | 3561.341 | 3852.515 |
| 221O | 2859.350 | 5061.349 |
| 221O | 2951.503 | 4874.332 |
| 221O | 2956.924 | 4730.681 |
| 221O | 2900.005 | 4608.714 |
| 222O | 2435.669 | 5869.131 |
| 222O | 2479.799 | 5801.884 |
| 222O | 2553.350 | 5761.956 |
| 222O | 2622.698 | 5740.942 |
| 222O | 2658.423 | 5709.420 |
| 222O | 2671.032 | 5675.797 |
| 222O | 2673.133 | 5631.666 |
| 222O | 2645.814 | 5574.927 |
| 222O | 2620.597 | 5539.202 |
| 222O | 2626.901 | 5467.752 |
| 222O | 2677.336 | 5408.912 |
| 224 | 1409.291 | 6210.554 |
| 224 | 1414.712 | 5020.693 |
| 224T | 2703.851 | 4617.082 |
| 225 | 1276.482 | 6278.314 |
| 427O | 1377.770 | 5287.099 |
| 427O | 1380.242 | 5082.360 |
| 427O | 1339.783 | 5087.177 |
| 427O | 1307.031 | 5091.030 |
| 228T | 438.971 | 5204.999 |
| 228T | 463.365 | 5188.737 |
| 228T | 569.070 | 5137.240 |
| 228T | 840.109 | 5085.742 |
| 228T | 1146.383 | 5069.480 |
| 228T | 1216.853 | 5072.190 |
| 230T | 2349.796 | 3876.908 |
| 230T | 2482.605 | 3874.198 |
| 230T | 2544.944 | 3898.591 |
| 230T | 2661.491 | 3912.143 |
| 230T | 2745.513 | 3933.827 |
| 230T | 2916.268 | 3941.958 |

| | | |
|---|---|---|
| 230T | 3016.552 | 3977.193 |
| 230T | 3149.361 | 4009.717 |
| 231O | 319.714 | 4947.512 |
| 231O | 349.529 | 4901.436 |
| 231O | 772.349 | 4546.375 |
| 231O | 807.584 | 4467.773 |
| 231O | 829.268 | 4484.036 |
| 231O | 934.973 | 4465.063 |
| 231O | 972.918 | 4446.090 |
| 231O | 1016.284 | 4446.090 |
| 231O | 1054.230 | 4435.249 |
| 231O | 1108.438 | 4381.041 |
| 231O | 1143.673 | 4324.123 |
| 231O | 1222.274 | 4305.150 |
| 231O | 1246.668 | 4288.888 |
| 231O | 1279.192 | 4280.756 |
| 231O | 1845.664 | 3982.614 |
| 232 | -612.660 | 5283.601 |
| 232 | -588.266 | 5270.049 |
| 232 | -574.714 | 5237.524 |
| 232 | -553.031 | 5226.682 |
| 232 | -536.769 | 5251.076 |
| 232 | -496.113 | 5297.153 |
| 232 | -447.326 | 5297.153 |
| 232 | -384.987 | 5275.470 |
| 233 | -393.118 | 5039.666 |
| 233 | -398.539 | 5158.923 |
| 233 | -382.277 | 5191.447 |
| 235 | 409.157 | 3437.825 |
| 235 | 577.201 | 3478.481 |
| 235 | 680.196 | 3516.426 |
| 235 | 937.683 | 3562.503 |
| 235 | 1162.646 | 3570.634 |
| 235T | 1284.613 | 3719.706 |
| 235T | 1346.952 | 3760.362 |
| 235T | 1406.581 | 3749.520 |
| 235T | 1523.127 | 3754.941 |
| 235T | 1636.964 | 3830.832 |
| 235T | 1742.669 | 3830.832 |
| 235T | 1802.298 | 3879.619 |
| 235T | 1880.899 | 3887.750 |
| 236 | 487.758 | 3223.704 |
| 236 | 829.268 | 3329.410 |
| 236 | 1056.940 | 3383.617 |
| 236 | 1206.012 | 3372.776 |
| 238 | 6610.529 | 3055.660 |
| 238 | 6629.502 | 3042.108 |
| 238 | 6645.764 | 3036.687 |
| 238 | 6686.420 | 3006.873 |
| 238 | 6824.650 | 3071.923 |
| 238 | 6924.934 | 3055.660 |
| 238 | 6935.776 | 2912.010 |
| 238 | 6962.880 | 2860.512 |
| 238 | 6957.459 | 2825.277 |
| 238 | 6976.432 | 2741.255 |
| 238 | 6946.617 | 2668.074 |
| 238 | 6924.934 | 2573.211 |
| 238 | 6922.224 | 2532.555 |
| 238T | 6987.273 | 2548.817 |
| 238T | 7038.771 | 2589.473 |
| 238T | 7147.186 | 2489.189 |
| 238T | 7220.367 | 2356.380 |
| 238T | 7149.897 | 2101.603 |
| 238T | 7163.449 | 2066.368 |
| 238T | 7125.503 | 1882.061 |
| 238T | 7193.263 | 1792.619 |
| 238T | 7364.018 | 1749.252 |
| 439O | 6754.852 | 3426.909 |
| 240O | 6824.650 | 4364.779 |
| 240O | 6849.043 | 4337.675 |
| 240O | 6857.175 | 3914.854 |
| 240O | 6859.885 | 3860.646 |
| 240O | 6881.568 | 3817.280 |
| 241 | 6022.375 | 2077.209 |
| 241 | 6090.134 | 2199.177 |
| 241 | 6239.206 | 2139.548 |
| 241 | 6298.834 | 2144.969 |
| 241 | 6325.938 | 2185.625 |
| 241 | 6344.911 | 2215.439 |
| 241 | 6396.408 | 2234.412 |
| 241 | 6420.802 | 2261.516 |
| 241 | 6464.168 | 2280.489 |





| | | |
|---|---|---|
| 241 | 6534.638 | 2345.538 |
| 241 | 6618.660 | 2359.090 |
| 241 | 6697.262 | 2394.325 |
| 241 | 6708.103 | 2459.374 |
| 241 | 6748.759 | 2502.741 |
| 241 | 6762.311 | 2556.948 |
| 246 | 11538.018 | 6424.675 |
| 247 | 9944.309 | 6362.336 |
| 247 | 9965.992 | 6367.757 |
| 247 | 10098.801 | 6321.680 |
| 247 | 10139.457 | 6324.390 |
| 247 | 10171.981 | 6286.445 |
| 247 | 11413.340 | 6286.445 |
| 248 | 8797.814 | 6245.789 |
| 248 | 8889.967 | 6272.893 |
| 248 | 8949.596 | 6270.183 |
| 248 | 8982.120 | 6294.576 |
| 248 | 9171.848 | 6289.155 |
| 248 | 9364.285 | 6272.893 |
| 248 | 9475.411 | 6278.314 |
| 249 | 6919.514 | 6270.183 |
| 249 | 6989.984 | 6234.948 |
| 249 | 7033.350 | 6232.237 |
| 249 | 7168.869 | 6256.631 |
| 249 | 7469.723 | 6264.762 |
| 249 | 7602.532 | 6226.816 |
| 249 | 7843.757 | 6205.133 |
| 249 | 7906.096 | 6188.871 |
| 249 | 8047.036 | 6194.292 |
| 249 | 8217.790 | 6161.767 |
| 249 | 8290.971 | 6186.161 |
| 249 | 8350.599 | 6175.319 |
| 249 | 8410.228 | 6112.980 |
| 249 | 8453.594 | 6096.718 |
| 249 | 8597.245 | 6118.401 |
| 250 | 8903.519 | 5053.218 |
| 252 | 6930.355 | 5294.442 |
| 252 | 7242.050 | 5291.732 |
| 252 | 7448.040 | 5294.442 |
| 252 | 7691.975 | 5299.863 |
| 252 | 7794.970 | 5305.284 |
| 252 | 8009.090 | 5299.863 |
| 252 | 8122.927 | 5286.311 |
| 252 | 8307.233 | 5286.311 |
| 252 | 8396.676 | 5294.442 |
| 252 | 8421.070 | 5310.705 |
| 253 | 8742.170 | 4446.078 |
| 253 | 8785.175 | 4492.155 |
| 253 | 8797.462 | 4529.016 |
| 253 | 8825.108 | 4562.806 |
| 253 | 8831.251 | 4648.816 |
| 253 | 8861.969 | 4716.395 |
| 253 | 8935.692 | 4719.467 |
| 253 | 9393.388 | 4879.199 |
| 253 | 9503.972 | 4989.784 |
| 254 | 9458.465 | 4879.075 |
| 229O | 412.222 | 5339.144 |
| 229O | 440.348 | 5350.132 |
| 229O | 499.854 | 5287.792 |
| 229O | 508.355 | 5219.785 |
| 229O | 1216.760 | 5109.274 |
| 227O | 1394.363 | 5323.874 |
| 227O | 1393.373 | 5050.216 |
| 226O | 1397.887 | 5012.595 |
| 226O | 1466.037 | 4992.342 |
| 226O | 2684.493 | 4725.982 |
| 202O | 2566.828 | 868.115 |
| 202O | 2641.975 | 801.638 |
| 202O | 2795.160 | 714.930 |
| 202O | 3699.816 | 691.808 |
| 210T | 4580.478 | 2358.835 |
| 210T | 4622.410 | 2379.801 |
| 210T | 4664.343 | 2379.801 |
| 210T | 4701.033 | 2316.902 |
| 210T | 4732.482 | 2285.453 |
| 210T | 4737.724 | 2212.072 |
| 210T | 4779.656 | 2175.381 |
| 210T | 4858.279 | 2122.966 |
| 210T | 4936.902 | 2028.618 |
| 210T | 4931.661 | 1944.754 |
| 210T | 4926.419 | 1871.372 |
| 210T | 4973.593 | 1792.749 |

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210T            5015.525          1719.368
245             9152.137          6398.130
245             9593.523          6410.986
245             9859.213          6419.556
245             9910.636          6462.409
245             9782.077          6655.248
245             9747.795          6723.813
245             9756.365          6848.087
245             9777.792          6950.935
243T            9824.930          7092.350
243T            9953.489          7165.200
244             9632.091          7310.901
244             9623.521          7139.488
244             9627.806          7066.638
244             9653.518          7032.355
244             9692.086          7023.785
243             10206.323         7298.045
207O            5155.858          4201.364
207O            5117.541          2680.183
206             5125.205          2572.895
206             5113.710          1316.101
239O            7038.845          2990.441
204             5313.532          1014.113
204             5339.477          991.984
204             5391.367          985.116
204             5432.573          1038.532
204             5503.540          1031.664
204             5527.195          1062.187
202T            4754.477          688.780
202T            4910.469          810.454
202T            4907.350          885.331
202T            4963.507          932.129
202T            5022.784          941.488
202T            5057.103          922.769
402O            2602.049          880.662
402O            2807.754          749.011
402O            4336.552          722.681
```

# EPA SWMM 5.1
# MASTER PLAN 100-YEAR FUTURE CONDITIONS OUTPUT

olsson | MHFD MILE HIGH FLOOD DISTRICT | City of Thornton | ADAMS COUNTY COLORADO

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
--------------------------------------------------------------

WARNING 04: minimum elevation drop used for Conduit 216
WARNING 04: minimum elevation drop used for Conduit 222
WARNING 04: minimum elevation drop used for Conduit 223
WARNING 04: minimum elevation drop used for Conduit 226
WARNING 04: minimum elevation drop used for Conduit 227
WARNING 04: minimum elevation drop used for Conduit 229
WARNING 04: minimum elevation drop used for Conduit 231
WARNING 04: minimum elevation drop used for Conduit 250T
WARNING 04: minimum elevation drop used for Conduit 202
WARNING 04: minimum elevation drop used for Conduit 230
WARNING 04: minimum elevation drop used for Conduit 221
WARNING 04: minimum elevation drop used for Conduit 207
WARNING 08: elevation drop exceeds length for Conduit 240
WARNING 08: elevation drop exceeds length for Conduit 239
WARNING 04: minimum elevation drop used for Conduit 98

***********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
***********************************************************

***************
Analysis Options
***************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Flow Routing Method ...... KINWAVE
Starting Date ............ 01/01/2005 00:00:00
Ending Date .............. 01/01/2005 06:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Routing Time Step ........ 5.00 sec


*************************        Volume         Volume
Flow Routing Continuity        acre-feet      10^6 gal
*************************     ---------      ---------
Dry Weather Inflow .......         0.000          0.000
Wet Weather Inflow .......         0.000          0.000
Groundwater Inflow .......         0.000          0.000
RDII Inflow ..............         0.000          0.000
External Inflow ..........       479.926        156.391
External Outflow .........       397.456        129.517
Flooding Loss ............         0.000          0.000
Evaporation Loss .........         0.000          0.000
Exfiltration Loss ........         0.000          0.000
Initial Stored Volume ....         0.000          0.000
Final Stored Volume ......        94.624         30.835
Continuity Error (%) .....        -2.533


*********************************
Highest Flow Instability Indexes
*********************************
Link 502 (13)
Link 502O (8)
Link 202T (5)
Link 202O (4)
Link 201 (4)


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     5.00 sec
Average Time Step           :     5.00 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.01
Percent Not Converging      :     0.00
```





```
******************
Node Depth Summary
******************

-------------------------------------------------------------------------------
                            Average  Maximum  Maximum  Time of Max    Reported
                              Depth    Depth      HGL   Occurrence   Max Depth
Node                Type       Feet     Feet     Feet days hr:min        Feet
-------------------------------------------------------------------------------
102                 JUNCTION   0.65     2.16  5151.05    0  00:45        2.16
103                 JUNCTION   0.65     2.16  5153.16    0  00:45        2.16
104                 JUNCTION   2.82     5.85  5085.85    0  00:53        5.85
105                 JUNCTION  13.50    15.00  5100.00    0  00:26       15.00
108                 JUNCTION   0.29     1.17  5180.17    0  00:45        1.17
109                 JUNCTION   0.28     1.27  5195.27    0  00:40        1.27
110                 JUNCTION   0.34     1.49  5121.49    0  00:40        1.49
110T                JUNCTION  10.34    11.49  5115.49    0  00:40       11.49
111                 JUNCTION   0.04     0.26  5123.26    0  00:35        0.26
112T                JUNCTION  16.00    16.00  5139.00    0  00:00       16.00
114                 JUNCTION   8.38     8.85  5113.85    0  01:15        8.85
115                 JUNCTION   6.03     6.45  5138.45    0  02:39        6.45
116                 JUNCTION   0.92     2.64  5154.94    0  01:04        2.64
116O                JUNCTION   2.05     2.45  5154.75    0  02:37        2.45
117                 JUNCTION   0.49     1.88  5163.88    0  00:45        1.88
118T                JUNCTION   8.04     8.13  5166.13    0  00:48        8.13
119                 JUNCTION   0.04     0.14  5172.14    0  00:40        0.14
120                 JUNCTION   1.55     3.61  5180.61    0  00:56        3.61
120T                JUNCTION   1.51     3.61  5161.61    0  00:57        3.61
121                 JUNCTION   0.35     0.50  5216.67    0  01:39        0.50
122                 JUNCTION   0.00     0.00  5259.00    0  00:00        0.00
122O                JUNCTION  10.93    11.07  5270.07    0  01:36       11.07
123                 JUNCTION   0.28     1.02  5178.02    0  01:05        1.02
124                 JUNCTION   0.19     0.68  5286.68    0  00:39        0.68
124T                JUNCTION   0.32     1.35  5223.35    0  01:05        1.35
125                 JUNCTION   0.14     0.44  5316.44    0  00:45        0.44
126                 JUNCTION   7.15     7.60  5220.60    0  00:56        7.59
127                 JUNCTION   0.00     0.00  5241.00    0  00:00        0.00
128                 JUNCTION   0.12     0.39  5266.39    0  00:40        0.39
128T                JUNCTION   0.15     0.66  5264.66    0  00:52        0.65
129                 JUNCTION   0.00     0.00  5267.00    0  00:00        0.00
131                 JUNCTION   0.34     1.75  5251.75    0  00:41        1.74
131O                JUNCTION   0.38     1.45  5251.45    0  00:53        1.44
130T                JUNCTION   0.43     1.49  5184.49    0  00:59        1.49
132                 JUNCTION   0.30     1.33  5287.33    0  00:35        1.32
132T                JUNCTION   0.35     1.75  5280.75    0  00:40        1.74
133                 JUNCTION   0.20     0.76  5293.76    0  00:40        0.76
135                 JUNCTION   0.32     1.42  5274.42    0  00:35        1.42
135T                JUNCTION   0.35     1.42  5237.42    0  00:40        1.41
136                 JUNCTION   0.19     0.54  5276.54    0  00:45        0.54
138                 JUNCTION   0.50     1.38  5080.38    0  01:46        1.37
138T                JUNCTION   2.26     3.00  5076.00    0  00:52        3.00
139                 JUNCTION   0.21     0.45  5087.45    0  01:45        0.45
140                 JUNCTION   0.00     0.00  5092.00    0  00:00        0.00
141                 JUNCTION   0.19     0.69  5093.69    0  00:45        0.69
143                 JUNCTION   0.18     0.60  5054.60    0  01:07        0.60
144                 JUNCTION   0.25     0.81  5075.81    0  00:50        0.81
145                 JUNCTION   0.19     0.95  5067.95    0  00:40        0.94
146                 JUNCTION   0.00     0.00  5054.00    0  00:00        0.00
147                 JUNCTION   0.15     0.43  5055.43    0  01:12        0.42
148                 JUNCTION   0.14     0.43  5073.43    0  00:59        0.43
149                 JUNCTION   0.07     0.28  5115.28    0  00:45        0.28
150                 JUNCTION   0.23     0.97  5056.97    0  00:48        0.97
150T                JUNCTION   0.16     0.47  5055.47    0  01:17        0.47
151                 JUNCTION   0.27     1.19  5062.19    0  00:48        1.19
152                 JUNCTION   0.24     1.23  5101.23    0  00:40        1.23
153                 JUNCTION   0.02     0.07  5063.07    0  00:45        0.07
154                 JUNCTION   0.02     0.06  5069.06    0  00:55        0.06
118                 JUNCTION   3.12     3.59  5176.59    0  00:40        3.59
107                 JUNCTION  20.30    21.17  5159.17    0  00:47       21.17
143T                JUNCTION   0.26     0.85  5055.85    0  00:59        0.85
134                 JUNCTION   0.20     0.83  5184.83    0  00:45        0.83
130                 JUNCTION   0.39     1.37  5184.37    0  01:01        1.36
121O                JUNCTION   6.08     6.28  5204.65    0  01:29        6.28
140O                JUNCTION   0.23     0.54  5090.34    0  01:17        0.53
102T                JUNCTION  20.50    23.40  5120.40    0  01:17       23.40
101                 JUNCTION  12.08    13.47  5097.82    0  00:47       13.46
115T                JUNCTION   2.42     2.86  5134.86    0  01:07        2.85
100                 OUTFALL    4.81     7.85  5074.85    0  00:54        7.85
137                 OUTFALL    0.14     0.27  5069.27    0  02:10        0.27
142                 OUTFALL    0.00     0.00  5051.00    0  00:00        0.00
```

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 155 | OUTFALL | 0.00 | 0.00 | 5046.00 | 0 | 00:00 | 0.00 | |
| 129O | DIVIDER | 5.10 | 5.66 | 5272.66 | 0 | 00:52 | 5.64 | |
| 127O | DIVIDER | 7.06 | 7.57 | 5248.57 | 0 | 00:47 | 7.57 | |
| 126O | DIVIDER | 9.75 | 10.85 | 5223.85 | 0 | 01:04 | 10.85 | |
| 139O | DIVIDER | 8.09 | 9.00 | 5088.38 | 0 | 01:43 | 9.00 | |
| 107O | DIVIDER | 7.15 | 8.03 | 5146.03 | 0 | 00:48 | 8.03 | |
| 106 | DIVIDER | 6.35 | 7.47 | 5117.47 | 0 | 00:58 | 7.47 | |
| 102O | DIVIDER | 1.37 | 4.30 | 5144.30 | 0 | 01:14 | 4.30 | |
| 113 | DIVIDER | 16.96 | 16.96 | 5166.00 | 0 | 00:00 | 16.96 | |
| 112 | DIVIDER | 21.50 | 21.50 | 5164.00 | 0 | 00:00 | 21.50 | |
| 316 | STORAGE | 8.66 | 10.94 | 5163.24 | 0 | 02:37 | 10.94 | |
| 302 | STORAGE | 2.09 | 7.98 | 5156.87 | 0 | 00:57 | 7.97 | |
| 322 | STORAGE | 2.66 | 5.75 | 5264.75 | 0 | 01:36 | 5.75 | |
| 331 | STORAGE | 2.25 | 7.09 | 5257.09 | 0 | 00:53 | 7.08 | |
| 327 | STORAGE | 0.31 | 1.48 | 5242.48 | 0 | 00:47 | 1.48 | |
| 326 | STORAGE | 0.42 | 2.56 | 5215.56 | 0 | 01:04 | 2.56 | |
| 329 | STORAGE | 0.21 | 1.03 | 5268.03 | 0 | 00:52 | 1.03 | |
| 321S | STORAGE | 3.21 | 4.78 | 5203.15 | 0 | 01:29 | 4.78 | |
| 307 | STORAGE | 1.27 | 2.40 | 5140.40 | 0 | 00:48 | 2.40 | |
| 340 | STORAGE | 5.02 | 6.27 | 5096.07 | 0 | 01:17 | 6.27 | |
| 339 | STORAGE | 6.59 | 9.08 | 5088.46 | 0 | 01:43 | 9.08 | |
| 321N | STORAGE | 3.74 | 6.54 | 5222.71 | 0 | 01:16 | 6.54 | |
| 302O | STORAGE | 2.54 | 9.84 | 5149.84 | 0 | 01:14 | 9.84 | |

**********
Node Inflow Summary
**********

| Node | Type | Maximum Lateral Inflow CFS | Maximum Total Inflow CFS | Time of Max Occurrence days hr:min | Lateral Inflow Volume 10^6 gal | Total Inflow Volume 10^6 gal | Flow Balance Error Percent |
|---|---|---|---|---|---|---|---|
| 102 | JUNCTION | 159.01 | 334.90 | 0 00:50 | 5.55 | 11.3 | 0.000 |
| 103 | JUNCTION | 176.35 | 176.35 | 0 00:45 | 5.75 | 5.75 | 0.000 |
| 104 | JUNCTION | 70.89 | 1212.97 | 0 00:53 | 1.77 | 60.1 | 0.000 |
| 105 | JUNCTION | 159.61 | 703.08 | 0 00:55 | 4.46 | 41 | 0.000 |
| 108 | JUNCTION | 68.87 | 68.87 | 0 00:45 | 2.04 | 2.04 | 0.000 |
| 109 | JUNCTION | 65.48 | 65.48 | 0 00:40 | 1.6 | 1.6 | 0.000 |
| 110 | JUNCTION | 47.67 | 96.19 | 0 00:40 | 1.32 | 2.31 | 0.000 |
| 110T | JUNCTION | 0.00 | 301.55 | 0 00:41 | 0 | 27 | 0.000 |
| 111 | JUNCTION | 50.46 | 50.46 | 0 00:35 | 0.994 | 0.994 | 0.000 |
| 112T | JUNCTION | 0.00 | 0.00 | 0 00:00 | 0 | 0 | 0.000 gal |
| 114 | JUNCTION | 6.58 | 210.76 | 0 01:14 | 0.357 | 24.7 | 0.000 |
| 115 | JUNCTION | 106.96 | 164.78 | 0 02:00 | 1.82 | 22.6 | 0.000 |
| 116 | JUNCTION | 185.99 | 1316.32 | 0 01:03 | 4.43 | 46.4 | 0.000 |
| 116O | JUNCTION | 0.00 | 162.09 | 0 02:37 | 0 | 21 | 0.000 |
| 117 | JUNCTION | 134.66 | 134.66 | 0 00:45 | 3.81 | 3.81 | 0.000 |
| 118T | JUNCTION | 0.00 | 87.63 | 0 00:43 | 0 | 2.28 | 0.000 |
| 119 | JUNCTION | 17.46 | 17.46 | 0 00:40 | 0.558 | 0.558 | 0.000 |
| 120 | JUNCTION | 34.28 | 390.98 | 0 00:56 | 0.883 | 16.3 | 0.000 |
| 120T | JUNCTION | 0.00 | 1001.32 | 0 01:03 | 0 | 35.9 | 0.000 |
| 121 | JUNCTION | 35.07 | 54.64 | 0 01:05 | 0.986 | 3.76 | 0.000 |
| 122 | JUNCTION | 121.69 | 121.69 | 0 00:40 | 2.95 | 2.95 | 0.000 |
| 122O | JUNCTION | 0.00 | 32.84 | 0 01:36 | 0 | 2.78 | 0.000 |
| 123 | JUNCTION | 156.02 | 282.03 | 0 00:58 | 4.62 | 8.53 | 0.000 |
| 124 | JUNCTION | 53.95 | 67.52 | 0 00:39 | 1.04 | 1.63 | 0.000 |
| 124T | JUNCTION | 0.00 | 151.28 | 0 01:01 | 0 | 3.91 | 0.000 |
| 125 | JUNCTION | 18.26 | 18.26 | 0 00:45 | 0.59 | 0.59 | 0.000 |
| 126 | JUNCTION | 85.78 | 158.86 | 0 00:54 | 1.55 | 4.11 | 0.000 |
| 127 | JUNCTION | 101.60 | 101.60 | 0 00:35 | 1.9 | 1.9 | 0.000 |
| 128 | JUNCTION | 12.50 | 12.50 | 0 00:40 | 0.385 | 0.385 | 0.000 |
| 128T | JUNCTION | 0.00 | 47.65 | 0 00:52 | 0 | 0.96 | 0.000 |
| 129 | JUNCTION | 64.10 | 64.10 | 0 00:40 | 1.59 | 1.59 | 0.000 |
| 131 | JUNCTION | 33.39 | 339.70 | 0 00:41 | 0.842 | 7.52 | 0.000 |
| 131O | JUNCTION | 0.00 | 282.93 | 0 00:53 | 0 | 7.51 | 0.000 |
| 130T | JUNCTION | 0.00 | 619.23 | 0 00:59 | 0 | 19.6 | 0.000 |
| 132 | JUNCTION | 219.28 | 219.28 | 0 00:35 | 4.51 | 4.51 | 0.000 |
| 132T | JUNCTION | 0.00 | 306.70 | 0 00:40 | 0 | 6.67 | 0.000 |
| 133 | JUNCTION | 89.01 | 89.01 | 0 00:40 | 2.16 | 2.16 | 0.000 |
| 135 | JUNCTION | 105.41 | 105.41 | 0 00:35 | 2.31 | 2.31 | 0.000 |
| 135T | JUNCTION | 0.00 | 130.66 | 0 00:42 | 0 | 3.37 | 0.000 |
| 136 | JUNCTION | 30.08 | 30.08 | 0 00:45 | 1.06 | 1.06 | 0.000 |
| 138 | JUNCTION | 73.87 | 129.19 | 0 01:13 | 2.24 | 5.66 | 0.000 |
| 138T | JUNCTION | 0.00 | 193.65 | 0 01:21 | 0 | 11.1 | 0.000 |
| 139 | JUNCTION | 157.91 | 158.63 | 0 00:40 | 4.07 | 7.83 | 0.000 |
| 140 | JUNCTION | 129.28 | 129.28 | 0 00:50 | 4.54 | 4.54 | 0.000 |
| 141 | JUNCTION | 63.72 | 63.72 | 0 00:45 | 1.92 | 1.92 | 0.000 |
| 143 | JUNCTION | 136.26 | 433.38 | 0 01:04 | 3.5 | 14.8 | 0.000 |
| 144 | JUNCTION | 131.46 | 131.46 | 0 00:50 | 4.72 | 4.72 | -0.000 |





| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 145 | JUNCTION | 257.76 | 257.76 | 0 | 00:40 | 6.17 | 6.17 | -0.000 |
| 146 | JUNCTION | 99.25 | 638.79 | 0 | 01:11 | 3 | 27.3 | 0.000 |
| 147 | JUNCTION | 184.64 | 568.78 | 0 | 01:13 | 6.15 | 24.3 | 0.000 |
| 148 | JUNCTION | 90.30 | 118.41 | 0 | 00:59 | 2.44 | 4.49 | 0.000 |
| 149 | JUNCTION | 63.55 | 63.55 | 0 | 00:45 | 1.9 | 1.9 | 0.000 |
| 150 | JUNCTION | 129.47 | 353.70 | 0 | 00:47 | 3.95 | 10.2 | -0.000 |
| 150T | JUNCTION | 0.00 | 314.57 | 0 | 01:19 | 0 | 13.6 | 0.000 |
| 151 | JUNCTION | 77.01 | 226.79 | 0 | 00:48 | 2.56 | 6.21 | 0.000 |
| 152 | JUNCTION | 160.01 | 160.01 | 0 | 00:40 | 3.6 | 3.6 | 0.000 |
| 153 | JUNCTION | 30.06 | 30.06 | 0 | 00:45 | 0.991 | 0.991 | 0.000 |
| 154 | JUNCTION | 29.49 | 29.49 | 0 | 00:55 | 1.29 | 1.29 | 0.000 |
| 118 | JUNCTION | 72.04 | 72.04 | 0 | 00:40 | 1.72 | 1.72 | 0.000 |
| 107 | JUNCTION | 96.79 | 217.89 | 0 | 00:45 | 2.28 | 5.93 | 0.000 |
| 143T | JUNCTION | 0.00 | 341.63 | 0 | 00:58 | 0 | 11.2 | 0.000 |
| 134 | JUNCTION | 104.54 | 233.92 | 0 | 00:45 | 3.06 | 6.44 | 0.000 |
| 130 | JUNCTION | 186.15 | 418.35 | 0 | 01:00 | 5.61 | 13.2 | 0.000 |
| 121O | JUNCTION | 0.00 | 48.14 | 0 | 01:29 | 0 | 3.76 | 0.000 |
| 140O | JUNCTION | 0.00 | 97.70 | 0 | 01:17 | 0 | 4.03 | 0.000 |
| 102T | JUNCTION | 283.60 | 425.69 | 0 | 00:47 | 5.27 | 16.5 | 0.000 |
| 101 | JUNCTION | 37.25 | 460.35 | 0 | 00:47 | 0.992 | 17.5 | 0.000 |
| 115T | JUNCTION | 0.00 | 205.79 | 0 | 01:07 | 0 | 24.7 | 0.000 |
| 100 | OUTFALL | 18.51 | 1226.60 | 0 | 00:54 | 0.432 | 60.4 | 0.000 |
| 137 | OUTFALL | 69.34 | 204.14 | 0 | 01:51 | 3.73 | 14.6 | 0.000 |
| 142 | OUTFALL | 142.10 | 756.04 | 0 | 01:09 | 4.93 | 32.2 | 0.000 |
| 155 | OUTFALL | 388.76 | 635.72 | 0 | 00:58 | 7.41 | 22.2 | 0.000 |
| 129O | DIVIDER | 0.00 | 55.96 | 0 | 00:52 | 0 | 1.59 | 0.000 |
| 127O | DIVIDER | 0.00 | 79.27 | 0 | 00:47 | 0 | 1.9 | -0.000 |
| 126O | DIVIDER | 0.00 | 162.26 | 0 | 01:04 | 0 | 5.42 | -0.000 |
| 139O | DIVIDER | 0.00 | 110.91 | 0 | 01:43 | 0 | 6.82 | -0.000 |
| 107O | DIVIDER | 0.00 | 215.11 | 0 | 00:48 | 0 | 5.8 | 0.000 |
| 106 | DIVIDER | 173.13 | 312.90 | 0 | 00:58 | 4.01 | 10.1 | 0.000 |
| 102O | DIVIDER | 0.00 | 288.01 | 0 | 01:14 | 0 | 11.3 | -0.000 |
| 113 | DIVIDER | 89.28 | 89.28 | 0 | 00:35 | 1.71 | 1.71 | -0.000 |
| 112 | DIVIDER | 15.33 | 103.62 | 0 | 00:36 | 0.359 | 2.07 | 0.000 |
| 316 | STORAGE | 0.00 | 1316.32 | 0 | 01:03 | 0 | 46.4 | -0.002 |
| 302 | STORAGE | 0.00 | 334.90 | 0 | 00:50 | 0 | 11.3 | 0.037 |
| 322 | STORAGE | 0.00 | 121.69 | 0 | 00:40 | 0 | 2.95 | 0.009 |
| 331 | STORAGE | 0.00 | 339.70 | 0 | 00:41 | 0 | 7.52 | 0.047 |
| 327 | STORAGE | 0.00 | 101.60 | 0 | 00:35 | 0 | 1.9 | 0.026 |
| 326 | STORAGE | 0.00 | 158.86 | 0 | 00:54 | 0 | 4.11 | 0.017 |
| 329 | STORAGE | 0.00 | 64.10 | 0 | 00:40 | 0 | 1.59 | 0.000 |
| 321S | STORAGE | 0.00 | 52.27 | 0 | 01:16 | 0 | 3.76 | 0.003 |
| 307 | STORAGE | 0.00 | 217.89 | 0 | 00:45 | 0 | 5.93 | 0.033 |
| 340 | STORAGE | 0.00 | 129.28 | 0 | 00:50 | 0 | 4.54 | -0.001 |
| 339 | STORAGE | 0.00 | 158.63 | 0 | 00:40 | 0 | 7.83 | 0.009 |
| 321N | STORAGE | 0.00 | 54.64 | 0 | 01:05 | 0 | 3.76 | 0.006 |
| 302O | STORAGE | 0.00 | 318.52 | 0 | 00:57 | 0 | 11.3 | 0.020 |

**********
Node Flooding Summary
**********

No nodes were flooded.

**********
Storage Volume Summary
**********

| Storage Unit | Average Volume 1000 ft3 | Avg Pcnt Full | Evap Pcnt Loss | Exfil Pcnt Loss | Maximum Volume 1000 ft3 | Max Pcnt Full | Time of Max Occurrence days hr:min | Maximum Outflow CFS |
|---|---|---|---|---|---|---|---|---|
| 316 | 3434.636 | 43 | 0 | 0 | 4670.483 | 59 | 0 02:37 | 162.09 |
| 302 | 6.496 | 2 | 0 | 0 | 51.827 | 19 | 0 00:56 | 318.52 |
| 322 | 115.833 | 22 | 0 | 0 | 250.370 | 47 | 0 01:36 | 32.84 |
| 331 | 98.058 | 27 | 0 | 0 | 308.903 | 84 | 0 00:53 | 282.93 |
| 327 | 13.382 | 16 | 0 | 0 | 64.547 | 78 | 0 00:47 | 79.27 |
| 326 | 18.069 | 10 | 0 | 0 | 111.625 | 61 | 0 01:04 | 128.99 |
| 329 | 8.958 | 19 | 0 | 0 | 44.919 | 94 | 0 00:51 | 55.96 |
| 321S | 17.794 | 19 | 0 | 0 | 36.976 | 39 | 0 01:29 | 48.14 |
| 307 | 55.383 | 37 | 0 | 0 | 104.463 | 71 | 0 00:48 | 215.11 |
| 340 | 173.456 | 36 | 0 | 0 | 266.523 | 55 | 0 01:17 | 97.70 |
| 339 | 168.431 | 46 | 0 | 0 | 266.851 | 73 | 0 01:43 | 110.91 |
| 321N | 17.287 | 16 | 0 | 0 | 46.467 | 44 | 0 01:16 | 52.27 |
| 302O | 30.322 | 15 | 0 | 0 | 160.751 | 82 | 0 01:14 | 288.01 |

**********
Outfall Loading Summary

**********

| Outfall Node | Flow Freq Pcnt | Avg Flow CFS | Max Flow CFS | Total Volume 10^6 gal |
|---|---|---|---|---|
| 100 | 97.20 | 384.83 | 1226.60 | 60.433 |
| 137 | 97.20 | 92.95 | 204.14 | 14.596 |
| 142 | 97.20 | 205.26 | 756.04 | 32.234 |
| 155 | 98.59 | 139.65 | 635.72 | 22.244 |
| System | 97.55 | 822.69 | 635.72 | 129.507 |

**********
Link Flow Summary
**********

| Link | Type | Maximum \|Flow\| CFS | Time of Max Occurrence days hr:min | Maximum \|Veloc\| ft/sec | Max/ Full Flow | Max/ Full Depth |
|---|---|---|---|---|---|---|
| 203 | CONDUIT | 176.34 | 0 00:45 | 8.58 | 0.06 | 0.31 |
| 205 | CONDUIT | 702.84 | 0 00:56 | 4.98 | 0.18 | 0.41 |
| 406 | CONDUIT | 264.59 | 0 01:03 | 11.81 | 0.04 | 0.29 |
| 407O | CONDUIT | 146.98 | 0 01:03 | 4.12 | 0.21 | 0.48 |
| 208 | CONDUIT | 68.37 | 0 00:47 | 3.95 | 0.06 | 0.23 |
| 209 | CONDUIT | 62.40 | 0 00:48 | 4.22 | 0.15 | 0.41 |
| 210 | CONDUIT | 96.16 | 0 00:40 | 5.41 | 0.01 | 0.15 |
| 211 | CONDUIT | 48.62 | 0 00:40 | 1.12 | 0.10 | 0.25 |
| 412 | CONDUIT | 0.00 | 0 00:00 | 0.00 | 0.00 | 0.00 |
| 212T | CONDUIT | 0.00 | 0 00:00 | 0.00 | 0.00 | 0.00 |
| 413 | CONDUIT | 0.00 | 0 00:00 | 0.00 | 0.00 | 0.00 |
| 214 | CONDUIT | 210.76 | 0 01:15 | 4.48 | 0.08 | 0.35 |
| 215T | CONDUIT | 204.66 | 0 01:15 | 5.36 | 0.09 | 0.36 |
| 216 | DUMMY | 1316.32 | 0 01:03 | | | |
| 216O | CONDUIT | 162.09 | 0 02:39 | 5.94 | 0.07 | 0.31 |
| 217 | CONDUIT | 134.71 | 0 00:45 | 4.15 | 0.04 | 0.27 |
| 218 | CONDUIT | 71.26 | 0 00:42 | 3.14 | 0.10 | 0.29 |
| 218T | CONDUIT | 87.07 | 0 00:47 | 1.96 | 0.01 | 0.10 |
| 219 | CONDUIT | 17.19 | 0 00:48 | 0.97 | 0.03 | 0.13 |
| 220 | CONDUIT | 390.94 | 0 00:57 | 7.73 | 0.48 | 0.72 |
| 220T | CONDUIT | 1000.57 | 0 01:04 | 5.08 | 0.30 | 0.53 |
| 221O | CONDUIT | 47.92 | 0 01:32 | 5.36 | 0.00 | 0.13 |
| 222 | DUMMY | 121.69 | 0 00:40 | | | |
| 222O | CONDUIT | 32.84 | 0 01:39 | 6.06 | 0.00 | 0.10 |
| 223 | DUMMY | 282.03 | 0 00:58 | | | |
| 224 | CONDUIT | 67.06 | 0 00:42 | 6.93 | 0.01 | 0.13 |
| 224T | CONDUIT | 150.88 | 0 01:05 | 7.05 | 0.02 | 0.20 |
| 225 | CONDUIT | 18.15 | 0 00:47 | 4.19 | 0.00 | 0.09 |
| 226 | DUMMY | 158.86 | 0 00:54 | | | |
| 426O | CONDUIT | 103.42 | 0 01:05 | 4.10 | 0.03 | 0.27 |
| 227 | DUMMY | 101.60 | 0 00:35 | | | |
| 427O | CONDUIT | 45.93 | 0 00:49 | 12.34 | 0.00 | 0.11 |
| 228 | CONDUIT | 12.49 | 0 00:40 | 3.72 | 0.00 | 0.08 |
| 228T | CONDUIT | 45.67 | 0 00:56 | 6.03 | 0.00 | 0.12 |
| 229 | DUMMY | 64.10 | 0 00:40 | | | |
| 429O | CONDUIT | 36.01 | 0 00:52 | 3.85 | 0.39 | 0.66 |
| 230T | CONDUIT | 612.72 | 0 01:03 | 4.87 | 0.12 | 0.30 |
| 231 | DUMMY | 339.70 | 0 00:41 | | | |
| 231O | CONDUIT | 256.53 | 0 01:01 | 5.63 | 0.01 | 0.09 |
| 232 | CONDUIT | 218.18 | 0 00:38 | 6.04 | 0.03 | 0.26 |
| 232T | CONDUIT | 306.57 | 0 00:41 | 7.66 | 0.03 | 0.17 |
| 233 | CONDUIT | 88.83 | 0 00:40 | 7.21 | 0.01 | 0.15 |
| 235 | CONDUIT | 104.92 | 0 00:40 | 9.24 | 0.04 | 0.28 |
| 235T | CONDUIT | 129.51 | 0 00:46 | 4.12 | 0.02 | 0.10 |
| 236 | CONDUIT | 29.75 | 0 00:51 | 4.74 | 0.00 | 0.11 |
| 238 | CONDUIT | 119.41 | 0 01:23 | 1.11 | 0.01 | 0.07 |
| 238T | CONDUIT | 164.14 | 0 02:10 | 0.70 | 0.11 | 0.27 |
| 439O | CONDUIT | 84.12 | 0 01:46 | 3.11 | 0.16 | 0.46 |
| 240O | CONDUIT | 70.88 | 0 01:45 | 0.84 | 0.24 | 0.44 |
| 241 | CONDUIT | 59.34 | 0 00:58 | 1.99 | 0.40 | 0.66 |
| 246 | DUMMY | 638.79 | 0 01:11 | | | |
| 247 | DUMMY | 568.78 | 0 01:13 | | | |
| 248 | CONDUIT | 115.91 | 0 01:12 | 1.68 | 0.19 | 0.42 |
| 249 | CONDUIT | 52.97 | 0 01:13 | 1.58 | 0.07 | 0.25 |
| 250 | CONDUIT | 285.73 | 0 01:17 | 0.62 | 0.01 | 0.05 |
| 250T | DUMMY | 314.57 | 0 01:19 | | | |
| 251 | CONDUIT | 226.75 | 0 00:48 | 4.03 | 0.02 | 0.11 |
| 252 | CONDUIT | 150.26 | 0 00:48 | 4.05 | 0.10 | 0.30 |





| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 253 | CONDUIT | 19.17 | 0 | 01:45 | 0.41 | 0.00 | 0.01 |
| 254 | CONDUIT | 19.72 | 0 | 01:52 | 0.43 | 0.00 | 0.01 |
| 229O | CONDUIT | 21.44 | 0 | 00:35 | 11.17 | 1.08 | 1.00 |
| 227O | CONDUIT | 35.98 | 0 | 00:35 | 12.63 | 1.08 | 1.00 |
| 226O | CONDUIT | 63.64 | 0 | 02:04 | 10.08 | 1.08 | 1.00 |
| 202O | CONDUIT | 287.89 | 0 | 01:17 | 11.66 | 0.69 | 0.61 |
| 202 | DUMMY | 334.90 | 0 | 00:50 | | | |
| 210T | CONDUIT | 289.96 | 0 | 00:48 | 5.17 | 0.10 | 0.37 |
| 245 | CONDUIT | 214.27 | 0 | 00:59 | 2.04 | 0.23 | 0.42 |
| 243T | CONDUIT | 334.19 | 0 | 01:07 | 0.94 | 0.04 | 0.15 |
| 244 | CONDUIT | 130.74 | 0 | 00:52 | 3.51 | 0.16 | 0.40 |
| 243 | DUMMY | 433.38 | 0 | 01:04 | | | |
| 234 | CONDUIT | 233.90 | 0 | 00:45 | 4.41 | 0.04 | 0.17 |
| 230 | DUMMY | 418.35 | 0 | 01:00 | | | |
| 221 | DUMMY | 54.64 | 0 | 01:05 | | | |
| 207 | DUMMY | 217.89 | 0 | 00:45 | | | |
| 240 | DUMMY | 129.28 | 0 | 00:50 | | | |
| 239 | DUMMY | 158.63 | 0 | 00:40 | | | |
| 207O | CONDUIT | 51.90 | 0 | 01:59 | 8.31 | 1.08 | 1.00 |
| 206 | CONDUIT | 50.52 | 0 | 02:16 | 8.06 | 1.08 | 1.00 |
| 239O | CONDUIT | 28.87 | 0 | 03:57 | 4.55 | 1.08 | 1.00 |
| 204 | CONDUIT | 1212.88 | 0 | 00:54 | 11.05 | 0.33 | 0.58 |
| 202T | CONDUIT | 425.31 | 0 | 00:48 | 18.51 | 0.63 | 0.58 |
| 201 | CONDUIT | 460.20 | 0 | 00:48 | 25.98 | 0.27 | 0.39 |
| 402O | CONDUIT | 0.00 | 0 | 00:00 | 0.00 | 0.00 | 0.00 |
| 98 | DUMMY | 164.78 | 0 | 02:00 | | | |
| 213 | CONDUIT | 88.34 | 0 | 00:36 | 10.49 | 0.73 | 0.64 |
| 212 | CONDUIT | 102.79 | 0 | 00:39 | 10.83 | 0.86 | 0.71 |
| 502 | DUMMY | 318.52 | 0 | 00:57 | | | |
| 507 | DUMMY | 215.11 | 0 | 00:48 | | | |
| 516 | DUMMY | 162.09 | 0 | 02:37 | | | |
| 521S | DUMMY | 48.14 | 0 | 01:29 | | | |
| 522 | DUMMY | 32.84 | 0 | 01:36 | | | |
| 526 | DUMMY | 128.99 | 0 | 01:04 | | | |
| 527 | DUMMY | 79.27 | 0 | 00:47 | | | |
| 529 | DUMMY | 55.96 | 0 | 00:52 | | | |
| 531 | DUMMY | 282.93 | 0 | 00:53 | | | |
| 539 | DUMMY | 110.91 | 0 | 01:43 | | | |
| 540 | DUMMY | 97.70 | 0 | 01:17 | | | |
| 521N | DUMMY | 52.27 | 0 | 01:16 | | | |
| 502O | DUMMY | 288.01 | 0 | 01:14 | | | |

**********
Conduit Surcharge Summary
**********

| Conduit | Hours Full: Both Ends | Hours Full: Upstream | Hours Full: Dnstream | Hours Above Full Normal Flow | Hours Capacity Limited |
|---|---|---|---|---|---|
| 229O | 1.70 | 1.70 | 1.70 | 1.68 | 1.70 |
| 227O | 0.78 | 0.78 | 0.78 | 0.80 | 0.78 |
| 226O | 1.51 | 1.51 | 1.51 | 0.09 | 1.51 |
| 207O | 1.31 | 1.31 | 1.31 | 0.08 | 1.31 |
| 206 | 1.85 | 1.85 | 1.85 | 1.88 | 1.85 |
| 239O | 3.11 | 3.11 | 3.11 | 0.15 | 3.11 |

Analysis begun on:  Mon Jun  8 09:17:23 2020
Analysis ended on:  Mon Jun  8 09:17:23 2020
Total elapsed time: < 1 sec

## Table F-1 - Master Plan Peak Flows and Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Future Percent Imperviousness | Future Conditions Master Plan Peak Flow (cfs) | | | | | | | Future Condtions Master Plan Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 100 | 1691 | 2.6 | 46 | 210 | 323 | 445 | 783 | 977 | 1,227 | 1,860 | 28 | 47 | 72 | 122 | 153 | 185 | 260 |
| 101 | 317 | 0.5 | 51 | 94 | 139 | 189 | 318 | 385 | 460 | 671 | 10 | 16 | 22 | 34 | 43 | 54 | 81 |
| 102O | 215 | 0.3 | 42 | 46 | 75 | 110 | 192 | 235 | 288 | 429 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |
| 302O | 215 | 0.3 | 42 | 49 | 79 | 116 | 203 | 256 | 319 | 429 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |
| 302 | 215 | 0.3 | 42 | 49 | 79 | 116 | 204 | 261 | 335 | 503 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |
| 102 | 215 | 0.3 | 42 | 49 | 79 | 116 | 204 | 261 | 335 | 503 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |
| 103 | 111 | 0.2 | 39 | 24 | 40 | 60 | 107 | 138 | 176 | 267 | 3 | 4 | 6 | 11 | 14 | 18 | 27 |
| 102T | 298 | 0.5 | 51 | 89 | 131 | 178 | 298 | 358 | 426 | 608 | 10 | 15 | 21 | 32 | 40 | 51 | 76 |
| 104 | 1684 | 2.6 | 46 | 207 | 318 | 439 | 773 | 965 | 1,213 | 1,847 | 28 | 47 | 71 | 121 | 152 | 184 | 258 |
| 105 | 1333 | 2.1 | 45 | 106 | 167 | 236 | 421 | 541 | 703 | 1,104 | 17 | 30 | 48 | 85 | 106 | 126 | 170 |
| 106 | 173 | 0.3 | 58 | 41 | 75 | 106 | 183 | 238 | 313 | 480 | 6 | 9 | 13 | 20 | 25 | 31 | 46 |
| 107 | 107 | 0.2 | 52 | 37 | 57 | 80 | 135 | 171 | 218 | 326 | 4 | 5 | 7 | 11 | 14 | 18 | 27 |
| 307 | 107 | 0.2 | 52 | 37 | 57 | 80 | 135 | 171 | 218 | 326 | 4 | 5 | 7 | 11 | 14 | 18 | 27 |
| 107O | 107 | 0.2 | 52 | 22 | 46 | 72 | 132 | 168 | 215 | 321 | 3 | 5 | 7 | 11 | 14 | 18 | 27 |
| 108 | 42 | 0.1 | 32 | 8 | 13 | 21 | 40 | 53 | 69 | 106 | 1 | 1 | 2 | 4 | 5 | 6 | 10 |
| 109 | 30 | 0.0 | 46 | 11 | 17 | 24 | 41 | 52 | 65 | 98 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |
| 110 | 41 | 0.1 | 97 | 17 | 27 | 37 | 61 | 77 | 96 | 176 | 1 | 2 | 3 | 5 | 6 | 7 | 11 |
| 110T | 1077 | 1.7 | 43 | 53 | 82 | 115 | 189 | 240 | 302 | 446 | 9 | 17 | 30 | 57 | 71 | 83 | 105 |
| 111 | 18 | 0.0 | 54 | 10 | 15 | 20 | 32 | 40 | 50 | 74 | 1 | 1 | 1 | 2 | 2 | 3 | 5 |
| 112 | 40 | 0.1 | 9 | 16 | 26 | 38 | 64 | 82 | 104 | 152 | 1 | 2 | 2 | 4 | 5 | 6 | 10 |
| 112T | 40 | 0.1 | 43 | 0 | 0 | 0 | 0 | 0 | 0 | 37 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 113 | 33 | 0.1 | 42 | 14 | 22 | 33 | 54 | 70 | 89 | 134 | 1 | 1 | 2 | 3 | 4 | 5 | 8 |
| 114 | 1036 | 1.6 | 41 | 36 | 55 | 78 | 140 | 164 | 211 | 319 | 7 | 15 | 27 | 53 | 66 | 76 | 94 |
| 115 | 988 | 1.5 | 43 | 24 | 40 | 74 | 135 | 150 | 165 | 206 | 6 | 13 | 24 | 49 | 61 | 69 | 84 |
| 115T | 1028 | 1.6 | 43 | 37 | 56 | 80 | 138 | 162 | 206 | 311 | 7 | 15 | 27 | 53 | 66 | 76 | 94 |
| 116O | 957 | 1.5 | 42 | 14 | 40 | 74 | 135 | 147 | 162 | 187 | 5 | 12 | 22 | 46 | 57 | 64 | 77 |
| 316 | 957 | 1.5 | 42 | 181 | 280 | 397 | 726 | 929 | 1,316 | 2,292 | 24 | 37 | 51 | 84 | 109 | 142 | 221 |
| 116 | 957 | 1.5 | 42 | 181 | 280 | 397 | 726 | 929 | 1,316 | 2,292 | 24 | 37 | 51 | 84 | 109 | 142 | 221 |
| 117 | 72 | 0.1 | 43 | 21 | 34 | 49 | 83 | 106 | 135 | 202 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 118T | 56 | 0.1 | 40 | 12 | 18 | 23 | 47 | 64 | 88 | 143 | 1 | 2 | 2 | 4 | 5 | 7 | 11 |
| 118 | 43 | 0.1 | 36 | 9 | 14 | 19 | 39 | 53 | 72 | 117 | 1 | 1 | 2 | 3 | 4 | 5 | 9 |
| 119 | 14 | 0.0 | 50 | 4 | 5 | 6 | 9 | 13 | 17 | 28 | 0 | 1 | 1 | 1 | 1 | 2 | 3 |
| 120 | 343 | 0.5 | 43 | 74 | 112 | 148 | 249 | 308 | 391 | 713 | 9 | 13 | 18 | 30 | 38 | 50 | 77 |
| 120T | 733 | 1.1 | 43 | 139 | 212 | 298 | 516 | 691 | 1,001 | 1,745 | 19 | 29 | 40 | 65 | 85 | 110 | 170 |
| 121 | 86 | 0.1 | 34 | 8 | 12 | 17 | 30 | 40 | 55 | 104 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 321N | 86 | 0.1 | 34 | 8 | 12 | 17 | 30 | 40 | 55 | 104 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 321S | 86 | 0.1 | 34 | 8 | 12 | 17 | 28 | 34 | 52 | 103 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 121O | 86 | 0.1 | 34 | 8 | 12 | 16 | 26 | 33 | 48 | 101 | 2 | 3 | 4 | 7 | 9 | 12 | 18 |
| 122O | 58 | 0.1 | 37 | 6 | 9 | 13 | 22 | 27 | 33 | 75 | 1 | 2 | 3 | 5 | 7 | 9 | 13 |
| 322 | 58 | 0.1 | 37 | 16 | 27 | 41 | 74 | 95 | 122 | 184 | 1 | 2 | 3 | 5 | 7 | 9 | 14 |
| 122 | 58 | 0.1 | 37 | 16 | 27 | 41 | 74 | 95 | 122 | 184 | 1 | 2 | 3 | 5 | 7 | 9 | 14 |
| 123 | 232 | 0.4 | 46 | 32 | 49 | 68 | 156 | 207 | 282 | 580 | 3 | 5 | 7 | 13 | 19 | 26 | 44 |
| 124 | 30 | 0.0 | 47 | 11 | 17 | 25 | 42 | 53 | 68 | 101 | 1 | 1 | 2 | 3 | 4 | 5 | 8 |
| 124T | 135 | 0.2 | 48 | 11 | 17 | 25 | 74 | 101 | 151 | 361 | 1 | 1 | 2 | 5 | 8 | 12 | 22 |
| 125 | 11 | 0.0 | 47 | 3 | 5 | 7 | 11 | 14 | 18 | 27 | 0 | 1 | 1 | 1 | 1 | 2 | 3 |
| 126O | 104 | 0.2 | 48 | 32 | 48 | 63 | 99 | 118 | 162 | 327 | 3 | 5 | 6 | 10 | 13 | 17 | 25 |
| 326 | 70 | 0.1 | 46 | 23 | 36 | 48 | 78 | 111 | 159 | 312 | 2 | 3 | 4 | 7 | 9 | 13 | 21 |
| 126 | 70 | 0.1 | 46 | 23 | 36 | 48 | 78 | 111 | 159 | 312 | 2 | 3 | 4 | 7 | 9 | 13 | 21 |

## Table F-1 - Master Plan Peak Flows and Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Future Percent Imperviousness | Future Conditions Master Plan Peak Flow (cfs) | | | | | | | Future Condtions Master Plan Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 127O | 34 | 0.1 | 53 | 10 | 16 | 21 | 46 | 61 | 79 | 140 | 1 | 2 | 2 | 4 | 5 | 6 | 9 |
| 327 | 34 | 0.1 | 53 | 20 | 30 | 41 | 64 | 81 | 102 | 150 | 1 | 2 | 2 | 4 | 5 | 6 | 9 |
| 127 | 34 | 0.1 | 53 | 20 | 30 | 41 | 64 | 81 | 102 | 150 | 1 | 2 | 2 | 4 | 5 | 6 | 9 |
| 128 | 7 | 0.0 | 50 | 2 | 3 | 5 | 8 | 10 | 13 | 19 | 0 | 0 | 0 | 1 | 1 | 1 | 2 |
| 128T | 37 | 0.1 | 43 | 2 | 3 | 6 | 12 | 20 | 48 | 93 | 0 | 0 | 1 | 1 | 2 | 3 | 6 |
| 129O | 30 | 0.0 | 42 | 9 | 15 | 21 | 26 | 32 | 56 | 94 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |
| 329 | 30 | 0.0 | 42 | 10 | 16 | 23 | 40 | 51 | 64 | 96 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |
| 129 | 30 | 0.0 | 42 | 10 | 16 | 23 | 40 | 51 | 64 | 96 | 1 | 1 | 2 | 3 | 4 | 5 | 7 |
| 130T | 391 | 0.6 | 44 | 74 | 108 | 153 | 274 | 410 | 619 | 1,049 | 11 | 16 | 22 | 36 | 46 | 60 | 93 |
| 130 | 269 | 0.4 | 44 | 47 | 62 | 80 | 177 | 272 | 418 | 719 | 7 | 10 | 14 | 24 | 31 | 41 | 63 |
| 131O | 149 | 0.2 | 49 | 32 | 39 | 40 | 112 | 175 | 283 | 486 | 4 | 6 | 9 | 14 | 18 | 23 | 35 |
| 331 | 149 | 0.2 | 49 | 59 | 86 | 119 | 206 | 265 | 340 | 514 | 4 | 6 | 9 | 14 | 18 | 23 | 35 |
| 131 | 149 | 0.2 | 49 | 59 | 86 | 119 | 206 | 265 | 340 | 514 | 4 | 6 | 9 | 14 | 18 | 23 | 35 |
| 132 | 86 | 0.1 | 50 | 39 | 57 | 81 | 135 | 173 | 219 | 330 | 3 | 4 | 5 | 9 | 11 | 14 | 21 |
| 132T | 127 | 0.2 | 52 | 55 | 80 | 112 | 189 | 241 | 307 | 459 | 4 | 6 | 8 | 13 | 16 | 20 | 31 |
| 133 | 42 | 0.1 | 56 | 17 | 25 | 31 | 54 | 70 | 89 | 134 | 1 | 2 | 3 | 4 | 5 | 7 | 10 |
| 134 | 122 | 0.2 | 43 | 33 | 55 | 81 | 142 | 183 | 234 | 352 | 3 | 5 | 7 | 12 | 15 | 20 | 30 |
| 135 | 43 | 0.1 | 45 | 17 | 28 | 40 | 65 | 83 | 105 | 158 | 1 | 2 | 3 | 4 | 6 | 7 | 11 |
| 135T | 63 | 0.1 | 45 | 21 | 33 | 48 | 81 | 103 | 131 | 196 | 2 | 3 | 4 | 6 | 8 | 10 | 16 |
| 136 | 20 | 0.0 | 45 | 5 | 7 | 11 | 18 | 24 | 30 | 45 | 1 | 1 | 1 | 2 | 3 | 3 | 5 |
| 137 | 364 | 0.6 | 30 | 12 | 28 | 51 | 96 | 135 | 204 | 440 | 4 | 8 | 12 | 23 | 32 | 45 | 76 |
| 138 | 215 | 0.3 | 35 | 9 | 16 | 24 | 45 | 68 | 129 | 299 | 1 | 2 | 2 | 6 | 10 | 17 | 36 |
| 138T | 252 | 0.4 | 36 | 14 | 31 | 54 | 96 | 127 | 194 | 386 | 4 | 7 | 12 | 19 | 25 | 34 | 56 |
| 139 | 170 | 0.3 | 36 | 24 | 39 | 57 | 98 | 125 | 159 | 267 | 4 | 6 | 9 | 14 | 18 | 24 | 39 |
| 339 | 170 | 0.3 | 36 | 24 | 39 | 57 | 98 | 125 | 159 | 267 | 4 | 6 | 9 | 14 | 18 | 24 | 39 |
| 139O | 170 | 0.3 | 36 | 7 | 18 | 29 | 48 | 61 | 111 | 259 | 2 | 4 | 7 | 11 | 15 | 21 | 36 |
| 140 | 93 | 0.1 | 29 | 13 | 24 | 39 | 75 | 99 | 129 | 199 | 2 | 3 | 5 | 8 | 11 | 14 | 22 |
| 340 | 93 | 0.1 | 29 | 13 | 24 | 39 | 75 | 99 | 129 | 199 | 2 | 3 | 5 | 8 | 11 | 14 | 22 |
| 140O | 93 | 0.1 | 29 | 11 | 13 | 16 | 19 | 45 | 98 | 184 | 2 | 3 | 5 | 8 | 9 | 12 | 20 |
| 141 | 37 | 0.1 | 38 | 8 | 14 | 22 | 38 | 50 | 64 | 96 | 1 | 1 | 2 | 3 | 5 | 6 | 9 |
| 142 | 623 | 1.0 | 52 | 112 | 171 | 239 | 424 | 559 | 756 | 1,198 | 21 | 30 | 40 | 60 | 77 | 99 | 151 |
| 143 | 263 | 0.4 | 50 | 56 | 92 | 137 | 251 | 328 | 433 | 668 | 9 | 13 | 19 | 29 | 36 | 45 | 68 |
| 143T | 199 | 0.3 | 50 | 49 | 78 | 113 | 205 | 264 | 342 | 522 | 7 | 10 | 14 | 22 | 27 | 34 | 52 |
| 144 | 89 | 0.1 | 44 | 20 | 30 | 45 | 80 | 102 | 131 | 198 | 2 | 4 | 5 | 9 | 11 | 14 | 22 |
| 145 | 109 | 0.2 | 54 | 48 | 73 | 101 | 164 | 206 | 258 | 381 | 4 | 6 | 8 | 12 | 15 | 19 | 28 |
| 146 | 535 | 0.8 | 49 | 89 | 138 | 197 | 355 | 470 | 639 | 1,018 | 17 | 25 | 33 | 51 | 65 | 84 | 129 |
| 147 | 481 | 0.8 | 47 | 76 | 119 | 171 | 314 | 418 | 569 | 908 | 15 | 21 | 29 | 44 | 58 | 75 | 115 |
| 148 | 77 | 0.1 | 61 | 22 | 32 | 41 | 71 | 91 | 118 | 180 | 3 | 4 | 6 | 9 | 11 | 14 | 20 |
| 149 | 38 | 0.1 | 46 | 10 | 15 | 21 | 38 | 49 | 64 | 96 | 1 | 2 | 2 | 3 | 5 | 6 | 9 |
| 150 | 191 | 0.3 | 48 | 55 | 83 | 121 | 215 | 276 | 354 | 535 | 6 | 9 | 12 | 19 | 24 | 31 | 47 |
| 150T | 293 | 0.5 | 38 | 36 | 58 | 87 | 167 | 226 | 315 | 514 | 7 | 11 | 15 | 24 | 32 | 42 | 66 |
| 151 | 119 | 0.2 | 44 | 33 | 51 | 76 | 136 | 176 | 227 | 345 | 3 | 5 | 7 | 12 | 15 | 19 | 29 |
| 152 | 65 | 0.1 | 50 | 28 | 44 | 62 | 101 | 127 | 160 | 237 | 2 | 3 | 4 | 7 | 9 | 11 | 17 |
| 153 | 41 | 0.1 | 22 | 2 | 4 | 5 | 10 | 19 | 30 | 58 | 0 | 0 | 1 | 1 | 2 | 3 | 6 |
| 154 | 61 | 0.1 | 14 | 1 | 2 | 3 | 8 | 17 | 29 | 61 | 0 | 0 | 1 | 1 | 2 | 4 | 8 |
| 155 | 388 | 0.6 | 56 | 113 | 162 | 214 | 360 | 473 | 636 | 995 | 15 | 21 | 29 | 43 | 55 | 68 | 101 |

## Table F-2 - Master Plan Peak Flows Along 4100 Drainageway

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Future Peak Flows (cfs) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 100 | --- | South Platte River | 1,691 | 2.6 | 0 | 0 | 210 | 323 | 445 | 783 | 977 | 1,227 | 1,860 | 28 | 47 | 72 | 122 | 153 | 185 | 260 |
| 104 | 204 | | 1,684 | 2.6 | 523 | 523 | 207 | 318 | 439 | 773 | 965 | 1,213 | 1,847 | 28 | 47 | 71 | 121 | 152 | 184 | 258 |
| 105 | 205 | | 1,333 | 2.1 | 514 | 1,037 | 106 | 167 | 236 | 421 | 541 | 703 | 1,104 | 17 | 30 | 48 | 85 | 106 | 126 | 170 |
| 110T | 210T | | 1,077 | 1.7 | 2,333 | 3,370 | 53 | 82 | 115 | 189 | 240 | 302 | 446 | 9 | 17 | 30 | 57 | 71 | 83 | 105 |
| 114 | 214 | | 1,036 | 1.6 | 136 | 3,506 | 36 | 55 | 78 | 140 | 164 | 211 | 319 | 7 | 15 | 27 | 53 | 66 | 76 | 94 |
| 115T | 215T | B Tributary Confluence | 1,028 | 1.6 | 1,625 | 5,131 | 37 | 56 | 80 | 138 | 162 | 206 | 311 | 7 | 15 | 27 | 53 | 66 | 76 | 94 |
| 115 | 215 | Welby Road | 988 | 1.5 | 0 | 5,131 | 24 | 40 | 74 | 135 | 150 | 165 | 206 | 6 | 13 | 24 | 49 | 61 | 69 | 84 |
| 116O | 216O | | 957 | 1.5 | 864 | 5,995 | 14 | 40 | 74 | 135 | 147 | 162 | 187 | 5 | 12 | 22 | 46 | 57 | 64 | 77 |
| 116 | 216 | H Tributary Confluence | 957 | 1.5 | 0 | 5,995 | 181 | 280 | 397 | 726 | 929 | 1,316 | 2,292 | 24 | 37 | 51 | 84 | 109 | 142 | 221 |
| 120T | 220T | | 733 | 1.1 | 636 | 6,631 | 139 | 212 | 298 | 516 | 691 | 1,001 | 1,745 | 19 | 29 | 40 | 65 | 85 | 110 | 170 |
| 130T | 230T | D Tributary Confluence | 391 | 0.6 | 1,799 | 8,430 | 74 | 108 | 153 | 274 | 410 | 619 | 1,049 | 11 | 16 | 22 | 36 | 46 | 60 | 93 |
| 130 | 230 | | 269 | 0.4 | 0 | 8,430 | 47 | 62 | 80 | 177 | 272 | 418 | 719 | 7 | 10 | 14 | 24 | 31 | 41 | 63 |
| 131O | 231O | | 149 | 0.2 | 3,121 | 11,551 | 32 | 39 | 40 | 112 | 175 | 283 | 486 | 4 | 6 | 9 | 14 | 18 | 23 | 35 |
| 131 | 231 | | 149 | 0.2 | 0 | 11,551 | 59 | 86 | 119 | 206 | 265 | 340 | 514 | 4 | 6 | 9 | 14 | 18 | 23 | 35 |
| 132T | 232T | | 127 | 0.2 | 785 | 12,336 | 55 | 80 | 112 | 189 | 241 | 307 | 459 | 4 | 6 | 8 | 13 | 16 | 20 | 31 |
| 132 | 232 | | 86 | 0.1 | 631 | 12,967 | 39 | 57 | 81 | 135 | 173 | 219 | 330 | 3 | 4 | 5 | 9 | 11 | 14 | 21 |

## Table F-3 - Master Plan Peak Flows Along School Tributary

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Link Length (ft) | Length (feet) | Future Peak Flows (cfs) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 101 | 201 | Colorado Boulevard | 317 | 0.5 | 0 | 0 | 94 | 139 | 189 | 318 | 385 | 460 | 671 | 10 | 16 | 22 | 34 | 43 | 54 | 81 |
| 102T | 202T | | 298 | 0.5 | 1,337 | 1,337 | 89 | 131 | 178 | 298 | 358 | 426 | 608 | 10 | 15 | 21 | 32 | 40 | 51 | 76 |
| 102O | 202O | | 215 | 0.3 | 2,655 | 3,992 | 46 | 75 | 110 | 192 | 235 | 288 | 429 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |
| 302O | 502O | RTD NMRL | 215 | 0.3 | 349 | 4,341 | 49 | 79 | 116 | 203 | 256 | 319 | 429 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |
| 102 | 202 | | 215 | 0.3 | 0 | 4,341 | 49 | 79 | 116 | 204 | 261 | 335 | 503 | 6 | 9 | 13 | 21 | 27 | 35 | 53 |

**Figure F-2**
**4100 Drainageway**
**Master Plan Peak Discharge vs. Drainageway Station**

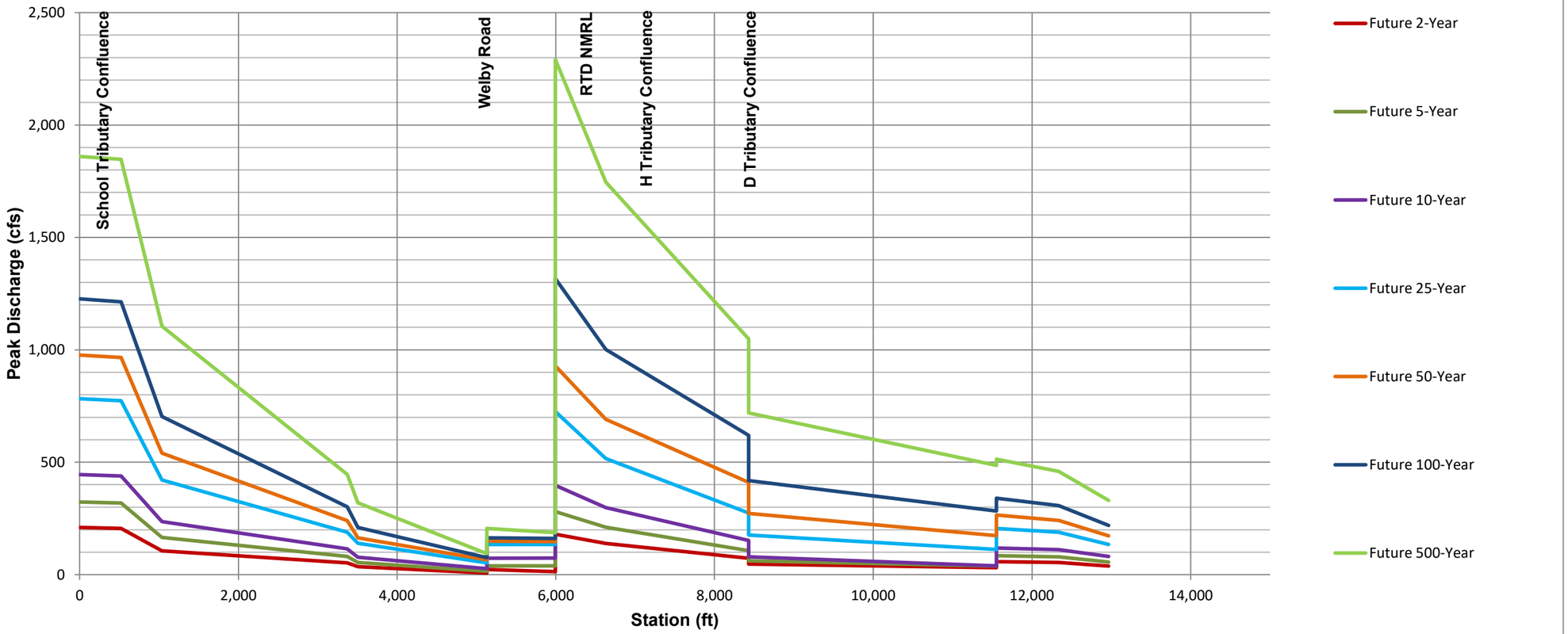
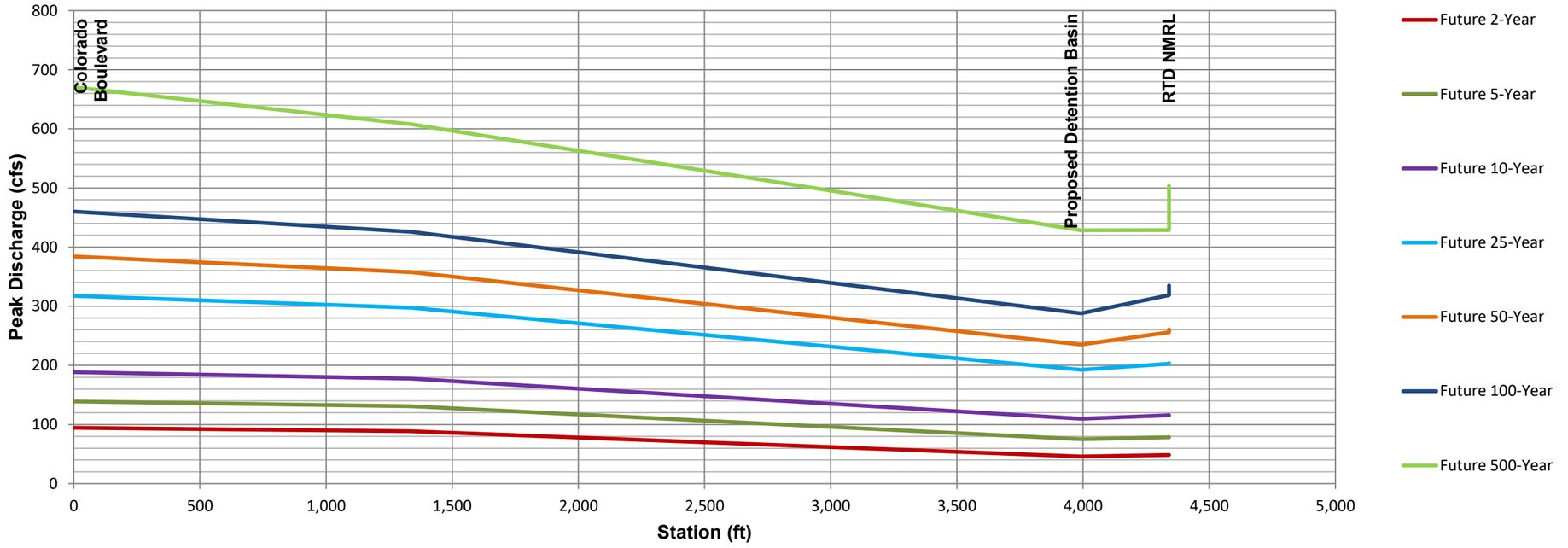


**Figure F-3**
**School Tributary**
**Master Plan Peak Discharge vs. Drainageway Station**



# North K Tributary Channel Section: Downstream of Access Road

| Project Description | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

| Input Data | |
|---|---|
| Roughness Coefficient | 0.040 |
| Channel Slope | 0.002 ft/ft |
| Left Side Slope | 3.000 H:V |
| Right Side Slope | 3.000 H:V |
| Bottom Width | 10.00 ft |
| Discharge | 433.00 cfs |

| Results | |
|---|---|
| Normal Depth | 60.0 in |
| Flow Area | 125.2 ft² |
| Wetted Perimeter | 41.6 ft |
| Hydraulic Radius | 36.1 in |
| Top Width | 40.02 ft |
| Critical Depth | 34.8 in |
| Critical Slope | 0.019 ft/ft |
| Velocity | 3.46 ft/s |
| Velocity Head | 0.19 ft |
| Specific Energy | 5.19 ft |
| Froude Number | 0.345 |
| Flow Type | Subcritical |

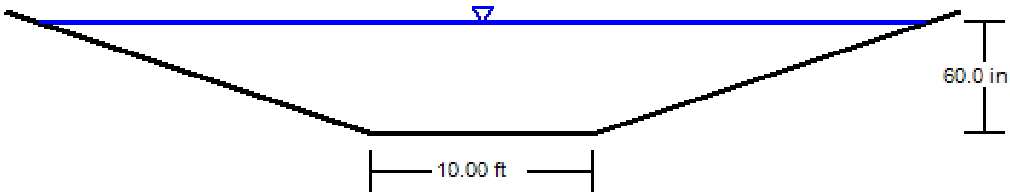
| GVF Input Data | |
|---|---|
| Downstream Depth | 0.0 in |
| Length | 0.0 ft |
| Number Of Steps | 0 |

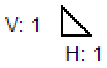
| GVF Output Data | |
|---|---|
| Upstream Depth | 0.0 in |
| Profile Description | N/A |
| Profile Headloss | 0.00 ft |
| Downstream Velocity | (N/A) ft/s |
| Upstream Velocity | (N/A) ft/s |
| Normal Depth | 60.0 in |
| Critical Depth | 34.8 in |
| Channel Slope | 0.002 ft/ft |
| Critical Slope | 0.019 ft/ft |

# North K Tributary Channel Section: Downstream of Access Road

| Project Description | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

| Input Data | |
|---|---|
| Roughness Coefficient | 0.040 |
| Channel Slope | 0.002 ft/ft |
| Normal Depth | 60.0 in |
| Left Side Slope | 3.000 H:V |
| Right Side Slope | 3.000 H:V |
| Bottom Width | 10.00 ft |
| Discharge | 433.00 cfs |



# North K Tributary Channel Section: Upstream of McKay

| Project Description | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

| Input Data | |
|---|---|
| Roughness Coefficient | 0.040 |
| Channel Slope | 0.004 ft/ft |
| Left Side Slope | 3.000 H:V |
| Right Side Slope | 3.000 H:V |
| Bottom Width | 10.00 ft |
| Discharge | 258.00 cfs |

| Results | |
|---|---|
| Normal Depth | 39.8 in |
| Flow Area | 66.2 ft² |
| Wetted Perimeter | 31.0 ft |
| Hydraulic Radius | 25.6 in |
| Top Width | 29.91 ft |
| Critical Depth | 26.3 in |
| Critical Slope | 0.021 ft/ft |
| Velocity | 3.90 ft/s |
| Velocity Head | 0.24 ft |
| Specific Energy | 3.55 ft |
| Froude Number | 0.462 |
| Flow Type | Subcritical |

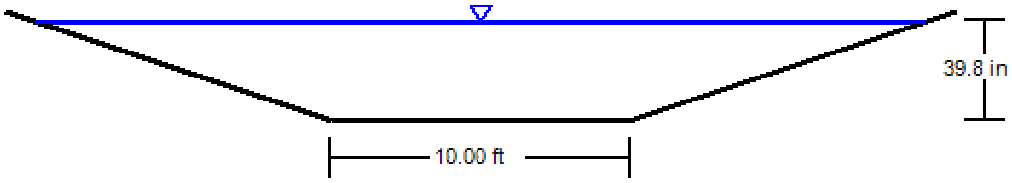
| GVF Input Data | |
|---|---|
| Downstream Depth | 0.0 in |
| Length | 0.0 ft |
| Number Of Steps | 0 |

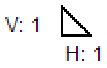
| GVF Output Data | |
|---|---|
| Upstream Depth | 0.0 in |
| Profile Description | N/A |
| Profile Headloss | 0.00 ft |
| Downstream Velocity | (N/A) ft/s |
| Upstream Velocity | (N/A) ft/s |
| Normal Depth | 39.8 in |
| Critical Depth | 26.3 in |
| Channel Slope | 0.004 ft/ft |
| Critical Slope | 0.021 ft/ft |

# North K Tributary Channel Section: Upstream of McKay

| Project Description | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

| Input Data | |
|---|---|
| Roughness Coefficient | 0.040 |
| Channel Slope | 0.004 ft/ft |
| Normal Depth | 39.8 in |
| Left Side Slope | 3.000 H:V |
| Right Side Slope | 3.000 H:V |
| Bottom Width | 10.00 ft |
| Discharge | 258.00 cfs |

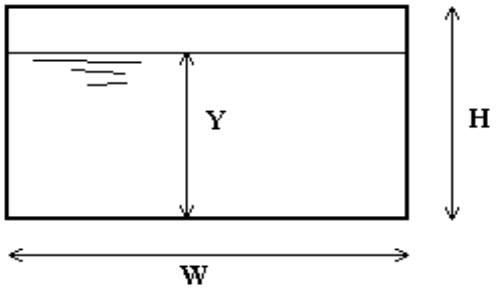


# BOX CONDUIT FLOW (Normal & Critical Depth Computation)

**Project:** Basin 4100 and DFA 0056 Outfall Systems Plan

**Box ID:** North K Tributary - Driveway Crossing (S): 100-year - 2-year




| **Design Information (Input)** | | | |
|---|---|---|---|
| Box conduit invert slope | So = | 0.0050 | ft/ft |
| Box Manning's n-value | n = | 0.0150 | |
| Box Width | W = | 12.00 | ft |
| Box Height | H = | 4.00 | ft |
| **Design discharge** | **Q =** | **377.00** | **cfs** |

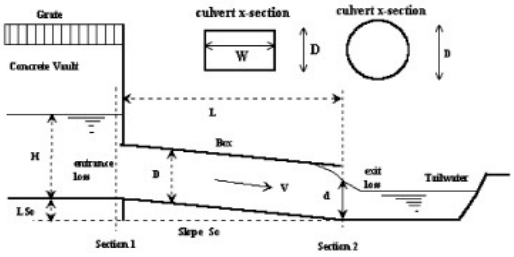
| **Full-flow capacity (Calculated)** | | | |
|---|---|---|---|
| Full-flow area | Af = | 48.00 | sq ft |
| Full-flow wetted perimeter | Pf = | 32.00 | ft |
| Full-flow capacity | Qf = | 441.79 | cfs |

| **Calculations of Normal Flow Condition** | | | |
|---|---|---|---|
| Normal flow depth (<H ) | Yn = | 2.87 | ft |
| Flow area | An = | 34.47 | sq ft |
| Wetted perimeter | Pn = | 17.75 | ft |
| Flow velocity | Vn = | 10.94 | fps |
| Discharge | Qn = | 377.01 | cfs |
| Percent Full | Flow = | 85.3% | of full flow |
| Normal Depth Froude Number | $Fr_n$ = | 1.14 | supercritical |

| **Calculation of Critical Flow Condition** | | | |
|---|---|---|---|
| Critical flow depth | Yc = | 3.13 | ft |
| Critical flow area | Ac = | 37.55 | sq ft |
| Critical flow velocity | Vc = | 10.04 | fps |
| Critical Depth Froude Number | $Fr_c$ = | 1.00 | |

# CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

**Project:** Basin 4100 and DFA 0056 Outfall Systems Plan
**Basin ID:** North K Tributary - Driveway Crossing (S): 100-year - 2-year
**Status:**




## Design Information (Input):

**Circular Culvert:** Barrel Diameter in Inches — D = [ ] inches
Inlet Edge Type (choose from pull-down list): Grooved End Projection

**OR:**

**Box Culvert:** Barrel Height (Rise) in Feet — Height (Rise) = 4.00 ft.
Barrel Width (Span) in Feet — Width (Span) = 12.00 ft.
Inlet Edge Type (choose from pull-down list): Square Edge w/ 30-78 deg. Flared Wingwall

| | | | |
|---|---|---|---|
| Number of Barrels | No = | 1 | |
| Inlet Elevation at Culvert Invert | Inlet Elev = | 5049.4 | ft. elev. |
| Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.) | Outlet Elev = | 5048.94 | ft. elev. |
| Culvert Length in Feet | L = | 92 | ft. |
| Manning's Roughness | n = | 0.015 | |
| Bend Loss Coefficient | $K_b$ = | 0 | |
| Exit Loss Coefficient | $K_x$ = | 1 | |

## Design Information (calculated):

| | | |
|---|---|---|
| Entrance Loss Coefficient | $K_e$ = | 0.40 |
| Friction Loss Coefficient | $K_f$ = | 0.60 |
| Sum of All Loss Coefficients | $K_s$ = | 2.00 |
| Orifice Inlet Condition Coefficient | $C_d$ = | 0.87 |
| Minimum Energy Condition Coefficient | $KE_{low}$ = | 0.0594 |

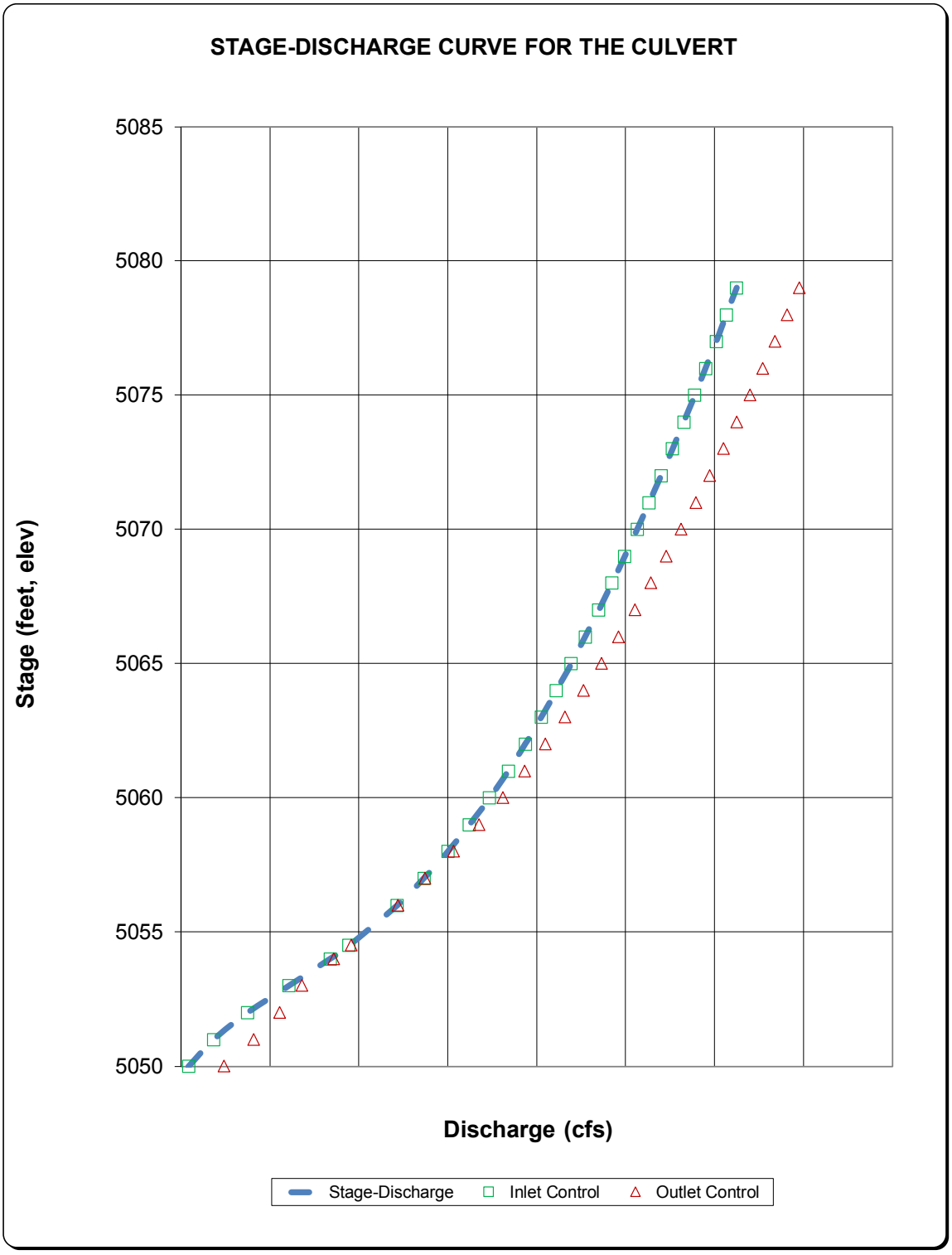
## Calculations of Culvert Capacity (output):

| Water Surface Elevation (ft., linked) | Tailwater Surface Elevation ft | Culvert Inlet-Control Flowrate cfs | Culvert Outlet-Control Flowrate cfs | Controlling Culvert Flowrate cfs (output) | Inlet Equation Used: | Flow Control Used |
|---|---|---|---|---|---|---|
| 5050.00 | | 16.80 | 97.04 | **16.80** | Min. Energy. Eqn. | INLET |
| 5051.00 | | 72.90 | 163.90 | **72.90** | Min. Energy. Eqn. | INLET |
| 5052.00 | | 149.50 | 221.60 | **149.50** | Regression Eqn. | INLET |
| 5053.00 | | 241.80 | 272.38 | **241.80** | Regression Eqn. | INLET |
| 5054.00 | | 335.10 | 343.41 | **335.10** | Regression Eqn. | INLET |
| 5054.50 | | 377.50 | 383.10 | **377.50** | Regression Eqn. | INLET |
| 5056.00 | | 485.80 | 487.44 | **485.80** | Regression Eqn. | INLET |
| 5057.00 | | 546.00 | 548.82 | **546.00** | Regression Eqn. | INLET |
| 5058.00 | | 599.50 | 612.68 | **599.50** | Regression Eqn. | INLET |
| 5059.00 | | 648.20 | 670.49 | **648.20** | Regression Eqn. | INLET |
| 5060.00 | | 693.30 | 723.69 | **693.30** | Regression Eqn. | INLET |
| 5061.00 | | 735.50 | 773.26 | **735.50** | Regression Eqn. | INLET |
| 5062.00 | | 774.00 | 819.83 | **774.00** | Orifice Eqn. | INLET |
| 5063.00 | | 809.70 | 863.89 | **809.70** | Orifice Eqn. | INLET |
| 5064.00 | | 843.80 | 905.79 | **843.80** | Orifice Eqn. | INLET |
| 5065.00 | | 876.70 | 945.87 | **876.70** | Orifice Eqn. | INLET |
| 5066.00 | | 908.30 | 984.31 | **908.30** | Orifice Eqn. | INLET |
| 5067.00 | | 938.90 | 1,021.30 | **938.90** | Orifice Eqn. | INLET |
| 5068.00 | | 968.50 | 1,056.99 | **968.50** | Orifice Eqn. | INLET |
| 5069.00 | | 997.30 | 1,091.51 | **997.30** | Orifice Eqn. | INLET |
| 5070.00 | | 1,025.20 | 1,124.97 | **1,025.20** | Orifice Eqn. | INLET |
| 5071.00 | | 1,052.40 | 1,157.49 | **1,052.40** | Orifice Eqn. | INLET |
| 5072.00 | | 1,078.90 | 1,189.10 | **1,078.90** | Orifice Eqn. | INLET |
| 5073.00 | | 1,104.80 | 1,219.88 | **1,104.80** | Orifice Eqn. | INLET |
| 5074.00 | | 1,130.10 | 1,249.93 | **1,130.10** | Orifice Eqn. | INLET |
| 5075.00 | | 1,154.80 | 1,279.25 | **1,154.80** | Orifice Eqn. | INLET |
| 5076.00 | | 1,179.00 | 1,307.93 | **1,179.00** | Orifice Eqn. | INLET |
| 5077.00 | | 1,202.80 | 1,335.98 | **1,202.80** | Orifice Eqn. | INLET |
| 5078.00 | | 1,226.00 | 1,363.47 | **1,226.00** | Orifice Eqn. | INLET |
| 5079.00 | | 1,248.90 | 1,390.41 | **1,248.90** | Orifice Eqn. | INLET |

Processing Time: 01.88 Seconds

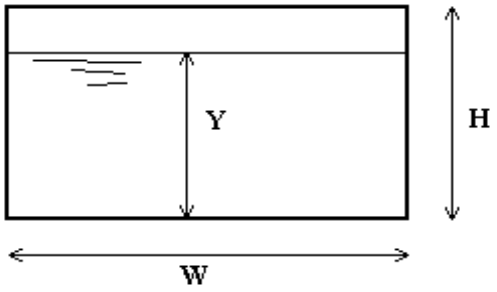
## CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

**Project:** Basin 4100 and DFA 0056 Outfall Systems Plan
**Basin ID:** North K Tributary - Driveway Crossing (S): 100-year - 2-year



# BOX CONDUIT FLOW (Normal & Critical Depth Computation)

**Project:** Basin 4100 and DFA 0056 Outfall Systems Plan
**Box ID:** North K Tributary - Driveway Crossing (T)




| **Design Information (Input)** | | | |
|---|---|---|---|
| Box conduit invert slope | So = | 0.0020 | ft/ft |
| Box Manning's n-value | n = | 0.0150 | |
| Box Width | W = | 12.00 | ft |
| Box Height | H = | 6.00 | ft |
| **Design discharge** | **Q =** | **258.00** | **cfs** |

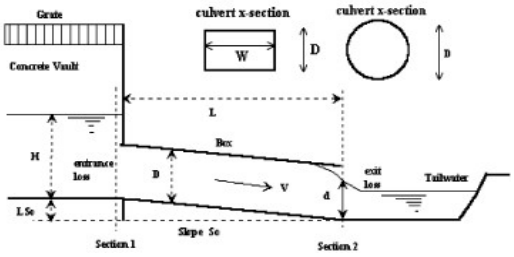
| **Full-flow capacity (Calculated)** | | | |
|---|---|---|---|
| Full-flow area | Af = | 72.00 | sq ft |
| Full-flow wetted perimeter | Pf = | 36.00 | ft |
| Full-flow capacity | Qf = | 507.73 | cfs |

| **Calculations of Normal Flow Condition** | | | |
|---|---|---|---|
| Normal flow depth (<H ) | Yn = | 3.03 | ft |
| Flow area | An = | 36.41 | sq ft |
| Wetted perimeter | Pn = | 18.07 | ft |
| Flow velocity | Vn = | 7.09 | fps |
| Discharge | Qn = | 258.00 | cfs |
| Percent Full | Flow = | 50.8% | of full flow |
| Normal Depth Froude Number | $Fr_n$ = | 0.72 | subcritical |

| **Calculation of Critical Flow Condition** | | | |
|---|---|---|---|
| Critical flow depth | Yc = | 2.43 | ft |
| Critical flow area | Ac = | 29.16 | sq ft |
| Critical flow velocity | Vc = | 8.85 | fps |
| Critical Depth Froude Number | $Fr_c$ = | 1.00 | |

# CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

**Project:** Basin 4100 and DFA 0056 Outfall Systems Plan
**Basin ID:** North K Tributary - Driveway Crossing (T)
**Status:**




## Design Information (Input):

**Circular Culvert:** Barrel Diameter in Inches — D = [ ] inches
Inlet Edge Type (choose from pull-down list): Grooved End Projection

**OR:**

**Box Culvert:** Barrel Height (Rise) in Feet — Height (Rise) = 6.00 ft.
Barrel Width (Span) in Feet — Width (Span) = 12.00 ft.
Inlet Edge Type (choose from pull-down list): Square Edge w/ 30-78 deg. Flared Wingwall

| | | | |
|---|---|---|---|
| Number of Barrels | No = | 1 | |
| Inlet Elevation at Culvert Invert | Inlet Elev = | 5051.56 | ft. elev. |
| Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.) | Outlet Elev = | 5051.44 | ft. elev. |
| Culvert Length in Feet | L = | 67 | ft. |
| Manning's Roughness | n = | 0.015 | |
| Bend Loss Coefficient | $K_b$ = | 0 | |
| Exit Loss Coefficient | $K_x$ = | 1 | |

## Design Information (calculated):

| | | |
|---|---|---|
| Entrance Loss Coefficient | $K_e$ = | 0.40 |
| Friction Loss Coefficient | $K_f$ = | 0.25 |
| Sum of All Loss Coefficients | $K_s$ = | 1.65 |
| Orifice Inlet Condition Coefficient | $C_d$ = | 0.87 |
| Minimum Energy Condition Coefficient | $KE_{low}$ = | 0.0694 |

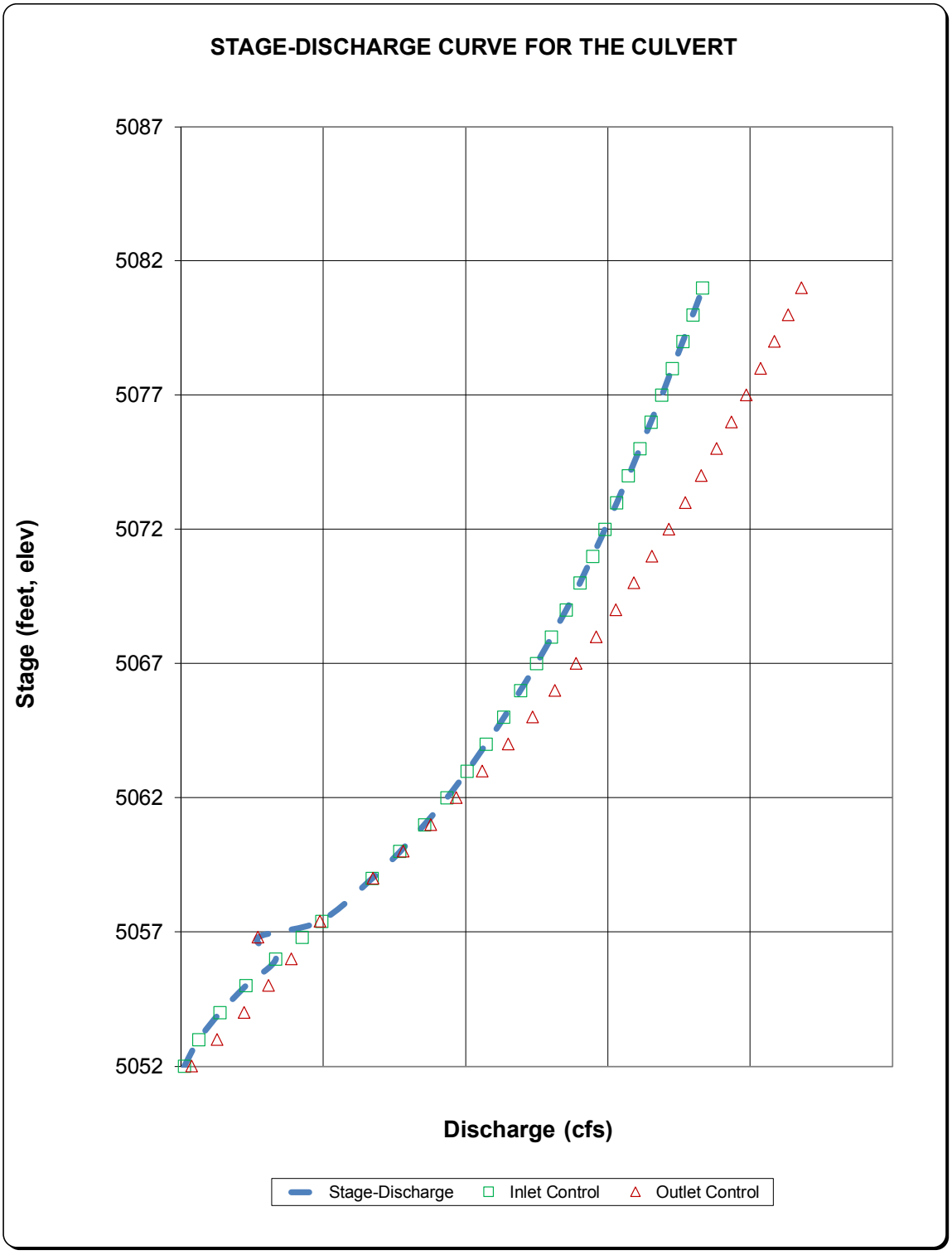
## Calculations of Culvert Capacity (output):

| Water Surface Elevation (ft., linked) | Tailwater Surface Elevation ft | Culvert Inlet-Control Flowrate cfs | Culvert Outlet-Control Flowrate cfs | Controlling Culvert Flowrate cfs (output) | Inlet Equation Used: | Flow Control Used |
|---|---|---|---|---|---|---|
| 5052.00 | | 10.50 | 37.06 | **10.50** | Min. Energy. Eqn. | INLET |
| 5053.00 | | 61.90 | 127.49 | **61.90** | Min. Energy. Eqn. | INLET |
| 5054.00 | | 136.60 | 221.36 | **136.60** | Min. Energy. Eqn. | INLET |
| 5055.00 | | 227.30 | 308.40 | **227.30** | Regression Eqn. | INLET |
| 5056.00 | | 332.10 | 387.83 | **332.10** | Regression Eqn. | INLET |
| 5056.80 | 5056.44 | 424.20 | 269.54 | **269.54** | Regression Eqn. | OUTLET |
| 5057.40 | | 494.70 | 488.17 | **488.17** | Regression Eqn. | OUTLET |
| 5059.00 | | 671.30 | 674.42 | **671.30** | Regression Eqn. | INLET |
| 5060.00 | | 768.00 | 780.42 | **768.00** | Regression Eqn. | INLET |
| 5061.00 | | 854.70 | 877.09 | **854.70** | Regression Eqn. | INLET |
| 5062.00 | | 933.20 | 966.46 | **933.20** | Regression Eqn. | INLET |
| 5063.00 | | 1,005.10 | 1,059.21 | **1,005.10** | Regression Eqn. | INLET |
| 5064.00 | | 1,071.60 | 1,150.51 | **1,071.60** | Regression Eqn. | INLET |
| 5065.00 | | 1,133.90 | 1,235.09 | **1,133.90** | Regression Eqn. | INLET |
| 5066.00 | | 1,192.60 | 1,314.25 | **1,192.60** | Regression Eqn. | INLET |
| 5067.00 | | 1,248.30 | 1,388.88 | **1,248.30** | Regression Eqn. | INLET |
| 5068.00 | | 1,301.50 | 1,459.73 | **1,301.50** | Regression Eqn. | INLET |
| 5069.00 | | 1,352.60 | 1,527.27 | **1,352.60** | Regression Eqn. | INLET |
| 5070.00 | | 1,400.50 | 1,591.96 | **1,400.50** | Orifice Eqn. | INLET |
| 5071.00 | | 1,445.20 | 1,654.13 | **1,445.20** | Orifice Eqn. | INLET |
| 5072.00 | | 1,488.50 | 1,714.03 | **1,488.50** | Orifice Eqn. | INLET |
| 5073.00 | | 1,530.60 | 1,771.92 | **1,530.60** | Orifice Eqn. | INLET |
| 5074.00 | | 1,571.50 | 1,827.96 | **1,571.50** | Orifice Eqn. | INLET |
| 5075.00 | | 1,611.40 | 1,882.34 | **1,611.40** | Orifice Eqn. | INLET |
| 5076.00 | | 1,650.40 | 1,935.20 | **1,650.40** | Orifice Eqn. | INLET |
| 5077.00 | | 1,688.40 | 1,986.66 | **1,688.40** | Orifice Eqn. | INLET |
| 5078.00 | | 1,725.60 | 2,036.81 | **1,725.60** | Orifice Eqn. | INLET |
| 5079.00 | | 1,762.10 | 2,085.76 | **1,762.10** | Orifice Eqn. | INLET |
| 5080.00 | | 1,797.80 | 2,133.58 | **1,797.80** | Orifice Eqn. | INLET |
| 5081.00 | | 1,832.70 | 2,180.35 | **1,832.70** | Orifice Eqn. | INLET |

Processing Time: 01.15 Seconds

## CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

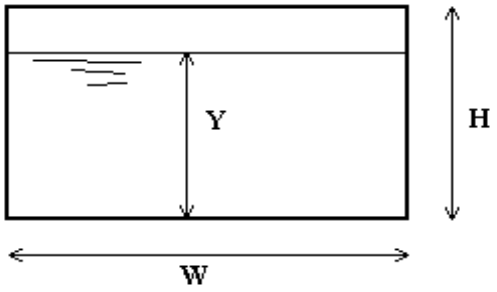
**Project:** Basin 4100 and DFA 0056 Outfall Systems Plan
**Basin ID:** North K Tributary - Driveway Crossing (T)



# BOX CONDUIT FLOW (Normal & Critical Depth Computation)

**Project:** Basin 4100 and DFA 0056 Outfall Systems Plan

**Box ID:** North K Tributary - McKay Road (22)




| **Design Information (Input)** | | | |
|---|---|---|---|
| Box conduit invert slope | So = | 0.0040 | ft/ft |
| Box Manning's n-value | n = | 0.0130 | |
| Box Width | W = | 16.00 | ft |
| Box Height | H = | 3.00 | ft |
| **Design discharge** | **Q =** | **258.00** | **cfs** |

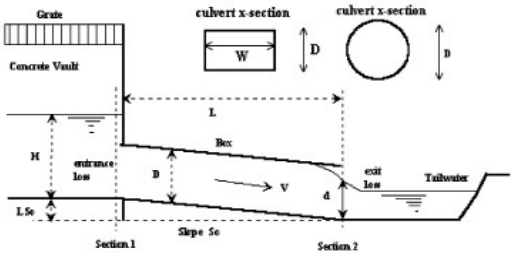
| **Full-flow capacity (Calculated)** | | | |
|---|---|---|---|
| Full-flow area | Af = | 48.00 | sq ft |
| Full-flow wetted perimeter | Pf = | 38.00 | ft |
| Full-flow capacity | Qf = | 406.59 | cfs |

| **Calculations of Normal Flow Condition** | | | |
|---|---|---|---|
| Normal flow depth (<H ) | Yn = | 1.75 | ft |
| Flow area | An = | 27.98 | sq ft |
| Wetted perimeter | Pn = | 19.50 | ft |
| Flow velocity | Vn = | 9.22 | fps |
| Discharge | Qn = | 258.01 | cfs |
| Percent Full | Flow = | 63.5% | of full flow |
| Normal Depth Froude Number | $Fr_n$ = | 1.23 | supercritical |

| **Calculation of Critical Flow Condition** | | | |
|---|---|---|---|
| Critical flow depth | Yc = | 2.01 | ft |
| Critical flow area | Ac = | 32.10 | sq ft |
| Critical flow velocity | Vc = | 8.04 | fps |
| Critical Depth Froude Number | $Fr_c$ = | 1.00 | |

# CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

**Project:** Basin 4100 and DFA 0056 Outfall Systems Plan
**Basin ID:** North K Tributary - McKay Road Crossing (22)
**Status:**




## Design Information (Input):

**Circular Culvert:** Barrel Diameter in Inches — D = [ ] inches
Inlet Edge Type (choose from pull-down list): Grooved End Projection

**OR:**

**Box Culvert:** Barrel Height (Rise) in Feet — Height (Rise) = 3.00 ft.
Barrel Width (Span) in Feet — Width (Span) = 16.00 ft.
Inlet Edge Type (choose from pull-down list): Square Edge w/ 30-78 deg. Flared Wingwall

| | | | |
|---|---|---|---|
| Number of Barrels | No = | 1 | |
| Inlet Elevation at Culvert Invert | Inlet Elev = | 5052.95 | ft. elev. |
| Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.) | Outlet Elev = | 5052.44 | ft. elev. |
| Culvert Length in Feet | L = | 103.4 | ft. |
| Manning's Roughness | n = | 0.015 | |
| Bend Loss Coefficient | $K_b$ = | 0 | |
| Exit Loss Coefficient | $K_x$ = | 1 | |

## Design Information (calculated):

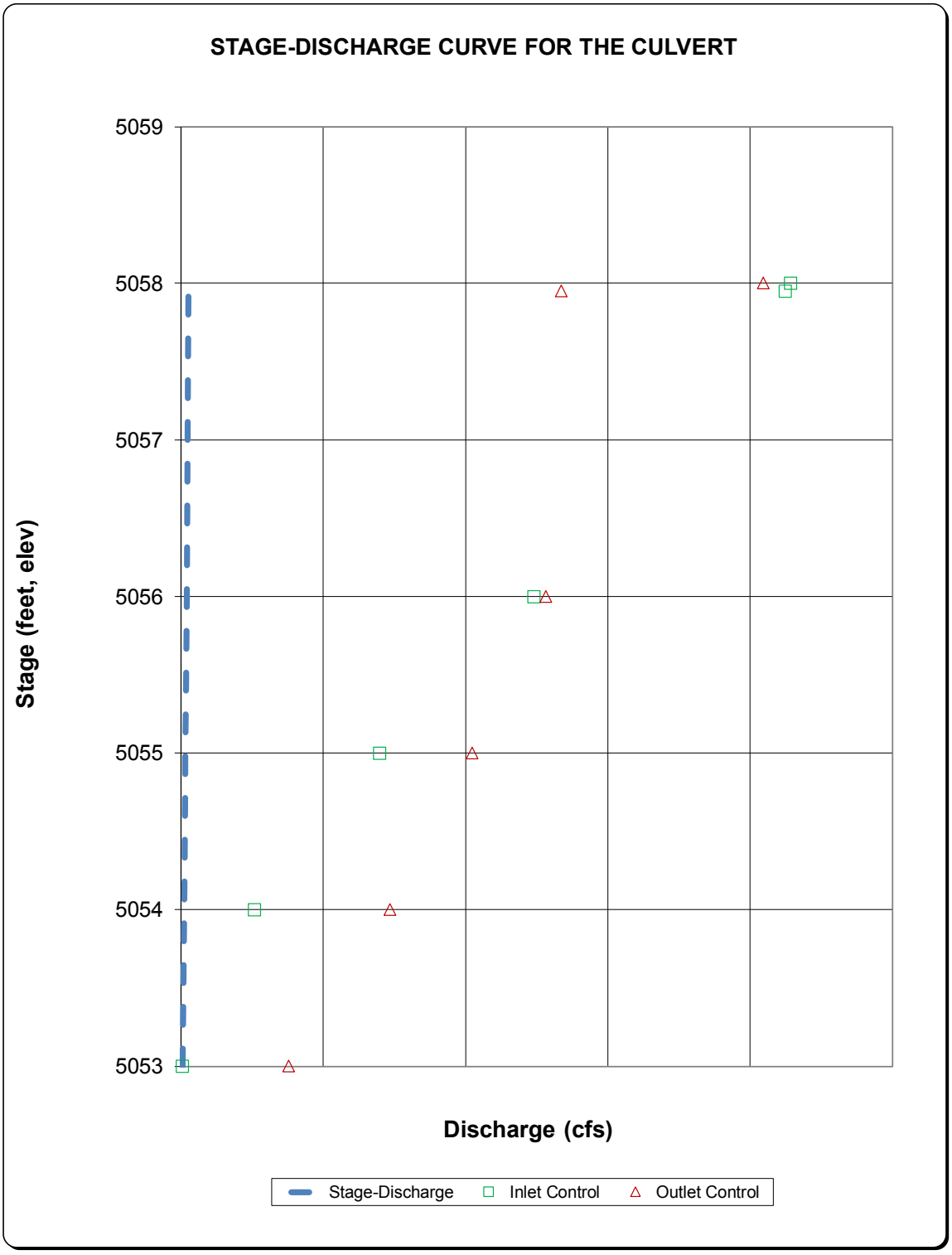
| | | |
|---|---|---|
| Entrance Loss Coefficient | $K_e$ = | 0.40 |
| Friction Loss Coefficient | $K_f$ = | 0.99 |
| Sum of All Loss Coefficients | $K_s$ = | 2.39 |
| Orifice Inlet Condition Coefficient | $C_d$ = | 0.87 |
| Minimum Energy Condition Coefficient | $KE_{low}$ = | 0.0608 |

## Calculations of Culvert Capacity (output):

| Water Surface Elevation (ft., linked) | Tailwater Surface Elevation ft | Culvert Inlet-Control Flowrate cfs | Culvert Outlet-Control Flowrate cfs | Controlling Culvert Flowrate cfs (output) | Inlet Equation Used: | Flow Control Used |
|---|---|---|---|---|---|---|
| 5053.00 | | 0.60 | 75.67 | **0.60** | Min. Energy. Eqn. | INLET |
| 5054.00 | | 51.60 | 146.69 | **51.60** | Min. Energy. Eqn. | INLET |
| 5055.00 | | 139.50 | 204.76 | **139.50** | Regression Eqn. | INLET |
| 5056.00 | | 248.00 | 256.60 | **248.00** | Regression Eqn. | INLET |
| 5057.95 | 5056.80 | 424.40 | 267.22 | **267.22** | Regression Eqn. | OUTLET |
| 5058.00 | | 428.10 | 409.13 | **409.13** | Regression Eqn. | OUTLET |
| | | | | | Invalid Entry | |
| | | | | | Invalid Entry | |
| | | | | | Invalid Entry |

## CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

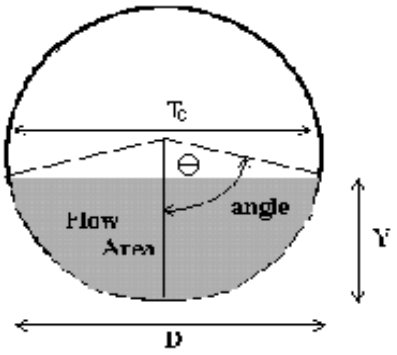
**Project:** Basin 4100 and DFA 0056 Outfall Systems Plan
**Basin ID:** North K Tributary - McKay Road Crossing (22)



# CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

**Project:** Basin 4100 and DFA 0056 Outfall Systems Plan

**Pipe ID:** Drainageway 4100 - Secondary Outlet at old Riverdale Road




| Design Information (Input) | | | |
|---|---|---|---|
| Pipe Invert Slope | So = | 0.0078 | ft/ft |
| Pipe Manning's n-value | n = | 0.0150 | |
| Pipe Diameter | D = | 48.00 | inches |
| **Design discharge** | **Q =** | **110.00** | **cfs** |

| Full-flow Capacity (Calculated) | | | |
|---|---|---|---|
| Full-flow area | Af = | 12.57 | sq ft |
| Full-flow wetted perimeter | Pf = | 12.57 | ft |
| Half Central Angle | Theta = | 3.14 | radians |
| Full-flow capacity | Qf = | 110.24 | cfs |

| Calculation of Normal Flow Condition | | | |
|---|---|---|---|
| Half Central Angle (0<Theta<3.14) | Theta = | 2.26 | radians |
| Flow area | An = | 11.00 | sq ft |
| Top width | Tn = | 3.09 | ft |
| Wetted perimeter | Pn = | 9.04 | ft |
| Flow depth | Yn = | 3.27 | ft |
| Flow velocity | Vn = | 10.00 | fps |
| Discharge | Qn = | 110.00 | cfs |
| Percent Full Flow | Flow = | 99.8% | of full flow |
| Normal Depth Froude Number | $Fr_n$ = | 0.93 | subcritical |

| Calculation of Critical Flow Condition | | | |
|---|---|---|---|
| Half Central Angle (0<Theta-c<3.14) | Theta-c = | 2.20 | radians |
| Critical flow area | Ac = | 10.68 | sq ft |
| Critical top width | Tc = | 3.24 | ft |
| Critical flow depth | Yc = | 3.17 | ft |
| Critical flow velocity | Vc = | 10.30 | fps |
| Critical Depth Froude Number | $Fr_c$ = | 1.00 | |

HEC-RAS Plan: Selected Plan

| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Thornton Pkway a | Thornton Parkway | 51209 | 2-YR | 8.00 | 5169.97 | 5170.23 | | 5170.26 | 0.015098 | 1.39 | 5.75 | 24.41 | 0.51 |
| Thornton Pkway a | Thornton Parkway | 51209 | 5-YR | 13.00 | 5169.97 | 5170.31 | | 5170.35 | 0.015601 | 1.69 | 7.71 | 25.12 | 0.54 |
| Thornton Pkway a | Thornton Parkway | 51209 | 10-YR | 21.00 | 5169.97 | 5170.42 | | 5170.48 | 0.015323 | 2.00 | 10.50 | 26.09 | 0.56 |
| Thornton Pkway a | Thornton Parkway | 51209 | 25-YR | 40.00 | 5169.97 | 5170.61 | | 5170.71 | 0.015472 | 2.58 | 15.58 | 27.78 | 0.59 |
| Thornton Pkway a | Thornton Parkway | 51209 | 50-YR | 53.00 | 5169.97 | 5170.71 | | 5170.84 | 0.015947 | 2.91 | 18.40 | 28.67 | 0.62 |
| Thornton Pkway a | Thornton Parkway | 51209 | 100-YR | 69.00 | 5169.97 | 5170.83 | | 5170.99 | 0.015601 | 3.21 | 21.91 | 29.73 | 0.63 |
| Thornton Pkway a | Thornton Parkway | 51209 | 500-YR | 106.00 | 5169.97 | 5171.05 | | 5171.27 | 0.015767 | 3.80 | 28.80 | 31.60 | 0.66 |
| | | | | | | | | | | | | | |
| Thornton Pkway a | Thornton Parkway | 51116 | 2-YR | 8.00 | 5167.17 | 5167.62 | 5167.62 | 5167.77 | 0.058483 | 3.14 | 2.55 | 8.78 | 1.03 |
| Thornton Pkway a | Thornton Parkway | 51116 | 5-YR | 13.00 | 5167.17 | 5167.75 | 5167.75 | 5167.93 | 0.051722 | 3.43 | 3.79 | 10.40 | 1.00 |
| Thornton Pkway a | Thornton Parkway | 51116 | 10-YR | 21.00 | 5167.17 | 5167.90 | 5167.90 | 5168.13 | 0.049010 | 3.82 | 5.49 | 12.28 | 1.01 |
| Thornton Pkway a | Thornton Parkway | 51116 | 25-YR | 40.00 | 5167.17 | 5168.15 | 5168.15 | 5168.47 | 0.042091 | 4.55 | 8.86 | 14.64 | 0.99 |
| Thornton Pkway a | Thornton Parkway | 51116 | 50-YR | 53.00 | 5167.17 | 5168.29 | 5168.29 | 5168.66 | 0.037046 | 4.88 | 11.08 | 15.75 | 0.96 |
| Thornton Pkway a | Thornton Parkway | 51116 | 100-YR | 69.00 | 5167.17 | 5168.44 | 5168.44 | 5168.87 | 0.034990 | 5.31 | 13.46 | 16.87 | 0.96 |
| Thornton Pkway a | Thornton Parkway | 51116 | 500-YR | 106.00 | 5167.17 | 5168.75 | 5168.75 | 5169.27 | 0.030243 | 5.95 | 18.99 | 19.21 | 0.94 |
| | | | | | | | | | | | | | |
| Thornton Pkway a | Thornton Parkway | 51090 | 2-YR | 8.00 | 5163.00 | 5163.81 | | 5163.84 | 0.004816 | 1.32 | 6.06 | 11.66 | 0.32 |
| Thornton Pkway a | Thornton Parkway | 51090 | 5-YR | 13.00 | 5163.00 | 5163.94 | | 5163.99 | 0.006793 | 1.70 | 7.63 | 12.98 | 0.39 |
| Thornton Pkway a | Thornton Parkway | 51090 | 10-YR | 21.00 | 5163.00 | 5164.21 | | 5164.27 | 0.005530 | 1.83 | 11.46 | 14.90 | 0.37 |
| Thornton Pkway a | Thornton Parkway | 51090 | 25-YR | 40.00 | 5163.00 | 5164.93 | | 5164.98 | 0.002517 | 1.68 | 23.78 | 19.34 | 0.27 |
| Thornton Pkway a | Thornton Parkway | 51090 | 50-YR | 53.00 | 5163.00 | 5165.39 | | 5165.43 | 0.001555 | 1.61 | 33.20 | 22.09 | 0.22 |
| Thornton Pkway a | Thornton Parkway | 51090 | 100-YR | 69.00 | 5163.00 | 5165.92 | | 5165.96 | 0.001008 | 1.56 | 45.80 | 25.32 | 0.19 |
| Thornton Pkway a | Thornton Parkway | 51090 | 500-YR | 106.00 | 5163.00 | 5167.07 | | 5167.10 | 0.000511 | 1.48 | 78.90 | 32.11 | 0.14 |
| | | | | | | | | | | | | | |
| Thornton Pkway a | Thornton Parkway | 51016 | 2-YR | 8.00 | 5162.84 | 5163.31 | | 5163.34 | 0.009712 | 1.43 | 5.61 | 16.43 | 0.43 |
| Thornton Pkway a | Thornton Parkway | 51016 | 5-YR | 13.00 | 5162.84 | 5163.62 | | 5163.64 | 0.003236 | 1.16 | 11.24 | 19.76 | 0.27 |
| Thornton Pkway a | Thornton Parkway | 51016 | 10-YR | 21.00 | 5162.84 | 5164.05 | | 5164.07 | 0.001453 | 1.01 | 20.69 | 24.19 | 0.19 |
| Thornton Pkway a | Thornton Parkway | 51016 | 25-YR | 40.00 | 5162.84 | 5164.87 | | 5164.89 | 0.000618 | 0.93 | 42.79 | 29.62 | 0.14 |
| Thornton Pkway a | Thornton Parkway | 51016 | 50-YR | 53.00 | 5162.84 | 5165.35 | | 5165.37 | 0.000426 | 0.92 | 57.66 | 32.11 | 0.12 |
| Thornton Pkway a | Thornton Parkway | 51016 | 100-YR | 69.00 | 5162.84 | 5165.90 | | 5165.91 | 0.000304 | 0.92 | 75.88 | 34.66 | 0.10 |
| Thornton Pkway a | Thornton Parkway | 51016 | 500-YR | 106.00 | 5162.84 | 5167.06 | | 5167.08 | 0.000183 | 0.93 | 119.17 | 39.51 | 0.09 |
| | | | | | | | | | | | | | |
| Thornton Pkway a | Thornton Parkway | 50986 | 2-YR | 8.00 | 5162.00 | 5163.18 | 5162.60 | 5163.21 | 0.002410 | 1.38 | 5.80 | 11.97 | 0.25 |
| Thornton Pkway a | Thornton Parkway | 50986 | 5-YR | 13.00 | 5162.00 | 5163.52 | 5162.76 | 5163.56 | 0.002291 | 1.65 | 7.88 | 14.58 | 0.26 |
| Thornton Pkway a | Thornton Parkway | 50986 | 10-YR | 21.00 | 5162.00 | 5163.94 | 5162.96 | 5164.01 | 0.002260 | 1.99 | 10.55 | 17.69 | 0.27 |
| Thornton Pkway a | Thornton Parkway | 50986 | 25-YR | 40.00 | 5162.00 | 5164.74 | 5163.33 | 5164.84 | 0.002276 | 2.58 | 15.50 | 23.06 | 0.29 |
| Thornton Pkway a | Thornton Parkway | 50986 | 50-YR | 53.00 | 5162.00 | 5165.20 | 5163.55 | 5165.33 | 0.002276 | 2.89 | 18.35 | 26.32 | 0.30 |
| Thornton Pkway a | Thornton Parkway | 50986 | 100-YR | 69.00 | 5162.00 | 5165.72 | 5163.80 | 5165.88 | 0.002248 | 3.20 | 21.57 | 30.16 | 0.30 |
| Thornton Pkway a | Thornton Parkway | 50986 | 500-YR | 106.00 | 5162.00 | 5166.83 | 5164.32 | 5167.04 | 0.002101 | 3.72 | 28.49 | 37.60 | 0.31 |
| | | | | | | | | | | | | | |
| Thornton Pkway a | Thornton Parkway | 50978 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| Thornton Pkway a | Thornton Parkway | 50879 | 2-YR | 8.00 | 5160.99 | 5161.62 | | 5161.65 | 0.005856 | 1.42 | 5.64 | 11.87 | 0.35 |
| Thornton Pkway a | Thornton Parkway | 50879 | 5-YR | 13.00 | 5160.99 | 5161.76 | | 5161.81 | 0.006816 | 1.77 | 7.33 | 13.57 | 0.40 |
| Thornton Pkway a | Thornton Parkway | 50879 | 10-YR | 21.00 | 5160.99 | 5161.95 | | 5162.03 | 0.007748 | 2.19 | 9.59 | 15.47 | 0.44 |
| Thornton Pkway a | Thornton Parkway | 50879 | 25-YR | 40.00 | 5160.99 | 5162.27 | | 5162.41 | 0.009075 | 2.94 | 13.67 | 17.84 | 0.50 |
| Thornton Pkway a | Thornton Parkway | 50879 | 50-YR | 53.00 | 5160.99 | 5162.44 | | 5162.61 | 0.009886 | 3.37 | 15.87 | 18.97 | 0.53 |
| Thornton Pkway a | Thornton Parkway | 50879 | 100-YR | 69.00 | 5160.99 | 5162.62 | | 5162.84 | 0.010375 | 3.79 | 18.48 | 20.22 | 0.56 |
| Thornton Pkway a | Thornton Parkway | 50879 | 500-YR | 106.00 | 5160.99 | 5162.94 | | 5163.28 | 0.012204 | 4.70 | 22.99 | 22.31 | 0.63 |
| | | | | | | | | | | | | | |
| Thornton Pkway a | Thornton Parkway | 50849 | 2-YR | 8.00 | 5160.87 | 5161.23 | | 5161.30 | 0.030240 | 2.17 | 3.69 | 13.52 | 0.73 |
| Thornton Pkway a | Thornton Parkway | 50849 | 5-YR | 13.00 | 5160.87 | 5161.32 | | 5161.43 | 0.030670 | 2.59 | 5.02 | 14.18 | 0.77 |
| Thornton Pkway a | Thornton Parkway | 50849 | 10-YR | 21.00 | 5160.87 | 5161.44 | | 5161.59 | 0.032193 | 3.11 | 6.75 | 15.00 | 0.82 |
| Thornton Pkway a | Thornton Parkway | 50849 | 25-YR | 40.00 | 5160.87 | 5161.66 | 5161.60 | 5161.90 | 0.034036 | 3.95 | 10.14 | 16.40 | 0.88 |
| Thornton Pkway a | Thornton Parkway | 50849 | 50-YR | 53.00 | 5160.87 | 5161.77 | 5161.73 | 5162.07 | 0.034565 | 4.38 | 12.11 | 17.15 | 0.91 |
| Thornton Pkway a | Thornton Parkway | 50849 | 100-YR | 69.00 | 5160.87 | 5161.88 | 5161.86 | 5162.26 | 0.037138 | 4.96 | 13.95 | 17.81 | 0.97 |
| Thornton Pkway a | Thornton Parkway | 50849 | 500-YR | 106.00 | 5160.87 | 5162.13 | 5162.13 | 5162.65 | 0.034978 | 5.77 | 18.68 | 19.36 | 0.98 |
| | | | | | | | | | | | | | |
| Thornton Pkway a | Thornton Parkway | 50804 | 2-YR | 8.00 | 5158.97 | 5159.36 | 5159.36 | 5159.49 | 0.056276 | 2.94 | 2.72 | 10.03 | 1.00 |
| Thornton Pkway a | Thornton Parkway | 50804 | 5-YR | 13.00 | 5158.97 | 5159.46 | 5159.46 | 5159.64 | 0.053890 | 3.39 | 3.83 | 11.05 | 1.01 |
| Thornton Pkway a | Thornton Parkway | 50804 | 10-YR | 21.00 | 5158.97 | 5159.61 | 5159.61 | 5159.83 | 0.049133 | 3.80 | 5.53 | 12.52 | 1.01 |
| Thornton Pkway a | Thornton Parkway | 50804 | 25-YR | 40.00 | 5158.97 | 5159.86 | 5159.86 | 5160.17 | 0.043966 | 4.46 | 8.96 | 14.62 | 1.00 |
| Thornton Pkway a | Thornton Parkway | 50804 | 50-YR | 53.00 | 5158.97 | 5159.99 | 5159.99 | 5160.36 | 0.042896 | 4.82 | 10.99 | 15.64 | 1.01 |
| Thornton Pkway a | Thornton Parkway | 50804 | 100-YR | 69.00 | 5158.97 | 5160.14 | 5160.14 | 5160.56 | 0.038547 | 5.19 | 13.38 | 16.99 | 0.99 |
| Thornton Pkway a | Thornton Parkway | 50804 | 500-YR | 106.00 | 5158.97 | 5160.44 | 5160.44 | 5160.96 | 0.032333 | 5.81 | 18.86 | 19.71 | 0.96 |
| | | | | | | | | | | | | | |
| Thornton Pkway a | Thornton Parkway | 50779 | 2-YR | 8.00 | 5154.00 | 5154.76 | | 5154.77 | 0.001269 | 0.74 | 10.74 | 18.05 | 0.17 |
| Thornton Pkway a | Thornton Parkway | 50779 | 5-YR | 13.00 | 5154.00 | 5154.96 | | 5154.97 | 0.001424 | 0.90 | 14.52 | 20.17 | 0.19 |
| Thornton Pkway a | Thornton Parkway | 50779 | 10-YR | 21.00 | 5154.00 | 5155.19 | | 5155.21 | 0.001579 | 1.09 | 19.32 | 21.63 | 0.20 |
| Thornton Pkway a | Thornton Parkway | 50779 | 25-YR | 40.00 | 5154.00 | 5155.57 | | 5155.60 | 0.001781 | 1.44 | 27.95 | 23.65 | 0.23 |
| Thornton Pkway a | Thornton Parkway | 50779 | 50-YR | 53.00 | 5154.00 | 5155.77 | | 5155.81 | 0.001885 | 1.63 | 32.81 | 24.73 | 0.24 |
| Thornton Pkway a | Thornton Parkway | 50779 | 100-YR | 69.00 | 5154.00 | 5155.97 | | 5156.03 | 0.002037 | 1.86 | 37.96 | 25.84 | 0.25 |
| Thornton Pkway a | Thornton Parkway | 50779 | 500-YR | 106.00 | 5154.00 | 5156.37 | | 5156.45 | 0.002254 | 2.26 | 48.67 | 27.39 | 0.28 |
| | | | | | | | | | | | | | |
| Thornton Pkway a | Thornton Parkway | 50659 | 2-YR | 8.00 | 5153.67 | 5154.14 | 5154.14 | 5154.29 | 0.058687 | 3.12 | 2.56 | 8.92 | 1.03 |
| Thornton Pkway a | Thornton Parkway | 50659 | 5-YR | 13.00 | 5153.67 | 5154.26 | 5154.26 | 5154.45 | 0.053626 | 3.46 | 3.75 | 10.44 | 1.02 |
| Thornton Pkway a | Thornton Parkway | 50659 | 10-YR | 21.00 | 5153.67 | 5154.43 | 5154.43 | 5154.64 | 0.045487 | 3.72 | 5.64 | 12.42 | 0.97 |
| Thornton Pkway a | Thornton Parkway | 50659 | 25-YR | 40.00 | 5153.67 | 5154.67 | 5154.67 | 5154.97 | 0.046115 | 4.43 | 9.02 | 15.62 | 1.02 |
| Thornton Pkway a | Thornton Parkway | 50659 | 50-YR | 53.00 | 5153.67 | 5154.80 | 5154.80 | 5155.16 | 0.041144 | 4.79 | 11.15 | 16.87 | 1.00 |
| Thornton Pkway a | Thornton Parkway | 50659 | 100-YR | 69.00 | 5153.67 | 5154.95 | 5154.95 | 5155.35 | 0.036611 | 5.12 | 13.77 | 18.35 | 0.97 |
| Thornton Pkway a | Thornton Parkway | 50659 | 500-YR | 106.00 | 5153.67 | 5155.23 | 5155.23 | 5155.73 | 0.031500 | 5.75 | 19.49 | 21.71 | 0.95 |
| | | | | | | | | | | | | | |
| Thornton Pkway a | Thornton Parkway | 50641 | 2-YR | 8.00 | 5149.00 | 5149.81 | | 5149.83 | 0.002881 | 1.11 | 7.20 | 12.21 | 0.26 |
| Thornton Pkway a | Thornton Parkway | 50641 | 5-YR | 13.00 | 5149.00 | 5150.02 | | 5150.04 | 0.003086 | 1.31 | 9.90 | 13.71 | 0.27 |
| Thornton Pkway a | Thornton Parkway | 50641 | 10-YR | 21.00 | 5149.00 | 5150.26 | | 5150.30 | 0.003364 | 1.56 | 13.42 | 15.19 | 0.29 |
| Thornton Pkway a | Thornton Parkway | 50641 | 25-YR | 40.00 | 5149.00 | 5150.67 | | 5150.73 | 0.003833 | 1.98 | 20.22 | 17.69 | 0.33 |
| Thornton Pkway a | Thornton Parkway | 50641 | 50-YR | 53.00 | 5149.00 | 5150.88 | | 5150.96 | 0.004123 | 2.20 | 24.07 | 18.90 | 0.34 |
| Thornton Pkway a | Thornton Parkway | 50641 | 100-YR | 69.00 | 5149.00 | 5151.09 | | 5151.19 | 0.004373 | 2.46 | 28.12 | 20.05 | 0.36 |
| Thornton Pkway a | Thornton Parkway | 50641 | 500-YR | 106.00 | 5149.00 | 5151.45 | 5150.55 | 5151.59 | 0.004858 | 3.00 | 35.69 | 21.93 | 0.40 |
| | | | | | | | | | | | | | |
| Thornton Pkway a | Thornton Parkway | 50380 | 2-YR | 8.00 | 5147.97 | 5148.47 | 5148.29 | 5148.50 | 0.010988 | 1.56 | 5.12 | 14.32 | 0.46 |
| Thornton Pkway a | Thornton Parkway | 50380 | 5-YR | 13.00 | 5147.97 | 5148.60 | 5148.39 | 5148.65 | 0.011018 | 1.80 | 7.24 | 16.47 | 0.48 |
| Thornton Pkway a | Thornton Parkway | 50380 | 10-YR | 21.00 | 5147.97 | 5148.77 | 5148.52 | 5148.84 | 0.011002 | 2.05 | 10.25 | 19.12 | 0.49 |

HEC-RAS Plan: Selected Plan (Continued)

| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Thornton Pkway a | Thornton Parkway | 50380 | 25-YR | 40.00 | 5147.97 | 5149.06 | 5148.75 | 5149.15 | 0.011005 | 2.44 | 16.43 | 24.67 | 0.52 |
| Thornton Pkway a | Thornton Parkway | 50380 | 50-YR | 53.00 | 5147.97 | 5149.19 | 5148.87 | 5149.30 | 0.011009 | 2.72 | 19.82 | 29.36 | 0.53 |
| Thornton Pkway a | Thornton Parkway | 50380 | 100-YR | 69.00 | 5147.97 | 5149.32 | 5149.00 | 5149.46 | 0.011016 | 3.01 | 24.03 | 34.13 | 0.54 |
| Thornton Pkway a | Thornton Parkway | 50380 | 500-YR | 106.00 | 5147.97 | 5149.56 | 5149.25 | 5149.74 | 0.011007 | 3.50 | 33.52 | 42.86 | 0.56 |
| | | | | | | | | | | | | | |
| North K Tributar | North K Trib | 71600 | 2-YR | 48.00 | 5052.36 | 5054.06 | | 5054.12 | 0.001965 | 1.89 | 25.38 | 20.08 | 0.30 |
| North K Tributar | North K Trib | 71600 | 5-YR | 73.00 | 5052.36 | 5054.54 | | 5054.60 | 0.001759 | 2.06 | 35.49 | 22.59 | 0.29 |
| North K Tributar | North K Trib | 71600 | 10-YR | 101.00 | 5052.36 | 5055.00 | | 5055.08 | 0.001541 | 2.18 | 46.36 | 24.08 | 0.28 |
| North K Tributar | North K Trib | 71600 | 25-YR | 164.00 | 5052.36 | 5055.90 | | 5055.99 | 0.001282 | 2.37 | 69.33 | 26.95 | 0.26 |
| North K Tributar | North K Trib | 71600 | 50-YR | 206.00 | 5052.36 | 5056.54 | | 5056.63 | 0.001057 | 2.36 | 87.25 | 28.94 | 0.24 |
| North K Tributar | North K Trib | 71600 | 100-YR | 258.00 | 5052.36 | 5057.08 | | 5057.18 | 0.001024 | 2.50 | 103.74 | 37.97 | 0.24 |
| North K Tributar | North K Trib | 71600 | 500-YR | 381.00 | 5052.36 | 5059.52 | | 5059.54 | 0.000121 | 1.21 | 352.06 | 130.27 | 0.09 |
| | | | | | | | | | | | | | |
| North K Tributar | North K Trib | 71233 | 2-YR | 48.00 | 5051.63 | 5053.45 | | 5053.49 | 0.001477 | 1.71 | 28.12 | 20.92 | 0.26 |
| North K Tributar | North K Trib | 71233 | 5-YR | 73.00 | 5051.63 | 5054.02 | | 5054.07 | 0.001190 | 1.78 | 41.07 | 24.36 | 0.24 |
| North K Tributar | North K Trib | 71233 | 10-YR | 101.00 | 5051.63 | 5054.56 | | 5054.61 | 0.001011 | 1.83 | 55.14 | 27.61 | 0.23 |
| North K Tributar | North K Trib | 71233 | 25-YR | 164.00 | 5051.63 | 5055.56 | | 5055.61 | 0.000802 | 1.92 | 85.50 | 33.57 | 0.21 |
| North K Tributar | North K Trib | 71233 | 50-YR | 206.00 | 5051.63 | 5056.28 | | 5056.34 | 0.000581 | 1.86 | 111.56 | 37.94 | 0.19 |
| North K Tributar | North K Trib | 71233 | 100-YR | 258.00 | 5051.63 | 5056.85 | | 5056.91 | 0.000524 | 1.96 | 133.87 | 41.32 | 0.18 |
| North K Tributar | North K Trib | 71233 | 500-YR | 381.00 | 5051.63 | 5059.45 | | 5059.48 | 0.000167 | 1.58 | 260.25 | 61.73 | 0.11 |
| | | | | | | | | | | | | | |
| North K Tributar | North K Trib | 71213 | 2-YR | 48.00 | 5051.58 | 5053.42 | 5052.40 | 5053.47 | 0.001406 | 1.67 | 28.68 | 21.19 | 0.25 |
| North K Tributar | North K Trib | 71213 | 5-YR | 73.00 | 5051.58 | 5054.00 | 5052.64 | 5054.05 | 0.001130 | 1.74 | 41.92 | 24.68 | 0.24 |
| North K Tributar | North K Trib | 71213 | 10-YR | 101.00 | 5051.58 | 5054.54 | 5052.86 | 5054.59 | 0.000961 | 1.79 | 56.28 | 27.98 | 0.22 |
| North K Tributar | North K Trib | 71213 | 25-YR | 164.00 | 5051.58 | 5055.54 | 5053.27 | 5055.60 | 0.000687 | 1.91 | 85.85 | 34.00 | 0.20 |
| North K Tributar | North K Trib | 71213 | 50-YR | 206.00 | 5051.58 | 5056.27 | 5053.50 | 5056.33 | 0.000507 | 1.91 | 107.87 | 38.41 | 0.18 |
| North K Tributar | North K Trib | 71213 | 100-YR | 258.00 | 5051.58 | 5056.83 | 5053.77 | 5056.90 | 0.000490 | 2.07 | 124.73 | 41.79 | 0.18 |
| North K Tributar | North K Trib | 71213 | 500-YR | 381.00 | 5051.58 | 5059.42 | 5054.28 | 5059.48 | 0.000210 | 1.88 | 203.05 | 59.99 | 0.13 |
| | | | | | | | | | | | | | |
| North K Tributar | North K Trib | 71208 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| North K Tributar | North K Trib | 71137 | 2-YR | 56.00 | 5051.43 | 5053.34 | | 5053.39 | 0.001668 | 1.86 | 30.13 | 21.60 | 0.28 |
| North K Tributar | North K Trib | 71137 | 5-YR | 92.00 | 5051.43 | 5053.87 | | 5053.95 | 0.001715 | 2.16 | 42.59 | 24.86 | 0.29 |
| North K Tributar | North K Trib | 71137 | 10-YR | 137.00 | 5051.43 | 5054.37 | | 5054.47 | 0.001661 | 2.47 | 55.76 | 27.85 | 0.30 |
| North K Tributar | North K Trib | 71137 | 25-YR | 251.00 | 5051.43 | 5055.27 | | 5055.42 | 0.001691 | 3.14 | 82.96 | 33.18 | 0.32 |
| North K Tributar | North K Trib | 71137 | 50-YR | 328.00 | 5051.43 | 5055.96 | | 5056.11 | 0.001389 | 3.26 | 107.28 | 37.31 | 0.30 |
| North K Tributar | North K Trib | 71137 | 100-YR | 433.00 | 5051.43 | 5056.42 | | 5056.63 | 0.001565 | 3.75 | 125.20 | 40.09 | 0.32 |
| North K Tributar | North K Trib | 71137 | 500-YR | 668.00 | 5051.43 | 5058.75 | | 5058.91 | 0.000690 | 3.34 | 216.60 | 58.02 | 0.23 |
| | | | | | | | | | | | | | |
| North K Tributar | North K Trib | 71117 | 2-YR | 56.00 | 5051.40 | 5053.29 | | 5053.35 | 0.002735 | 1.91 | 29.38 | 21.03 | 0.28 |
| North K Tributar | North K Trib | 71117 | 5-YR | 92.00 | 5051.40 | 5053.83 | | 5053.90 | 0.002766 | 2.22 | 41.51 | 24.29 | 0.30 |
| North K Tributar | North K Trib | 71117 | 10-YR | 137.00 | 5051.40 | 5054.33 | | 5054.43 | 0.002766 | 2.52 | 54.40 | 27.30 | 0.31 |
| North K Tributar | North K Trib | 71117 | 25-YR | 251.00 | 5051.40 | 5055.22 | | 5055.37 | 0.002715 | 3.18 | 81.15 | 32.70 | 0.33 |
| North K Tributar | North K Trib | 71117 | 50-YR | 328.00 | 5051.40 | 5055.92 | | 5056.08 | 0.002166 | 3.27 | 105.57 | 36.95 | 0.30 |
| North K Tributar | North K Trib | 71117 | 100-YR | 433.00 | 5051.40 | 5056.38 | | 5056.59 | 0.002443 | 3.76 | 123.15 | 39.74 | 0.33 |
| North K Tributar | North K Trib | 71117 | 500-YR | 668.00 | 5051.40 | 5058.74 | | 5058.88 | 0.000985 | 3.23 | 235.88 | 60.53 | 0.22 |
| | | | | | | | | | | | | | |
| North K Tributar | North K Trib | 70900 | 2-YR | 56.00 | 5050.96 | 5052.78 | | 5052.84 | 0.002003 | 1.99 | 28.16 | 20.94 | 0.30 |
| North K Tributar | North K Trib | 70900 | 5-YR | 92.00 | 5050.96 | 5053.31 | | 5053.39 | 0.002027 | 2.30 | 40.04 | 24.11 | 0.31 |
| North K Tributar | North K Trib | 70900 | 10-YR | 137.00 | 5050.96 | 5053.81 | | 5053.91 | 0.002019 | 2.60 | 52.88 | 27.12 | 0.32 |
| North K Tributar | North K Trib | 70900 | 25-YR | 251.00 | 5050.96 | 5054.73 | | 5054.88 | 0.001886 | 3.22 | 80.25 | 32.61 | 0.33 |
| North K Tributar | North K Trib | 70900 | 50-YR | 328.00 | 5050.96 | 5055.57 | | 5055.72 | 0.001306 | 3.17 | 109.82 | 37.65 | 0.29 |
| North K Tributar | North K Trib | 70900 | 100-YR | 433.00 | 5050.96 | 5055.96 | | 5056.17 | 0.001584 | 3.73 | 125.00 | 39.99 | 0.32 |
| North K Tributar | North K Trib | 70900 | 500-YR | 668.00 | 5050.96 | 5058.63 | | 5058.73 | 0.000469 | 2.83 | 311.62 | 99.22 | 0.19 |
| | | | | | | | | | | | | | |
| North K Tributar | North K Trib | 70450 | 2-YR | 56.00 | 5050.06 | 5051.95 | 5050.97 | 5052.01 | 0.001719 | 1.88 | 29.76 | 21.41 | 0.28 |
| North K Tributar | North K Trib | 70450 | 5-YR | 92.00 | 5050.06 | 5052.35 | 5051.26 | 5052.44 | 0.002235 | 2.38 | 38.67 | 23.79 | 0.33 |
| North K Tributar | North K Trib | 70450 | 10-YR | 137.00 | 5050.06 | 5052.80 | 5051.59 | 5052.92 | 0.002423 | 2.73 | 50.11 | 26.53 | 0.35 |
| North K Tributar | North K Trib | 70450 | 25-YR | 251.00 | 5050.06 | 5053.78 | 5052.23 | 5053.94 | 0.002339 | 3.18 | 79.05 | 32.44 | 0.36 |
| North K Tributar | North K Trib | 70450 | 50-YR | 328.00 | 5050.06 | 5055.04 | 5052.54 | 5055.15 | 0.001161 | 2.63 | 124.71 | 47.36 | 0.26 |
| North K Tributar | North K Trib | 70450 | 100-YR | 433.00 | 5050.06 | 5055.25 | 5052.98 | 5055.42 | 0.001697 | 3.25 | 133.12 | 58.85 | 0.32 |
| North K Tributar | North K Trib | 70450 | 500-YR | 668.00 | 5050.06 | 5058.59 | 5053.72 | 5058.61 | 0.000117 | 1.20 | 757.04 | 264.95 | 0.09 |
| | | | | | | | | | | | | | |
| North K Tributar | North K Trib | 70180 | 2-YR | 56.00 | 5049.52 | 5050.42 | 5050.42 | 5050.79 | 0.026878 | 4.92 | 11.38 | 15.37 | 1.01 |
| North K Tributar | North K Trib | 70180 | 5-YR | 92.00 | 5049.52 | 5051.13 | | 5051.36 | 0.008703 | 3.87 | 23.77 | 19.62 | 0.62 |
| North K Tributar | North K Trib | 70180 | 10-YR | 137.00 | 5049.52 | 5051.79 | | 5051.99 | 0.005114 | 3.59 | 38.21 | 23.63 | 0.50 |
| North K Tributar | North K Trib | 70180 | 25-YR | 251.00 | 5049.52 | 5053.04 | | 5053.23 | 0.002964 | 3.47 | 72.41 | 31.12 | 0.40 |
| North K Tributar | North K Trib | 70180 | 50-YR | 328.00 | 5049.52 | 5054.84 | | 5054.91 | 0.000644 | 2.31 | 169.67 | 102.60 | 0.20 |
| North K Tributar | North K Trib | 70180 | 100-YR | 433.00 | 5049.52 | 5054.93 | | 5055.06 | 0.001006 | 2.93 | 179.94 | 108.82 | 0.26 |
| North K Tributar | North K Trib | 70180 | 500-YR | 668.00 | 5049.52 | 5058.57 | | 5058.58 | 0.000081 | 1.27 | 757.57 | 223.28 | 0.08 |
| | | | | | | | | | | | | | |
| North K Tributar | North K Trib | 70160 | 2-YR | 0.10 | 5049.48 | 5049.51 | 5049.51 | 5049.51 | 0.008805 | 0.33 | 0.30 | 10.18 | 0.34 |
| North K Tributar | North K Trib | 70160 | 5-YR | 36.00 | 5049.48 | 5051.19 | 5050.17 | 5051.22 | 0.001044 | 1.39 | 25.92 | 20.27 | 0.22 |
| North K Tributar | North K Trib | 70160 | 10-YR | 81.00 | 5049.48 | 5051.83 | 5050.60 | 5051.89 | 0.001576 | 2.03 | 39.99 | 24.07 | 0.28 |
| North K Tributar | North K Trib | 70160 | 25-YR | 195.00 | 5049.48 | 5053.05 | 5051.35 | 5053.16 | 0.001687 | 2.64 | 73.97 | 31.41 | 0.30 |
| North K Tributar | North K Trib | 70160 | 50-YR | 272.00 | 5049.48 | 5054.84 | 5051.73 | 5054.90 | 0.000567 | 1.95 | 139.61 | 42.13 | 0.19 |
| North K Tributar | North K Trib | 70160 | 100-YR | 377.00 | 5049.48 | 5054.92 | 5052.17 | 5055.03 | 0.001010 | 2.64 | 143.29 | 42.65 | 0.25 |
| North K Tributar | North K Trib | 70160 | 500-YR | 612.00 | 5049.48 | 5058.51 | 5052.95 | 5058.57 | 0.000244 | 2.08 | 296.21 | 203.85 | 0.14 |
| | | | | | | | | | | | | | |
| North K Tributar | North K Trib | 70140 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| North K Tributar | North K Trib | 70050 | 2-YR | 0.10 | 5048.94 | 5049.20 | 5049.20 | 5049.26 | 0.091812 | 2.02 | 0.05 | 0.38 | 0.99 |
| North K Tributar | North K Trib | 70050 | 5-YR | 36.00 | 5048.94 | 5050.87 | 5050.87 | 5051.19 | 0.033096 | 4.52 | 7.97 | 13.33 | 1.03 |
| North K Tributar | North K Trib | 70050 | 10-YR | 81.00 | 5048.94 | 5051.33 | 5051.33 | 5051.79 | 0.024528 | 5.50 | 14.99 | 18.60 | 0.97 |
| North K Tributar | North K Trib | 70050 | 25-YR | 195.00 | 5048.94 | 5052.07 | 5052.07 | 5052.88 | 0.020769 | 7.31 | 27.23 | 26.43 | 0.98 |
| North K Tributar | North K Trib | 70050 | 50-YR | 272.00 | 5048.94 | 5052.46 | 5052.46 | 5053.48 | 0.019786 | 8.19 | 33.83 | 31.44 | 0.99 |
| North K Tributar | North K Trib | 70050 | 100-YR | 377.00 | 5048.94 | 5052.94 | 5052.94 | 5054.22 | 0.018956 | 9.17 | 41.75 | 38.17 | 1.00 |
| North K Tributar | North K Trib | 70050 | 500-YR | 612.00 | 5048.94 | 5053.90 | 5053.90 | 5055.66 | 0.017144 | 10.74 | 57.62 | 49.17 | 1.00 |
| | | | | | | | | | | | | | |
| North K Tributar | North K Trib | 70030 | 2-YR | 0.10 | 5046.61 | 5046.75 | 5046.68 | 5046.75 | 0.001900 | 0.29 | 0.34 | 4.42 | 0.19 |
| North K Tributar | North K Trib | 70030 | 5-YR | 36.00 | 5046.61 | 5047.98 | 5047.45 | 5048.01 | 0.001899 | 1.36 | 26.43 | 34.40 | 0.27 |
| North K Tributar | North K Trib | 70030 | 10-YR | 81.00 | 5046.61 | 5048.45 | 5047.73 | 5048.50 | 0.001902 | 1.87 | 44.55 | 41.62 | 0.30 |
| North K Tributar | North K Trib | 70030 | 25-YR | 195.00 | 5046.61 | 5049.24 | 5048.21 | 5049.34 | 0.001900 | 2.60 | 80.50 | 49.04 | 0.32 |

HEC-RAS Plan: Selected Plan (Continued)

| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| North K Tributar | North K Trib | 70030 | 50-YR | 272.00 | 5046.61 | 5049.65 | 5048.48 | 5049.77 | 0.001902 | 2.93 | 101.13 | 52.86 | 0.33 |
| North K Tributar | North K Trib | 70030 | 100-YR | 377.00 | 5046.61 | 5050.12 | 5048.78 | 5050.27 | 0.001901 | 3.29 | 126.91 | 57.27 | 0.34 |
| North K Tributar | North K Trib | 70030 | 500-YR | 612.00 | 5046.61 | 5050.96 | 5049.33 | 5051.17 | 0.001903 | 3.90 | 178.62 | 65.29 | 0.36 |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 40882 | 2-YR | 8.00 | 5223.98 | 5224.26 | 5224.18 | 5224.30 | 0.011460 | 1.46 | 5.49 | 24.74 | 0.55 |
| North G Tributar | North G Trib | 40882 | 5-YR | 12.00 | 5223.98 | 5224.32 | 5224.24 | 5224.37 | 0.011908 | 1.72 | 7.05 | 28.05 | 0.58 |
| North G Tributar | North G Trib | 40882 | 10-YR | 17.00 | 5223.98 | 5224.29 | 5224.29 | 5224.41 | 0.036981 | 2.78 | 6.13 | 26.65 | 0.99 |
| North G Tributar | North G Trib | 40882 | 25-YR | 30.00 | 5223.98 | 5224.40 | 5224.40 | 5224.57 | 0.030118 | 3.26 | 9.51 | 31.48 | 0.96 |
| North G Tributar | North G Trib | 40882 | 50-YR | 40.00 | 5223.98 | 5224.49 | 5224.49 | 5224.67 | 0.025299 | 3.43 | 12.40 | 36.56 | 0.91 |
| North G Tributar | North G Trib | 40882 | 100-YR | 55.00 | 5223.98 | 5224.57 | 5224.57 | 5224.79 | 0.025387 | 3.85 | 15.57 | 40.34 | 0.94 |
| North G Tributar | North G Trib | 40882 | 500-YR | 104.00 | 5223.98 | 5224.83 | 5224.83 | 5225.09 | 0.019096 | 4.36 | 27.99 | 135.41 | 0.87 |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 40566 | 2-YR | 8.00 | 5217.97 | 5218.22 | 5218.22 | 5218.31 | 0.036952 | 2.48 | 3.23 | 15.78 | 0.97 |
| North G Tributar | North G Trib | 40566 | 5-YR | 12.00 | 5217.97 | 5218.29 | 5218.29 | 5218.40 | 0.034237 | 2.77 | 4.33 | 16.88 | 0.96 |
| North G Tributar | North G Trib | 40566 | 10-YR | 17.00 | 5217.97 | 5218.49 | 5218.35 | 5218.56 | 0.010853 | 2.10 | 8.09 | 20.18 | 0.58 |
| North G Tributar | North G Trib | 40566 | 25-YR | 30.00 | 5217.97 | 5220.72 | 5218.51 | 5220.72 | 0.000040 | 0.36 | 84.47 | 45.20 | 0.05 |
| North G Tributar | North G Trib | 40566 | 50-YR | 40.00 | 5217.97 | 5222.08 | 5218.58 | 5222.08 | 0.000011 | 0.26 | 160.70 | 189.36 | 0.03 |
| North G Tributar | North G Trib | 40566 | 100-YR | 55.00 | 5217.97 | 5222.71 | 5218.73 | 5222.71 | 0.000007 | 0.23 | 333.82 | 242.95 | 0.02 |
| North G Tributar | North G Trib | 40566 | 500-YR | 104.00 | 5217.97 | 5222.88 | 5219.04 | 5222.88 | 0.000018 | 0.39 | 372.06 | 254.00 | 0.03 |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 40546 | 2-YR | 8.00 | 5216.17 | 5217.48 | | 5217.52 | 0.004910 | 1.53 | 5.23 | 9.71 | 0.37 |
| North G Tributar | North G Trib | 40546 | 5-YR | 12.00 | 5216.17 | 5217.90 | | 5217.92 | 0.001865 | 1.15 | 10.47 | 15.40 | 0.25 |
| North G Tributar | North G Trib | 40546 | 10-YR | 17.00 | 5216.17 | 5218.50 | | 5218.51 | 0.000515 | 0.77 | 22.15 | 23.47 | 0.14 |
| North G Tributar | North G Trib | 40546 | 25-YR | 30.00 | 5216.17 | 5220.72 | | 5220.72 | 0.000022 | 0.30 | 99.70 | 45.66 | 0.03 |
| North G Tributar | North G Trib | 40546 | 50-YR | 40.00 | 5216.17 | 5222.08 | | 5222.08 | 0.000009 | 0.25 | 160.58 | 196.80 | 0.02 |
| North G Tributar | North G Trib | 40546 | 100-YR | 55.00 | 5216.17 | 5222.71 | | 5222.71 | 0.000011 | 0.29 | 217.30 | 231.30 | 0.03 |
| North G Tributar | North G Trib | 40546 | 500-YR | 104.00 | 5216.17 | 5222.88 | | 5222.88 | 0.000031 | 0.51 | 253.11 | 239.63 | 0.04 |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 40524 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 40438 | 2-YR | 8.00 | 5211.00 | 5212.01 | 5211.88 | 5212.07 | 0.022075 | 1.93 | 4.14 | 68.80 | 0.55 |
| North G Tributar | North G Trib | 40438 | 5-YR | 12.00 | 5211.00 | 5212.08 | 5211.97 | 5212.17 | 0.028534 | 2.45 | 4.89 | 70.37 | 0.65 |
| North G Tributar | North G Trib | 40438 | 10-YR | 17.00 | 5211.00 | 5212.16 | 5212.05 | 5212.30 | 0.033051 | 2.95 | 5.77 | 72.14 | 0.71 |
| North G Tributar | North G Trib | 40438 | 25-YR | 30.00 | 5211.00 | 5212.25 | 5212.25 | 5212.56 | 0.061553 | 4.46 | 6.73 | 73.92 | 1.00 |
| North G Tributar | North G Trib | 40438 | 50-YR | 40.00 | 5211.00 | 5212.38 | 5212.38 | 5212.75 | 0.058085 | 4.92 | 8.14 | 76.36 | 1.00 |
| North G Tributar | North G Trib | 40438 | 100-YR | 55.00 | 5211.00 | 5212.55 | 5212.55 | 5213.02 | 0.054519 | 5.48 | 10.04 | 79.24 | 1.01 |
| North G Tributar | North G Trib | 40438 | 500-YR | 104.00 | 5211.00 | 5213.04 | 5213.04 | 5213.75 | 0.047527 | 6.78 | 15.33 | 99.79 | 1.01 |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 40418 | 2-YR | 8.00 | 5210.97 | 5211.07 | 5211.07 | 5211.12 | 0.156259 | 1.79 | 4.46 | 56.95 | 1.13 |
| North G Tributar | North G Trib | 40418 | 5-YR | 12.00 | 5210.97 | 5211.11 | 5211.11 | 5211.16 | 0.103089 | 1.84 | 6.52 | 58.59 | 0.97 |
| North G Tributar | North G Trib | 40418 | 10-YR | 17.00 | 5210.97 | 5211.14 | 5211.14 | 5211.21 | 0.096415 | 2.07 | 8.23 | 59.87 | 0.98 |
| North G Tributar | North G Trib | 40418 | 25-YR | 30.00 | 5210.97 | 5211.31 | | 5211.35 | 0.019515 | 1.59 | 19.18 | 68.02 | 0.50 |
| North G Tributar | North G Trib | 40418 | 50-YR | 40.00 | 5210.97 | 5211.36 | | 5211.41 | 0.020576 | 1.80 | 22.63 | 70.74 | 0.53 |
| North G Tributar | North G Trib | 40418 | 100-YR | 55.00 | 5210.97 | 5211.43 | | 5211.49 | 0.021449 | 2.05 | 27.38 | 74.40 | 0.55 |
| North G Tributar | North G Trib | 40418 | 500-YR | 104.00 | 5210.97 | 5211.59 | | 5211.69 | 0.023138 | 2.65 | 40.44 | 84.25 | 0.61 |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 40353 | 2-YR | 8.00 | 5208.56 | 5208.80 | | 5208.82 | 0.019656 | 0.97 | 8.21 | 55.19 | 0.45 |
| North G Tributar | North G Trib | 40353 | 5-YR | 12.00 | 5208.56 | 5208.86 | | 5208.88 | 0.015391 | 1.06 | 11.33 | 56.96 | 0.42 |
| North G Tributar | North G Trib | 40353 | 10-YR | 17.00 | 5208.56 | 5208.93 | | 5208.95 | 0.010538 | 1.09 | 15.76 | 59.39 | 0.36 |
| North G Tributar | North G Trib | 40353 | 25-YR | 30.00 | 5208.56 | 5208.86 | 5208.86 | 5208.97 | 0.089530 | 2.60 | 11.58 | 57.10 | 1.00 |
| North G Tributar | North G Trib | 40353 | 50-YR | 40.00 | 5208.56 | 5208.91 | 5208.91 | 5209.03 | 0.079596 | 2.81 | 14.32 | 58.63 | 0.98 |
| North G Tributar | North G Trib | 40353 | 100-YR | 55.00 | 5208.56 | 5208.97 | 5208.97 | 5209.12 | 0.072782 | 3.09 | 17.93 | 60.43 | 0.97 |
| North G Tributar | North G Trib | 40353 | 500-YR | 104.00 | 5208.56 | 5209.13 | 5209.13 | 5209.34 | 0.062623 | 3.75 | 28.20 | 67.47 | 0.96 |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 40056 | 2-YR | 8.00 | 5200.63 | 5200.82 | 5200.82 | 5200.89 | 0.108467 | 2.07 | 3.86 | 30.07 | 1.02 |
| North G Tributar | North G Trib | 40056 | 5-YR | 12.00 | 5200.63 | 5200.86 | 5200.86 | 5200.95 | 0.108604 | 2.36 | 5.09 | 32.72 | 1.05 |
| North G Tributar | North G Trib | 40056 | 10-YR | 17.00 | 5200.63 | 5200.91 | 5200.91 | 5201.01 | 0.096691 | 2.53 | 6.72 | 35.74 | 1.03 |
| North G Tributar | North G Trib | 40056 | 25-YR | 30.00 | 5200.63 | 5202.32 | | 5202.32 | 0.000021 | 0.15 | 180.47 | 151.33 | 0.02 |
| North G Tributar | North G Trib | 40056 | 50-YR | 40.00 | 5200.63 | 5203.03 | | 5203.03 | 0.000008 | 0.12 | 293.72 | 167.83 | 0.01 |
| North G Tributar | North G Trib | 40056 | 100-YR | 55.00 | 5200.63 | 5203.15 | | 5203.15 | 0.000012 | 0.16 | 314.06 | 169.57 | 0.02 |
| North G Tributar | North G Trib | 40056 | 500-YR | 104.00 | 5200.63 | 5203.58 | | 5203.58 | 0.000023 | 0.24 | 387.22 | 176.35 | 0.02 |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 40026 | 2-YR | 8.00 | 5198.37 | 5199.68 | | 5199.71 | 0.007091 | 1.26 | 6.33 | 12.71 | 0.32 |
| North G Tributar | North G Trib | 40026 | 5-YR | 12.00 | 5198.37 | 5200.15 | | 5200.16 | 0.001733 | 0.85 | 14.53 | 25.68 | 0.17 |
| North G Tributar | North G Trib | 40026 | 10-YR | 17.00 | 5198.37 | 5200.68 | | 5200.68 | 0.000366 | 0.55 | 34.94 | 50.72 | 0.09 |
| North G Tributar | North G Trib | 40026 | 25-YR | 30.00 | 5198.37 | 5202.32 | | 5202.32 | 0.000019 | 0.22 | 126.39 | 148.79 | 0.02 |
| North G Tributar | North G Trib | 40026 | 50-YR | 40.00 | 5198.37 | 5203.03 | | 5203.03 | 0.000013 | 0.21 | 166.13 | 161.31 | 0.02 |
| North G Tributar | North G Trib | 40026 | 100-YR | 55.00 | 5198.37 | 5203.15 | | 5203.15 | 0.000022 | 0.28 | 172.86 | 164.23 | 0.02 |
| North G Tributar | North G Trib | 40026 | 500-YR | 104.00 | 5198.37 | 5203.57 | | 5203.57 | 0.000052 | 0.45 | 196.37 | 175.01 | 0.04 |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 40000 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 38639 | 2-YR | 74.00 | 5165.96 | 5169.01 | | 5169.26 | 0.011133 | 3.96 | 18.67 | 12.41 | 0.47 |
| North G Tributar | North G Trib | 38639 | 5-YR | 112.00 | 5165.96 | 5169.53 | | 5169.90 | 0.012629 | 4.86 | 23.05 | 14.17 | 0.52 |
| North G Tributar | North G Trib | 38639 | 10-YR | 148.00 | 5165.96 | 5169.88 | | 5170.38 | 0.014913 | 5.71 | 25.92 | 15.35 | 0.57 |
| North G Tributar | North G Trib | 38639 | 25-YR | 249.00 | 5165.96 | 5170.65 | | 5171.56 | 0.020055 | 7.68 | 32.40 | 17.73 | 0.69 |
| North G Tributar | North G Trib | 38639 | 50-YR | 308.00 | 5165.96 | 5170.95 | | 5172.15 | 0.023902 | 8.82 | 34.93 | 18.66 | 0.76 |
| North G Tributar | North G Trib | 38639 | 100-YR | 391.00 | 5165.96 | 5171.30 | 5170.85 | 5172.95 | 0.029232 | 10.31 | 37.94 | 289.50 | 0.86 |
| North G Tributar | North G Trib | 38639 | 500-YR | 713.00 | 5165.96 | 5174.04 | 5173.81 | 5174.13 | 0.003358 | 3.52 | 357.10 | 459.67 | 0.29 |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 38609 | 2-YR | 74.00 | 5165.60 | 5168.44 | 5167.81 | 5168.76 | 0.023560 | 4.59 | 16.14 | 9.85 | 0.63 |
| North G Tributar | North G Trib | 38609 | 5-YR | 112.00 | 5165.60 | 5168.98 | 5168.40 | 5169.38 | 0.024460 | 5.06 | 22.15 | 12.28 | 0.66 |
| North G Tributar | North G Trib | 38609 | 10-YR | 148.00 | 5165.60 | 5169.24 | 5168.80 | 5169.76 | 0.029498 | 5.83 | 25.41 | 13.14 | 0.74 |
| North G Tributar | North G Trib | 38609 | 25-YR | 249.00 | 5165.60 | 5169.98 | 5169.61 | 5170.72 | 0.032536 | 6.89 | 36.14 | 15.75 | 0.80 |
| North G Tributar | North G Trib | 38609 | 50-YR | 308.00 | 5165.60 | 5170.20 | 5169.97 | 5171.14 | 0.036663 | 7.76 | 39.74 | 16.41 | 0.86 |
| North G Tributar | North G Trib | 38609 | 100-YR | 391.00 | 5165.60 | 5170.41 | 5170.41 | 5171.69 | 0.045325 | 9.09 | 43.17 | 17.01 | 0.97 |
| North G Tributar | North G Trib | 38609 | 500-YR | 713.00 | 5165.60 | 5171.85 | 5171.85 | 5173.48 | 0.033508 | 10.39 | 71.13 | 385.07 | 0.90 |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 38474 | 2-YR | 74.00 | 5164.00 | 5166.28 | 5166.28 | 5166.41 | 0.012629 | 3.66 | 31.89 | 94.92 | 0.50 |
| North G Tributar | North G Trib | 38474 | 5-YR | 112.00 | 5164.00 | 5166.36 | 5166.36 | 5166.53 | 0.017113 | 4.39 | 39.33 | 97.91 | 0.59 |
| North G Tributar | North G Trib | 38474 | 10-YR | 148.00 | 5164.00 | 5166.44 | 5166.44 | 5166.63 | 0.017251 | 4.56 | 48.15 | 100.61 | 0.60 |
| North G Tributar | North G Trib | 38474 | 25-YR | 249.00 | 5164.00 | 5166.59 | 5166.59 | 5166.87 | 0.022853 | 5.51 | 62.80 | 104.96 | 0.69 |
| North G Tributar | North G Trib | 38474 | 50-YR | 308.00 | 5164.00 | 5166.67 | 5166.67 | 5166.98 | 0.023377 | 5.74 | 72.04 | 107.57 | 0.71 |

HEC-RAS Plan: Selected Plan (Continued)

| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| North G Tributar | North G Trib | 38474 | 100-YR | 391.00 | 5164.00 | 5166.98 | 5166.77 | 5167.20 | 0.011868 | 4.49 | 106.07 | 116.28 | 0.52 |
| North G Tributar | North G Trib | 38474 | 500-YR | 713.00 | 5164.00 | 5167.14 | 5167.14 | 5167.65 | 0.023908 | 6.66 | 125.37 | 121.08 | 0.74 |
| | | | | | | | | | | | | | |
| North G Tributar | North G Trib | 38343 | 2-YR | 74.00 | 5162.00 | 5164.51 | | 5164.54 | 0.002128 | 1.84 | 57.66 | 91.37 | 0.22 |
| North G Tributar | North G Trib | 38343 | 5-YR | 112.00 | 5162.00 | 5164.76 | 5164.29 | 5164.79 | 0.001833 | 1.84 | 81.23 | 98.22 | 0.21 |
| North G Tributar | North G Trib | 38343 | 10-YR | 148.00 | 5162.00 | 5164.93 | 5164.38 | 5164.96 | 0.001850 | 1.93 | 97.94 | 102.49 | 0.21 |
| North G Tributar | North G Trib | 38343 | 25-YR | 249.00 | 5162.00 | 5165.27 | 5164.54 | 5165.32 | 0.002045 | 2.20 | 134.17 | 109.87 | 0.23 |
| North G Tributar | North G Trib | 38343 | 50-YR | 308.00 | 5162.00 | 5165.49 | | 5165.55 | 0.001882 | 2.22 | 159.04 | 114.56 | 0.22 |
| North G Tributar | North G Trib | 38343 | 100-YR | 391.00 | 5162.00 | 5164.77 | 5164.77 | 5165.16 | 0.021371 | 6.29 | 82.48 | 98.55 | 0.71 |
| North G Tributar | North G Trib | 38343 | 500-YR | 713.00 | 5162.00 | 5166.85 | | 5166.92 | 0.001132 | 2.19 | 335.55 | 144.70 | 0.18 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 21886 | 2-YR | 59.00 | 5259.00 | 5260.31 | | 5260.35 | 0.024328 | 1.42 | 39.56 | 51.75 | 0.25 |
| Drainageway 4100 | 4100_US | 21886 | 5-YR | 86.00 | 5259.00 | 5260.48 | | 5260.53 | 0.026105 | 1.62 | 47.94 | 52.91 | 0.27 |
| Drainageway 4100 | 4100_US | 21886 | 10-YR | 119.00 | 5259.00 | 5260.61 | | 5260.70 | 0.030401 | 1.89 | 55.11 | 53.88 | 0.30 |
| Drainageway 4100 | 4100_US | 21886 | 25-YR | 206.00 | 5259.00 | 5261.05 | | 5261.20 | 0.024799 | 2.08 | 79.69 | 57.11 | 0.28 |
| Drainageway 4100 | 4100_US | 21886 | 50-YR | 265.00 | 5259.00 | 5261.56 | 5260.43 | 5261.69 | 0.013843 | 1.85 | 109.41 | 61.15 | 0.22 |
| Drainageway 4100 | 4100_US | 21886 | 100-YR | 340.00 | 5259.00 | 5260.65 | 5260.65 | 5261.36 | 0.217814 | 5.15 | 57.17 | 54.16 | 0.80 |
| Drainageway 4100 | 4100_US | 21886 | 500-YR | 514.00 | 5259.00 | 5261.58 | | 5262.09 | 0.049517 | 3.52 | 111.06 | 61.37 | 0.41 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 21737 | 2-YR | 59.00 | 5255.59 | 5256.59 | | 5256.64 | 0.025594 | 1.05 | 43.65 | 79.96 | 0.24 |
| Drainageway 4100 | 4100_US | 21737 | 5-YR | 86.00 | 5255.59 | 5256.75 | 5256.38 | 5256.81 | 0.023932 | 1.14 | 57.01 | 87.82 | 0.24 |
| Drainageway 4100 | 4100_US | 21737 | 10-YR | 119.00 | 5255.59 | 5256.93 | | 5257.01 | 0.020712 | 1.19 | 74.11 | 96.95 | 0.23 |
| Drainageway 4100 | 4100_US | 21737 | 25-YR | 206.00 | 5255.59 | 5257.13 | | 5257.27 | 0.028478 | 1.60 | 94.12 | 102.39 | 0.28 |
| Drainageway 4100 | 4100_US | 21737 | 50-YR | 265.00 | 5255.59 | 5256.94 | 5256.94 | 5257.29 | 0.100846 | 2.64 | 74.58 | 97.23 | 0.51 |
| Drainageway 4100 | 4100_US | 21737 | 100-YR | 340.00 | 5255.59 | 5260.32 | | 5260.33 | 0.000296 | 0.42 | 507.34 | 149.41 | 0.04 |
| Drainageway 4100 | 4100_US | 21737 | 500-YR | 514.00 | 5255.59 | 5261.83 | | 5261.84 | 0.000192 | 0.41 | 748.26 | 168.79 | 0.03 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 21628 | 2-YR | 59.00 | 5250.81 | 5252.55 | | 5252.62 | 0.055737 | 2.17 | 27.25 | 27.37 | 0.38 |
| Drainageway 4100 | 4100_US | 21628 | 5-YR | 86.00 | 5250.81 | 5252.87 | | 5252.95 | 0.056041 | 2.32 | 37.14 | 33.93 | 0.39 |
| Drainageway 4100 | 4100_US | 21628 | 10-YR | 119.00 | 5250.81 | 5253.13 | | 5253.23 | 0.067268 | 2.55 | 46.73 | 42.55 | 0.43 |
| Drainageway 4100 | 4100_US | 21628 | 25-YR | 206.00 | 5250.81 | 5254.19 | | 5254.24 | 0.025990 | 1.67 | 123.40 | 104.28 | 0.27 |
| Drainageway 4100 | 4100_US | 21628 | 50-YR | 265.00 | 5250.81 | 5255.34 | | 5255.36 | 0.004874 | 1.00 | 263.75 | 136.08 | 0.13 |
| Drainageway 4100 | 4100_US | 21628 | 100-YR | 340.00 | 5250.81 | 5260.31 | | 5260.31 | 0.000068 | 0.27 | 1204.26 | 231.45 | 0.02 |
| Drainageway 4100 | 4100_US | 21628 | 500-YR | 514.00 | 5250.81 | 5261.83 | | 5261.83 | 0.000063 | 0.29 | 1571.09 | 253.45 | 0.02 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 21598 | 2-YR | 32.00 | 5248.75 | 5250.91 | 5249.70 | 5251.00 | 0.049611 | 2.39 | 13.38 | 6.91 | 0.30 |
| Drainageway 4100 | 4100_US | 21598 | 5-YR | 39.00 | 5248.75 | 5251.15 | 5249.84 | 5251.26 | 0.055908 | 2.58 | 15.13 | 7.81 | 0.33 |
| Drainageway 4100 | 4100_US | 21598 | 10-YR | 40.00 | 5248.75 | 5251.18 | 5249.85 | 5251.29 | 0.056617 | 2.60 | 15.38 | 7.93 | 0.33 |
| Drainageway 4100 | 4100_US | 21598 | 25-YR | 112.00 | 5248.75 | 5253.18 | 5251.03 | 5253.29 | 0.045843 | 2.66 | 42.03 | 22.13 | 0.34 |
| Drainageway 4100 | 4100_US | 21598 | 50-YR | 175.00 | 5248.75 | 5255.15 | 5251.89 | 5255.20 | 0.006014 | 1.42 | 114.65 | 147.82 | 0.14 |
| Drainageway 4100 | 4100_US | 21598 | 100-YR | 283.00 | 5248.75 | 5260.28 | 5252.77 | 5260.30 | 0.000301 | 0.60 | 336.62 | 243.77 | 0.04 |
| Drainageway 4100 | 4100_US | 21598 | 500-YR | 486.00 | 5248.75 | 5261.81 | 5253.83 | 5261.82 | 0.000584 | 0.84 | 575.59 | 263.63 | 0.05 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 21579 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 21394 | 2-YR | 32.00 | 5244.38 | 5246.40 | | 5246.43 | 0.010841 | 1.27 | 24.11 | 53.05 | 0.18 |
| Drainageway 4100 | 4100_US | 21394 | 5-YR | 39.00 | 5244.38 | 5246.49 | | 5246.53 | 0.012719 | 1.43 | 25.76 | 57.73 | 0.20 |
| Drainageway 4100 | 4100_US | 21394 | 10-YR | 40.00 | 5244.38 | 5246.50 | | 5246.54 | 0.013015 | 1.46 | 25.96 | 58.30 | 0.20 |
| Drainageway 4100 | 4100_US | 21394 | 25-YR | 112.00 | 5244.38 | 5247.02 | | 5247.23 | 0.032607 | 2.77 | 35.55 | 70.57 | 0.33 |
| Drainageway 4100 | 4100_US | 21394 | 50-YR | 175.00 | 5244.38 | 5247.26 | | 5247.70 | 0.051795 | 3.74 | 40.01 | 72.47 | 0.43 |
| Drainageway 4100 | 4100_US | 21394 | 100-YR | 283.00 | 5244.38 | 5247.44 | 5246.95 | 5248.47 | 0.101573 | 5.49 | 43.32 | 73.86 | 0.60 |
| Drainageway 4100 | 4100_US | 21394 | 500-YR | 486.00 | 5244.38 | 5248.21 | 5248.21 | 5250.18 | 0.107528 | 6.73 | 57.58 | 80.51 | 0.65 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 21357 | 2-YR | 32.00 | 5244.12 | 5246.18 | | 5246.19 | 0.004318 | 0.78 | 38.85 | 65.40 | 0.11 |
| Drainageway 4100 | 4100_US | 21357 | 5-YR | 39.00 | 5244.12 | 5246.26 | | 5246.27 | 0.004169 | 0.80 | 44.50 | 69.83 | 0.11 |
| Drainageway 4100 | 4100_US | 21357 | 10-YR | 40.00 | 5244.12 | 5246.27 | | 5246.28 | 0.004144 | 0.80 | 45.25 | 70.06 | 0.11 |
| Drainageway 4100 | 4100_US | 21357 | 25-YR | 112.00 | 5244.12 | 5246.79 | | 5246.83 | 0.003856 | 0.93 | 84.58 | 80.38 | 0.11 |
| Drainageway 4100 | 4100_US | 21357 | 50-YR | 175.00 | 5244.12 | 5247.09 | | 5247.14 | 0.004052 | 1.05 | 109.07 | 86.04 | 0.12 |
| Drainageway 4100 | 4100_US | 21357 | 100-YR | 283.00 | 5244.12 | 5247.47 | | 5247.54 | 0.004374 | 1.20 | 142.54 | 91.56 | 0.13 |
| Drainageway 4100 | 4100_US | 21357 | 500-YR | 486.00 | 5244.12 | 5247.97 | | 5248.09 | 0.005013 | 1.43 | 190.34 | 97.70 | 0.14 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 21249 | 2-YR | 32.00 | 5243.36 | 5244.28 | 5244.28 | 5244.60 | 0.454152 | 4.51 | 7.10 | 11.38 | 1.01 |
| Drainageway 4100 | 4100_US | 21249 | 5-YR | 39.00 | 5243.36 | 5244.38 | 5244.38 | 5244.73 | 0.442857 | 4.71 | 8.28 | 12.18 | 1.01 |
| Drainageway 4100 | 4100_US | 21249 | 10-YR | 40.00 | 5243.36 | 5244.40 | 5244.40 | 5244.75 | 0.443651 | 4.75 | 8.43 | 12.28 | 1.01 |
| Drainageway 4100 | 4100_US | 21249 | 25-YR | 112.00 | 5243.36 | 5245.23 | 5245.23 | 5245.53 | 0.169628 | 4.49 | 25.51 | 41.64 | 0.69 |
| Drainageway 4100 | 4100_US | 21249 | 50-YR | 175.00 | 5243.36 | 5245.45 | 5245.45 | 5245.81 | 0.142171 | 4.58 | 36.78 | 55.94 | 0.65 |
| Drainageway 4100 | 4100_US | 21249 | 100-YR | 283.00 | 5243.36 | 5245.75 | 5245.75 | 5246.19 | 0.104124 | 4.41 | 55.38 | 71.03 | 0.58 |
| Drainageway 4100 | 4100_US | 21249 | 500-YR | 486.00 | 5243.36 | 5246.16 | 5246.16 | 5246.68 | 0.070706 | 4.16 | 89.52 | 92.98 | 0.49 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 21234.72 | 2-YR | 32.00 | 5239.69 | 5241.84 | | 5241.85 | 0.003743 | 0.76 | 39.92 | 59.59 | 0.11 |
| Drainageway 4100 | 4100_US | 21234.72 | 5-YR | 39.00 | 5239.69 | 5241.93 | | 5241.94 | 0.003705 | 0.79 | 45.33 | 62.99 | 0.11 |
| Drainageway 4100 | 4100_US | 21234.72 | 10-YR | 40.00 | 5239.69 | 5241.94 | | 5241.95 | 0.003691 | 0.79 | 46.04 | 63.06 | 0.11 |
| Drainageway 4100 | 4100_US | 21234.72 | 25-YR | 112.00 | 5239.69 | 5242.46 | | 5242.50 | 0.004079 | 0.99 | 79.70 | 66.03 | 0.12 |
| Drainageway 4100 | 4100_US | 21234.72 | 50-YR | 175.00 | 5239.69 | 5242.75 | | 5242.81 | 0.004616 | 1.14 | 99.12 | 67.69 | 0.13 |
| Drainageway 4100 | 4100_US | 21234.72 | 100-YR | 283.00 | 5239.69 | 5243.15 | | 5243.25 | 0.005227 | 1.34 | 126.40 | 70.33 | 0.14 |
| Drainageway 4100 | 4100_US | 21234.72 | 500-YR | 486.00 | 5239.69 | 5243.67 | | 5243.85 | 0.006395 | 1.66 | 164.54 | 74.71 | 0.16 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 21052 | 2-YR | 32.00 | 5238.41 | 5239.34 | 5239.34 | 5239.65 | 0.450271 | 4.49 | 7.12 | 11.40 | 1.00 |
| Drainageway 4100 | 4100_US | 21052 | 5-YR | 39.00 | 5238.41 | 5239.43 | 5239.43 | 5239.78 | 0.442857 | 4.71 | 8.28 | 12.18 | 1.01 |
| Drainageway 4100 | 4100_US | 21052 | 10-YR | 40.00 | 5238.41 | 5239.45 | 5239.45 | 5239.80 | 0.443651 | 4.75 | 8.43 | 12.28 | 1.01 |
| Drainageway 4100 | 4100_US | 21052 | 25-YR | 112.00 | 5238.41 | 5240.27 | 5240.27 | 5240.54 | 0.154708 | 4.28 | 26.93 | 49.93 | 0.66 |
| Drainageway 4100 | 4100_US | 21052 | 50-YR | 175.00 | 5238.41 | 5240.49 | 5240.49 | 5240.79 | 0.121335 | 4.21 | 40.26 | 70.67 | 0.60 |
| Drainageway 4100 | 4100_US | 21052 | 100-YR | 283.00 | 5238.41 | 5240.71 | 5240.71 | 5241.10 | 0.106881 | 4.33 | 57.78 | 87.81 | 0.58 |
| Drainageway 4100 | 4100_US | 21052 | 500-YR | 486.00 | 5238.41 | 5241.05 | 5241.05 | 5241.59 | 0.072803 | 4.01 | 87.70 | 91.05 | 0.49 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 21040 | 2-YR | 32.00 | 5235.41 | 5237.60 | | 5237.61 | 0.003829 | 0.78 | 38.22 | 48.54 | 0.11 |
| Drainageway 4100 | 4100_US | 21040 | 5-YR | 39.00 | 5235.41 | 5237.71 | | 5237.72 | 0.003796 | 0.81 | 43.38 | 51.90 | 0.11 |
| Drainageway 4100 | 4100_US | 21040 | 10-YR | 40.00 | 5235.41 | 5237.72 | | 5237.73 | 0.003810 | 0.82 | 44.02 | 52.27 | 0.11 |
| Drainageway 4100 | 4100_US | 21040 | 25-YR | 112.00 | 5235.41 | 5238.31 | | 5238.35 | 0.004166 | 1.04 | 78.98 | 63.29 | 0.12 |
| Drainageway 4100 | 4100_US | 21040 | 50-YR | 175.00 | 5235.41 | 5238.62 | | 5238.68 | 0.004666 | 1.20 | 99.17 | 66.73 | 0.13 |
| Drainageway 4100 | 4100_US | 21040 | 100-YR | 283.00 | 5235.41 | 5239.03 | | 5239.13 | 0.005268 | 1.40 | 127.50 | 71.23 | 0.14 |
| Drainageway 4100 | 4100_US | 21040 | 500-YR | 486.00 | 5235.41 | 5239.58 | | 5239.75 | 0.006250 | 1.70 | 168.25 | 76.72 | 0.16 |
| | | | | | | | | | | | | | |

HEC-RAS Plan: Selected Plan (Continued)

| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Drainageway 4100 | 4100_US | 20857 | 2-YR | 32.00 | 5234.04 | 5234.96 | 5234.96 | 5235.28 | 0.462038 | 4.54 | 7.05 | 11.35 | 1.01 |
| Drainageway 4100 | 4100_US | 20857 | 5-YR | 39.00 | 5234.04 | 5235.06 | 5235.06 | 5235.41 | 0.442857 | 4.71 | 8.28 | 12.18 | 1.01 |
| Drainageway 4100 | 4100_US | 20857 | 10-YR | 40.00 | 5234.04 | 5235.08 | 5235.08 | 5235.43 | 0.443651 | 4.75 | 8.43 | 12.28 | 1.01 |
| Drainageway 4100 | 4100_US | 20857 | 25-YR | 112.00 | 5234.04 | 5235.90 | 5235.90 | 5236.17 | 0.155762 | 4.29 | 26.90 | 50.32 | 0.66 |
| Drainageway 4100 | 4100_US | 20857 | 50-YR | 175.00 | 5234.04 | 5236.12 | 5236.12 | 5236.41 | 0.119358 | 4.18 | 40.58 | 71.75 | 0.60 |
| Drainageway 4100 | 4100_US | 20857 | 100-YR | 283.00 | 5234.04 | 5236.35 | 5236.35 | 5236.72 | 0.102007 | 4.24 | 59.11 | 91.17 | 0.57 |
| Drainageway 4100 | 4100_US | 20857 | 500-YR | 486.00 | 5234.04 | 5236.66 | 5236.66 | 5237.17 | 0.074747 | 4.04 | 89.52 | 100.32 | 0.50 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 20845 | 2-YR | 32.00 | 5231.04 | 5233.14 | | 5233.15 | 0.003617 | 0.73 | 41.54 | 70.19 | 0.10 |
| Drainageway 4100 | 4100_US | 20845 | 5-YR | 39.00 | 5231.04 | 5233.22 | | 5233.23 | 0.003523 | 0.75 | 47.20 | 72.71 | 0.10 |
| Drainageway 4100 | 4100_US | 20845 | 10-YR | 40.00 | 5231.04 | 5233.23 | | 5233.24 | 0.003518 | 0.75 | 47.91 | 72.80 | 0.10 |
| Drainageway 4100 | 4100_US | 20845 | 25-YR | 112.00 | 5231.04 | 5233.72 | | 5233.75 | 0.003655 | 0.91 | 84.81 | 76.86 | 0.11 |
| Drainageway 4100 | 4100_US | 20845 | 50-YR | 175.00 | 5231.04 | 5234.03 | | 5234.08 | 0.003728 | 1.01 | 109.00 | 79.40 | 0.11 |
| Drainageway 4100 | 4100_US | 20845 | 100-YR | 283.00 | 5231.04 | 5234.43 | | 5234.51 | 0.003996 | 1.16 | 141.63 | 82.60 | 0.12 |
| Drainageway 4100 | 4100_US | 20845 | 500-YR | 486.00 | 5231.04 | 5235.02 | | 5235.14 | 0.004367 | 1.37 | 190.99 | 87.14 | 0.13 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 20663 | 2-YR | 32.00 | 5229.68 | 5230.60 | 5230.60 | 5230.92 | 0.455129 | 4.51 | 7.09 | 11.38 | 1.01 |
| Drainageway 4100 | 4100_US | 20663 | 5-YR | 39.00 | 5229.68 | 5230.70 | 5230.70 | 5231.05 | 0.442857 | 4.71 | 8.28 | 12.18 | 1.01 |
| Drainageway 4100 | 4100_US | 20663 | 10-YR | 40.00 | 5229.68 | 5230.72 | 5230.72 | 5231.07 | 0.443651 | 4.75 | 8.43 | 12.28 | 1.01 |
| Drainageway 4100 | 4100_US | 20663 | 25-YR | 112.00 | 5229.68 | 5231.55 | 5231.55 | 5231.80 | 0.143235 | 4.14 | 27.88 | 53.58 | 0.64 |
| Drainageway 4100 | 4100_US | 20663 | 50-YR | 175.00 | 5229.68 | 5231.68 | 5231.68 | 5232.07 | 0.162676 | 4.71 | 35.44 | 57.23 | 0.69 |
| Drainageway 4100 | 4100_US | 20663 | 100-YR | 283.00 | 5229.68 | 5231.96 | 5231.96 | 5232.50 | 0.113367 | 4.41 | 51.37 | 58.90 | 0.59 |
| Drainageway 4100 | 4100_US | 20663 | 500-YR | 486.00 | 5229.68 | 5232.44 | 5232.44 | 5233.15 | 0.067589 | 4.02 | 80.37 | 61.95 | 0.48 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 20651 | 2-YR | 32.00 | 5226.68 | 5228.87 | | 5228.88 | 0.003544 | 0.75 | 37.45 | 39.58 | 0.10 |
| Drainageway 4100 | 4100_US | 20651 | 5-YR | 39.00 | 5226.68 | 5228.98 | | 5229.00 | 0.003520 | 0.79 | 41.97 | 40.53 | 0.10 |
| Drainageway 4100 | 4100_US | 20651 | 10-YR | 40.00 | 5226.68 | 5229.00 | | 5229.02 | 0.003512 | 0.79 | 42.60 | 40.66 | 0.10 |
| Drainageway 4100 | 4100_US | 20651 | 25-YR | 112.00 | 5226.68 | 5229.70 | | 5229.75 | 0.004191 | 1.08 | 72.69 | 45.38 | 0.12 |
| Drainageway 4100 | 4100_US | 20651 | 50-YR | 175.00 | 5226.68 | 5230.09 | | 5230.17 | 0.004756 | 1.27 | 90.97 | 47.88 | 0.13 |
| Drainageway 4100 | 4100_US | 20651 | 100-YR | 283.00 | 5226.68 | 5230.59 | | 5230.72 | 0.005587 | 1.53 | 115.44 | 50.80 | 0.15 |
| Drainageway 4100 | 4100_US | 20651 | 500-YR | 486.00 | 5226.68 | 5231.23 | | 5231.46 | 0.007081 | 1.94 | 149.48 | 54.66 | 0.17 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 20433 | 2-YR | 32.00 | 5225.07 | 5226.00 | 5226.00 | 5226.31 | 0.449307 | 4.49 | 7.13 | 11.40 | 1.00 |
| Drainageway 4100 | 4100_US | 20433 | 5-YR | 39.00 | 5225.07 | 5226.09 | 5226.09 | 5226.44 | 0.442857 | 4.71 | 8.28 | 12.18 | 1.01 |
| Drainageway 4100 | 4100_US | 20433 | 10-YR | 40.00 | 5225.07 | 5226.11 | 5226.11 | 5226.46 | 0.443651 | 4.75 | 8.43 | 12.28 | 1.01 |
| Drainageway 4100 | 4100_US | 20433 | 25-YR | 112.00 | 5225.07 | 5226.95 | 5226.95 | 5227.20 | 0.138810 | 4.09 | 28.16 | 53.74 | 0.63 |
| Drainageway 4100 | 4100_US | 20433 | 50-YR | 175.00 | 5225.07 | 5227.15 | 5227.15 | 5227.43 | 0.117558 | 4.14 | 41.00 | 73.86 | 0.59 |
| Drainageway 4100 | 4100_US | 20433 | 100-YR | 283.00 | 5225.07 | 5227.38 | 5227.38 | 5227.73 | 0.096295 | 4.12 | 61.10 | 97.35 | 0.55 |
| Drainageway 4100 | 4100_US | 20433 | 500-YR | 486.00 | 5225.07 | 5227.69 | 5227.69 | 5228.13 | 0.072058 | 3.97 | 94.91 | 117.82 | 0.49 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 20421 | 2-YR | 32.00 | 5222.07 | 5224.07 | | 5224.08 | 0.005658 | 0.88 | 37.53 | 84.77 | 0.13 |
| Drainageway 4100 | 4100_US | 20421 | 5-YR | 39.00 | 5222.07 | 5224.13 | | 5224.15 | 0.005535 | 0.89 | 42.77 | 85.64 | 0.13 |
| Drainageway 4100 | 4100_US | 20421 | 10-YR | 40.00 | 5222.07 | 5224.14 | | 5224.15 | 0.005533 | 0.89 | 43.44 | 85.74 | 0.13 |
| Drainageway 4100 | 4100_US | 20421 | 25-YR | 112.00 | 5222.07 | 5224.53 | | 5224.57 | 0.005859 | 1.07 | 77.65 | 90.68 | 0.14 |
| Drainageway 4100 | 4100_US | 20421 | 50-YR | 175.00 | 5222.07 | 5224.73 | | 5224.79 | 0.006799 | 1.24 | 96.24 | 93.27 | 0.15 |
| Drainageway 4100 | 4100_US | 20421 | 100-YR | 283.00 | 5222.07 | 5225.00 | | 5225.10 | 0.007993 | 1.45 | 121.65 | 96.70 | 0.17 |
| Drainageway 4100 | 4100_US | 20421 | 500-YR | 486.00 | 5222.07 | 5225.22 | | 5225.44 | 0.013314 | 1.99 | 143.68 | 98.55 | 0.22 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 20331 | 2-YR | 32.00 | 5221.36 | 5222.29 | 5222.29 | 5222.60 | 0.449307 | 4.49 | 7.13 | 11.40 | 1.00 |
| Drainageway 4100 | 4100_US | 20331 | 5-YR | 39.00 | 5221.36 | 5222.38 | 5222.38 | 5222.73 | 0.442857 | 4.71 | 8.28 | 12.18 | 1.01 |
| Drainageway 4100 | 4100_US | 20331 | 10-YR | 40.00 | 5221.36 | 5222.40 | 5222.40 | 5222.75 | 0.443651 | 4.75 | 8.43 | 12.28 | 1.01 |
| Drainageway 4100 | 4100_US | 20331 | 25-YR | 112.00 | 5221.36 | 5223.22 | 5223.22 | 5223.49 | 0.151053 | 4.23 | 27.30 | 52.08 | 0.65 |
| Drainageway 4100 | 4100_US | 20331 | 50-YR | 175.00 | 5221.36 | 5223.42 | 5223.42 | 5223.73 | 0.128744 | 4.29 | 39.31 | 68.67 | 0.62 |
| Drainageway 4100 | 4100_US | 20331 | 100-YR | 283.00 | 5221.36 | 5223.66 | 5223.66 | 5224.06 | 0.101262 | 4.20 | 57.46 | 82.12 | 0.56 |
| Drainageway 4100 | 4100_US | 20331 | 500-YR | 486.00 | 5221.36 | 5224.76 | | 5224.93 | 0.009407 | 1.78 | 157.50 | 95.65 | 0.19 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 20306 | 2-YR | 32.00 | 5215.18 | 5217.20 | | 5217.22 | 0.005541 | 0.88 | 33.15 | 41.23 | 0.13 |
| Drainageway 4100 | 4100_US | 20306 | 5-YR | 39.00 | 5215.18 | 5217.30 | | 5217.32 | 0.005398 | 0.90 | 37.29 | 41.81 | 0.13 |
| Drainageway 4100 | 4100_US | 20306 | 10-YR | 40.00 | 5215.18 | 5217.31 | | 5217.33 | 0.005408 | 0.91 | 37.80 | 41.90 | 0.13 |
| Drainageway 4100 | 4100_US | 20306 | 25-YR | 112.00 | 5215.18 | 5217.97 | | 5218.02 | 0.005694 | 1.18 | 66.61 | 46.36 | 0.14 |
| Drainageway 4100 | 4100_US | 20306 | 50-YR | 175.00 | 5215.18 | 5218.33 | | 5218.42 | 0.006254 | 1.36 | 83.73 | 48.13 | 0.15 |
| Drainageway 4100 | 4100_US | 20306 | 100-YR | 283.00 | 5215.18 | 5219.36 | | 5219.45 | 0.003185 | 1.22 | 135.99 | 52.87 | 0.11 |
| Drainageway 4100 | 4100_US | 20306 | 500-YR | 486.00 | 5215.18 | 5224.86 | | 5224.87 | 0.000154 | 0.49 | 539.51 | 95.69 | 0.03 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 20238 | 2-YR | 32.00 | 5214.73 | 5215.66 | 5215.66 | 5215.97 | 0.448346 | 4.49 | 7.13 | 11.41 | 1.00 |
| Drainageway 4100 | 4100_US | 20238 | 5-YR | 39.00 | 5214.73 | 5215.75 | 5215.75 | 5216.10 | 0.442857 | 4.71 | 8.28 | 12.18 | 1.01 |
| Drainageway 4100 | 4100_US | 20238 | 10-YR | 40.00 | 5214.73 | 5215.77 | 5215.77 | 5216.12 | 0.443651 | 4.75 | 8.43 | 12.28 | 1.01 |
| Drainageway 4100 | 4100_US | 20238 | 25-YR | 112.00 | 5214.73 | 5216.51 | 5216.51 | 5216.85 | 0.204899 | 4.71 | 23.77 | 37.94 | 0.75 |
| Drainageway 4100 | 4100_US | 20238 | 50-YR | 175.00 | 5214.73 | 5216.75 | 5216.75 | 5217.21 | 0.154453 | 4.63 | 34.10 | 45.14 | 0.67 |
| Drainageway 4100 | 4100_US | 20238 | 100-YR | 283.00 | 5214.73 | 5219.21 | | 5219.28 | 0.001991 | 1.01 | 155.96 | 54.13 | 0.09 |
| Drainageway 4100 | 4100_US | 20238 | 500-YR | 486.00 | 5214.73 | 5224.85 | | 5224.86 | 0.000116 | 0.44 | 586.66 | 94.59 | 0.03 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 20226 | 2-YR | 32.00 | 5211.28 | 5212.83 | 5212.20 | 5212.89 | 0.049923 | 2.03 | 15.82 | 17.16 | 0.36 |
| Drainageway 4100 | 4100_US | 20226 | 5-YR | 39.00 | 5211.28 | 5213.02 | 5212.30 | 5213.09 | 0.038695 | 2.01 | 19.58 | 21.27 | 0.33 |
| Drainageway 4100 | 4100_US | 20226 | 10-YR | 40.00 | 5211.28 | 5213.05 | 5212.32 | 5213.11 | 0.037170 | 2.00 | 20.15 | 21.37 | 0.32 |
| Drainageway 4100 | 4100_US | 20226 | 25-YR | 112.00 | 5211.28 | 5214.70 | 5213.06 | 5214.77 | 0.006450 | 1.48 | 62.41 | 30.56 | 0.15 |
| Drainageway 4100 | 4100_US | 20226 | 50-YR | 175.00 | 5211.28 | 5214.88 | 5213.34 | 5215.02 | 0.011822 | 2.09 | 68.06 | 31.65 | 0.21 |
| Drainageway 4100 | 4100_US | 20226 | 100-YR | 283.00 | 5211.28 | 5219.23 | 5213.90 | 5219.26 | 0.000475 | 0.76 | 245.81 | 49.13 | 0.05 |
| Drainageway 4100 | 4100_US | 20226 | 500-YR | 486.00 | 5211.28 | 5224.85 | 5214.83 | 5224.86 | 0.000124 | 0.56 | 611.44 | 98.45 | 0.03 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 20176 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18947 | 2-YR | 47.00 | 5189.02 | 5191.04 | | 5191.10 | 0.013052 | 1.95 | 24.15 | 19.49 | 0.31 |
| Drainageway 4100 | 4100_US | 18947 | 5-YR | 62.00 | 5189.02 | 5191.27 | | 5191.34 | 0.013387 | 2.17 | 28.58 | 21.04 | 0.32 |
| Drainageway 4100 | 4100_US | 18947 | 10-YR | 80.00 | 5189.02 | 5191.50 | | 5191.59 | 0.013426 | 2.40 | 33.28 | 22.66 | 0.33 |
| Drainageway 4100 | 4100_US | 18947 | 25-YR | 177.00 | 5189.02 | 5192.45 | | 5192.63 | 0.014965 | 3.41 | 51.87 | 29.08 | 0.37 |
| Drainageway 4100 | 4100_US | 18947 | 50-YR | 272.00 | 5189.02 | 5193.01 | | 5193.30 | 0.018654 | 4.33 | 62.83 | 32.89 | 0.43 |
| Drainageway 4100 | 4100_US | 18947 | 100-YR | 418.00 | 5189.02 | 5193.64 | | 5194.12 | 0.024213 | 5.56 | 75.19 | 39.15 | 0.50 |
| Drainageway 4100 | 4100_US | 18947 | 500-YR | 719.00 | 5189.02 | 5194.51 | | 5195.46 | 0.036170 | 7.79 | 92.30 | 47.20 | 0.63 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18917 | 2-YR | 47.00 | 5188.73 | 5190.31 | | 5190.44 | 0.039568 | 2.88 | 16.29 | 16.51 | 0.51 |
| Drainageway 4100 | 4100_US | 18917 | 5-YR | 62.00 | 5188.73 | 5190.57 | | 5190.71 | 0.034899 | 2.99 | 20.77 | 18.15 | 0.49 |
| Drainageway 4100 | 4100_US | 18917 | 10-YR | 80.00 | 5188.73 | 5190.84 | | 5190.99 | 0.031185 | 3.08 | 25.99 | 19.90 | 0.47 |

HEC-RAS Plan: Selected Plan (Continued)

| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Drainageway 4100 | 4100_US | 18917 | 25-YR | 177.00 | 5188.73 | 5191.82 | | 5192.03 | 0.027520 | 3.65 | 48.55 | 26.13 | 0.47 |
| Drainageway 4100 | 4100_US | 18917 | 50-YR | 272.00 | 5188.73 | 5192.33 | | 5192.61 | 0.028301 | 4.29 | 65.34 | 37.24 | 0.50 |
| Drainageway 4100 | 4100_US | 18917 | 100-YR | 418.00 | 5188.73 | 5192.92 | | 5193.28 | 0.027792 | 4.94 | 89.04 | 43.18 | 0.51 |
| Drainageway 4100 | 4100_US | 18917 | 500-YR | 719.00 | 5188.73 | 5193.82 | | 5194.31 | 0.026441 | 5.76 | 131.02 | 50.40 | 0.52 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18877 | 2-YR | 47.00 | 5187.50 | 5189.75 | | 5189.80 | 0.008149 | 1.61 | 29.19 | 21.61 | 0.24 |
| Drainageway 4100 | 4100_US | 18877 | 5-YR | 62.00 | 5187.50 | 5190.02 | | 5190.06 | 0.008621 | 1.77 | 35.09 | 23.55 | 0.26 |
| Drainageway 4100 | 4100_US | 18877 | 10-YR | 80.00 | 5187.50 | 5190.31 | | 5190.37 | 0.008603 | 1.89 | 42.42 | 25.76 | 0.26 |
| Drainageway 4100 | 4100_US | 18877 | 25-YR | 177.00 | 5187.50 | 5191.27 | | 5191.37 | 0.010214 | 2.46 | 73.00 | 41.67 | 0.30 |
| Drainageway 4100 | 4100_US | 18877 | 50-YR | 272.00 | 5187.50 | 5191.78 | | 5191.91 | 0.010836 | 2.92 | 95.09 | 45.67 | 0.32 |
| Drainageway 4100 | 4100_US | 18877 | 100-YR | 418.00 | 5187.50 | 5192.37 | | 5192.55 | 0.011474 | 3.43 | 123.42 | 50.11 | 0.34 |
| Drainageway 4100 | 4100_US | 18877 | 500-YR | 719.00 | 5187.50 | 5193.27 | | 5193.55 | 0.012234 | 4.17 | 171.53 | 56.42 | 0.36 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18819 | 2-YR | 47.00 | 5187.10 | 5189.20 | | 5189.25 | 0.010937 | 1.85 | 25.41 | 18.94 | 0.28 |
| Drainageway 4100 | 4100_US | 18819 | 5-YR | 62.00 | 5187.10 | 5189.38 | | 5189.45 | 0.013037 | 2.14 | 29.03 | 19.86 | 0.31 |
| Drainageway 4100 | 4100_US | 18819 | 10-YR | 80.00 | 5187.10 | 5189.59 | | 5189.68 | 0.017290 | 2.39 | 33.43 | 23.90 | 0.36 |
| Drainageway 4100 | 4100_US | 18819 | 25-YR | 177.00 | 5187.10 | 5190.33 | | 5190.47 | 0.025725 | 2.97 | 59.69 | 42.09 | 0.44 |
| Drainageway 4100 | 4100_US | 18819 | 50-YR | 272.00 | 5187.10 | 5190.82 | | 5190.99 | 0.024945 | 3.34 | 81.54 | 47.09 | 0.45 |
| Drainageway 4100 | 4100_US | 18819 | 100-YR | 418.00 | 5187.10 | 5191.42 | | 5191.64 | 0.022649 | 3.76 | 111.76 | 54.76 | 0.44 |
| Drainageway 4100 | 4100_US | 18819 | 500-YR | 719.00 | 5187.10 | 5192.45 | | 5192.71 | 0.016878 | 4.18 | 175.06 | 66.95 | 0.41 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18762 | 2-YR | 47.00 | 5186.70 | 5188.81 | | 5188.83 | 0.005163 | 1.40 | 37.37 | 46.18 | 0.20 |
| Drainageway 4100 | 4100_US | 18762 | 5-YR | 62.00 | 5186.70 | 5188.99 | | 5189.02 | 0.004807 | 1.46 | 46.05 | 48.20 | 0.20 |
| Drainageway 4100 | 4100_US | 18762 | 10-YR | 80.00 | 5186.70 | 5189.18 | | 5189.21 | 0.004510 | 1.52 | 55.41 | 49.82 | 0.19 |
| Drainageway 4100 | 4100_US | 18762 | 25-YR | 177.00 | 5186.70 | 5189.88 | | 5189.94 | 0.004390 | 1.84 | 92.57 | 55.94 | 0.20 |
| Drainageway 4100 | 4100_US | 18762 | 50-YR | 272.00 | 5186.70 | 5190.39 | | 5190.47 | 0.004371 | 2.07 | 121.89 | 60.21 | 0.21 |
| Drainageway 4100 | 4100_US | 18762 | 100-YR | 418.00 | 5186.70 | 5191.01 | | 5191.12 | 0.004368 | 2.33 | 160.94 | 65.56 | 0.21 |
| Drainageway 4100 | 4100_US | 18762 | 500-YR | 719.00 | 5186.70 | 5192.12 | | 5192.27 | 0.003973 | 2.65 | 240.51 | 77.83 | 0.21 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18732 | 2-YR | 47.00 | 5186.49 | 5188.64 | 5187.61 | 5188.67 | 0.005396 | 1.46 | 40.22 | 47.54 | 0.20 |
| Drainageway 4100 | 4100_US | 18732 | 5-YR | 62.00 | 5186.49 | 5188.83 | 5187.79 | 5188.86 | 0.005488 | 1.59 | 49.41 | 49.93 | 0.21 |
| Drainageway 4100 | 4100_US | 18732 | 10-YR | 80.00 | 5186.49 | 5189.03 | 5187.96 | 5189.06 | 0.005546 | 1.72 | 59.42 | 52.16 | 0.22 |
| Drainageway 4100 | 4100_US | 18732 | 25-YR | 177.00 | 5186.49 | 5189.72 | 5188.62 | 5189.78 | 0.006659 | 2.30 | 97.95 | 58.96 | 0.25 |
| Drainageway 4100 | 4100_US | 18732 | 50-YR | 272.00 | 5186.49 | 5190.22 | 5188.92 | 5190.30 | 0.007213 | 2.68 | 128.72 | 63.66 | 0.27 |
| Drainageway 4100 | 4100_US | 18732 | 100-YR | 418.00 | 5186.49 | 5190.84 | 5189.26 | 5190.95 | 0.007708 | 3.12 | 169.85 | 69.21 | 0.28 |
| Drainageway 4100 | 4100_US | 18732 | 500-YR | 719.00 | 5186.49 | 5191.97 | 5189.83 | 5192.11 | 0.007221 | 3.59 | 252.62 | 82.34 | 0.29 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18716 | | Bridge | | | | | | | | | |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18649 | 2-YR | 47.00 | 5186.00 | 5188.11 | | 5188.14 | 0.005336 | 1.43 | 42.02 | 59.89 | 0.20 |
| Drainageway 4100 | 4100_US | 18649 | 5-YR | 62.00 | 5186.00 | 5188.31 | | 5188.34 | 0.004981 | 1.50 | 52.72 | 63.30 | 0.20 |
| Drainageway 4100 | 4100_US | 18649 | 10-YR | 80.00 | 5186.00 | 5188.52 | | 5188.55 | 0.004675 | 1.57 | 64.26 | 66.92 | 0.20 |
| Drainageway 4100 | 4100_US | 18649 | 25-YR | 177.00 | 5186.00 | 5189.01 | | 5189.07 | 0.007867 | 2.35 | 91.44 | 74.88 | 0.27 |
| Drainageway 4100 | 4100_US | 18649 | 50-YR | 272.00 | 5186.00 | 5189.37 | | 5189.47 | 0.009668 | 2.86 | 112.81 | 79.59 | 0.30 |
| Drainageway 4100 | 4100_US | 18649 | 100-YR | 418.00 | 5186.00 | 5189.81 | | 5189.95 | 0.011722 | 3.47 | 139.45 | 84.98 | 0.34 |
| Drainageway 4100 | 4100_US | 18649 | 500-YR | 719.00 | 5186.00 | 5190.46 | | 5190.71 | 0.014831 | 4.41 | 181.04 | 156.89 | 0.39 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18600 | 2-YR | 47.00 | 5185.97 | 5187.11 | 5187.11 | 5187.47 | 0.039644 | 4.80 | 9.80 | 13.14 | 0.98 |
| Drainageway 4100 | 4100_US | 18600 | 5-YR | 62.00 | 5185.97 | 5187.28 | 5187.28 | 5187.69 | 0.038718 | 5.12 | 12.12 | 14.49 | 0.99 |
| Drainageway 4100 | 4100_US | 18600 | 10-YR | 80.00 | 5185.97 | 5187.46 | 5187.46 | 5187.91 | 0.037593 | 5.41 | 14.79 | 15.89 | 0.99 |
| Drainageway 4100 | 4100_US | 18600 | 25-YR | 177.00 | 5185.97 | 5188.17 | 5188.17 | 5188.47 | 0.015077 | 4.99 | 49.35 | 73.61 | 0.69 |
| Drainageway 4100 | 4100_US | 18600 | 50-YR | 272.00 | 5185.97 | 5188.40 | 5188.40 | 5188.77 | 0.016812 | 5.75 | 66.54 | 77.37 | 0.74 |
| Drainageway 4100 | 4100_US | 18600 | 100-YR | 418.00 | 5185.97 | 5188.66 | 5188.66 | 5189.13 | 0.018911 | 6.66 | 87.55 | 81.39 | 0.80 |
| Drainageway 4100 | 4100_US | 18600 | 500-YR | 719.00 | 5185.97 | 5189.10 | 5189.10 | 5189.73 | 0.020800 | 7.92 | 124.63 | 110.59 | 0.87 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18558 | 2-YR | 47.00 | 5182.97 | 5185.19 | | 5185.21 | 0.006670 | 1.24 | 37.90 | 35.77 | 0.21 |
| Drainageway 4100 | 4100_US | 18558 | 5-YR | 62.00 | 5182.97 | 5185.45 | | 5185.48 | 0.006405 | 1.29 | 48.01 | 41.36 | 0.21 |
| Drainageway 4100 | 4100_US | 18558 | 10-YR | 80.00 | 5182.97 | 5185.70 | | 5185.73 | 0.006833 | 1.34 | 59.59 | 50.96 | 0.22 |
| Drainageway 4100 | 4100_US | 18558 | 25-YR | 177.00 | 5182.97 | 5186.38 | | 5186.42 | 0.009024 | 1.65 | 107.20 | 86.90 | 0.26 |
| Drainageway 4100 | 4100_US | 18558 | 50-YR | 272.00 | 5182.97 | 5186.75 | | 5186.81 | 0.009392 | 1.90 | 141.30 | 97.71 | 0.27 |
| Drainageway 4100 | 4100_US | 18558 | 100-YR | 418.00 | 5182.97 | 5187.19 | | 5187.30 | 0.010270 | 2.15 | 188.17 | 118.41 | 0.29 |
| Drainageway 4100 | 4100_US | 18558 | 500-YR | 719.00 | 5182.97 | 5188.24 | | 5188.39 | 0.004949 | 2.00 | 326.78 | 143.83 | 0.22 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18545 | 2-YR | 47.00 | 5182.88 | 5185.11 | | 5185.13 | 0.005572 | 1.15 | 40.98 | 38.00 | 0.19 |
| Drainageway 4100 | 4100_US | 18545 | 5-YR | 62.00 | 5182.88 | 5185.38 | | 5185.40 | 0.005804 | 1.19 | 52.23 | 47.57 | 0.20 |
| Drainageway 4100 | 4100_US | 18545 | 10-YR | 80.00 | 5182.88 | 5185.63 | | 5185.65 | 0.005958 | 1.23 | 65.29 | 57.98 | 0.20 |
| Drainageway 4100 | 4100_US | 18545 | 25-YR | 177.00 | 5182.88 | 5186.28 | | 5186.31 | 0.007676 | 1.54 | 115.26 | 90.87 | 0.24 |
| Drainageway 4100 | 4100_US | 18545 | 50-YR | 272.00 | 5182.88 | 5186.65 | | 5186.70 | 0.007750 | 1.83 | 150.04 | 96.44 | 0.25 |
| Drainageway 4100 | 4100_US | 18545 | 100-YR | 418.00 | 5182.88 | 5187.10 | | 5187.17 | 0.008002 | 2.18 | 195.40 | 104.84 | 0.26 |
| Drainageway 4100 | 4100_US | 18545 | 500-YR | 719.00 | 5182.88 | 5188.23 | | 5188.31 | 0.005015 | 2.29 | 328.44 | 131.30 | 0.22 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18465 | 2-YR | 47.00 | 5182.32 | 5183.45 | 5183.45 | 5183.82 | 0.167645 | 4.90 | 9.60 | 13.02 | 1.01 |
| Drainageway 4100 | 4100_US | 18465 | 5-YR | 62.00 | 5182.32 | 5183.61 | 5183.61 | 5184.04 | 0.163747 | 5.22 | 11.87 | 14.35 | 1.01 |
| Drainageway 4100 | 4100_US | 18465 | 10-YR | 80.00 | 5182.32 | 5183.87 | 5183.77 | 5184.26 | 0.171624 | 5.04 | 15.86 | 21.01 | 1.02 |
| Drainageway 4100 | 4100_US | 18465 | 25-YR | 177.00 | 5182.32 | 5184.80 | | 5184.99 | 0.056024 | 3.51 | 50.38 | 50.01 | 0.62 |
| Drainageway 4100 | 4100_US | 18465 | 50-YR | 272.00 | 5182.32 | 5185.21 | | 5185.42 | 0.048990 | 3.66 | 74.28 | 62.72 | 0.59 |
| Drainageway 4100 | 4100_US | 18465 | 100-YR | 418.00 | 5182.32 | 5185.74 | | 5185.97 | 0.036656 | 3.82 | 109.41 | 69.72 | 0.54 |
| Drainageway 4100 | 4100_US | 18465 | 500-YR | 719.00 | 5182.32 | 5187.71 | | 5187.81 | 0.007898 | 2.56 | 281.09 | 104.58 | 0.27 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18419 | 2-YR | 47.00 | 5179.94 | 5182.77 | | 5182.79 | 0.003710 | 1.17 | 40.34 | 26.39 | 0.17 |
| Drainageway 4100 | 4100_US | 18419 | 5-YR | 62.00 | 5179.94 | 5183.22 | | 5183.24 | 0.004039 | 1.14 | 54.34 | 39.64 | 0.17 |
| Drainageway 4100 | 4100_US | 18419 | 10-YR | 80.00 | 5179.94 | 5183.46 | | 5183.49 | 0.004890 | 1.22 | 65.41 | 49.94 | 0.19 |
| Drainageway 4100 | 4100_US | 18419 | 25-YR | 177.00 | 5179.94 | 5184.01 | | 5184.06 | 0.009662 | 1.80 | 98.26 | 70.42 | 0.27 |
| Drainageway 4100 | 4100_US | 18419 | 50-YR | 272.00 | 5179.94 | 5184.38 | | 5184.45 | 0.010945 | 2.18 | 125.05 | 74.16 | 0.30 |
| Drainageway 4100 | 4100_US | 18419 | 100-YR | 418.00 | 5179.94 | 5185.19 | | 5185.26 | 0.007567 | 2.22 | 188.22 | 82.01 | 0.26 |
| Drainageway 4100 | 4100_US | 18419 | 500-YR | 719.00 | 5179.94 | 5187.57 | | 5187.62 | 0.002219 | 1.74 | 415.97 | 114.69 | 0.15 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18247 | 2-YR | 74.00 | 5178.74 | 5180.81 | 5180.18 | 5180.90 | 0.037129 | 2.46 | 30.12 | 37.47 | 0.48 |
| Drainageway 4100 | 4100_US | 18247 | 5-YR | 108.00 | 5178.74 | 5181.18 | 5180.56 | 5181.25 | 0.031627 | 2.14 | 50.51 | 68.94 | 0.44 |
| Drainageway 4100 | 4100_US | 18247 | 10-YR | 153.00 | 5178.74 | 5181.49 | 5180.81 | 5181.56 | 0.020833 | 2.11 | 72.38 | 73.45 | 0.38 |
| Drainageway 4100 | 4100_US | 18247 | 25-YR | 274.00 | 5178.74 | 5182.26 | 5181.25 | 5182.33 | 0.010350 | 2.06 | 132.97 | 82.89 | 0.29 |
| Drainageway 4100 | 4100_US | 18247 | 50-YR | 410.00 | 5178.74 | 5183.10 | 5181.50 | 5183.16 | 0.006017 | 1.99 | 205.71 | 89.59 | 0.23 |
| Drainageway 4100 | 4100_US | 18247 | 100-YR | 619.00 | 5178.74 | 5184.47 | 5181.82 | 5184.52 | 0.003129 | 1.85 | 335.39 | 100.14 | 0.18 |

HEC-RAS Plan: Selected Plan (Continued)

| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Drainageway 4100 | 4100_US | 18247 | 500-YR | 1049.00 | 5178.74 | 5187.33 | 5182.39 | 5187.37 | 0.001106 | 1.58 | 688.90 | 186.41 | 0.12 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18226 | 2-YR | 74.00 | 5178.59 | 5180.26 | 5179.44 | 5180.34 | 0.020049 | 2.32 | 31.92 | 29.65 | 0.36 |
| Drainageway 4100 | 4100_US | 18226 | 5-YR | 108.00 | 5178.59 | 5180.61 | 5179.75 | 5180.72 | 0.020660 | 2.61 | 41.35 | 34.06 | 0.38 |
| Drainageway 4100 | 4100_US | 18226 | 10-YR | 153.00 | 5178.59 | 5180.99 | 5180.01 | 5181.13 | 0.019713 | 2.93 | 52.29 | 42.92 | 0.38 |
| Drainageway 4100 | 4100_US | 18226 | 25-YR | 274.00 | 5178.59 | 5181.84 | 5180.59 | 5182.03 | 0.017610 | 3.57 | 76.74 | 53.10 | 0.39 |
| Drainageway 4100 | 4100_US | 18226 | 50-YR | 410.00 | 5178.59 | 5182.70 | 5181.04 | 5182.96 | 0.015313 | 4.02 | 101.91 | 65.35 | 0.38 |
| Drainageway 4100 | 4100_US | 18226 | 100-YR | 619.00 | 5178.59 | 5184.09 | 5181.63 | 5184.39 | 0.011521 | 4.36 | 142.11 | 79.87 | 0.35 |
| Drainageway 4100 | 4100_US | 18226 | 500-YR | 1049.00 | 5178.59 | 5187.07 | 5182.65 | 5187.29 | 0.019879 | 3.87 | 285.24 | 172.89 | 0.42 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18210 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18113 | 2-YR | 74.00 | 5178.14 | 5180.19 | 5178.97 | 5180.26 | 0.009505 | 2.10 | 35.32 | 27.51 | 0.26 |
| Drainageway 4100 | 4100_US | 18113 | 5-YR | 108.00 | 5178.14 | 5180.49 | 5179.23 | 5180.60 | 0.012767 | 2.66 | 40.56 | 30.04 | 0.31 |
| Drainageway 4100 | 4100_US | 18113 | 10-YR | 153.00 | 5178.14 | 5180.77 | 5179.52 | 5180.95 | 0.017404 | 3.36 | 45.55 | 32.49 | 0.37 |
| Drainageway 4100 | 4100_US | 18113 | 25-YR | 274.00 | 5178.14 | 5181.29 | 5180.16 | 5181.68 | 0.030507 | 5.02 | 54.60 | 37.07 | 0.50 |
| Drainageway 4100 | 4100_US | 18113 | 50-YR | 410.00 | 5178.14 | 5181.65 | 5180.77 | 5182.35 | 0.047227 | 6.72 | 60.99 | 40.65 | 0.64 |
| Drainageway 4100 | 4100_US | 18113 | 100-YR | 619.00 | 5178.14 | 5181.99 | 5181.58 | 5183.32 | 0.079019 | 9.25 | 66.92 | 44.67 | 0.84 |
| Drainageway 4100 | 4100_US | 18113 | 500-YR | 1049.00 | 5178.14 | 5183.00 | 5183.00 | 5185.38 | 0.103071 | 12.37 | 84.80 | 64.76 | 0.99 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 18083 | 2-YR | 74.00 | 5177.74 | 5179.43 | 5179.25 | 5179.58 | 0.093740 | 3.10 | 23.85 | 41.98 | 0.73 |
| Drainageway 4100 | 4100_US | 18083 | 5-YR | 108.00 | 5177.74 | 5179.66 | 5179.45 | 5179.81 | 0.079000 | 3.11 | 34.72 | 53.62 | 0.68 |
| Drainageway 4100 | 4100_US | 18083 | 10-YR | 153.00 | 5177.74 | 5179.86 | 5179.63 | 5180.03 | 0.066683 | 3.30 | 46.64 | 63.56 | 0.65 |
| Drainageway 4100 | 4100_US | 18083 | 25-YR | 274.00 | 5177.74 | 5180.36 | 5179.96 | 5180.55 | 0.038833 | 3.48 | 83.19 | 79.40 | 0.54 |
| Drainageway 4100 | 4100_US | 18083 | 50-YR | 410.00 | 5177.74 | 5180.83 | | 5181.02 | 0.028067 | 3.63 | 122.96 | 89.65 | 0.48 |
| Drainageway 4100 | 4100_US | 18083 | 100-YR | 619.00 | 5177.74 | 5181.39 | | 5181.60 | 0.022693 | 3.92 | 175.31 | 97.81 | 0.45 |
| Drainageway 4100 | 4100_US | 18083 | 500-YR | 1049.00 | 5177.74 | 5181.95 | 5181.14 | 5182.30 | 0.028627 | 5.08 | 232.05 | 105.17 | 0.53 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 17660 | 2-YR | 74.00 | 5172.12 | 5173.69 | 5172.90 | 5173.71 | 0.005278 | 1.09 | 67.81 | 66.50 | 0.19 |
| Drainageway 4100 | 4100_US | 17660 | 5-YR | 108.00 | 5172.12 | 5173.96 | 5173.07 | 5173.98 | 0.005455 | 1.26 | 85.53 | 69.03 | 0.20 |
| Drainageway 4100 | 4100_US | 17660 | 10-YR | 153.00 | 5172.12 | 5174.23 | 5173.19 | 5174.26 | 0.005644 | 1.46 | 106.39 | 81.03 | 0.21 |
| Drainageway 4100 | 4100_US | 17660 | 25-YR | 274.00 | 5172.12 | 5174.71 | 5173.46 | 5174.76 | 0.006824 | 1.93 | 148.63 | 93.76 | 0.24 |
| Drainageway 4100 | 4100_US | 17660 | 50-YR | 410.00 | 5172.12 | 5175.08 | 5173.72 | 5175.16 | 0.008152 | 2.37 | 184.38 | 97.97 | 0.27 |
| Drainageway 4100 | 4100_US | 17660 | 100-YR | 619.00 | 5172.12 | 5175.55 | 5174.09 | 5175.67 | 0.009423 | 2.88 | 231.81 | 102.08 | 0.30 |
| Drainageway 4100 | 4100_US | 17660 | 500-YR | 1049.00 | 5172.12 | 5176.79 | 5174.70 | 5176.93 | 0.006970 | 3.15 | 364.64 | 111.80 | 0.28 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 17210 | 2-YR | 74.00 | 5166.00 | 5166.44 | 5166.44 | 5166.60 | 0.211724 | 3.24 | 22.85 | 70.03 | 1.00 |
| Drainageway 4100 | 4100_US | 17210 | 5-YR | 108.00 | 5166.00 | 5166.54 | 5166.54 | 5166.74 | 0.198517 | 3.63 | 29.78 | 73.38 | 1.00 |
| Drainageway 4100 | 4100_US | 17210 | 10-YR | 153.00 | 5166.00 | 5166.65 | 5166.65 | 5166.90 | 0.181467 | 3.99 | 38.31 | 76.40 | 0.99 |
| Drainageway 4100 | 4100_US | 17210 | 25-YR | 274.00 | 5166.00 | 5167.06 | | 5167.29 | 0.084972 | 3.85 | 71.18 | 84.86 | 0.74 |
| Drainageway 4100 | 4100_US | 17210 | 50-YR | 410.00 | 5166.00 | 5167.48 | | 5167.70 | 0.049934 | 3.78 | 108.53 | 90.26 | 0.60 |
| Drainageway 4100 | 4100_US | 17210 | 100-YR | 619.00 | 5166.00 | 5167.98 | | 5168.23 | 0.036144 | 4.04 | 154.86 | 96.90 | 0.54 |
| Drainageway 4100 | 4100_US | 17210 | 500-YR | 1049.00 | 5166.00 | 5167.90 | 5167.90 | 5168.70 | 0.121336 | 7.17 | 147.43 | 95.85 | 0.99 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 16910 | 2-YR | 74.00 | 5161.93 | 5162.86 | | 5162.87 | 0.003905 | 0.82 | 90.31 | 108.75 | 0.16 |
| Drainageway 4100 | 4100_US | 16910 | 5-YR | 108.00 | 5161.93 | 5163.17 | | 5163.18 | 0.002953 | 0.87 | 123.96 | 113.71 | 0.14 |
| Drainageway 4100 | 4100_US | 16910 | 10-YR | 153.00 | 5161.93 | 5163.37 | | 5163.39 | 0.003356 | 1.04 | 147.84 | 118.66 | 0.16 |
| Drainageway 4100 | 4100_US | 16910 | 25-YR | 274.00 | 5161.93 | 5163.78 | | 5163.81 | 0.004267 | 1.40 | 197.75 | 128.62 | 0.19 |
| Drainageway 4100 | 4100_US | 16910 | 50-YR | 410.00 | 5161.93 | 5164.11 | | 5164.15 | 0.005058 | 1.71 | 241.92 | 136.56 | 0.21 |
| Drainageway 4100 | 4100_US | 16910 | 100-YR | 619.00 | 5161.93 | 5164.52 | | 5164.59 | 0.005858 | 2.08 | 299.74 | 145.11 | 0.23 |
| Drainageway 4100 | 4100_US | 16910 | 500-YR | 1049.00 | 5161.93 | 5166.88 | | 5166.91 | 0.001165 | 1.45 | 704.42 | 198.48 | 0.12 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 16789 | 2-YR | 74.00 | 5160.00 | 5162.20 | 5160.83 | 5162.24 | 0.007437 | 1.66 | 45.69 | 132.42 | 0.23 |
| Drainageway 4100 | 4100_US | 16789 | 5-YR | 108.00 | 5160.00 | 5162.75 | 5161.07 | 5162.77 | 0.003778 | 1.44 | 90.39 | 148.15 | 0.17 |
| Drainageway 4100 | 4100_US | 16789 | 10-YR | 153.00 | 5160.00 | 5162.91 | 5161.38 | 5162.94 | 0.003982 | 1.55 | 115.52 | 151.82 | 0.18 |
| Drainageway 4100 | 4100_US | 16789 | 25-YR | 274.00 | 5160.00 | 5163.25 | 5162.19 | 5163.29 | 0.004142 | 1.73 | 167.97 | 158.22 | 0.19 |
| Drainageway 4100 | 4100_US | 16789 | 50-YR | 410.00 | 5160.00 | 5163.49 | 5162.80 | 5163.56 | 0.004780 | 1.97 | 206.82 | 162.38 | 0.20 |
| Drainageway 4100 | 4100_US | 16789 | 100-YR | 619.00 | 5160.00 | 5163.87 | 5163.00 | 5163.95 | 0.004689 | 2.11 | 268.30 | 168.14 | 0.21 |
| Drainageway 4100 | 4100_US | 16789 | 500-YR | 1049.00 | 5160.00 | 5166.82 | 5163.30 | 5166.84 | 0.000352 | 0.89 | 891.50 | 247.58 | 0.06 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 16777 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_US | 16764 | 2-YR | 74.00 | 5159.90 | 5161.76 | | 5161.83 | 0.006533 | 1.72 | 38.51 | 137.77 | 0.22 |
| Drainageway 4100 | 4100_US | 16764 | 5-YR | 108.00 | 5159.90 | 5162.08 | | 5162.19 | 0.007952 | 2.11 | 45.60 | 146.23 | 0.25 |
| Drainageway 4100 | 4100_US | 16764 | 10-YR | 153.00 | 5159.90 | 5162.25 | | 5162.44 | 0.012215 | 2.74 | 49.72 | 150.15 | 0.32 |
| Drainageway 4100 | 4100_US | 16764 | 25-YR | 274.00 | 5159.90 | 5162.52 | 5161.78 | 5163.00 | 0.025925 | 4.30 | 56.65 | 156.33 | 0.47 |
| Drainageway 4100 | 4100_US | 16764 | 50-YR | 410.00 | 5159.90 | 5162.89 | 5162.84 | 5163.14 | 0.025563 | 4.66 | 114.76 | 164.50 | 0.47 |
| Drainageway 4100 | 4100_US | 16764 | 100-YR | 619.00 | 5159.90 | 5163.25 | | 5163.46 | 0.017134 | 4.12 | 176.26 | 174.13 | 0.40 |
| Drainageway 4100 | 4100_US | 16764 | 500-YR | 1049.00 | 5159.90 | 5166.79 | | 5166.81 | 0.000260 | 0.82 | 986.70 | 267.11 | 0.06 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 16734 | 2-YR | 139.00 | 5160.00 | 5161.19 | 5161.15 | 5161.30 | 0.040168 | 2.83 | 53.54 | 169.53 | 0.52 |
| Drainageway 4100 | 4100_DS | 16734 | 5-YR | 212.00 | 5160.00 | 5161.22 | 5161.22 | 5161.42 | 0.066683 | 3.74 | 59.45 | 171.10 | 0.67 |
| Drainageway 4100 | 4100_DS | 16734 | 10-YR | 298.00 | 5160.00 | 5161.33 | 5161.33 | 5161.56 | 0.054970 | 3.64 | 78.41 | 186.11 | 0.62 |
| Drainageway 4100 | 4100_DS | 16734 | 25-YR | 516.00 | 5160.00 | 5161.55 | 5161.55 | 5161.85 | 0.042699 | 3.63 | 120.40 | 198.27 | 0.56 |
| Drainageway 4100 | 4100_DS | 16734 | 50-YR | 691.00 | 5160.00 | 5161.67 | 5161.67 | 5162.04 | 0.043479 | 3.88 | 144.01 | 202.85 | 0.58 |
| Drainageway 4100 | 4100_DS | 16734 | 100-YR | 1001.00 | 5160.00 | 5163.22 | | 5163.29 | 0.001863 | 1.32 | 494.59 | 239.90 | 0.13 |
| Drainageway 4100 | 4100_DS | 16734 | 500-YR | 1745.00 | 5160.00 | 5166.78 | | 5166.80 | 0.000197 | 0.72 | 1487.56 | 305.26 | 0.05 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 16310 | 2-YR | 181.00 | 5155.99 | 5156.80 | | 5156.81 | 0.005433 | 0.72 | 250.60 | 467.68 | 0.17 |
| Drainageway 4100 | 4100_DS | 16310 | 5-YR | 280.00 | 5155.99 | 5157.62 | | 5157.62 | 0.000526 | 0.36 | 772.24 | 703.11 | 0.06 |
| Drainageway 4100 | 4100_DS | 16310 | 10-YR | 397.00 | 5155.99 | 5158.35 | | 5158.35 | 0.000213 | 0.30 | 1307.20 | 788.04 | 0.04 |
| Drainageway 4100 | 4100_DS | 16310 | 25-YR | 726.00 | 5155.99 | 5160.00 | | 5160.00 | 0.000072 | 0.28 | 2623.63 | 805.37 | 0.03 |
| Drainageway 4100 | 4100_DS | 16310 | 50-YR | 929.00 | 5155.99 | 5161.39 | | 5161.39 | 0.000036 | 0.25 | 3757.04 | 824.71 | 0.02 |
| Drainageway 4100 | 4100_DS | 16310 | 100-YR | 1316.00 | 5155.99 | 5163.24 | | 5163.24 | 0.000023 | 0.25 | 5300.37 | 841.22 | 0.02 |
| Drainageway 4100 | 4100_DS | 16310 | 500-YR | 2292.00 | 5155.99 | 5166.78 | | 5166.78 | 0.000016 | 0.27 | 8325.15 | 869.73 | 0.02 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 15853 | 2-YR | 181.00 | 5153.00 | 5156.80 | | 5156.80 | 0.000013 | 0.09 | 1955.17 | 878.05 | 0.01 |
| Drainageway 4100 | 4100_DS | 15853 | 5-YR | 280.00 | 5153.00 | 5157.62 | | 5157.62 | 0.000011 | 0.10 | 2679.09 | 886.54 | 0.01 |
| Drainageway 4100 | 4100_DS | 15853 | 10-YR | 397.00 | 5153.00 | 5158.35 | | 5158.35 | 0.000011 | 0.12 | 3328.84 | 893.74 | 0.01 |
| Drainageway 4100 | 4100_DS | 15853 | 25-YR | 726.00 | 5153.00 | 5160.00 | | 5160.00 | 0.000011 | 0.15 | 4815.28 | 907.13 | 0.01 |
| Drainageway 4100 | 4100_DS | 15853 | 50-YR | 929.00 | 5153.00 | 5161.39 | | 5161.39 | 0.000008 | 0.15 | 6085.51 | 921.05 | 0.01 |
| Drainageway 4100 | 4100_DS | 15853 | 100-YR | 1316.00 | 5153.00 | 5163.24 | | 5163.24 | 0.000007 | 0.17 | 7867.93 | 988.99 | 0.01 |
| Drainageway 4100 | 4100_DS | 15853 | 500-YR | 2292.00 | 5153.00 | 5166.78 | | 5166.78 | 0.000006 | 0.20 | 11417.38 | 1019.55 | 0.01 |

HEC-RAS Plan: Selected Plan (Continued)

| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Drainageway 4100 | 4100_DS | 15823 | 2-YR | 24.00 | 5153.00 | 5156.80 | | 5156.80 | 0.000010 | 0.10 | 243.36 | 802.73 | 0.01 |
| Drainageway 4100 | 4100_DS | 15823 | 5-YR | 40.00 | 5153.00 | 5157.62 | | 5157.62 | 0.000013 | 0.13 | 310.87 | 876.75 | 0.01 |
| Drainageway 4100 | 4100_DS | 15823 | 10-YR | 74.00 | 5153.00 | 5158.35 | | 5158.35 | 0.000024 | 0.20 | 370.95 | 896.68 | 0.02 |
| Drainageway 4100 | 4100_DS | 15823 | 25-YR | 135.00 | 5153.00 | 5160.00 | | 5160.00 | 0.000029 | 0.27 | 506.73 | 913.45 | 0.02 |
| Drainageway 4100 | 4100_DS | 15823 | 50-YR | 150.00 | 5153.00 | 5161.39 | | 5161.39 | 0.000018 | 0.24 | 621.14 | 946.24 | 0.02 |
| Drainageway 4100 | 4100_DS | 15823 | 100-YR | 165.00 | 5153.00 | 5163.24 | | 5163.24 | 0.000010 | 0.21 | 773.41 | 1000.53 | 0.01 |
| Drainageway 4100 | 4100_DS | 15823 | 500-YR | 206.00 | 5153.00 | 5166.78 | | 5166.78 | 0.000006 | 0.19 | 1064.71 | 1035.67 | 0.01 |
| Drainageway 4100 | 4100_DS | 15787 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 15543 | 2-YR | 24.00 | 5142.00 | 5143.22 | | 5143.41 | 0.065745 | 3.49 | 7.03 | 47.47 | 0.64 |
| Drainageway 4100 | 4100_DS | 15543 | 5-YR | 40.00 | 5142.00 | 5143.62 | 5143.36 | 5143.77 | 0.037160 | 3.32 | 14.20 | 81.50 | 0.51 |
| Drainageway 4100 | 4100_DS | 15543 | 10-YR | 74.00 | 5142.00 | 5144.09 | | 5144.22 | 0.022179 | 3.14 | 25.82 | 101.92 | 0.41 |
| Drainageway 4100 | 4100_DS | 15543 | 25-YR | 135.00 | 5142.00 | 5144.66 | | 5144.84 | 0.017437 | 3.35 | 40.43 | 140.01 | 0.38 |
| Drainageway 4100 | 4100_DS | 15543 | 50-YR | 150.00 | 5142.00 | 5144.76 | | 5144.95 | 0.017635 | 3.47 | 42.97 | 145.99 | 0.39 |
| Drainageway 4100 | 4100_DS | 15543 | 100-YR | 165.00 | 5142.00 | 5144.86 | | 5145.07 | 0.017533 | 3.55 | 45.64 | 151.65 | 0.39 |
| Drainageway 4100 | 4100_DS | 15543 | 500-YR | 206.00 | 5142.00 | 5145.15 | | 5145.38 | 0.016584 | 3.70 | 53.18 | 174.67 | 0.39 |
| Drainageway 4100 | 4100_DS | 15496 | 2-YR | 24.00 | 5140.12 | 5142.50 | 5141.44 | 5142.53 | 0.007787 | 1.44 | 16.67 | 13.60 | 0.23 |
| Drainageway 4100 | 4100_DS | 15496 | 5-YR | 40.00 | 5140.12 | 5142.93 | 5141.69 | 5142.98 | 0.009108 | 1.74 | 23.04 | 21.64 | 0.25 |
| Drainageway 4100 | 4100_DS | 15496 | 10-YR | 74.00 | 5140.12 | 5143.44 | 5142.20 | 5143.52 | 0.011345 | 2.34 | 31.98 | 103.31 | 0.30 |
| Drainageway 4100 | 4100_DS | 15496 | 25-YR | 135.00 | 5140.12 | 5143.96 | 5142.77 | 5144.12 | 0.015902 | 3.25 | 42.75 | 132.54 | 0.37 |
| Drainageway 4100 | 4100_DS | 15496 | 50-YR | 150.00 | 5140.12 | 5143.95 | 5142.90 | 5144.15 | 0.019810 | 3.62 | 42.62 | 132.22 | 0.41 |
| Drainageway 4100 | 4100_DS | 15496 | 100-YR | 165.00 | 5140.12 | 5143.92 | 5143.00 | 5144.17 | 0.025163 | 4.05 | 41.92 | 130.62 | 0.46 |
| Drainageway 4100 | 4100_DS | 15496 | 500-YR | 206.00 | 5140.12 | 5144.05 | 5143.26 | 5144.40 | 0.032293 | 4.75 | 45.07 | 140.86 | 0.53 |
| Drainageway 4100 | 4100_DS | 15412 | 2-YR | 24.00 | 5140.00 | 5140.78 | | 5140.95 | 0.090713 | 3.31 | 7.25 | 11.06 | 0.72 |
| Drainageway 4100 | 4100_DS | 15412 | 5-YR | 40.00 | 5140.00 | 5141.19 | | 5141.35 | 0.063520 | 3.22 | 12.44 | 15.17 | 0.63 |
| Drainageway 4100 | 4100_DS | 15412 | 10-YR | 74.00 | 5140.00 | 5141.91 | | 5142.04 | 0.031318 | 2.80 | 26.40 | 23.39 | 0.47 |
| Drainageway 4100 | 4100_DS | 15412 | 25-YR | 135.00 | 5140.00 | 5142.52 | | 5142.64 | 0.018952 | 2.87 | 51.48 | 49.43 | 0.39 |
| Drainageway 4100 | 4100_DS | 15412 | 50-YR | 150.00 | 5140.00 | 5142.87 | | 5142.94 | 0.010169 | 2.38 | 70.93 | 62.00 | 0.29 |
| Drainageway 4100 | 4100_DS | 15412 | 100-YR | 165.00 | 5140.00 | 5143.26 | | 5143.30 | 0.004911 | 1.85 | 103.02 | 101.72 | 0.21 |
| Drainageway 4100 | 4100_DS | 15412 | 500-YR | 206.00 | 5140.00 | 5143.53 | | 5143.57 | 0.003905 | 1.77 | 131.17 | 105.00 | 0.19 |
| Drainageway 4100 | 4100_DS | 15381 | 2-YR | 24.00 | 5138.17 | 5139.52 | 5138.86 | 5139.60 | 0.024095 | 2.33 | 10.30 | 26.84 | 0.36 |
| Drainageway 4100 | 4100_DS | 15381 | 5-YR | 40.00 | 5138.17 | 5140.02 | 5139.13 | 5140.14 | 0.025322 | 2.79 | 14.34 | 39.43 | 0.37 |
| Drainageway 4100 | 4100_DS | 15381 | 10-YR | 74.00 | 5138.17 | 5141.03 | 5139.61 | 5141.18 | 0.023276 | 3.17 | 23.35 | 49.68 | 0.37 |
| Drainageway 4100 | 4100_DS | 15381 | 25-YR | 135.00 | 5138.17 | 5140.89 | 5140.31 | 5141.48 | 0.089809 | 6.13 | 22.02 | 48.20 | 0.72 |
| Drainageway 4100 | 4100_DS | 15381 | 50-YR | 150.00 | 5138.17 | 5142.20 | 5140.48 | 5142.43 | 0.027448 | 3.87 | 38.92 | 65.80 | 0.43 |
| Drainageway 4100 | 4100_DS | 15381 | 100-YR | 165.00 | 5138.17 | 5142.88 | 5140.65 | 5143.04 | 0.014424 | 3.28 | 56.71 | 80.02 | 0.32 |
| Drainageway 4100 | 4100_DS | 15381 | 500-YR | 206.00 | 5138.17 | 5143.23 | 5141.08 | 5143.36 | 0.012013 | 3.21 | 92.36 | 120.40 | 0.30 |
| Drainageway 4100 | 4100_DS | 15376 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 15294 | 2-YR | 24.00 | 5133.05 | 5135.37 | | 5135.40 | 0.006172 | 1.50 | 16.05 | 7.66 | 0.18 |
| Drainageway 4100 | 4100_DS | 15294 | 5-YR | 40.00 | 5133.05 | 5136.08 | | 5136.13 | 0.007445 | 1.84 | 21.69 | 8.11 | 0.20 |
| Drainageway 4100 | 4100_DS | 15294 | 10-YR | 74.00 | 5133.05 | 5137.19 | | 5137.28 | 0.009962 | 2.37 | 31.19 | 9.68 | 0.23 |
| Drainageway 4100 | 4100_DS | 15294 | 25-YR | 135.00 | 5133.05 | 5138.29 | | 5138.45 | 0.012698 | 3.22 | 41.87 | 14.17 | 0.27 |
| Drainageway 4100 | 4100_DS | 15294 | 50-YR | 150.00 | 5133.05 | 5138.49 | | 5138.68 | 0.013444 | 3.42 | 43.85 | 15.01 | 0.28 |
| Drainageway 4100 | 4100_DS | 15294 | 100-YR | 165.00 | 5133.05 | 5138.69 | | 5138.89 | 0.014128 | 3.61 | 45.74 | 15.82 | 0.29 |
| Drainageway 4100 | 4100_DS | 15294 | 500-YR | 206.00 | 5133.05 | 5139.16 | | 5139.42 | 0.015991 | 4.09 | 50.35 | 22.76 | 0.32 |
| Drainageway 4100 | 4100_DS | 15264 | 2-YR | 24.00 | 5132.79 | 5135.16 | | 5135.20 | 0.007176 | 1.59 | 15.08 | 7.74 | 0.20 |
| Drainageway 4100 | 4100_DS | 15264 | 5-YR | 40.00 | 5132.79 | 5135.83 | | 5135.89 | 0.008552 | 1.95 | 20.56 | 8.52 | 0.22 |
| Drainageway 4100 | 4100_DS | 15264 | 10-YR | 74.00 | 5132.79 | 5136.88 | | 5136.96 | 0.011178 | 2.36 | 31.42 | 12.84 | 0.27 |
| Drainageway 4100 | 4100_DS | 15264 | 25-YR | 135.00 | 5132.79 | 5137.91 | | 5138.04 | 0.013646 | 2.86 | 47.18 | 17.57 | 0.31 |
| Drainageway 4100 | 4100_DS | 15264 | 50-YR | 150.00 | 5132.79 | 5138.10 | | 5138.24 | 0.014090 | 2.96 | 50.61 | 18.42 | 0.32 |
| Drainageway 4100 | 4100_DS | 15264 | 100-YR | 165.00 | 5132.79 | 5138.29 | | 5138.43 | 0.014378 | 3.05 | 54.11 | 19.28 | 0.32 |
| Drainageway 4100 | 4100_DS | 15264 | 500-YR | 206.00 | 5132.79 | 5138.74 | | 5138.91 | 0.014922 | 3.25 | 63.37 | 21.36 | 0.33 |
| Drainageway 4100 | 4100_DS | 15133 | 2-YR | 24.00 | 5132.18 | 5133.33 | 5132.98 | 5133.41 | 0.034896 | 2.19 | 10.96 | 15.44 | 0.46 |
| Drainageway 4100 | 4100_DS | 15133 | 5-YR | 40.00 | 5132.18 | 5133.52 | 5133.20 | 5133.65 | 0.049200 | 2.87 | 13.93 | 16.86 | 0.56 |
| Drainageway 4100 | 4100_DS | 15133 | 10-YR | 74.00 | 5132.18 | 5133.84 | 5133.53 | 5134.06 | 0.061754 | 3.73 | 19.85 | 19.21 | 0.65 |
| Drainageway 4100 | 4100_DS | 15133 | 25-YR | 135.00 | 5132.18 | 5134.30 | 5133.97 | 5134.63 | 0.065812 | 4.61 | 29.28 | 31.99 | 0.70 |
| Drainageway 4100 | 4100_DS | 15133 | 50-YR | 150.00 | 5132.18 | 5134.40 | 5134.06 | 5134.76 | 0.065903 | 4.77 | 31.42 | 36.34 | 0.70 |
| Drainageway 4100 | 4100_DS | 15133 | 100-YR | 165.00 | 5132.18 | 5134.48 | | 5134.87 | 0.067779 | 4.97 | 33.19 | 39.02 | 0.72 |
| Drainageway 4100 | 4100_DS | 15133 | 500-YR | 206.00 | 5132.18 | 5134.67 | | 5135.14 | 0.074128 | 5.50 | 37.45 | 44.80 | 0.76 |
| Drainageway 4100 | 4100_DS | 15102 | 2-YR | 24.00 | 5131.02 | 5131.44 | 5131.38 | 5131.57 | 0.122839 | 2.85 | 8.43 | 20.00 | 0.77 |
| Drainageway 4100 | 4100_DS | 15102 | 5-YR | 40.00 | 5131.02 | 5131.71 | 5131.52 | 5131.84 | 0.069987 | 2.92 | 13.69 | 20.00 | 0.62 |
| Drainageway 4100 | 4100_DS | 15102 | 10-YR | 74.00 | 5131.02 | 5132.13 | 5131.77 | 5132.30 | 0.051625 | 3.34 | 22.16 | 20.41 | 0.56 |
| Drainageway 4100 | 4100_DS | 15102 | 25-YR | 135.00 | 5131.02 | 5132.78 | 5132.15 | 5132.99 | 0.041781 | 3.66 | 36.92 | 25.64 | 0.54 |
| Drainageway 4100 | 4100_DS | 15102 | 50-YR | 150.00 | 5131.02 | 5132.93 | 5132.24 | 5133.14 | 0.040197 | 3.66 | 40.98 | 27.73 | 0.53 |
| Drainageway 4100 | 4100_DS | 15102 | 100-YR | 165.00 | 5131.02 | 5133.08 | 5132.33 | 5133.29 | 0.037488 | 3.65 | 45.26 | 29.33 | 0.52 |
| Drainageway 4100 | 4100_DS | 15102 | 500-YR | 206.00 | 5131.02 | 5133.47 | 5132.54 | 5133.67 | 0.030255 | 3.60 | 57.18 | 32.18 | 0.48 |
| Drainageway 4100 | 4100_DS | 15091 | | Culvert | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 14964 | 2-YR | 36.00 | 5127.93 | 5129.55 | | 5129.58 | 0.004112 | 1.51 | 24.07 | 37.44 | 0.25 |
| Drainageway 4100 | 4100_DS | 14964 | 5-YR | 55.00 | 5127.93 | 5129.80 | | 5129.85 | 0.004771 | 1.85 | 30.63 | 38.44 | 0.27 |
| Drainageway 4100 | 4100_DS | 14964 | 10-YR | 78.00 | 5127.93 | 5130.02 | | 5130.10 | 0.005552 | 2.20 | 36.64 | 39.14 | 0.30 |
| Drainageway 4100 | 4100_DS | 14964 | 25-YR | 140.00 | 5127.93 | 5130.47 | | 5130.60 | 0.007217 | 2.95 | 48.69 | 40.54 | 0.36 |
| Drainageway 4100 | 4100_DS | 14964 | 50-YR | 164.00 | 5127.93 | 5130.61 | | 5130.77 | 0.007779 | 3.19 | 52.43 | 40.98 | 0.38 |
| Drainageway 4100 | 4100_DS | 14964 | 100-YR | 211.00 | 5127.93 | 5130.86 | | 5131.06 | 0.008654 | 3.61 | 59.16 | 41.77 | 0.40 |
| Drainageway 4100 | 4100_DS | 14964 | 500-YR | 319.00 | 5127.93 | 5131.35 | | 5131.65 | 0.010213 | 4.42 | 72.20 | 43.22 | 0.45 |
| Drainageway 4100 | 4100_DS | 14934 | 2-YR | 36.00 | 5127.78 | 5129.44 | | 5129.47 | 0.003171 | 1.26 | 29.64 | 41.55 | 0.21 |
| Drainageway 4100 | 4100_DS | 14934 | 5-YR | 55.00 | 5127.78 | 5129.69 | | 5129.72 | 0.003193 | 1.45 | 41.42 | 50.70 | 0.22 |
| Drainageway 4100 | 4100_DS | 14934 | 10-YR | 78.00 | 5127.78 | 5129.92 | | 5129.95 | 0.003203 | 1.61 | 52.89 | 51.22 | 0.23 |
| Drainageway 4100 | 4100_DS | 14934 | 25-YR | 140.00 | 5127.78 | 5130.37 | | 5130.42 | 0.003361 | 1.95 | 76.19 | 52.26 | 0.24 |
| Drainageway 4100 | 4100_DS | 14934 | 50-YR | 164.00 | 5127.78 | 5130.51 | | 5130.57 | 0.003444 | 2.06 | 83.56 | 52.58 | 0.25 |
| Drainageway 4100 | 4100_DS | 14934 | 100-YR | 211.00 | 5127.78 | 5130.77 | | 5130.84 | 0.003521 | 2.25 | 97.22 | 53.17 | 0.26 |

HEC-RAS Plan: Selected Plan (Continued)

| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Drainageway 4100 | 4100_DS | 14934 | 500-YR | 319.00 | 5127.78 | 5131.28 | | 5131.38 | 0.003638 | 2.60 | 124.62 | 54.34 | 0.27 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 14592 | 2-YR | 36.00 | 5125.33 | 5126.11 | 5126.11 | 5126.37 | 0.088647 | 4.13 | 8.72 | 16.38 | 1.00 |
| Drainageway 4100 | 4100_DS | 14592 | 5-YR | 55.00 | 5125.33 | 5126.30 | 5126.30 | 5126.62 | 0.085122 | 4.56 | 12.05 | 18.90 | 1.01 |
| Drainageway 4100 | 4100_DS | 14592 | 10-YR | 78.00 | 5125.33 | 5126.48 | 5126.48 | 5126.86 | 0.081728 | 4.93 | 15.81 | 21.39 | 1.01 |
| Drainageway 4100 | 4100_DS | 14592 | 25-YR | 140.00 | 5125.33 | 5126.92 | 5126.92 | 5127.35 | 0.062448 | 5.31 | 26.73 | 35.17 | 0.93 |
| Drainageway 4100 | 4100_DS | 14592 | 50-YR | 164.00 | 5125.33 | 5127.04 | 5127.04 | 5127.49 | 0.056456 | 5.45 | 31.07 | 35.69 | 0.90 |
| Drainageway 4100 | 4100_DS | 14592 | 100-YR | 211.00 | 5125.33 | 5127.22 | 5127.22 | 5127.73 | 0.053883 | 5.87 | 37.48 | 36.43 | 0.90 |
| Drainageway 4100 | 4100_DS | 14592 | 500-YR | 319.00 | 5125.33 | 5127.55 | 5127.55 | 5128.21 | 0.051946 | 6.69 | 49.74 | 37.82 | 0.92 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 14580 | 2-YR | 36.00 | 5122.24 | 5123.97 | | 5124.00 | 0.002831 | 1.39 | 26.49 | 22.28 | 0.21 |
| Drainageway 4100 | 4100_DS | 14580 | 5-YR | 55.00 | 5122.24 | 5124.32 | | 5124.36 | 0.002935 | 1.65 | 34.46 | 23.46 | 0.22 |
| Drainageway 4100 | 4100_DS | 14580 | 10-YR | 78.00 | 5122.24 | 5124.67 | | 5124.72 | 0.003043 | 1.89 | 42.74 | 24.62 | 0.23 |
| Drainageway 4100 | 4100_DS | 14580 | 25-YR | 140.00 | 5122.24 | 5125.39 | | 5125.47 | 0.003283 | 2.39 | 61.59 | 28.07 | 0.25 |
| Drainageway 4100 | 4100_DS | 14580 | 50-YR | 164.00 | 5122.24 | 5125.61 | | 5125.70 | 0.003369 | 2.55 | 67.98 | 29.19 | 0.26 |
| Drainageway 4100 | 4100_DS | 14580 | 100-YR | 211.00 | 5122.24 | 5125.99 | | 5126.10 | 0.003547 | 2.83 | 79.34 | 31.09 | 0.27 |
| Drainageway 4100 | 4100_DS | 14580 | 500-YR | 319.00 | 5122.24 | 5126.70 | | 5126.85 | 0.003819 | 3.33 | 102.57 | 34.20 | 0.29 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 13985 | 2-YR | 36.00 | 5118.08 | 5118.85 | 5118.85 | 5119.12 | 0.090922 | 4.17 | 8.64 | 16.32 | 1.01 |
| Drainageway 4100 | 4100_DS | 13985 | 5-YR | 55.00 | 5118.08 | 5119.05 | 5119.05 | 5119.37 | 0.084237 | 4.55 | 12.10 | 18.94 | 1.00 |
| Drainageway 4100 | 4100_DS | 13985 | 10-YR | 78.00 | 5118.08 | 5119.24 | 5119.24 | 5119.61 | 0.080708 | 4.91 | 15.88 | 21.44 | 1.01 |
| Drainageway 4100 | 4100_DS | 13985 | 25-YR | 140.00 | 5118.08 | 5119.64 | 5119.64 | 5120.10 | 0.074198 | 5.47 | 25.62 | 28.64 | 1.00 |
| Drainageway 4100 | 4100_DS | 13985 | 50-YR | 164.00 | 5118.08 | 5119.74 | 5119.74 | 5120.26 | 0.071658 | 5.77 | 28.57 | 29.16 | 1.00 |
| Drainageway 4100 | 4100_DS | 13985 | 100-YR | 211.00 | 5118.08 | 5119.94 | 5119.94 | 5120.53 | 0.064310 | 6.16 | 34.59 | 30.19 | 0.98 |
| Drainageway 4100 | 4100_DS | 13985 | 500-YR | 319.00 | 5118.08 | 5120.33 | 5120.33 | 5121.07 | 0.057501 | 6.98 | 46.56 | 32.09 | 0.97 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 13973 | 2-YR | 36.00 | 5114.99 | 5116.64 | | 5116.66 | 0.003428 | 1.29 | 27.86 | 26.32 | 0.22 |
| Drainageway 4100 | 4100_DS | 13973 | 5-YR | 55.00 | 5114.99 | 5116.93 | | 5116.97 | 0.003546 | 1.55 | 35.70 | 26.95 | 0.23 |
| Drainageway 4100 | 4100_DS | 13973 | 10-YR | 78.00 | 5114.99 | 5117.22 | | 5117.27 | 0.003711 | 1.80 | 43.66 | 27.58 | 0.25 |
| Drainageway 4100 | 4100_DS | 13973 | 25-YR | 140.00 | 5114.99 | 5117.83 | | 5117.92 | 0.004120 | 2.34 | 60.86 | 28.90 | 0.27 |
| Drainageway 4100 | 4100_DS | 13973 | 50-YR | 164.00 | 5114.99 | 5118.03 | | 5118.12 | 0.004274 | 2.51 | 66.46 | 29.31 | 0.28 |
| Drainageway 4100 | 4100_DS | 13973 | 100-YR | 211.00 | 5114.99 | 5118.36 | | 5118.48 | 0.004555 | 2.82 | 76.38 | 30.03 | 0.30 |
| Drainageway 4100 | 4100_DS | 13973 | 500-YR | 319.00 | 5114.99 | 5119.00 | | 5119.18 | 0.005070 | 3.42 | 96.08 | 31.42 | 0.33 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 13739 | 2-YR | 36.00 | 5113.36 | 5114.14 | 5114.14 | 5114.40 | 0.088647 | 4.13 | 8.72 | 16.38 | 1.00 |
| Drainageway 4100 | 4100_DS | 13739 | 5-YR | 55.00 | 5113.36 | 5114.33 | 5114.33 | 5114.65 | 0.085122 | 4.56 | 12.05 | 18.90 | 1.01 |
| Drainageway 4100 | 4100_DS | 13739 | 10-YR | 78.00 | 5113.36 | 5114.52 | 5114.52 | 5114.89 | 0.080420 | 4.90 | 15.90 | 21.45 | 1.00 |
| Drainageway 4100 | 4100_DS | 13739 | 25-YR | 140.00 | 5113.36 | 5114.91 | 5114.91 | 5115.39 | 0.070149 | 5.51 | 25.54 | 29.53 | 0.98 |
| Drainageway 4100 | 4100_DS | 13739 | 50-YR | 164.00 | 5113.36 | 5115.03 | 5115.03 | 5115.54 | 0.065977 | 5.74 | 28.91 | 30.00 | 0.97 |
| Drainageway 4100 | 4100_DS | 13739 | 100-YR | 211.00 | 5113.36 | 5115.23 | 5115.23 | 5115.81 | 0.060499 | 6.15 | 35.00 | 30.93 | 0.95 |
| Drainageway 4100 | 4100_DS | 13739 | 500-YR | 319.00 | 5113.36 | 5115.61 | 5115.61 | 5116.34 | 0.054849 | 6.96 | 47.11 | 32.70 | 0.95 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 13727 | 2-YR | 36.00 | 5110.27 | 5111.85 | | 5111.90 | 0.004189 | 1.70 | 21.68 | 17.53 | 0.25 |
| Drainageway 4100 | 4100_DS | 13727 | 5-YR | 55.00 | 5110.27 | 5112.18 | | 5112.24 | 0.004632 | 2.06 | 27.59 | 18.63 | 0.28 |
| Drainageway 4100 | 4100_DS | 13727 | 10-YR | 78.00 | 5110.27 | 5112.50 | 5111.42 | 5112.58 | 0.005040 | 2.41 | 33.73 | 19.75 | 0.30 |
| Drainageway 4100 | 4100_DS | 13727 | 25-YR | 140.00 | 5110.27 | 5113.13 | 5111.87 | 5113.27 | 0.006023 | 3.15 | 46.86 | 21.93 | 0.34 |
| Drainageway 4100 | 4100_DS | 13727 | 50-YR | 164.00 | 5110.27 | 5113.23 | 5112.03 | 5113.41 | 0.007208 | 3.53 | 49.06 | 22.29 | 0.37 |
| Drainageway 4100 | 4100_DS | 13727 | 100-YR | 211.00 | 5110.27 | 5113.52 | 5112.30 | 5113.75 | 0.008217 | 4.02 | 55.65 | 23.39 | 0.41 |
| Drainageway 4100 | 4100_DS | 13727 | 500-YR | 319.00 | 5110.27 | 5113.78 | 5112.84 | 5114.21 | 0.013787 | 5.50 | 61.84 | 24.42 | 0.53 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 13600 | 2-YR | 36.00 | 5109.38 | 5110.15 | 5110.15 | 5110.42 | 0.091386 | 4.18 | 8.62 | 16.31 | 1.01 |
| Drainageway 4100 | 4100_DS | 13600 | 5-YR | 55.00 | 5109.38 | 5110.35 | 5110.35 | 5110.67 | 0.084237 | 4.55 | 12.10 | 18.94 | 1.00 |
| Drainageway 4100 | 4100_DS | 13600 | 10-YR | 78.00 | 5109.38 | 5110.54 | 5110.54 | 5110.91 | 0.081289 | 4.92 | 15.84 | 21.41 | 1.01 |
| Drainageway 4100 | 4100_DS | 13600 | 25-YR | 140.00 | 5109.38 | 5110.93 | 5110.93 | 5111.41 | 0.071491 | 5.54 | 25.38 | 30.73 | 0.99 |
| Drainageway 4100 | 4100_DS | 13600 | 50-YR | 164.00 | 5109.38 | 5111.16 | 5111.16 | 5111.54 | 0.043969 | 5.01 | 35.15 | 50.72 | 0.80 |
| Drainageway 4100 | 4100_DS | 13600 | 100-YR | 211.00 | 5109.38 | 5111.32 | 5111.32 | 5111.73 | 0.042177 | 5.33 | 43.46 | 52.75 | 0.80 |
| Drainageway 4100 | 4100_DS | 13600 | 500-YR | 319.00 | 5109.38 | 5111.96 | | 5112.22 | 0.017148 | 4.38 | 78.17 | 56.75 | 0.55 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 13588 | 2-YR | 36.00 | 5106.57 | 5108.18 | | 5108.21 | 0.003949 | 1.34 | 27.01 | 28.90 | 0.23 |
| Drainageway 4100 | 4100_DS | 13588 | 5-YR | 55.00 | 5106.57 | 5108.58 | | 5108.61 | 0.002870 | 1.42 | 39.75 | 33.82 | 0.21 |
| Drainageway 4100 | 4100_DS | 13588 | 10-YR | 78.00 | 5106.57 | 5109.01 | | 5109.04 | 0.002199 | 1.48 | 54.76 | 37.25 | 0.19 |
| Drainageway 4100 | 4100_DS | 13588 | 25-YR | 140.00 | 5106.57 | 5109.84 | | 5109.88 | 0.001695 | 1.67 | 87.74 | 42.02 | 0.18 |
| Drainageway 4100 | 4100_DS | 13588 | 50-YR | 164.00 | 5106.57 | 5110.34 | | 5110.37 | 0.001199 | 1.58 | 109.57 | 45.37 | 0.16 |
| Drainageway 4100 | 4100_DS | 13588 | 100-YR | 211.00 | 5106.57 | 5110.90 | | 5110.94 | 0.001049 | 1.64 | 136.23 | 49.64 | 0.15 |
| Drainageway 4100 | 4100_DS | 13588 | 500-YR | 319.00 | 5106.57 | 5112.09 | | 5112.13 | 0.000778 | 1.70 | 200.20 | 57.52 | 0.14 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 13510 | 2-YR | 53.00 | 5106.03 | 5107.82 | | 5107.86 | 0.004918 | 1.68 | 31.52 | 26.10 | 0.27 |
| Drainageway 4100 | 4100_DS | 13510 | 5-YR | 82.00 | 5106.03 | 5108.29 | | 5108.34 | 0.003967 | 1.88 | 43.81 | 26.87 | 0.26 |
| Drainageway 4100 | 4100_DS | 13510 | 10-YR | 115.00 | 5106.03 | 5108.75 | | 5108.81 | 0.003444 | 2.06 | 56.54 | 28.61 | 0.25 |
| Drainageway 4100 | 4100_DS | 13510 | 25-YR | 189.00 | 5106.03 | 5109.62 | | 5109.70 | 0.002825 | 2.34 | 83.75 | 33.91 | 0.24 |
| Drainageway 4100 | 4100_DS | 13510 | 50-YR | 240.00 | 5106.03 | 5110.14 | | 5110.23 | 0.002543 | 2.47 | 102.17 | 36.96 | 0.23 |
| Drainageway 4100 | 4100_DS | 13510 | 100-YR | 302.00 | 5106.03 | 5110.71 | | 5110.81 | 0.002279 | 2.58 | 124.37 | 40.26 | 0.22 |
| Drainageway 4100 | 4100_DS | 13510 | 500-YR | 446.00 | 5106.03 | 5111.92 | | 5112.03 | 0.001802 | 2.73 | 177.57 | 47.66 | 0.21 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 13478 | 2-YR | 53.00 | 5105.80 | 5107.69 | 5106.75 | 5107.73 | 0.003563 | 1.57 | 34.73 | 42.05 | 0.23 |
| Drainageway 4100 | 4100_DS | 13478 | 5-YR | 82.00 | 5105.80 | 5108.19 | 5106.98 | 5108.23 | 0.002719 | 1.68 | 49.73 | 44.03 | 0.22 |
| Drainageway 4100 | 4100_DS | 13478 | 10-YR | 115.00 | 5105.80 | 5108.67 | 5107.19 | 5108.72 | 0.002324 | 1.81 | 64.05 | 45.60 | 0.21 |
| Drainageway 4100 | 4100_DS | 13478 | 25-YR | 189.00 | 5105.80 | 5109.55 | 5107.61 | 5109.62 | 0.001976 | 2.06 | 90.58 | 48.63 | 0.20 |
| Drainageway 4100 | 4100_DS | 13478 | 50-YR | 240.00 | 5105.80 | 5110.07 | 5107.80 | 5110.15 | 0.001866 | 2.21 | 106.26 | 50.32 | 0.20 |
| Drainageway 4100 | 4100_DS | 13478 | 100-YR | 302.00 | 5105.80 | 5110.65 | 5108.01 | 5110.74 | 0.001783 | 2.38 | 123.50 | 52.29 | 0.20 |
| Drainageway 4100 | 4100_DS | 13478 | 500-YR | 446.00 | 5105.80 | 5111.85 | 5108.44 | 5111.97 | 0.001649 | 2.69 | 159.46 | 56.66 | 0.20 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 13472 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 13367 | 2-YR | 53.00 | 5105.41 | 5106.67 | | 5106.75 | 0.011847 | 2.17 | 24.42 | 50.52 | 0.40 |
| Drainageway 4100 | 4100_DS | 13367 | 5-YR | 82.00 | 5105.41 | 5106.94 | | 5107.04 | 0.012219 | 2.61 | 31.44 | 64.81 | 0.42 |
| Drainageway 4100 | 4100_DS | 13367 | 10-YR | 115.00 | 5105.41 | 5107.18 | | 5107.32 | 0.013017 | 3.04 | 37.79 | 82.24 | 0.45 |
| Drainageway 4100 | 4100_DS | 13367 | 25-YR | 189.00 | 5105.41 | 5107.59 | | 5107.83 | 0.015120 | 3.88 | 48.67 | 87.92 | 0.50 |
| Drainageway 4100 | 4100_DS | 13367 | 50-YR | 240.00 | 5105.41 | 5107.83 | | 5108.13 | 0.016303 | 4.37 | 54.92 | 91.70 | 0.53 |
| Drainageway 4100 | 4100_DS | 13367 | 100-YR | 302.00 | 5105.41 | 5108.11 | | 5108.48 | 0.016959 | 4.85 | 62.29 | 95.08 | 0.56 |
| Drainageway 4100 | 4100_DS | 13367 | 500-YR | 446.00 | 5105.41 | 5108.56 | | 5109.12 | 0.020723 | 6.02 | 74.12 | 98.02 | 0.63 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 13337 | 2-YR | 53.00 | 5104.99 | 5106.56 | | 5106.58 | 0.002402 | 1.19 | 51.00 | 62.06 | 0.19 |

HEC-RAS Plan: Selected Plan (Continued)

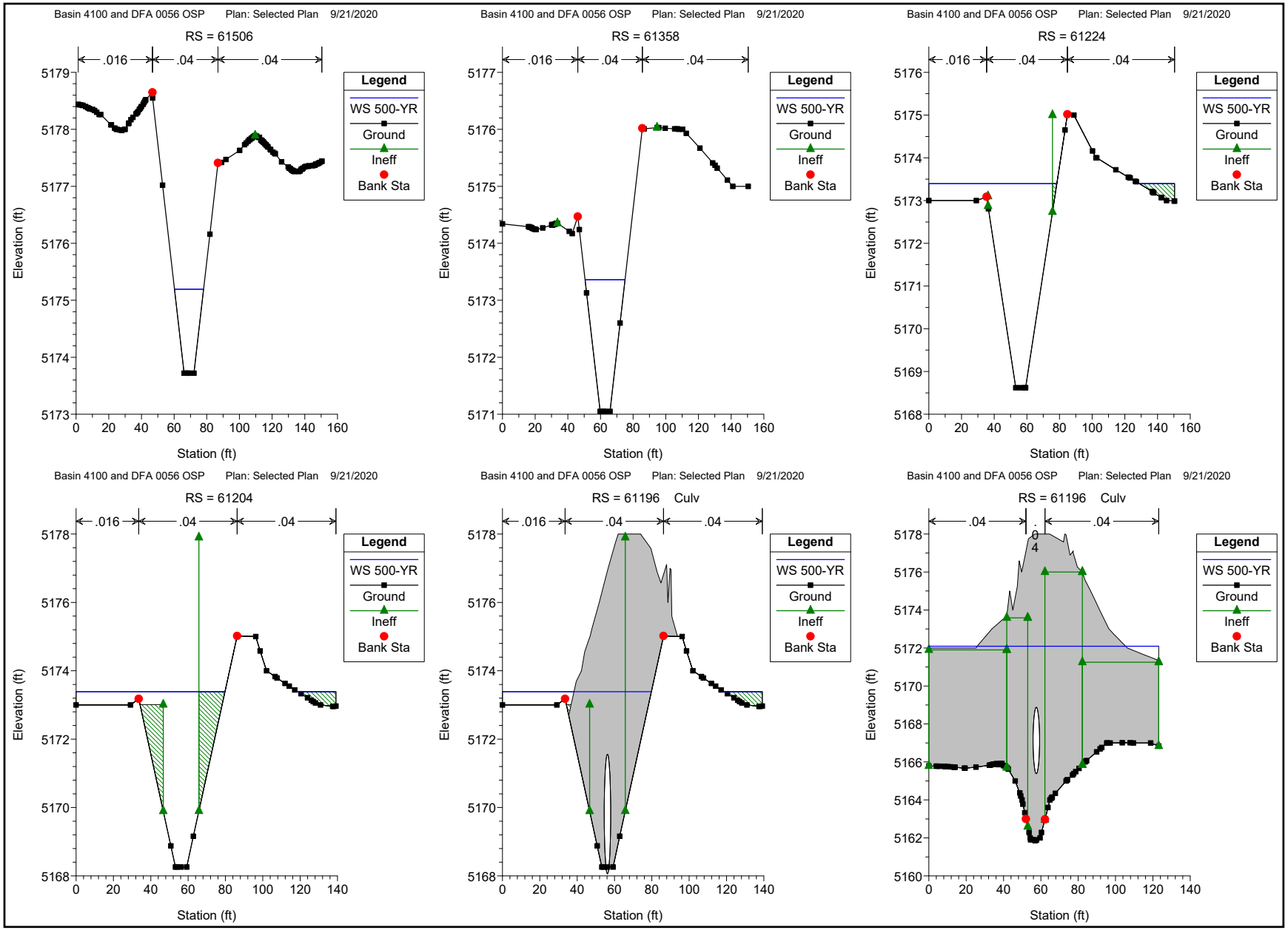
| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Drainageway 4100 | 4100_DS | 13337 | 5-YR | 82.00 | 5104.99 | 5106.85 | | 5106.87 | 0.002255 | 1.32 | 69.05 | 64.76 | 0.19 |
| Drainageway 4100 | 4100_DS | 13337 | 10-YR | 115.00 | 5104.99 | 5107.10 | | 5107.13 | 0.002273 | 1.47 | 85.84 | 67.30 | 0.20 |
| Drainageway 4100 | 4100_DS | 13337 | 25-YR | 189.00 | 5104.99 | 5107.54 | | 5107.58 | 0.002444 | 1.77 | 116.41 | 71.93 | 0.21 |
| Drainageway 4100 | 4100_DS | 13337 | 50-YR | 240.00 | 5104.99 | 5107.80 | | 5107.85 | 0.002557 | 1.95 | 135.22 | 75.75 | 0.22 |
| Drainageway 4100 | 4100_DS | 13337 | 100-YR | 302.00 | 5104.99 | 5108.10 | | 5108.16 | 0.002703 | 2.17 | 160.52 | 87.18 | 0.23 |
| Drainageway 4100 | 4100_DS | 13337 | 500-YR | 446.00 | 5104.99 | 5108.63 | | 5108.70 | 0.002713 | 2.44 | 208.18 | 93.02 | 0.24 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 12821 | 2-YR | 53.00 | 5101.50 | 5103.92 | | 5103.96 | 0.017203 | 1.53 | 34.53 | 23.78 | 0.22 |
| Drainageway 4100 | 4100_DS | 12821 | 5-YR | 82.00 | 5101.50 | 5104.23 | | 5104.29 | 0.019927 | 1.86 | 45.83 | 49.87 | 0.25 |
| Drainageway 4100 | 4100_DS | 12821 | 10-YR | 115.00 | 5101.50 | 5104.46 | | 5104.53 | 0.020453 | 2.05 | 57.44 | 51.46 | 0.26 |
| Drainageway 4100 | 4100_DS | 12821 | 25-YR | 189.00 | 5101.50 | 5104.97 | | 5105.05 | 0.015543 | 2.08 | 84.38 | 54.96 | 0.23 |
| Drainageway 4100 | 4100_DS | 12821 | 50-YR | 240.00 | 5101.50 | 5105.31 | | 5105.40 | 0.012569 | 2.04 | 103.34 | 57.29 | 0.21 |
| Drainageway 4100 | 4100_DS | 12821 | 100-YR | 302.00 | 5101.50 | 5105.68 | | 5105.78 | 0.010462 | 2.02 | 124.93 | 59.84 | 0.20 |
| Drainageway 4100 | 4100_DS | 12821 | 500-YR | 446.00 | 5101.50 | 5106.41 | | 5106.54 | 0.008038 | 2.03 | 170.84 | 64.93 | 0.18 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 12221 | 2-YR | 106.00 | 5097.30 | 5100.72 | 5098.84 | 5100.74 | 0.003712 | 1.01 | 101.64 | 87.21 | 0.11 |
| Drainageway 4100 | 4100_DS | 12221 | 5-YR | 167.00 | 5097.30 | 5101.09 | 5099.24 | 5101.11 | 0.003582 | 1.09 | 134.00 | 89.29 | 0.11 |
| Drainageway 4100 | 4100_DS | 12221 | 10-YR | 236.00 | 5097.30 | 5101.43 | 5099.61 | 5101.47 | 0.003450 | 1.16 | 165.45 | 91.58 | 0.11 |
| Drainageway 4100 | 4100_DS | 12221 | 25-YR | 421.00 | 5097.30 | 5102.15 | 5100.49 | 5102.21 | 0.003470 | 1.33 | 232.92 | 98.59 | 0.12 |
| Drainageway 4100 | 4100_DS | 12221 | 50-YR | 541.00 | 5097.30 | 5102.50 | 5100.62 | 5102.57 | 0.003643 | 1.44 | 268.08 | 103.66 | 0.12 |
| Drainageway 4100 | 4100_DS | 12221 | 100-YR | 703.00 | 5097.30 | 5102.90 | 5100.79 | 5102.99 | 0.003787 | 1.56 | 310.41 | 106.92 | 0.13 |
| Drainageway 4100 | 4100_DS | 12221 | 500-YR | 1104.00 | 5097.30 | 5103.79 | 5101.27 | 5103.93 | 0.003803 | 1.76 | 408.39 | 113.21 | 0.13 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 11964 | 2-YR | 106.00 | 5095.50 | 5096.99 | 5096.99 | 5097.51 | 0.393332 | 5.76 | 18.41 | 18.36 | 1.01 |
| Drainageway 4100 | 4100_DS | 11964 | 5-YR | 167.00 | 5095.50 | 5097.40 | 5097.40 | 5098.02 | 0.361205 | 6.30 | 26.50 | 21.62 | 1.00 |
| Drainageway 4100 | 4100_DS | 11964 | 10-YR | 236.00 | 5095.50 | 5097.76 | 5097.76 | 5098.47 | 0.346820 | 6.77 | 34.87 | 24.79 | 1.01 |
| Drainageway 4100 | 4100_DS | 11964 | 25-YR | 421.00 | 5095.50 | 5098.53 | 5098.53 | 5099.21 | 0.339483 | 6.63 | 63.65 | 48.09 | 1.00 |
| Drainageway 4100 | 4100_DS | 11964 | 50-YR | 541.00 | 5095.50 | 5098.99 | | 5099.60 | 0.205568 | 6.26 | 86.55 | 50.88 | 0.81 |
| Drainageway 4100 | 4100_DS | 11964 | 100-YR | 703.00 | 5095.50 | 5099.71 | | 5100.21 | 0.104925 | 5.58 | 124.92 | 55.23 | 0.61 |
| Drainageway 4100 | 4100_DS | 11964 | 500-YR | 1104.00 | 5095.50 | 5100.38 | | 5101.10 | 0.108796 | 6.63 | 162.90 | 59.22 | 0.65 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 11912 | 2-YR | 106.00 | 5091.76 | 5095.59 | | 5095.61 | 0.005245 | 1.11 | 94.83 | 48.45 | 0.13 |
| Drainageway 4100 | 4100_DS | 11912 | 5-YR | 167.00 | 5091.76 | 5096.16 | | 5096.19 | 0.005529 | 1.34 | 123.28 | 51.58 | 0.14 |
| Drainageway 4100 | 4100_DS | 11912 | 10-YR | 236.00 | 5091.76 | 5096.64 | | 5096.68 | 0.005981 | 1.55 | 148.75 | 54.22 | 0.15 |
| Drainageway 4100 | 4100_DS | 11912 | 25-YR | 421.00 | 5091.76 | 5097.22 | | 5097.31 | 0.010024 | 2.24 | 181.04 | 57.40 | 0.20 |
| Drainageway 4100 | 4100_DS | 11912 | 50-YR | 541.00 | 5091.76 | 5097.21 | | 5097.35 | 0.016696 | 2.89 | 180.57 | 57.35 | 0.26 |
| Drainageway 4100 | 4100_DS | 11912 | 100-YR | 703.00 | 5091.76 | 5097.07 | | 5097.33 | 0.032828 | 3.94 | 172.33 | 56.56 | 0.36 |
| Drainageway 4100 | 4100_DS | 11912 | 500-YR | 1104.00 | 5091.76 | 5098.46 | | 5098.76 | 0.022489 | 4.05 | 256.71 | 65.69 | 0.32 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 11321 | 2-YR | 106.00 | 5087.62 | 5090.97 | 5089.28 | 5091.01 | 0.012765 | 1.65 | 65.64 | 48.51 | 0.20 |
| Drainageway 4100 | 4100_DS | 11321 | 5-YR | 167.00 | 5087.62 | 5091.34 | | 5091.39 | 0.013095 | 1.87 | 93.30 | 82.51 | 0.21 |
| Drainageway 4100 | 4100_DS | 11321 | 10-YR | 236.00 | 5087.62 | 5091.63 | | 5091.69 | 0.012793 | 1.99 | 117.86 | 86.87 | 0.21 |
| Drainageway 4100 | 4100_DS | 11321 | 25-YR | 421.00 | 5087.62 | 5092.58 | | 5092.65 | 0.006325 | 1.71 | 206.87 | 99.34 | 0.16 |
| Drainageway 4100 | 4100_DS | 11321 | 50-YR | 541.00 | 5087.62 | 5093.37 | | 5093.43 | 0.003521 | 1.45 | 288.39 | 109.74 | 0.12 |
| Drainageway 4100 | 4100_DS | 11321 | 100-YR | 703.00 | 5087.62 | 5094.55 | | 5094.60 | 0.001696 | 1.18 | 430.58 | 128.09 | 0.09 |
| Drainageway 4100 | 4100_DS | 11321 | 500-YR | 1104.00 | 5087.62 | 5097.95 | | 5097.97 | 0.000381 | 0.77 | 928.15 | 165.47 | 0.05 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 11277 | 2-YR | 106.00 | 5087.28 | 5088.80 | 5088.80 | 5089.32 | 0.391545 | 5.78 | 18.35 | 18.15 | 1.01 |
| Drainageway 4100 | 4100_DS | 11277 | 5-YR | 167.00 | 5087.28 | 5089.82 | 5089.20 | 5090.07 | 0.108779 | 4.08 | 40.98 | 28.30 | 0.57 |
| Drainageway 4100 | 4100_DS | 11277 | 10-YR | 236.00 | 5087.28 | 5090.66 | 5089.56 | 5090.80 | 0.033917 | 3.03 | 76.68 | 48.65 | 0.34 |
| Drainageway 4100 | 4100_DS | 11277 | 25-YR | 421.00 | 5087.28 | 5092.16 | 5090.36 | 5092.30 | 0.009448 | 2.21 | 154.27 | 63.23 | 0.20 |
| Drainageway 4100 | 4100_DS | 11277 | 50-YR | 541.00 | 5087.28 | 5093.07 | 5090.63 | 5093.22 | 0.005798 | 1.99 | 202.56 | 72.00 | 0.16 |
| Drainageway 4100 | 4100_DS | 11277 | 100-YR | 703.00 | 5087.28 | 5094.33 | 5090.90 | 5094.49 | 0.003516 | 1.81 | 269.30 | 90.05 | 0.13 |
| Drainageway 4100 | 4100_DS | 11277 | 500-YR | 1104.00 | 5087.28 | 5097.79 | 5091.55 | 5097.93 | 0.001396 | 1.54 | 451.89 | 129.30 | 0.09 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 11260 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 11158 | 2-YR | 106.00 | 5085.00 | 5089.10 | | 5089.14 | 0.008430 | 1.57 | 67.47 | 24.66 | 0.16 |
| Drainageway 4100 | 4100_DS | 11158 | 5-YR | 167.00 | 5085.00 | 5089.88 | | 5089.94 | 0.009331 | 1.94 | 85.97 | 27.23 | 0.18 |
| Drainageway 4100 | 4100_DS | 11158 | 10-YR | 236.00 | 5085.00 | 5090.55 | | 5090.64 | 0.010614 | 2.32 | 101.78 | 29.36 | 0.20 |
| Drainageway 4100 | 4100_DS | 11158 | 25-YR | 421.00 | 5085.00 | 5091.78 | | 5091.94 | 0.014607 | 3.22 | 130.88 | 34.81 | 0.24 |
| Drainageway 4100 | 4100_DS | 11158 | 50-YR | 541.00 | 5085.00 | 5092.36 | | 5092.58 | 0.017300 | 3.74 | 144.61 | 37.60 | 0.27 |
| Drainageway 4100 | 4100_DS | 11158 | 100-YR | 703.00 | 5085.00 | 5093.04 | | 5093.34 | 0.020599 | 4.38 | 160.59 | 41.10 | 0.30 |
| Drainageway 4100 | 4100_DS | 11158 | 500-YR | 1104.00 | 5085.00 | 5094.36 | | 5094.88 | 0.028073 | 5.75 | 191.86 | 51.20 | 0.36 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 11128 | 2-YR | 106.00 | 5084.82 | 5088.74 | | 5088.79 | 0.015772 | 1.90 | 55.76 | 25.35 | 0.23 |
| Drainageway 4100 | 4100_DS | 11128 | 5-YR | 167.00 | 5084.82 | 5089.48 | | 5089.56 | 0.017738 | 2.18 | 76.74 | 31.25 | 0.24 |
| Drainageway 4100 | 4100_DS | 11128 | 10-YR | 236.00 | 5084.82 | 5090.12 | | 5090.21 | 0.018904 | 2.40 | 98.46 | 36.49 | 0.26 |
| Drainageway 4100 | 4100_DS | 11128 | 25-YR | 421.00 | 5084.82 | 5091.28 | | 5091.41 | 0.020235 | 2.91 | 144.78 | 43.62 | 0.28 |
| Drainageway 4100 | 4100_DS | 11128 | 50-YR | 541.00 | 5084.82 | 5091.82 | | 5091.98 | 0.020165 | 3.21 | 169.53 | 46.88 | 0.28 |
| Drainageway 4100 | 4100_DS | 11128 | 100-YR | 703.00 | 5084.82 | 5092.48 | | 5092.67 | 0.019791 | 3.52 | 201.32 | 50.40 | 0.29 |
| Drainageway 4100 | 4100_DS | 11128 | 500-YR | 1104.00 | 5084.82 | 5093.80 | | 5094.05 | 0.018763 | 4.05 | 272.40 | 57.19 | 0.29 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 11071 | 2-YR | 106.00 | 5084.47 | 5087.28 | | 5087.39 | 0.044794 | 2.71 | 39.17 | 22.88 | 0.36 |
| Drainageway 4100 | 4100_DS | 11071 | 5-YR | 167.00 | 5084.47 | 5087.89 | | 5088.03 | 0.045333 | 3.09 | 54.08 | 26.13 | 0.38 |
| Drainageway 4100 | 4100_DS | 11071 | 10-YR | 236.00 | 5084.47 | 5088.45 | | 5088.63 | 0.045089 | 3.38 | 69.80 | 29.31 | 0.39 |
| Drainageway 4100 | 4100_DS | 11071 | 25-YR | 421.00 | 5084.47 | 5089.60 | | 5089.84 | 0.039757 | 3.95 | 107.15 | 35.89 | 0.38 |
| Drainageway 4100 | 4100_DS | 11071 | 50-YR | 541.00 | 5084.47 | 5090.24 | | 5090.50 | 0.034821 | 4.16 | 131.13 | 39.52 | 0.37 |
| Drainageway 4100 | 4100_DS | 11071 | 100-YR | 703.00 | 5084.47 | 5091.04 | | 5091.32 | 0.028845 | 4.28 | 164.61 | 44.19 | 0.35 |
| Drainageway 4100 | 4100_DS | 11071 | 500-YR | 1104.00 | 5084.47 | 5092.55 | | 5092.89 | 0.022159 | 4.51 | 238.06 | 52.55 | 0.32 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 11051 | 2-YR | 106.00 | 5084.35 | 5086.00 | 5085.34 | 5086.18 | 0.084183 | 3.38 | 31.35 | 19.00 | 0.46 |
| Drainageway 4100 | 4100_DS | 11051 | 5-YR | 167.00 | 5084.35 | 5086.43 | 5085.68 | 5086.71 | 0.102189 | 4.23 | 39.44 | 19.00 | 0.52 |
| Drainageway 4100 | 4100_DS | 11051 | 10-YR | 236.00 | 5084.35 | 5086.79 | 5086.03 | 5087.20 | 0.123466 | 5.08 | 46.43 | 19.00 | 0.57 |
| Drainageway 4100 | 4100_DS | 11051 | 25-YR | 421.00 | 5084.35 | 5087.81 | 5086.83 | 5088.45 | 0.137135 | 6.40 | 65.79 | 19.00 | 0.61 |
| Drainageway 4100 | 4100_DS | 11051 | 50-YR | 541.00 | 5084.35 | 5088.50 | 5087.27 | 5089.23 | 0.133117 | 6.87 | 78.76 | 19.00 | 0.59 |
| Drainageway 4100 | 4100_DS | 11051 | 100-YR | 703.00 | 5084.35 | 5089.39 | 5087.83 | 5090.20 | 0.127463 | 7.23 | 97.42 | 23.23 | 0.60 |
| Drainageway 4100 | 4100_DS | 11051 | 500-YR | 1104.00 | 5084.35 | 5091.13 | 5089.23 | 5092.03 | 0.092713 | 7.65 | 144.73 | 31.61 | 0.54 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 11039 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 10834 | 2-YR | 210.00 | 5082.50 | 5085.98 | | 5086.07 | 0.028454 | 2.42 | 86.80 | 227.10 | 0.29 |
| Drainageway 4100 | 4100_DS | 10834 | 5-YR | 323.00 | 5082.50 | 5086.38 | | 5086.53 | 0.037339 | 3.12 | 103.59 | 277.59 | 0.35 |

HEC-RAS Plan: Selected Plan (Continued)

| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Drainageway 4100 | 4100_DS | 10834 | 10-YR | 445.00 | 5082.50 | 5086.72 | | 5086.94 | 0.046704 | 3.79 | 117.39 | 295.00 | 0.40 |
| Drainageway 4100 | 4100_DS | 10834 | 25-YR | 783.00 | 5082.50 | 5087.32 | | 5087.79 | 0.075763 | 5.49 | 142.51 | 330.26 | 0.52 |
| Drainageway 4100 | 4100_DS | 10834 | 50-YR | 977.00 | 5082.50 | 5087.58 | | 5088.21 | 0.092209 | 6.37 | 153.44 | 336.22 | 0.58 |
| Drainageway 4100 | 4100_DS | 10834 | 100-YR | 1227.00 | 5082.50 | 5087.78 | | 5088.67 | 0.122905 | 7.60 | 161.39 | 337.91 | 0.68 |
| Drainageway 4100 | 4100_DS | 10834 | 500-YR | 1860.00 | 5082.50 | 5087.84 | 5087.84 | 5089.84 | 0.268466 | 11.35 | 163.86 | 338.43 | 1.01 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 10803 | 2-YR | 210.00 | 5082.18 | 5084.45 | 5084.45 | 5084.82 | 0.054199 | 2.33 | 46.88 | 218.32 | 0.31 |
| Drainageway 4100 | 4100_DS | 10803 | 5-YR | 323.00 | 5082.18 | 5084.72 | 5084.72 | 5085.18 | 0.045261 | 2.17 | 64.52 | 226.53 | 0.30 |
| Drainageway 4100 | 4100_DS | 10803 | 10-YR | 445.00 | 5082.18 | 5084.97 | 5084.97 | 5085.52 | 0.039986 | 2.10 | 82.17 | 234.14 | 0.28 |
| Drainageway 4100 | 4100_DS | 10803 | 25-YR | 783.00 | 5082.18 | 5085.52 | 5085.52 | 5086.25 | 0.032994 | 2.29 | 124.96 | 248.56 | 0.27 |
| Drainageway 4100 | 4100_DS | 10803 | 50-YR | 977.00 | 5082.18 | 5085.77 | 5085.77 | 5086.60 | 0.032203 | 2.43 | 145.51 | 255.02 | 0.27 |
| Drainageway 4100 | 4100_DS | 10803 | 100-YR | 1227.00 | 5082.18 | 5086.23 | 5086.23 | 5086.94 | 0.029897 | 2.62 | 197.55 | 328.07 | 0.27 |
| Drainageway 4100 | 4100_DS | 10803 | 500-YR | 1860.00 | 5082.18 | 5087.65 | 5086.56 | 5087.68 | 0.000367 | 0.38 | 1374.14 | 366.58 | 0.03 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 10621 | 2-YR | 210.00 | 5079.96 | 5080.53 | 5079.71 | 5080.57 | 0.002350 | 0.24 | 138.61 | 129.13 | 0.07 |
| Drainageway 4100 | 4100_DS | 10621 | 5-YR | 323.00 | 5079.96 | 5081.64 | 5079.93 | 5081.64 | 0.000415 | 0.19 | 489.67 | 518.39 | 0.03 |
| Drainageway 4100 | 4100_DS | 10621 | 10-YR | 445.00 | 5079.96 | 5082.46 | 5080.11 | 5082.46 | 0.000120 | 0.12 | 1027.28 | 660.84 | 0.02 |
| Drainageway 4100 | 4100_DS | 10621 | 25-YR | 783.00 | 5079.96 | 5084.17 | 5080.50 | 5084.17 | 0.000032 | 0.10 | 2276.87 | 775.07 | 0.01 |
| Drainageway 4100 | 4100_DS | 10621 | 50-YR | 977.00 | 5079.96 | 5085.03 | 5080.85 | 5085.04 | 0.000022 | 0.10 | 2958.45 | 806.84 | 0.01 |
| Drainageway 4100 | 4100_DS | 10621 | 100-YR | 1227.00 | 5079.96 | 5085.81 | 5081.07 | 5085.81 | 0.000020 | 0.11 | 3602.91 | 855.48 | 0.01 |
| Drainageway 4100 | 4100_DS | 10621 | 500-YR | 1860.00 | 5079.96 | 5087.67 | 5081.32 | 5087.67 | 0.000015 | 0.12 | 5345.94 | 975.79 | 0.01 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 10599 | 2-YR | 100.00 | 5079.26 | 5080.44 | 5079.68 | 5080.48 | 0.002252 | 0.46 | 97.18 | 520.93 | 0.08 |
| Drainageway 4100 | 4100_DS | 10599 | 5-YR | 213.00 | 5079.26 | 5081.59 | 5079.95 | 5081.62 | 0.001018 | 0.47 | 209.52 | 641.03 | 0.06 |
| Drainageway 4100 | 4100_DS | 10599 | 10-YR | 335.00 | 5079.26 | 5082.42 | 5080.28 | 5082.45 | 0.000927 | 0.54 | 305.21 | 675.29 | 0.06 |
| Drainageway 4100 | 4100_DS | 10599 | 25-YR | 673.00 | 5079.26 | 5084.13 | 5080.87 | 5084.17 | 0.000618 | 0.61 | 541.19 | 730.10 | 0.05 |
| Drainageway 4100 | 4100_DS | 10599 | 50-YR | 867.00 | 5079.26 | 5084.99 | 5081.14 | 5085.03 | 0.000510 | 0.62 | 679.72 | 760.56 | 0.05 |
| Drainageway 4100 | 4100_DS | 10599 | 100-YR | 1117.00 | 5079.26 | 5085.76 | 5081.46 | 5085.81 | 0.000505 | 0.68 | 816.40 | 812.35 | 0.05 |
| Drainageway 4100 | 4100_DS | 10599 | 500-YR | 1750.00 | 5079.26 | 5087.63 | 5082.24 | 5087.66 | 0.000728 | 0.97 | 1442.19 | 949.09 | 0.06 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 10512 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 10435 | 2-YR | 100.00 | 5077.17 | 5080.13 | | 5080.15 | 0.004719 | 1.03 | 96.63 | 46.41 | 0.13 |
| Drainageway 4100 | 4100_DS | 10435 | 5-YR | 213.00 | 5077.17 | 5081.30 | | 5081.33 | 0.004743 | 1.40 | 152.83 | 49.11 | 0.14 |
| Drainageway 4100 | 4100_DS | 10435 | 10-YR | 335.00 | 5077.17 | 5081.99 | | 5082.04 | 0.006057 | 1.79 | 187.08 | 50.61 | 0.16 |
| Drainageway 4100 | 4100_DS | 10435 | 25-YR | 673.00 | 5077.17 | 5083.19 | | 5083.30 | 0.009574 | 2.69 | 249.34 | 53.23 | 0.21 |
| Drainageway 4100 | 4100_DS | 10435 | 50-YR | 867.00 | 5077.17 | 5083.63 | | 5083.79 | 0.011820 | 3.16 | 273.06 | 54.22 | 0.24 |
| Drainageway 4100 | 4100_DS | 10435 | 100-YR | 1117.00 | 5077.17 | 5084.21 | | 5084.42 | 0.013717 | 3.64 | 304.77 | 55.50 | 0.26 |
| Drainageway 4100 | 4100_DS | 10435 | 500-YR | 1750.00 | 5077.17 | 5085.48 | | 5085.83 | 0.016808 | 4.56 | 377.47 | 59.04 | 0.30 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 10378 | 2-YR | 100.00 | 5076.77 | 5078.46 | 5078.46 | 5079.08 | 0.379919 | 6.34 | 15.77 | 12.73 | 1.00 |
| Drainageway 4100 | 4100_DS | 10378 | 5-YR | 213.00 | 5076.77 | 5079.32 | 5079.32 | 5080.20 | 0.343693 | 7.53 | 28.29 | 16.20 | 1.00 |
| Drainageway 4100 | 4100_DS | 10378 | 10-YR | 335.00 | 5076.77 | 5080.36 | 5080.36 | 5080.94 | 0.152922 | 6.28 | 55.44 | 43.97 | 0.71 |
| Drainageway 4100 | 4100_DS | 10378 | 25-YR | 673.00 | 5076.77 | 5081.22 | 5081.04 | 5081.96 | 0.102337 | 6.27 | 99.30 | 57.12 | 0.61 |
| Drainageway 4100 | 4100_DS | 10378 | 50-YR | 867.00 | 5076.77 | 5081.99 | | 5082.61 | 0.046839 | 4.88 | 145.61 | 62.81 | 0.43 |
| Drainageway 4100 | 4100_DS | 10378 | 100-YR | 1117.00 | 5076.77 | 5082.72 | | 5083.35 | 0.029653 | 4.33 | 192.60 | 65.80 | 0.35 |
| Drainageway 4100 | 4100_DS | 10378 | 500-YR | 1750.00 | 5076.77 | 5084.21 | | 5084.90 | 0.017456 | 3.98 | 295.01 | 71.91 | 0.28 |
| | | | | | | | | | | | | | |
| Drainageway 4100 | 4100_DS | 10147 | 2-YR | 100.00 | 5069.33 | 5074.87 | 5071.10 | 5074.89 | 0.001903 | 1.01 | 96.99 | 29.21 | 0.09 |
| Drainageway 4100 | 4100_DS | 10147 | 5-YR | 213.00 | 5069.33 | 5076.69 | 5071.95 | 5076.72 | 0.001902 | 1.28 | 157.46 | 37.97 | 0.09 |
| Drainageway 4100 | 4100_DS | 10147 | 10-YR | 335.00 | 5069.33 | 5077.99 | 5072.67 | 5078.03 | 0.001902 | 1.46 | 211.70 | 45.72 | 0.09 |
| Drainageway 4100 | 4100_DS | 10147 | 25-YR | 673.00 | 5069.33 | 5080.34 | 5073.91 | 5080.40 | 0.001902 | 1.75 | 356.35 | 80.24 | 0.10 |
| Drainageway 4100 | 4100_DS | 10147 | 50-YR | 867.00 | 5069.33 | 5081.17 | 5074.50 | 5081.23 | 0.001901 | 1.85 | 429.28 | 94.52 | 0.10 |
| Drainageway 4100 | 4100_DS | 10147 | 100-YR | 1117.00 | 5069.33 | 5081.99 | 5075.15 | 5082.07 | 0.001902 | 1.94 | 511.48 | 105.29 | 0.10 |
| Drainageway 4100 | 4100_DS | 10147 | 500-YR | 1750.00 | 5069.33 | 5083.63 | 5076.55 | 5083.73 | 0.001903 | 2.12 | 703.98 | 130.22 | 0.10 |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 61506 | 2-YR | 11.00 | 5173.72 | 5174.29 | 5174.15 | 5174.37 | 0.011773 | 2.33 | 4.71 | 10.56 | 0.62 |
| Colorado Bouleva | Colorado Bouleva | 61506 | 5-YR | 17.00 | 5173.72 | 5174.44 | 5174.27 | 5174.55 | 0.012005 | 2.68 | 6.35 | 11.73 | 0.64 |
| Colorado Bouleva | Colorado Bouleva | 61506 | 10-YR | 24.00 | 5173.72 | 5174.56 | 5174.40 | 5174.71 | 0.012850 | 3.03 | 7.92 | 12.76 | 0.68 |
| Colorado Bouleva | Colorado Bouleva | 61506 | 25-YR | 41.00 | 5173.72 | 5174.83 | 5174.65 | 5175.02 | 0.013224 | 3.56 | 11.51 | 14.84 | 0.71 |
| Colorado Bouleva | Colorado Bouleva | 61506 | 50-YR | 52.00 | 5173.72 | 5174.96 | 5174.77 | 5175.19 | 0.013614 | 3.84 | 13.53 | 15.89 | 0.73 |
| Colorado Bouleva | Colorado Bouleva | 61506 | 100-YR | 65.00 | 5173.72 | 5175.09 | 5174.89 | 5175.35 | 0.014185 | 4.15 | 15.67 | 16.94 | 0.76 |
| Colorado Bouleva | Colorado Bouleva | 61506 | 500-YR | 98.00 | 5173.72 | 5175.19 | 5175.19 | 5175.68 | 0.023693 | 5.59 | 17.54 | 17.80 | 0.99 |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 61358 | 2-YR | 11.00 | 5171.05 | 5171.48 | 5171.48 | 5171.65 | 0.032762 | 3.32 | 3.31 | 9.43 | 0.99 |
| Colorado Bouleva | Colorado Bouleva | 61358 | 5-YR | 17.00 | 5171.05 | 5171.60 | 5171.60 | 5171.82 | 0.031552 | 3.75 | 4.53 | 10.41 | 1.00 |
| Colorado Bouleva | Colorado Bouleva | 61358 | 10-YR | 24.00 | 5171.05 | 5171.73 | 5171.73 | 5171.98 | 0.028513 | 4.02 | 5.97 | 11.46 | 0.98 |
| Colorado Bouleva | Colorado Bouleva | 61358 | 25-YR | 41.00 | 5171.05 | 5171.97 | 5171.97 | 5172.30 | 0.026885 | 4.60 | 8.92 | 13.36 | 0.99 |
| Colorado Bouleva | Colorado Bouleva | 61358 | 50-YR | 52.00 | 5171.05 | 5172.10 | 5172.10 | 5172.47 | 0.025990 | 4.86 | 10.70 | 14.39 | 0.99 |
| Colorado Bouleva | Colorado Bouleva | 61358 | 100-YR | 65.00 | 5171.05 | 5172.25 | 5172.25 | 5172.64 | 0.024320 | 5.05 | 12.88 | 15.56 | 0.98 |
| Colorado Bouleva | Colorado Bouleva | 61358 | 500-YR | 98.00 | 5171.05 | 5173.36 | 5172.54 | 5173.48 | 0.003565 | 2.78 | 35.20 | 24.46 | 0.41 |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 61224 | 2-YR | 11.00 | 5168.62 | 5169.60 | 5169.05 | 5169.62 | 0.001495 | 1.12 | 9.78 | 13.87 | 0.24 |
| Colorado Bouleva | Colorado Bouleva | 61224 | 5-YR | 17.00 | 5168.62 | 5170.01 | 5169.18 | 5170.03 | 0.000910 | 1.06 | 16.04 | 17.10 | 0.19 |
| Colorado Bouleva | Colorado Bouleva | 61224 | 10-YR | 24.00 | 5168.62 | 5170.42 | 5169.29 | 5170.43 | 0.000627 | 1.01 | 23.67 | 20.35 | 0.17 |
| Colorado Bouleva | Colorado Bouleva | 61224 | 25-YR | 41.00 | 5168.62 | 5171.26 | 5169.55 | 5171.27 | 0.000351 | 0.94 | 43.55 | 27.06 | 0.13 |
| Colorado Bouleva | Colorado Bouleva | 61224 | 50-YR | 52.00 | 5168.62 | 5171.73 | 5169.66 | 5171.74 | 0.000270 | 0.91 | 57.34 | 30.87 | 0.12 |
| Colorado Bouleva | Colorado Bouleva | 61224 | 100-YR | 65.00 | 5168.62 | 5172.31 | 5169.80 | 5172.32 | 0.000195 | 0.85 | 76.42 | 35.46 | 0.10 |
| Colorado Bouleva | Colorado Bouleva | 61224 | 500-YR | 98.00 | 5168.62 | 5173.40 | 5170.10 | 5173.41 | 0.000104 | 0.77 | 132.58 | 99.95 | 0.08 |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 61204 | 2-YR | 11.00 | 5168.26 | 5169.60 | 5168.69 | 5169.61 | 0.000444 | 0.73 | 15.17 | 16.69 | 0.13 |
| Colorado Bouleva | Colorado Bouleva | 61204 | 5-YR | 17.00 | 5168.26 | 5170.00 | 5168.81 | 5170.01 | 0.000337 | 0.75 | 22.58 | 19.95 | 0.12 |
| Colorado Bouleva | Colorado Bouleva | 61204 | 10-YR | 24.00 | 5168.26 | 5170.41 | 5168.93 | 5170.42 | 0.000250 | 0.79 | 30.38 | 23.22 | 0.11 |
| Colorado Bouleva | Colorado Bouleva | 61204 | 25-YR | 41.00 | 5168.26 | 5171.25 | 5169.17 | 5171.26 | 0.000178 | 0.88 | 46.37 | 29.93 | 0.10 |
| Colorado Bouleva | Colorado Bouleva | 61204 | 50-YR | 52.00 | 5168.26 | 5171.73 | 5169.30 | 5171.74 | 0.000158 | 0.94 | 55.42 | 33.72 | 0.10 |
| Colorado Bouleva | Colorado Bouleva | 61204 | 100-YR | 65.00 | 5168.26 | 5172.30 | 5169.44 | 5172.31 | 0.000136 | 0.98 | 66.36 | 38.31 | 0.09 |
| Colorado Bouleva | Colorado Bouleva | 61204 | 500-YR | 98.00 | 5168.26 | 5173.39 | 5169.72 | 5173.40 | 0.000184 | 0.99 | 103.29 | 100.22 | 0.10 |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 61196 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 60700 | 2-YR | 11.00 | 5161.85 | 5162.43 | 5162.41 | 5162.62 | 0.027600 | 3.46 | 3.18 | 7.36 | 0.93 |
| Colorado Bouleva | Colorado Bouleva | 60700 | 5-YR | 17.00 | 5161.85 | 5162.56 | 5162.56 | 5162.82 | 0.029525 | 4.06 | 4.19 | 8.02 | 0.99 |
| Colorado Bouleva | Colorado Bouleva | 60700 | 10-YR | 24.00 | 5161.85 | 5162.70 | 5162.70 | 5163.02 | 0.029264 | 4.54 | 5.28 | 8.69 | 1.01 |

HEC-RAS Plan: Selected Plan (Continued)

| River | Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| Colorado Bouleva | Colorado Bouleva | 60700 | 25-YR | 41.00 | 5161.85 | 5162.98 | 5162.98 | 5163.41 | 0.026136 | 5.26 | 7.79 | 10.12 | 1.01 |
| Colorado Bouleva | Colorado Bouleva | 60700 | 50-YR | 52.00 | 5161.85 | 5163.12 | 5163.12 | 5163.63 | 0.024952 | 5.71 | 9.11 | 10.78 | 1.01 |
| Colorado Bouleva | Colorado Bouleva | 60700 | 100-YR | 65.00 | 5161.85 | 5163.29 | 5163.29 | 5163.87 | 0.023466 | 6.13 | 10.61 | 11.52 | 1.00 |
| Colorado Bouleva | Colorado Bouleva | 60700 | 500-YR | 98.00 | 5161.85 | 5163.65 | 5163.65 | 5164.42 | 0.021295 | 7.02 | 13.97 | 13.28 | 1.00 |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 60680 | 2-YR | 11.00 | 5161.10 | 5161.79 | 5161.79 | 5162.01 | 0.032258 | 3.78 | 2.91 | 6.64 | 1.01 |
| Colorado Bouleva | Colorado Bouleva | 60680 | 5-YR | 17.00 | 5161.10 | 5161.95 | 5161.95 | 5162.22 | 0.030118 | 4.14 | 4.10 | 7.73 | 1.00 |
| Colorado Bouleva | Colorado Bouleva | 60680 | 10-YR | 24.00 | 5161.10 | 5162.11 | 5162.11 | 5162.42 | 0.029169 | 4.44 | 5.40 | 8.93 | 1.01 |
| Colorado Bouleva | Colorado Bouleva | 60680 | 25-YR | 41.00 | 5161.10 | 5162.39 | 5162.39 | 5162.78 | 0.027438 | 4.99 | 8.23 | 11.25 | 1.01 |
| Colorado Bouleva | Colorado Bouleva | 60680 | 50-YR | 52.00 | 5161.10 | 5162.53 | 5162.53 | 5162.97 | 0.024641 | 5.30 | 9.91 | 12.46 | 0.99 |
| Colorado Bouleva | Colorado Bouleva | 60680 | 100-YR | 65.00 | 5161.10 | 5162.69 | 5162.69 | 5163.17 | 0.022205 | 5.60 | 11.94 | 13.75 | 0.96 |
| Colorado Bouleva | Colorado Bouleva | 60680 | 500-YR | 98.00 | 5161.10 | 5163.02 | 5163.02 | 5163.59 | 0.018701 | 6.18 | 17.01 | 16.58 | 0.93 |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 60636 | 2-YR | 11.00 | 5158.98 | 5159.52 | 5159.52 | 5159.71 | 0.032876 | 3.50 | 3.14 | 8.25 | 1.00 |
| Colorado Bouleva | Colorado Bouleva | 60636 | 5-YR | 17.00 | 5158.98 | 5159.66 | 5159.66 | 5159.89 | 0.030890 | 3.87 | 4.40 | 9.50 | 1.00 |
| Colorado Bouleva | Colorado Bouleva | 60636 | 10-YR | 24.00 | 5158.98 | 5159.79 | 5159.79 | 5160.06 | 0.029443 | 4.17 | 5.75 | 10.68 | 1.00 |
| Colorado Bouleva | Colorado Bouleva | 60636 | 25-YR | 41.00 | 5158.98 | 5160.04 | 5160.04 | 5160.39 | 0.027349 | 4.75 | 8.64 | 12.79 | 1.01 |
| Colorado Bouleva | Colorado Bouleva | 60636 | 50-YR | 52.00 | 5158.98 | 5160.17 | 5160.17 | 5160.57 | 0.024731 | 5.06 | 10.36 | 13.83 | 0.98 |
| Colorado Bouleva | Colorado Bouleva | 60636 | 100-YR | 65.00 | 5158.98 | 5160.30 | 5160.30 | 5160.75 | 0.023027 | 5.40 | 12.29 | 14.91 | 0.97 |
| Colorado Bouleva | Colorado Bouleva | 60636 | 500-YR | 98.00 | 5158.98 | 5160.61 | 5160.61 | 5161.15 | 0.019426 | 5.99 | 17.30 | 17.44 | 0.94 |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 60438 | 2-YR | 11.00 | 5151.98 | 5152.60 | 5152.60 | 5152.81 | 0.033112 | 3.62 | 3.04 | 7.60 | 1.01 |
| Colorado Bouleva | Colorado Bouleva | 60438 | 5-YR | 17.00 | 5151.98 | 5152.76 | 5152.76 | 5153.00 | 0.030917 | 3.94 | 4.32 | 9.04 | 1.00 |
| Colorado Bouleva | Colorado Bouleva | 60438 | 10-YR | 24.00 | 5151.98 | 5152.90 | 5152.90 | 5153.18 | 0.029889 | 4.24 | 5.65 | 10.31 | 1.01 |
| Colorado Bouleva | Colorado Bouleva | 60438 | 25-YR | 41.00 | 5151.98 | 5153.15 | 5153.15 | 5153.51 | 0.025833 | 4.85 | 8.56 | 13.21 | 0.99 |
| Colorado Bouleva | Colorado Bouleva | 60438 | 50-YR | 52.00 | 5151.98 | 5153.30 | 5153.30 | 5153.69 | 0.022030 | 5.06 | 10.69 | 15.22 | 0.94 |
| Colorado Bouleva | Colorado Bouleva | 60438 | 100-YR | 65.00 | 5151.98 | 5153.44 | 5153.44 | 5153.87 | 0.019808 | 5.31 | 13.09 | 17.21 | 0.92 |
| Colorado Bouleva | Colorado Bouleva | 60438 | 500-YR | 98.00 | 5151.98 | 5153.75 | 5153.75 | 5154.24 | 0.017060 | 5.84 | 18.92 | 21.28 | 0.89 |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 60316 | 2-YR | 11.00 | 5148.12 | 5149.09 | 5148.50 | 5149.11 | 0.001539 | 1.25 | 8.77 | 9.74 | 0.23 |
| Colorado Bouleva | Colorado Bouleva | 60316 | 5-YR | 17.00 | 5148.12 | 5149.34 | 5148.62 | 5149.38 | 0.001702 | 1.51 | 11.28 | 9.99 | 0.25 |
| Colorado Bouleva | Colorado Bouleva | 60316 | 10-YR | 24.00 | 5148.12 | 5149.60 | 5148.75 | 5149.65 | 0.001810 | 1.73 | 13.90 | 10.23 | 0.26 |
| Colorado Bouleva | Colorado Bouleva | 60316 | 25-YR | 41.00 | 5148.12 | 5150.16 | 5149.00 | 5150.22 | 0.001947 | 2.08 | 19.74 | 11.17 | 0.28 |
| Colorado Bouleva | Colorado Bouleva | 60316 | 50-YR | 52.00 | 5148.12 | 5150.65 | 5149.15 | 5150.72 | 0.001600 | 2.02 | 25.73 | 13.03 | 0.25 |
| Colorado Bouleva | Colorado Bouleva | 60316 | 100-YR | 65.00 | 5148.12 | 5151.10 | 5149.30 | 5151.16 | 0.001640 | 1.99 | 32.72 | 18.28 | 0.26 |
| Colorado Bouleva | Colorado Bouleva | 60316 | 500-YR | 98.00 | 5148.12 | 5152.08 | 5149.66 | 5152.13 | 0.001034 | 1.73 | 57.71 | 49.67 | 0.22 |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 60295 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 60149 | 2-YR | 11.00 | 5147.11 | 5148.15 | | 5148.19 | 0.002505 | 1.62 | 6.80 | 6.97 | 0.29 |
| Colorado Bouleva | Colorado Bouleva | 60149 | 5-YR | 17.00 | 5147.11 | 5148.35 | | 5148.42 | 0.004255 | 2.03 | 8.38 | 9.40 | 0.38 |
| Colorado Bouleva | Colorado Bouleva | 60149 | 10-YR | 24.00 | 5147.11 | 5148.54 | | 5148.62 | 0.005851 | 2.32 | 10.35 | 12.47 | 0.45 |
| Colorado Bouleva | Colorado Bouleva | 60149 | 25-YR | 41.00 | 5147.11 | 5148.83 | | 5148.95 | 0.007747 | 2.79 | 14.70 | 17.45 | 0.53 |
| Colorado Bouleva | Colorado Bouleva | 60149 | 50-YR | 52.00 | 5147.11 | 5148.95 | | 5149.10 | 0.008384 | 3.08 | 16.87 | 19.49 | 0.56 |
| Colorado Bouleva | Colorado Bouleva | 60149 | 100-YR | 65.00 | 5147.11 | 5149.07 | | 5149.25 | 0.009048 | 3.42 | 19.00 | 21.19 | 0.59 |
| Colorado Bouleva | Colorado Bouleva | 60149 | 500-YR | 98.00 | 5147.11 | 5149.31 | | 5149.58 | 0.010069 | 4.16 | 23.74 | 24.42 | 0.65 |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 60139 | 2-YR | 11.00 | 5147.02 | 5148.07 | | 5148.14 | 0.007092 | 2.10 | 5.23 | 9.12 | 0.49 |
| Colorado Bouleva | Colorado Bouleva | 60139 | 5-YR | 17.00 | 5147.02 | 5148.27 | | 5148.36 | 0.007917 | 2.32 | 7.32 | 12.02 | 0.52 |
| Colorado Bouleva | Colorado Bouleva | 60139 | 10-YR | 24.00 | 5147.02 | 5148.45 | | 5148.55 | 0.007905 | 2.47 | 9.73 | 14.65 | 0.53 |
| Colorado Bouleva | Colorado Bouleva | 60139 | 25-YR | 41.00 | 5147.02 | 5148.74 | | 5148.87 | 0.008324 | 2.81 | 14.61 | 18.90 | 0.56 |
| Colorado Bouleva | Colorado Bouleva | 60139 | 50-YR | 52.00 | 5147.02 | 5148.87 | | 5149.01 | 0.008391 | 3.06 | 17.06 | 20.72 | 0.58 |
| Colorado Bouleva | Colorado Bouleva | 60139 | 100-YR | 65.00 | 5147.02 | 5148.98 | | 5149.16 | 0.008692 | 3.37 | 19.49 | 22.37 | 0.60 |
| Colorado Bouleva | Colorado Bouleva | 60139 | 500-YR | 98.00 | 5147.02 | 5149.23 | | 5149.47 | 0.009053 | 4.00 | 25.49 | 25.96 | 0.63 |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 60023 | 2-YR | 11.00 | 5145.96 | 5146.42 | 5146.42 | 5146.59 | 0.033679 | 3.32 | 3.32 | 9.68 | 1.00 |
| Colorado Bouleva | Colorado Bouleva | 60023 | 5-YR | 17.00 | 5145.96 | 5146.56 | 5146.56 | 5146.75 | 0.029011 | 3.58 | 4.75 | 11.02 | 0.96 |
| Colorado Bouleva | Colorado Bouleva | 60023 | 10-YR | 24.00 | 5145.96 | 5146.66 | 5146.66 | 5146.91 | 0.030465 | 4.03 | 5.96 | 12.05 | 1.01 |
| Colorado Bouleva | Colorado Bouleva | 60023 | 25-YR | 41.00 | 5145.96 | 5146.89 | 5146.89 | 5147.21 | 0.028139 | 4.54 | 9.03 | 14.31 | 1.01 |
| Colorado Bouleva | Colorado Bouleva | 60023 | 50-YR | 52.00 | 5145.96 | 5147.01 | 5147.01 | 5147.37 | 0.027358 | 4.82 | 10.79 | 15.44 | 1.01 |
| Colorado Bouleva | Colorado Bouleva | 60023 | 100-YR | 65.00 | 5145.96 | 5147.14 | 5147.14 | 5147.54 | 0.024774 | 5.11 | 12.79 | 16.74 | 0.99 |
| Colorado Bouleva | Colorado Bouleva | 60023 | 500-YR | 98.00 | 5145.96 | 5147.41 | 5147.41 | 5147.91 | 0.021054 | 5.70 | 17.78 | 19.58 | 0.96 |
| | | | | | | | | | | | | | |
| Colorado Bouleva | Colorado Bouleva | 60013 | 2-YR | 11.00 | 5144.98 | 5145.87 | 5145.67 | 5145.96 | 0.011010 | 2.52 | 4.37 | 8.15 | 0.61 |
| Colorado Bouleva | Colorado Bouleva | 60013 | 5-YR | 17.00 | 5144.98 | 5146.06 | 5145.84 | 5146.18 | 0.011008 | 2.81 | 6.05 | 9.58 | 0.62 |
| Colorado Bouleva | Colorado Bouleva | 60013 | 10-YR | 24.00 | 5144.98 | 5146.23 | 5145.99 | 5146.38 | 0.011012 | 3.07 | 7.82 | 10.85 | 0.64 |
| Colorado Bouleva | Colorado Bouleva | 60013 | 25-YR | 41.00 | 5144.98 | 5146.55 | 5146.27 | 5146.74 | 0.011009 | 3.52 | 11.65 | 13.15 | 0.66 |
| Colorado Bouleva | Colorado Bouleva | 60013 | 50-YR | 52.00 | 5144.98 | 5146.69 | 5146.42 | 5146.92 | 0.011017 | 3.84 | 13.59 | 14.26 | 0.67 |
| Colorado Bouleva | Colorado Bouleva | 60013 | 100-YR | 65.00 | 5144.98 | 5146.83 | 5146.57 | 5147.10 | 0.011011 | 4.19 | 15.70 | 15.42 | 0.69 |
| Colorado Bouleva | Colorado Bouleva | 60013 | 500-YR | 98.00 | 5144.98 | 5147.14 | 5146.88 | 5147.51 | 0.011003 | 4.90 | 20.83 | 18.08 | 0.72 |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Elevation (ft)
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Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
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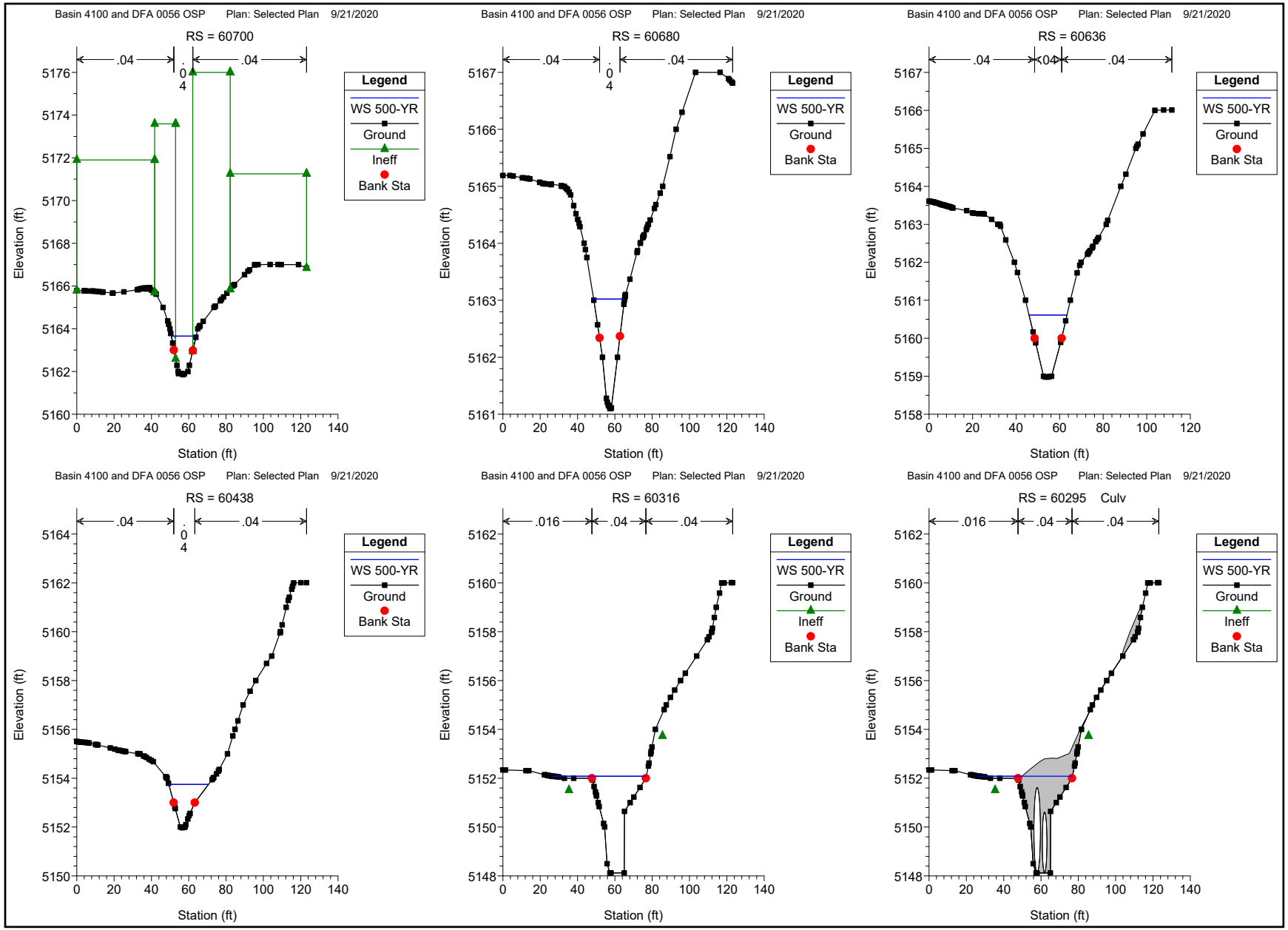
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Elevation (ft)
Station (ft)
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Station (ft)
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Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
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Ground
Bank Sta
Elevation (ft)
Station (ft)
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Ground
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Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
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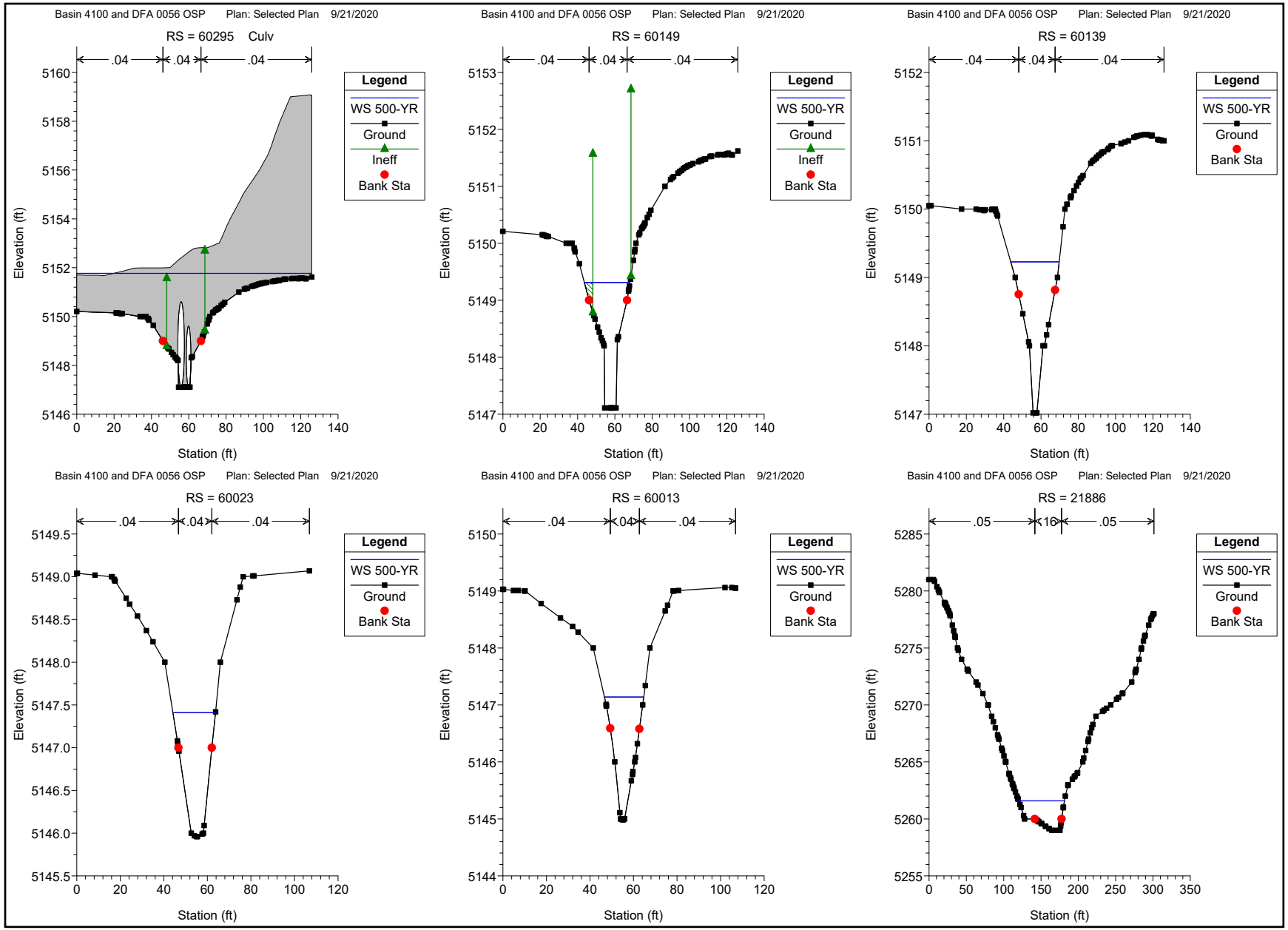
Station (ft)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Legend
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Ground
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Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
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Ground
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Elevation (ft)
Station (ft)
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Ground
Bank Sta
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Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
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Ground
Bank Sta
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Station (ft)
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Bank Sta
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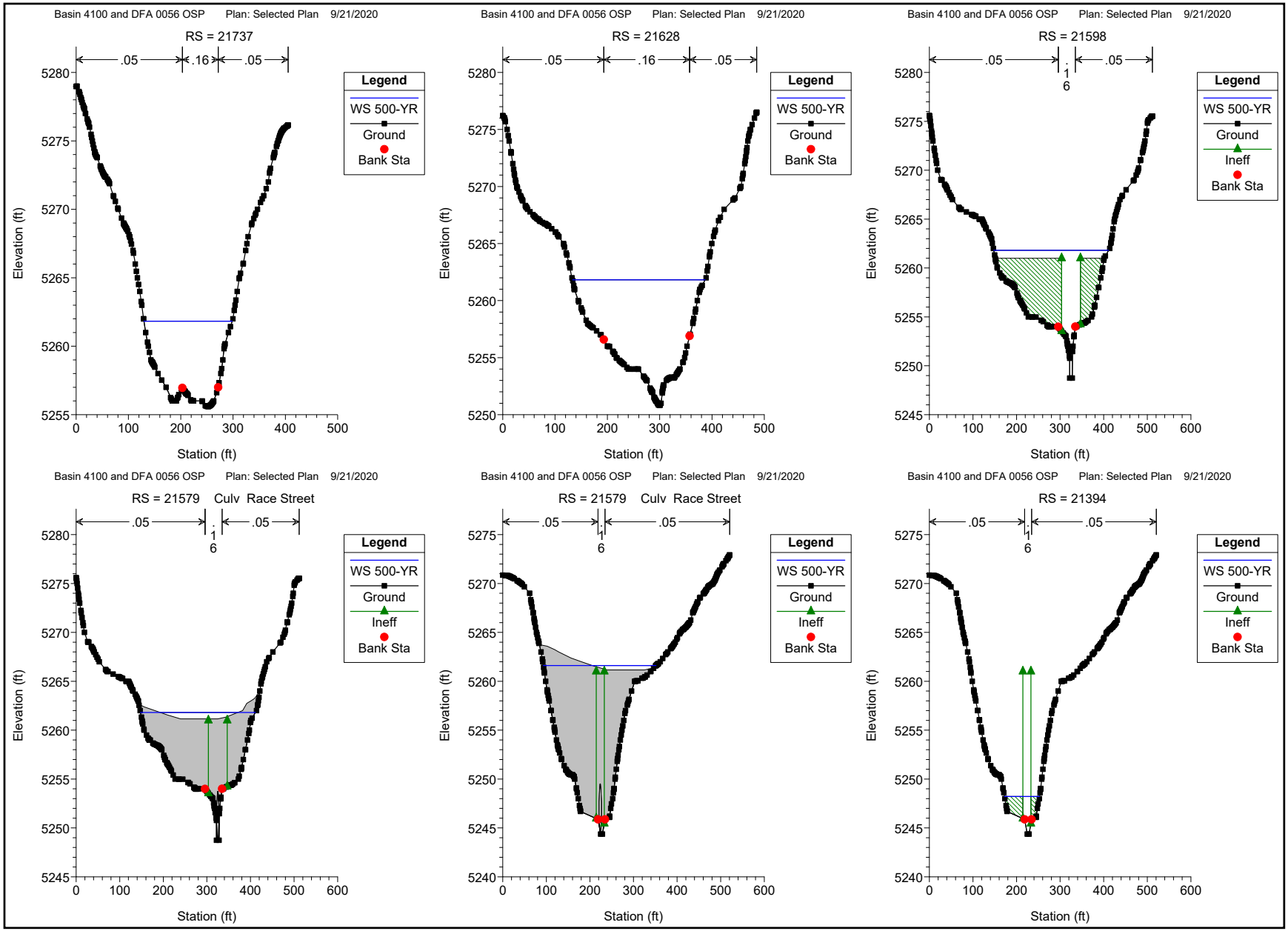
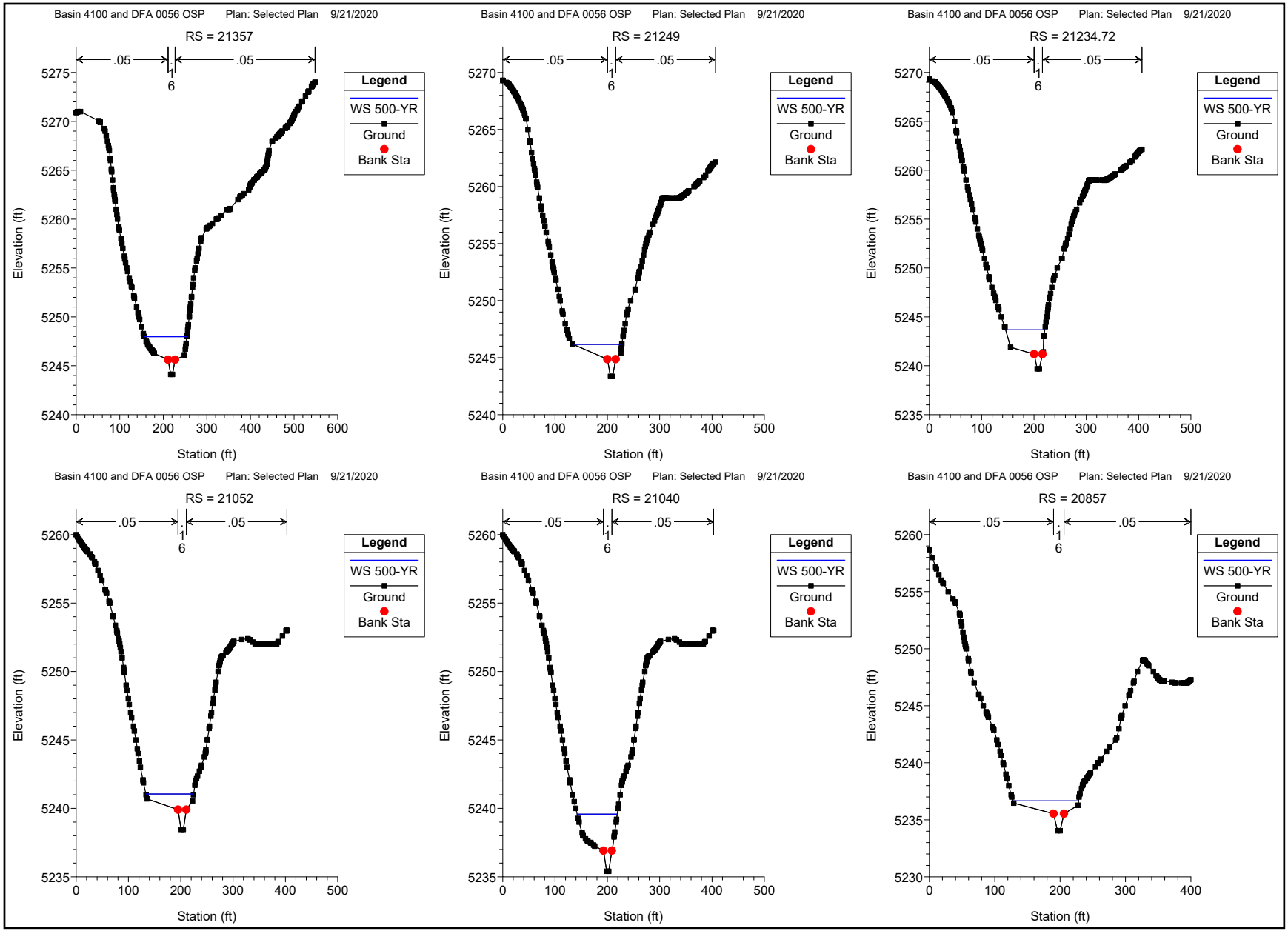
Ground
Bank Sta
Elevation (ft)
Station (ft)


Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 21737
.05
.16
.05
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 21628
.05
.16
.05
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 21598
.05
.16
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 21579 Culv Race Street
.05
.16
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 21579 Culv Race Street
.05
.16
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 21394
.05
.16
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 21357
.05
.05
1
6
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 21249
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 21234.72
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 21052
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 21040
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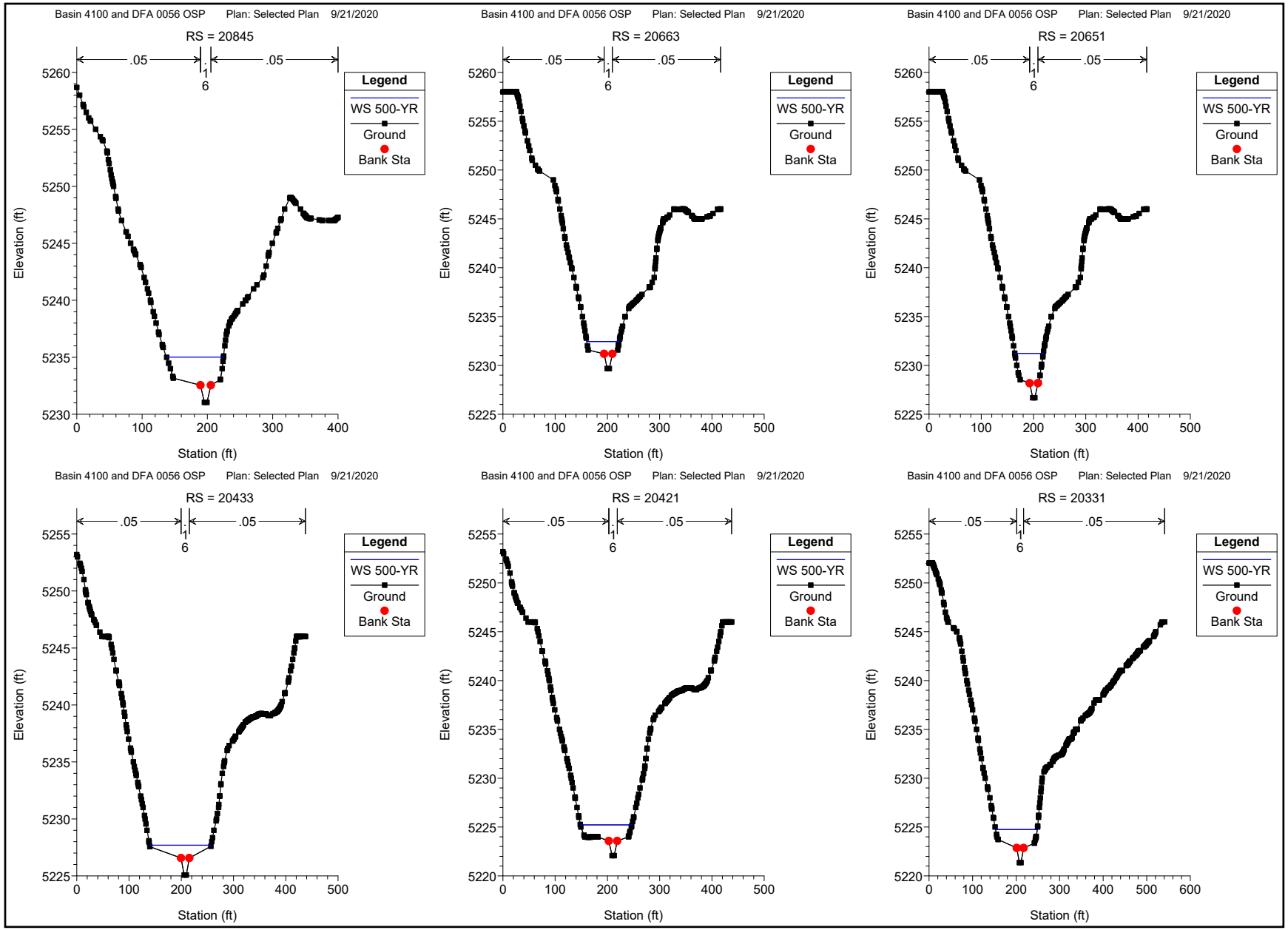
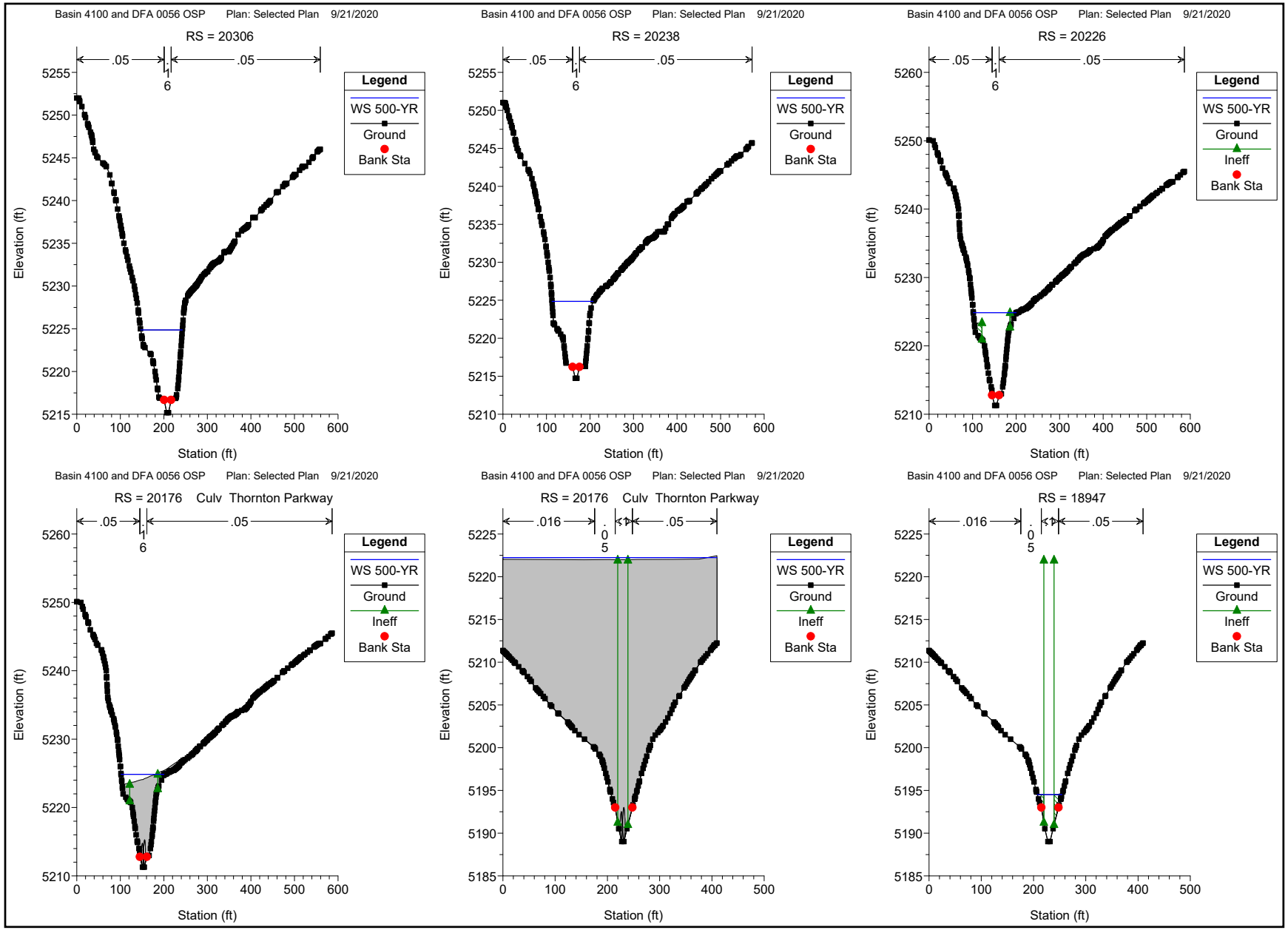
RS = 20857


Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 20845
.05
.05
1
6
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 20663
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 20651
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 20433
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 20421
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 20331


Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 20306
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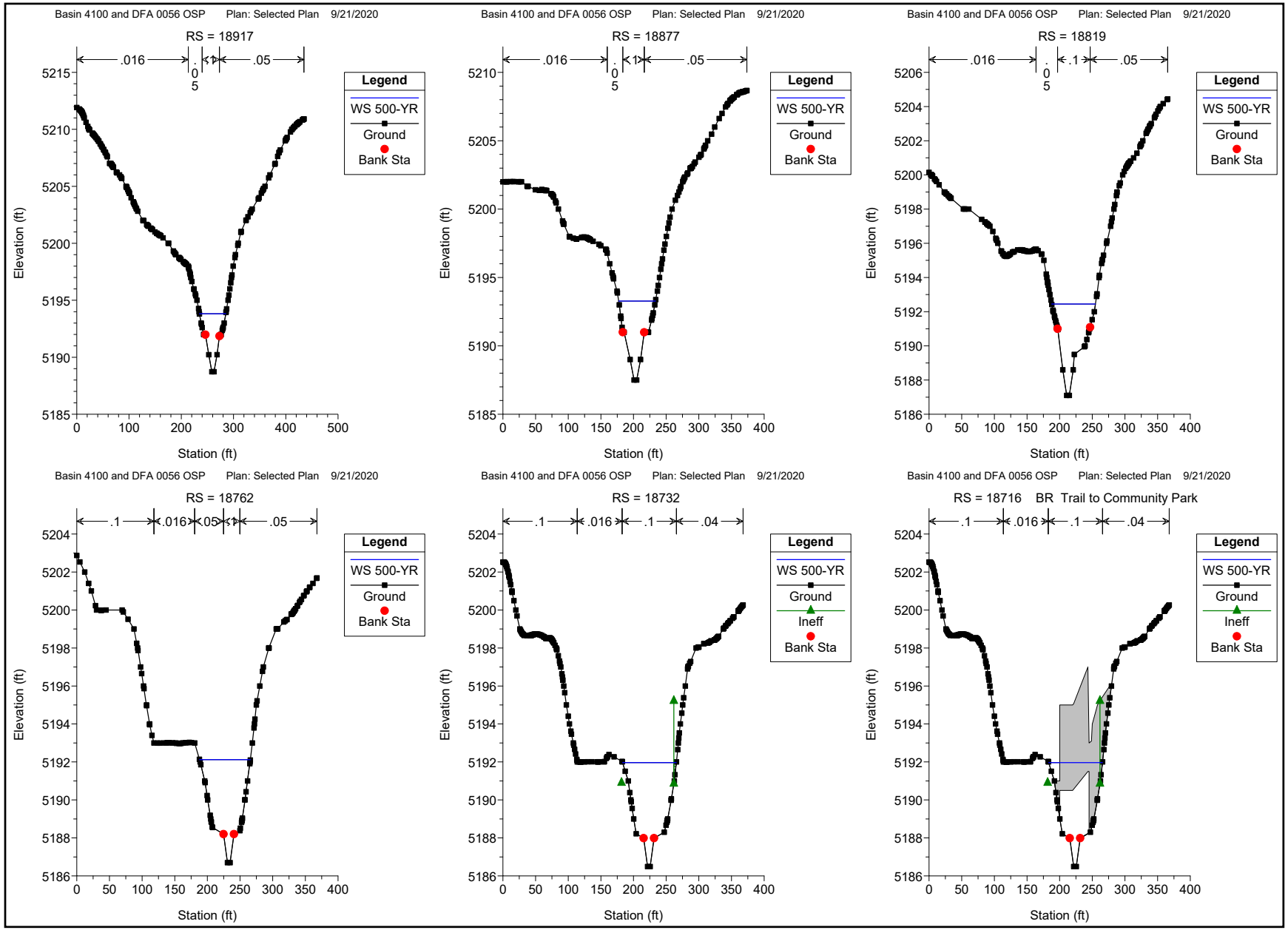
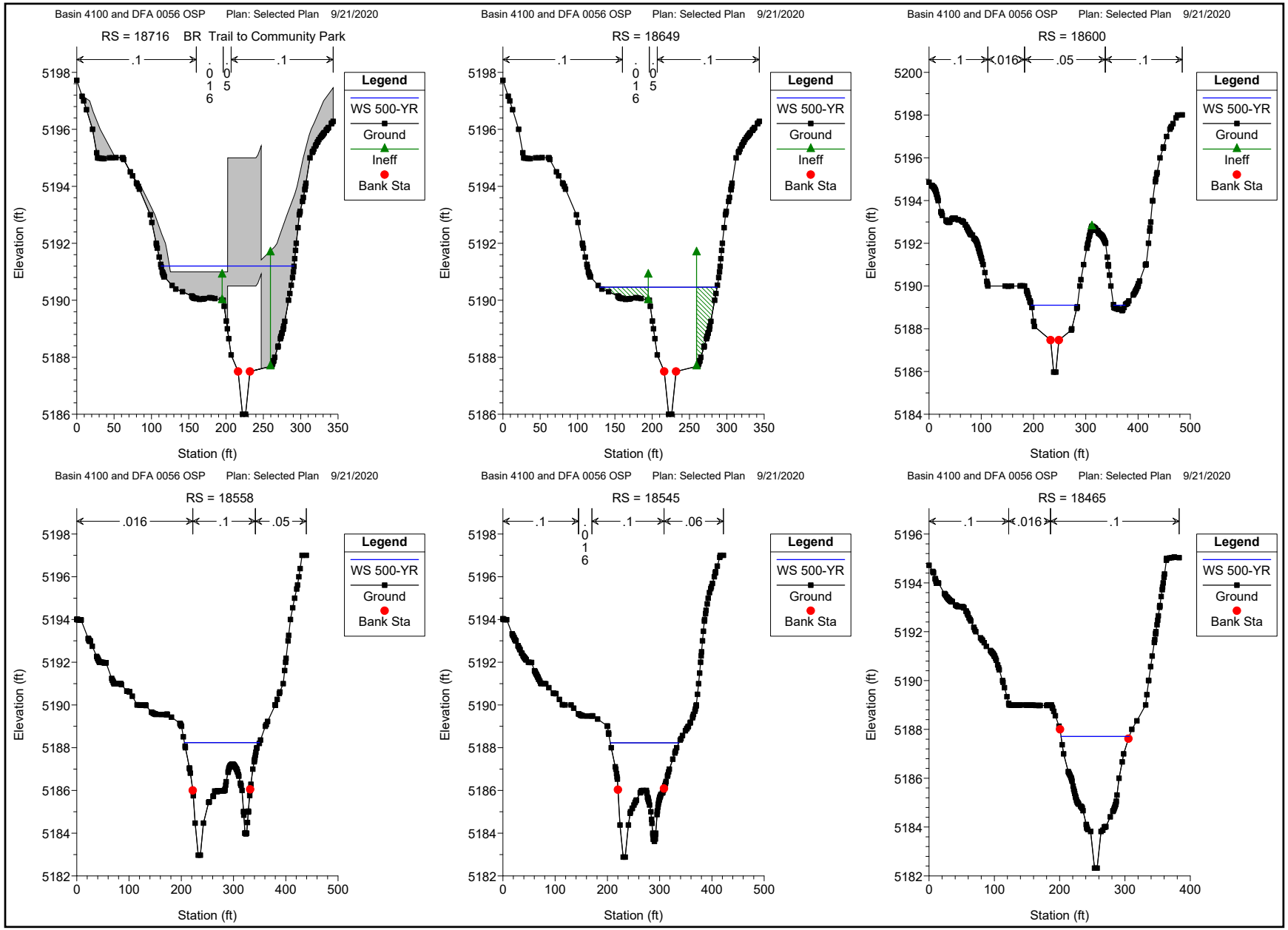
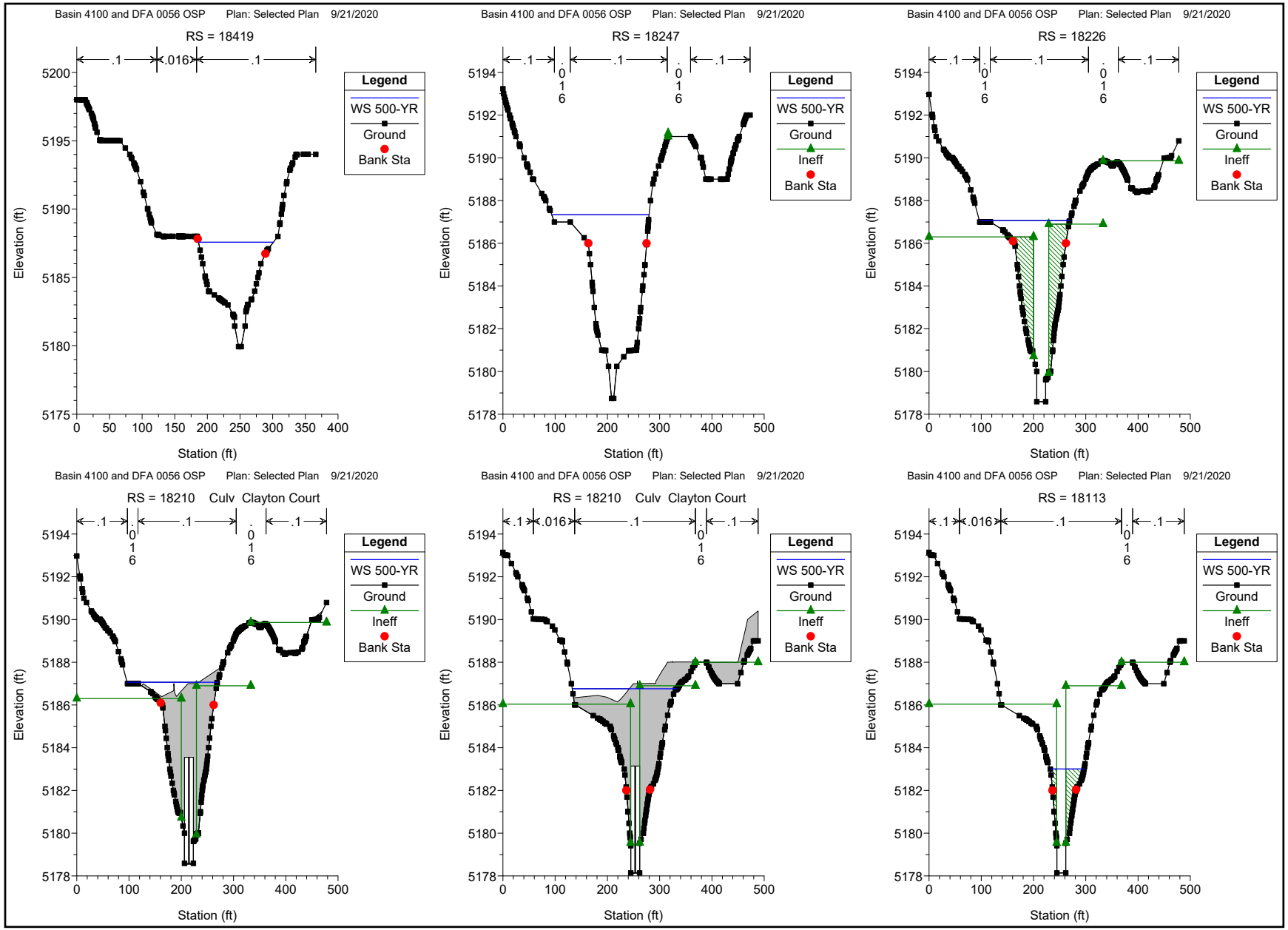
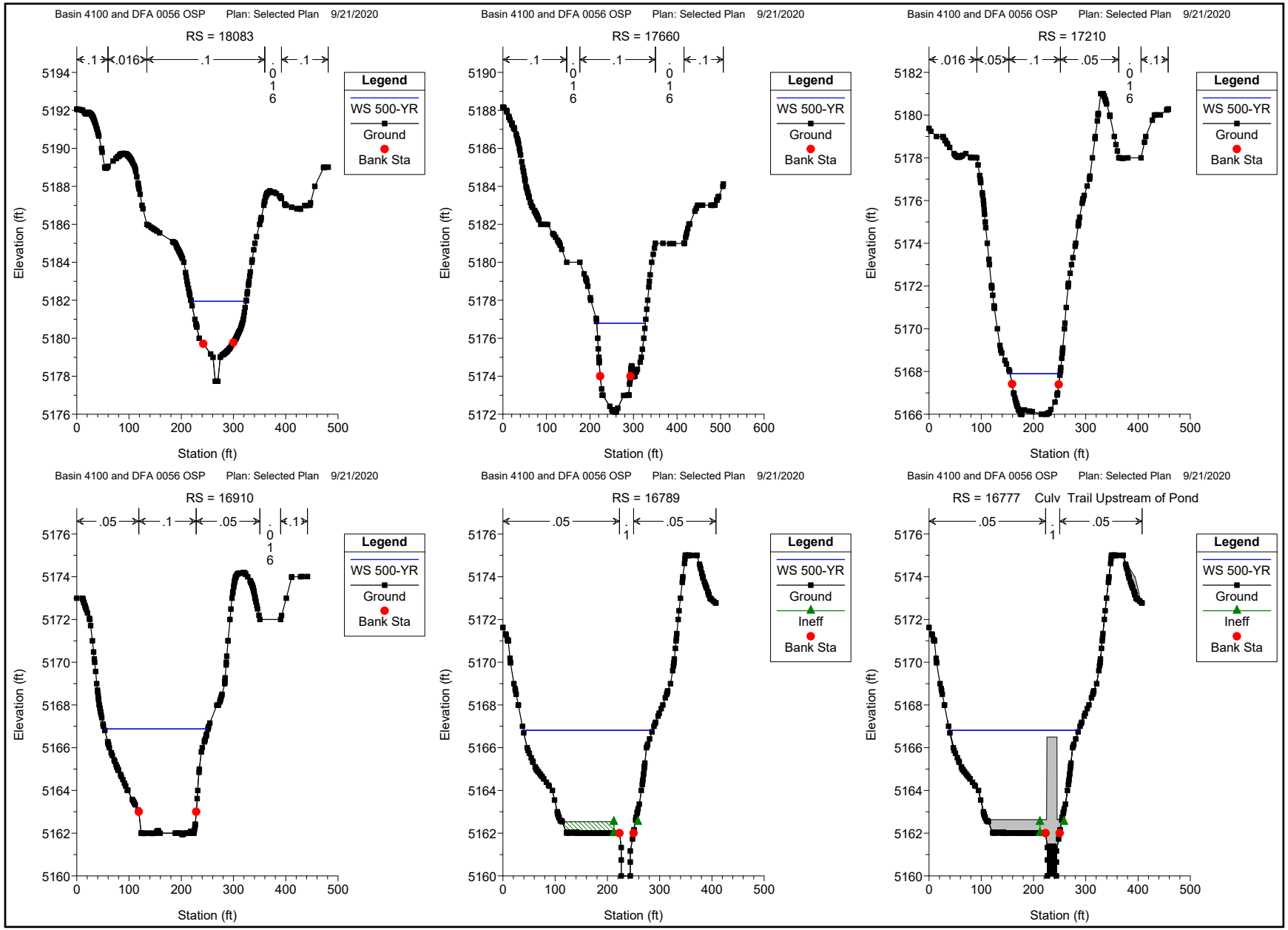
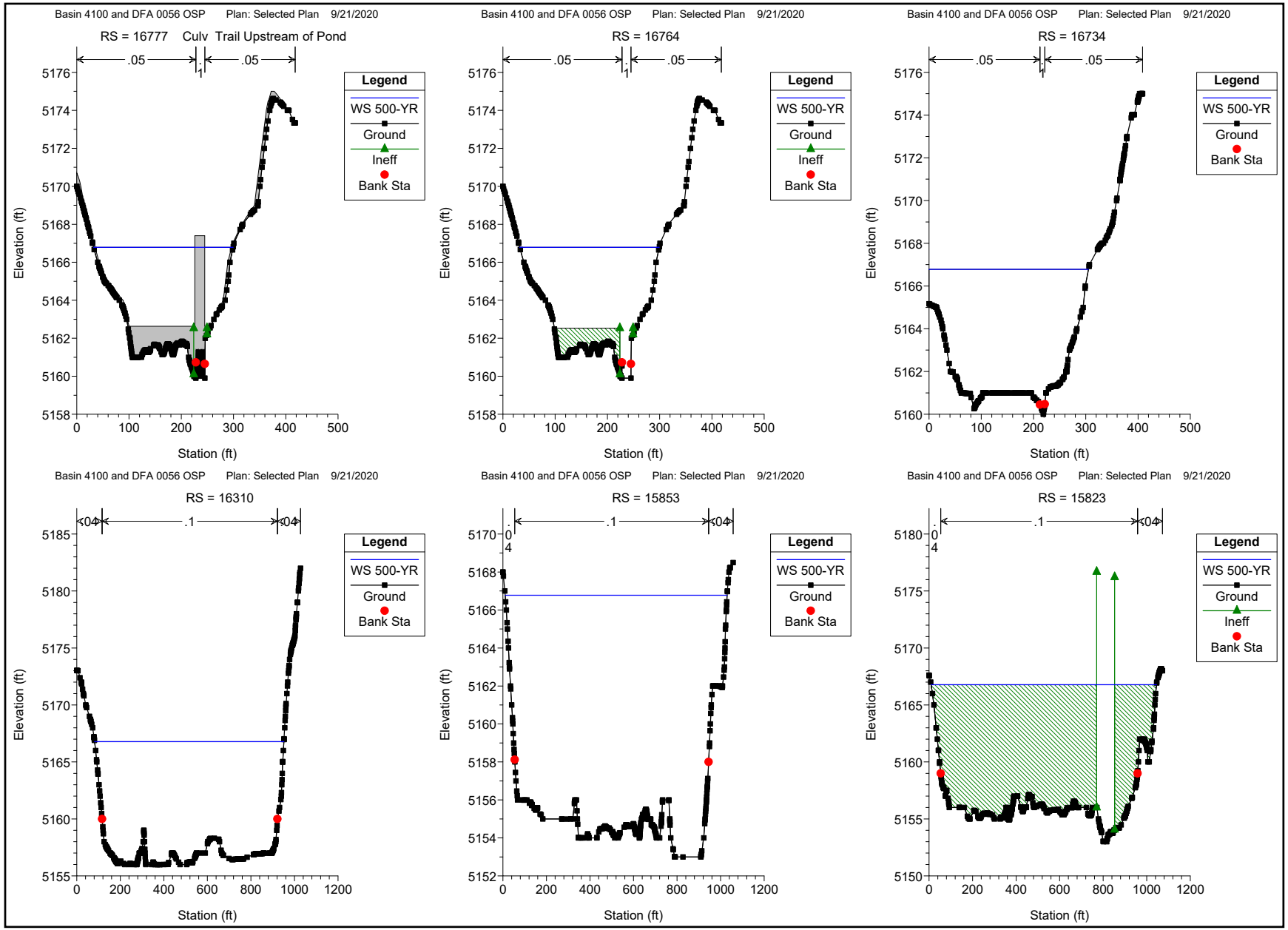
.05
6
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 20238
.05
.05
6
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 20226
.05
.05
6
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 20176 Culv Thornton Parkway
.05
.05
6
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 20176 Culv Thornton Parkway
.016
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18947
.016
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

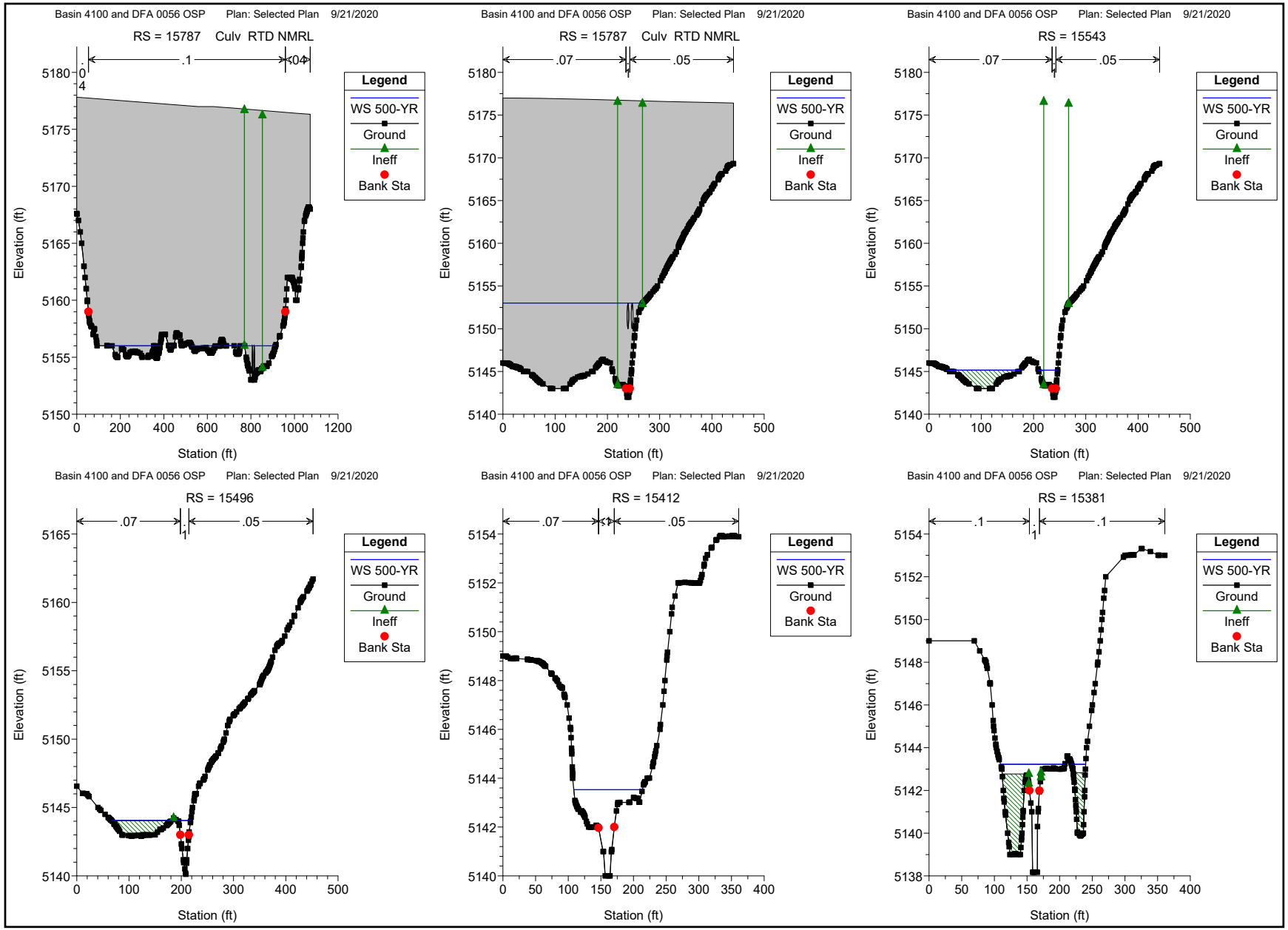

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18917
.016
.05
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18877
.016
.05
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18819
.016
.1
.05
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18762
.1
.016
.05
.05
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18732
.1
.016
.1
.04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18716 BR Trail to Community Park
.1
.016
.1
.04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

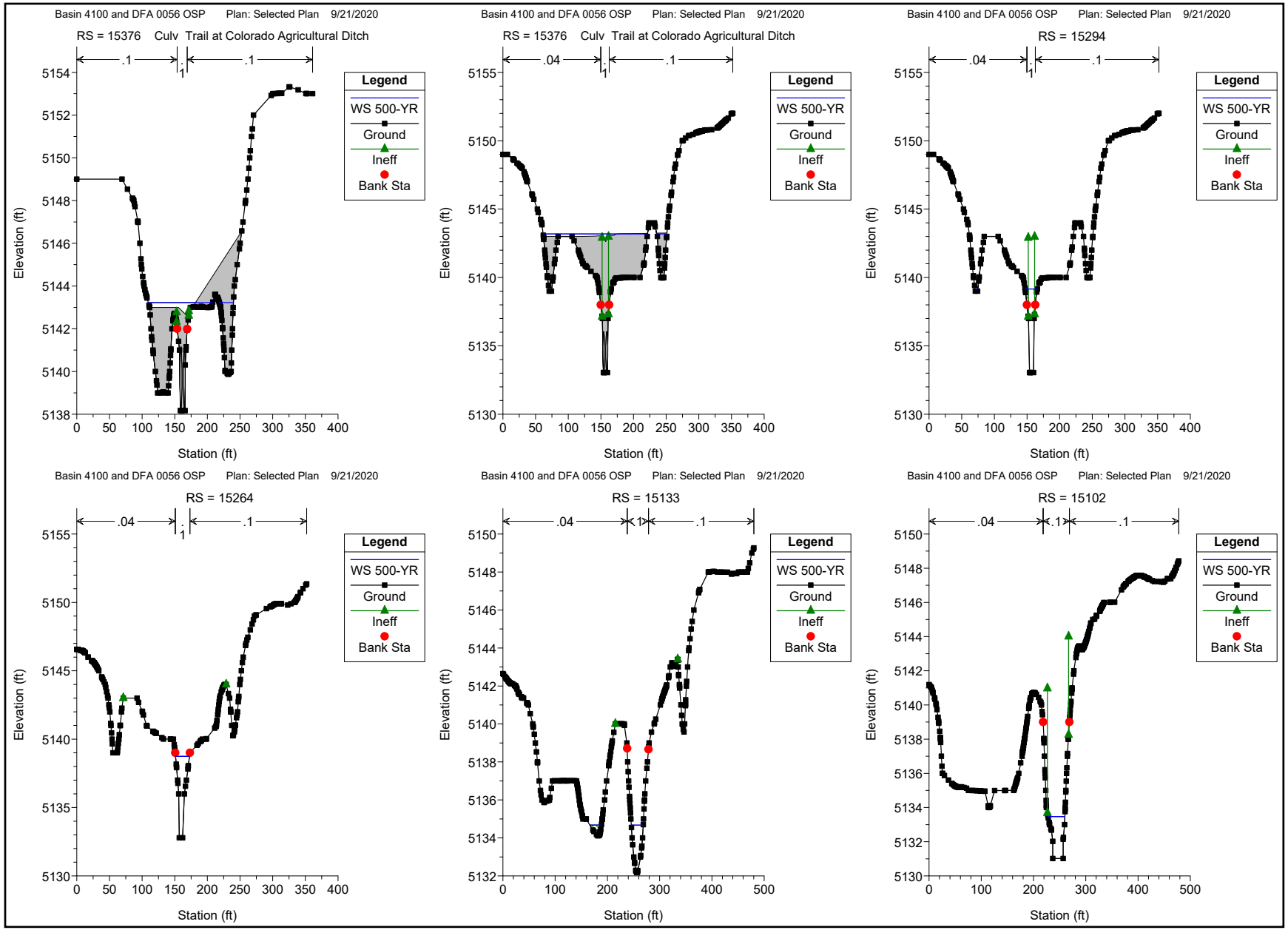

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18716 BR Trail to Community Park
.1 .016 .05 .1
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18649
.1 .016 .05 .1
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18600
.1 .016 .05 .1
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18558
.016 .1 .05
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18545
.1 .016 .1 .06
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18465
.1 .016 .1
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

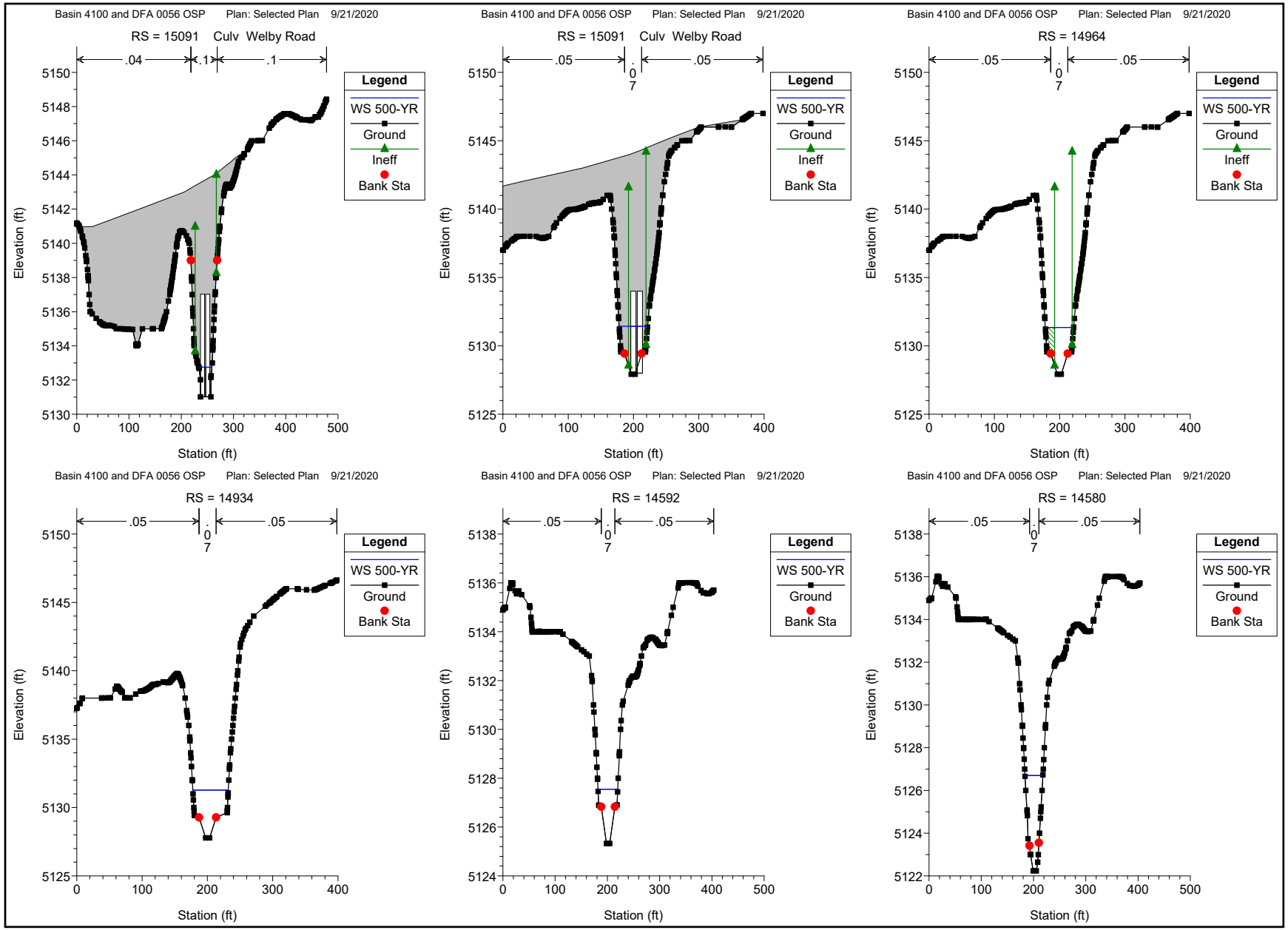

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18419
.1
.016
.1
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18247
.1
.016
.1
.016
.1
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18226
.1
.016
.1
.016
.1
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18210 Culv Clayton Court
.1
.016
.1
.016
.1
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18210 Culv Clayton Court
.1
.016
.1
.016
.1
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18113
.1
.016
.1
.016
.1
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

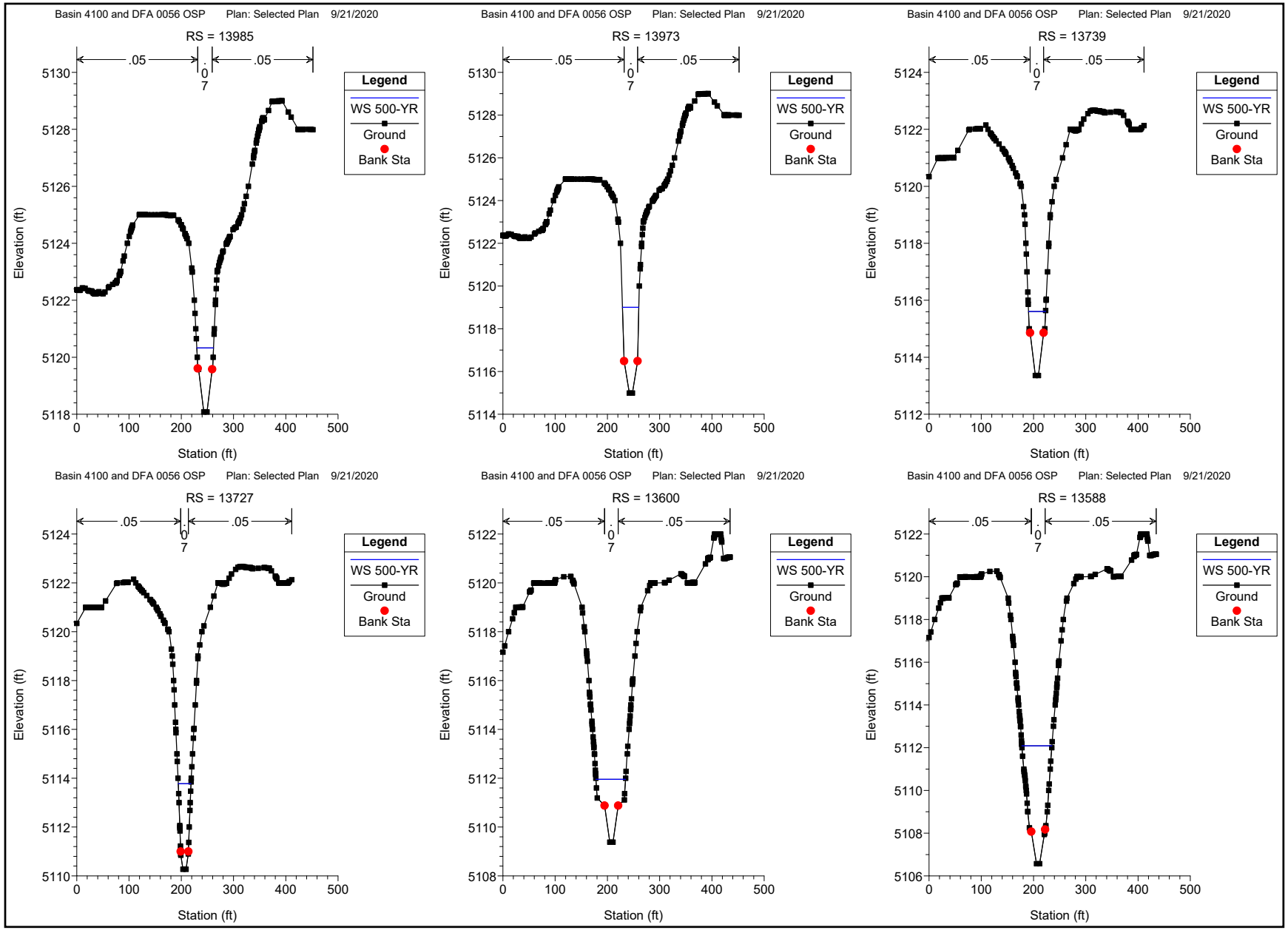

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 18083
.1 .016 .1 .01 6 .1
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 17660
.1 .01 6 .1 .01 6 .1
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 17210
.016 .05 .1 .05 .01 6 .1
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 16910
.05 .1 .05 .01 6 .1
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 16789
.05 .1 .05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 16777 Culv Trail Upstream of Pond
.05 .1 .05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 16777 Culv Trail Upstream of Pond
.05
.1
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 16764
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 16734
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 16310
.04
.1
.04
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15853
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15823


Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15787 Culv RTD NMRL
.1
.04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15787 Culv RTD NMRL
.07
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15543
.07
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15496
.07
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15412
.07
.05
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15381
.1
.1
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15376 Culv Trail at Colorado Agricultural Ditch
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15376 Culv Trail at Colorado Agricultural Ditch
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15294
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15264
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15133
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15102
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15091 Culv Welby Road
.04
.1
.1
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 15091 Culv Welby Road
.05
.05
.07
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 14964
.05
.05
.07
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 14934
.05
.05
.07
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 14592
.05
.05
.07
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 14580
.05
.05
.07
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)


Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 13985
.05
.05
0
7
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 13973
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 13739
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 13727
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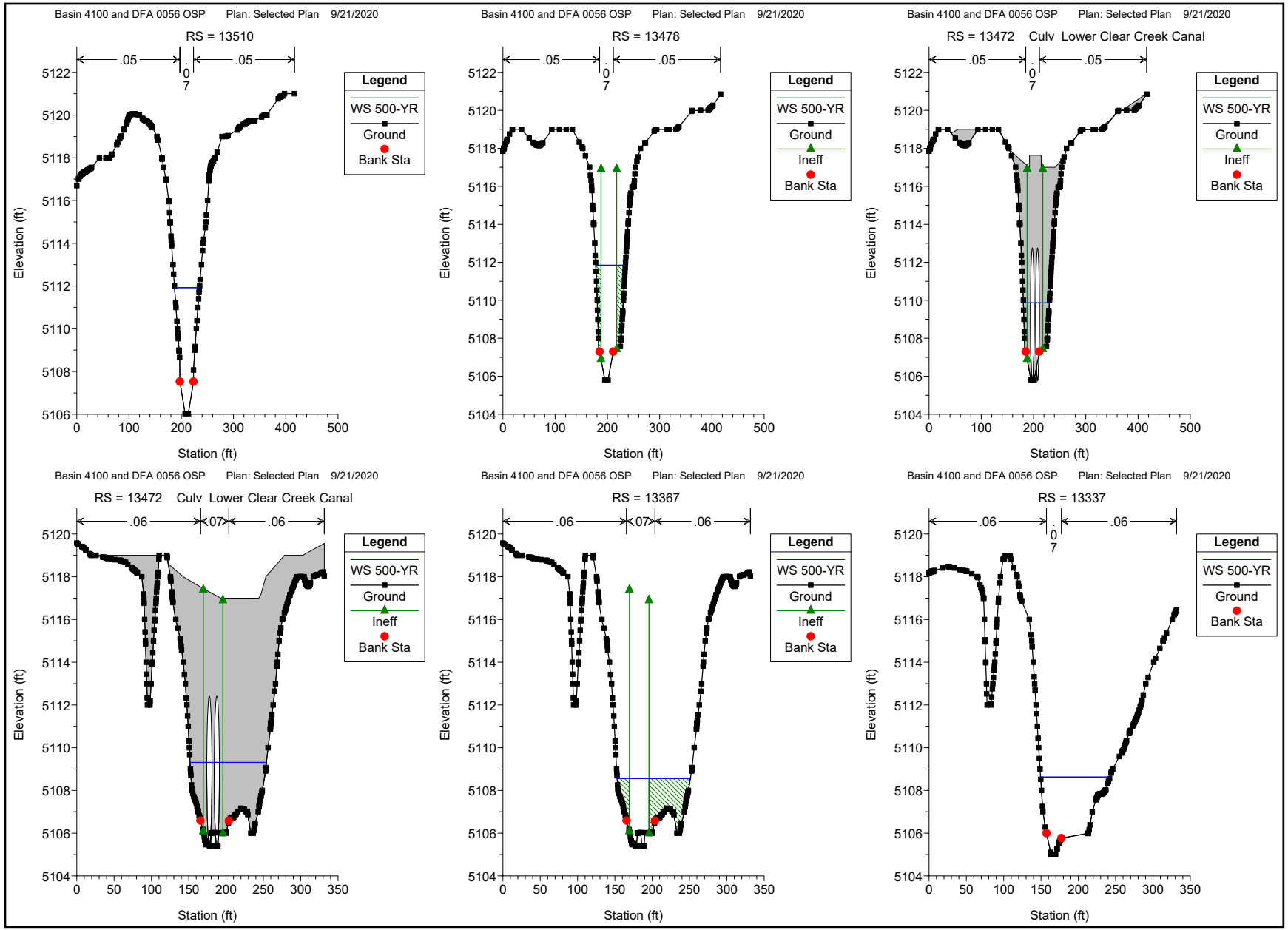
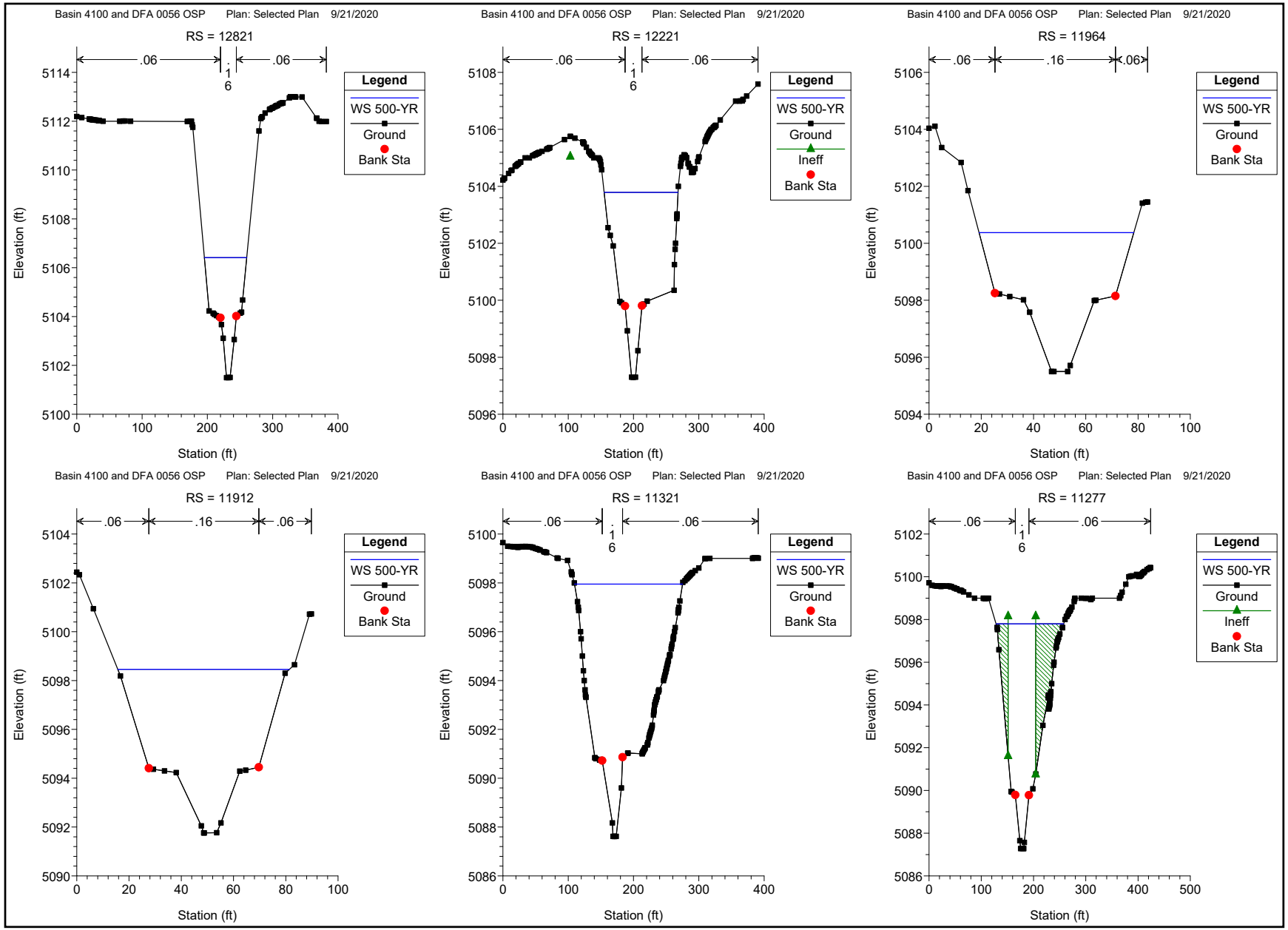
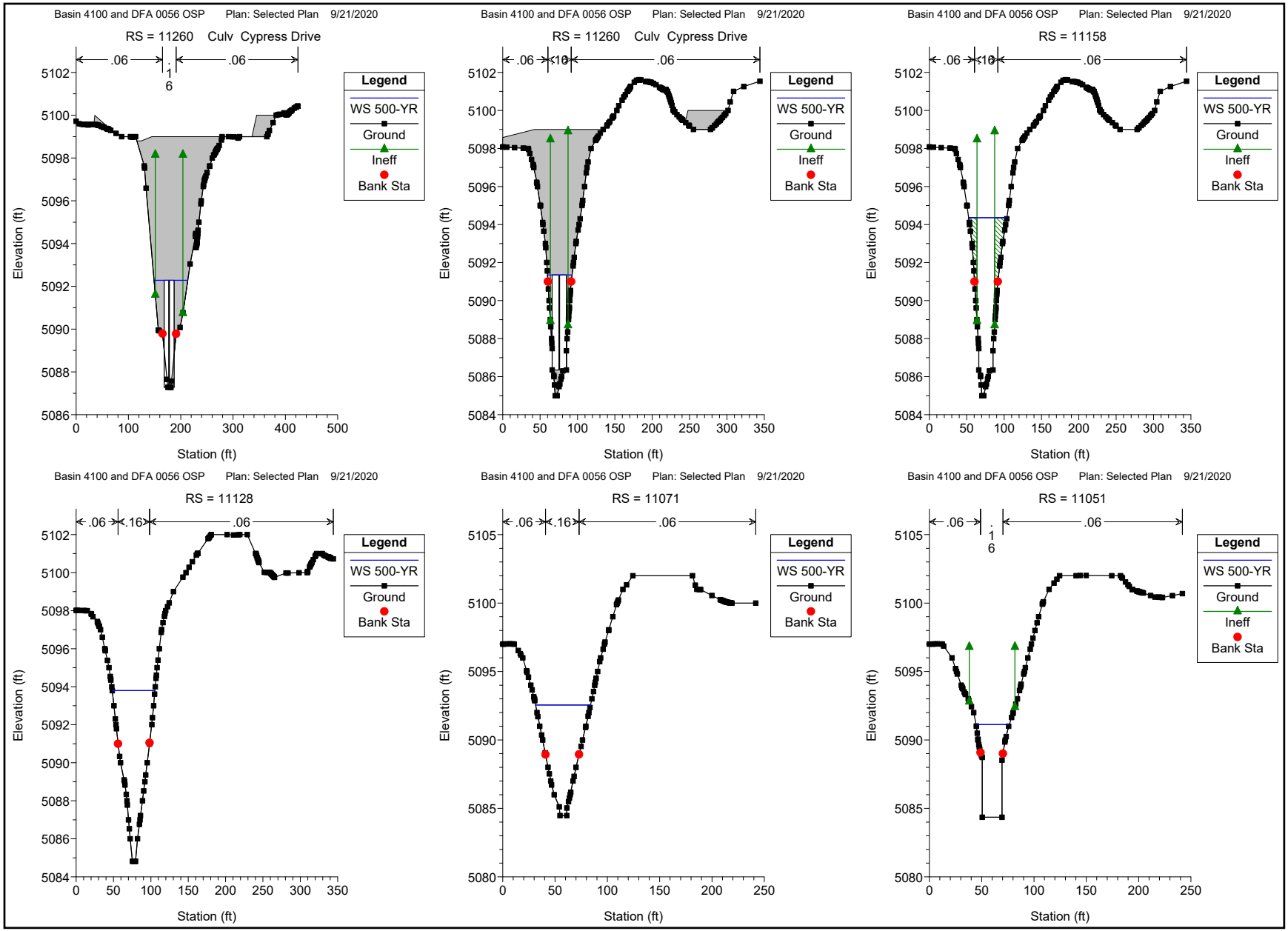
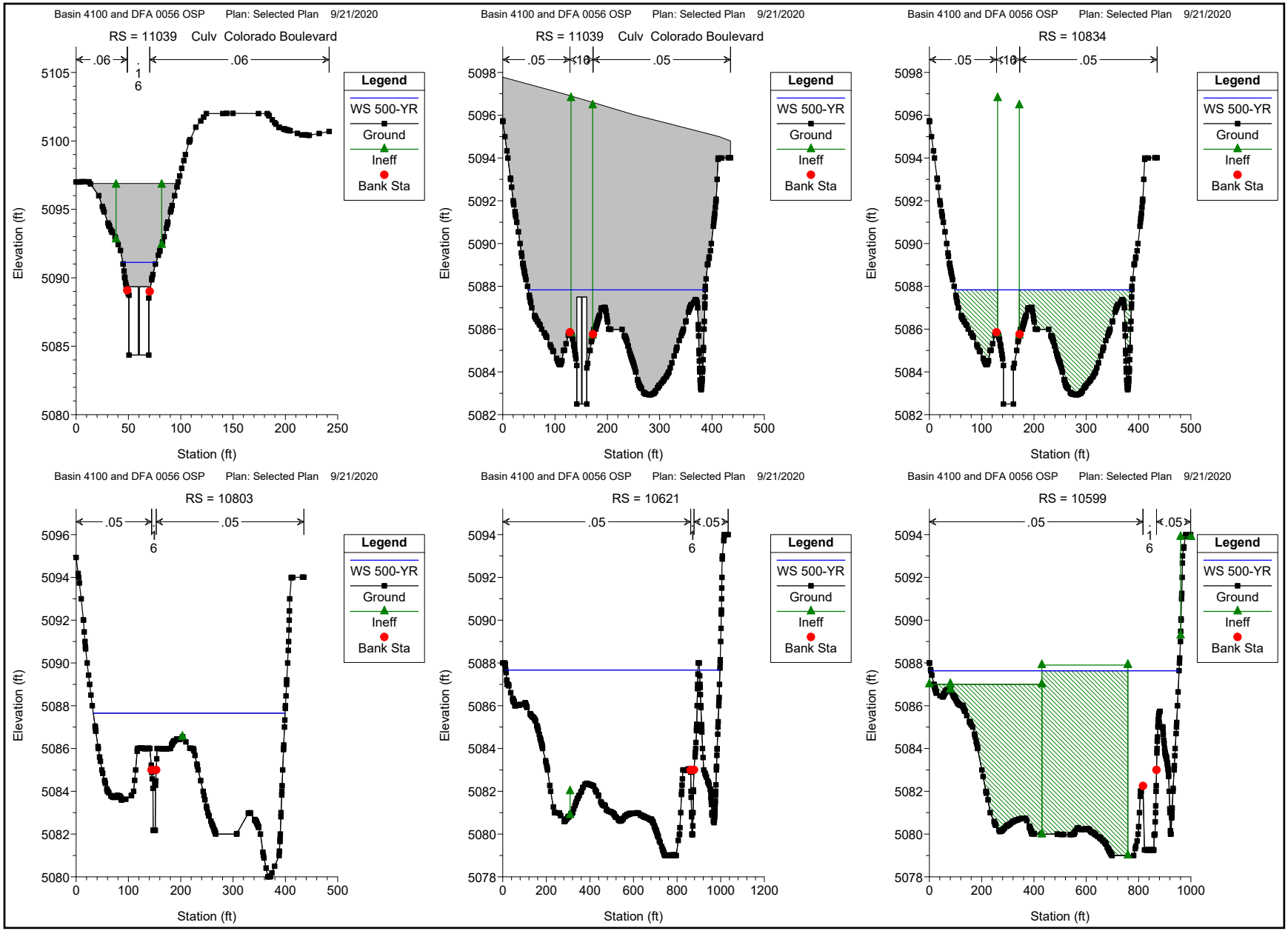
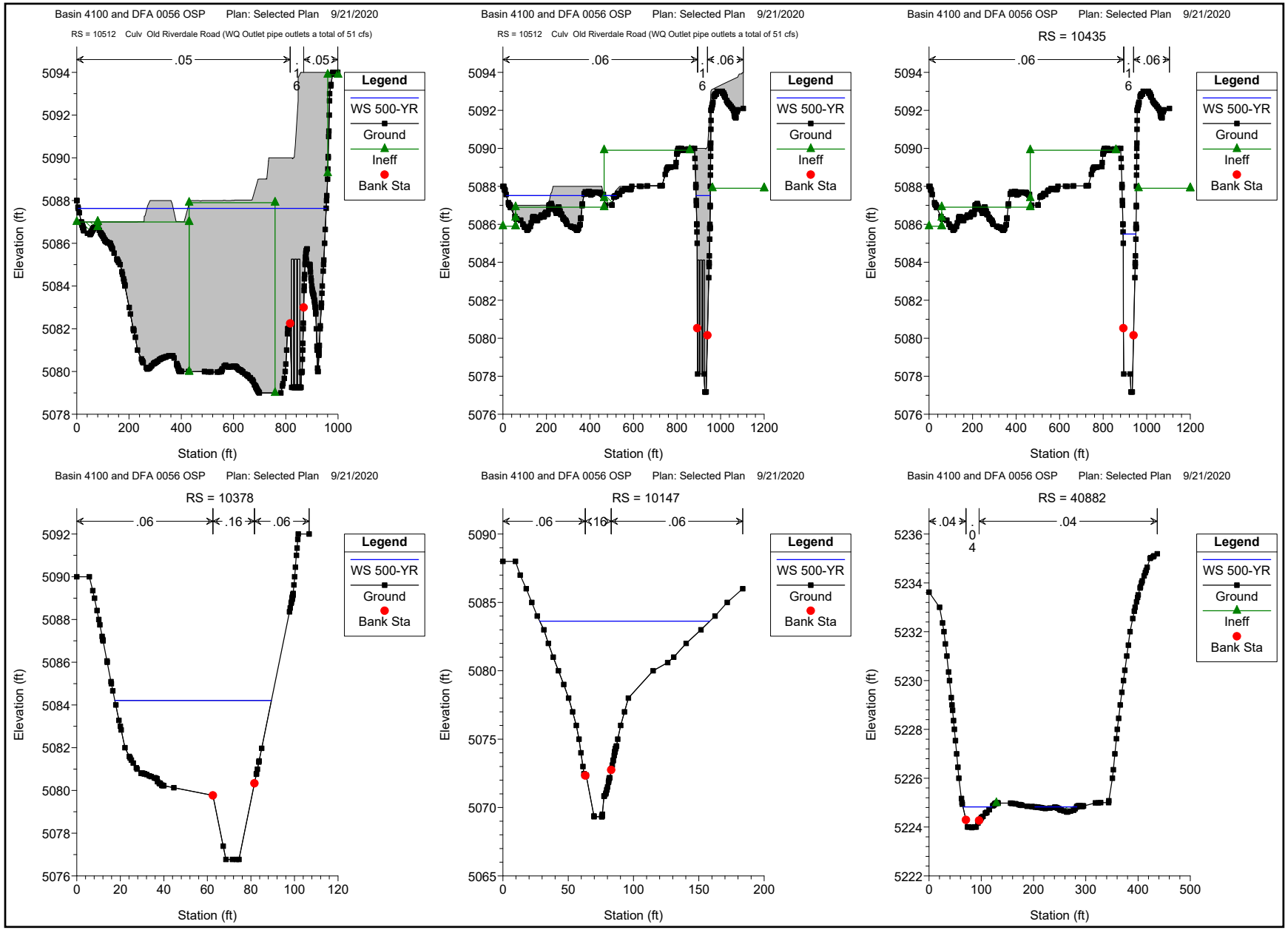
RS = 13600
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 13588

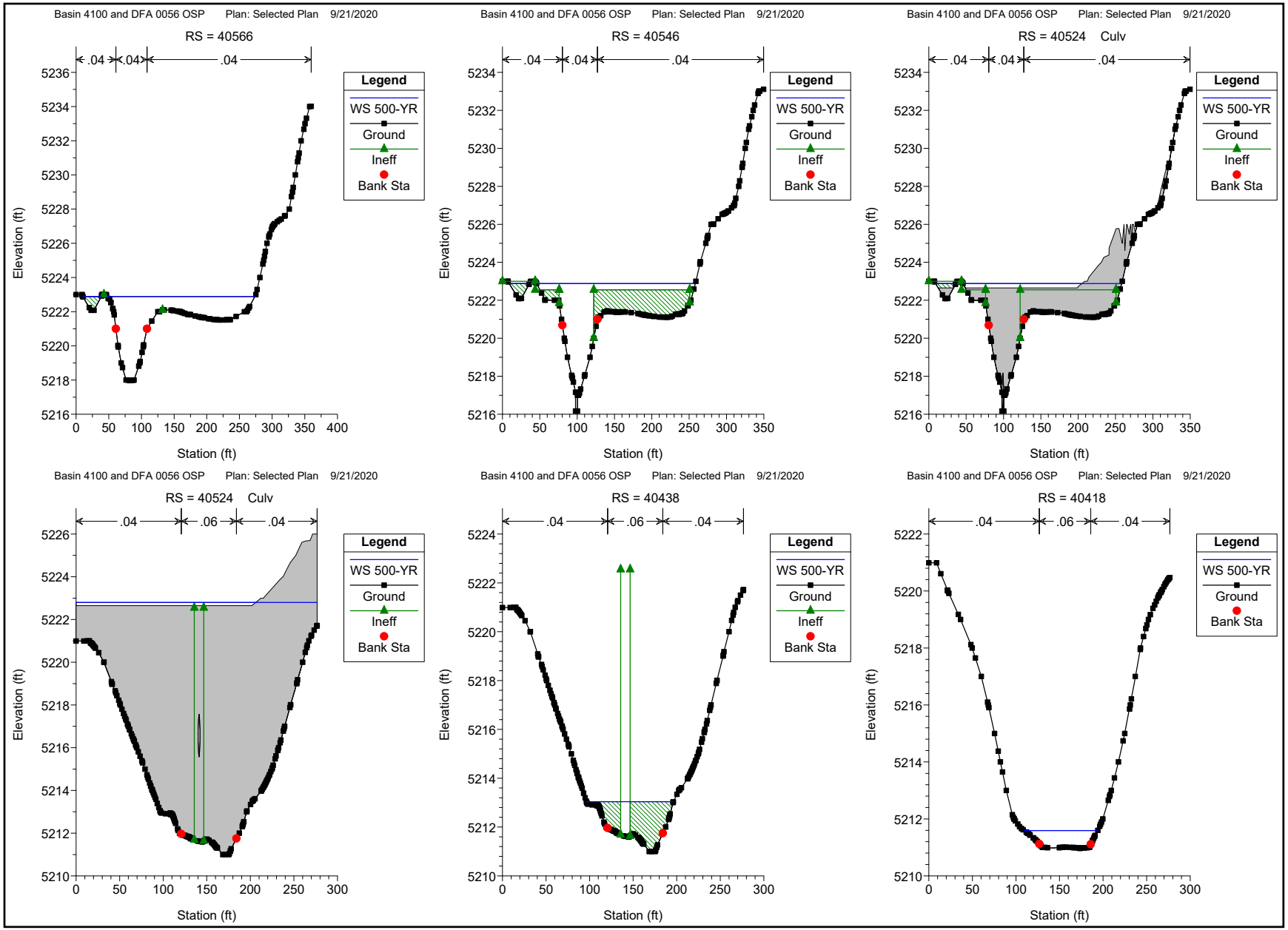

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 13510
.05
.05
0.07
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 13478
.05
.05
0.07
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 13472 Culv Lower Clear Creek Canal
.05
.05
0.07
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 13472 Culv Lower Clear Creek Canal
.06
.07
.06
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 13367
.06
.07
.06
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 13337
.06
.06
0.07
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

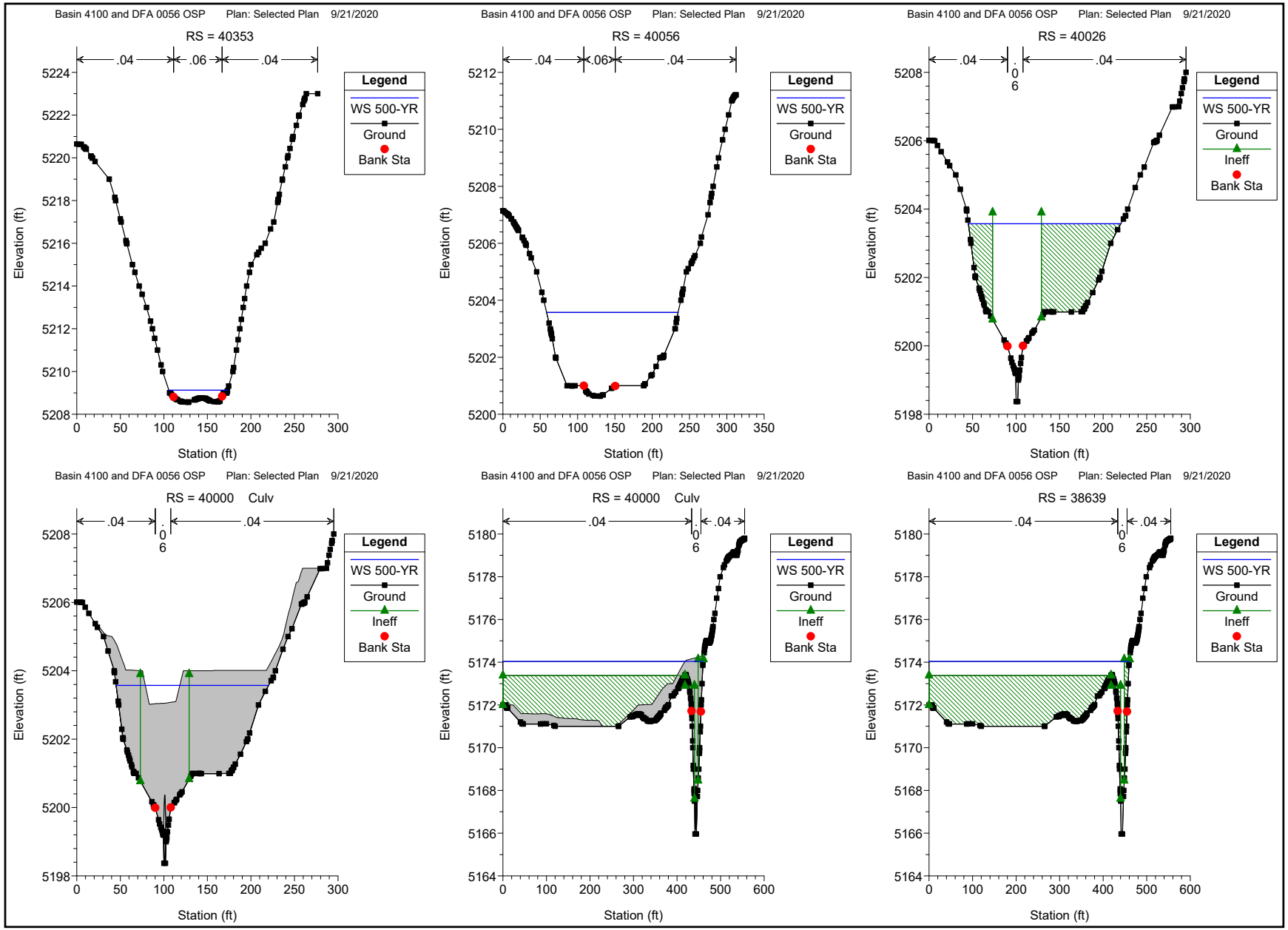

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 12821
.06
.16
.06
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 12221
.06
.16
.06
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 11964
.06
.16
.06
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 11912
.06
.16
.06
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 11321
.06
.16
.06
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 11277
.06
.16
.06
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

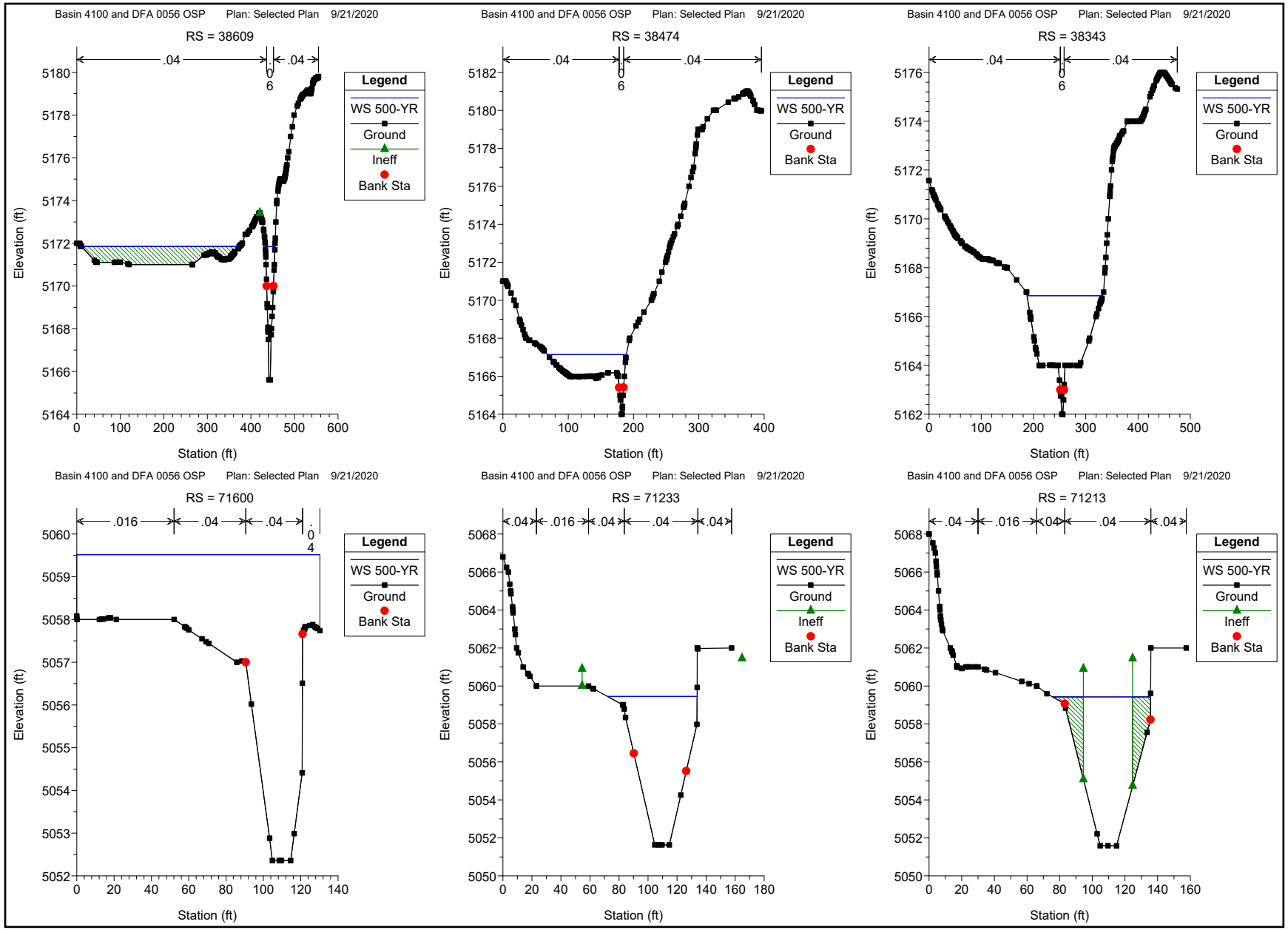

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 11260 Culv Cypress Drive
.06
.16
.06
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 11260 Culv Cypress Drive
.06
.16
.06
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 11158
.06
.16
.06
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 11128
.06
.16
.06
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 11071
.06
.16
.06
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 11051
.06
.16
.06
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

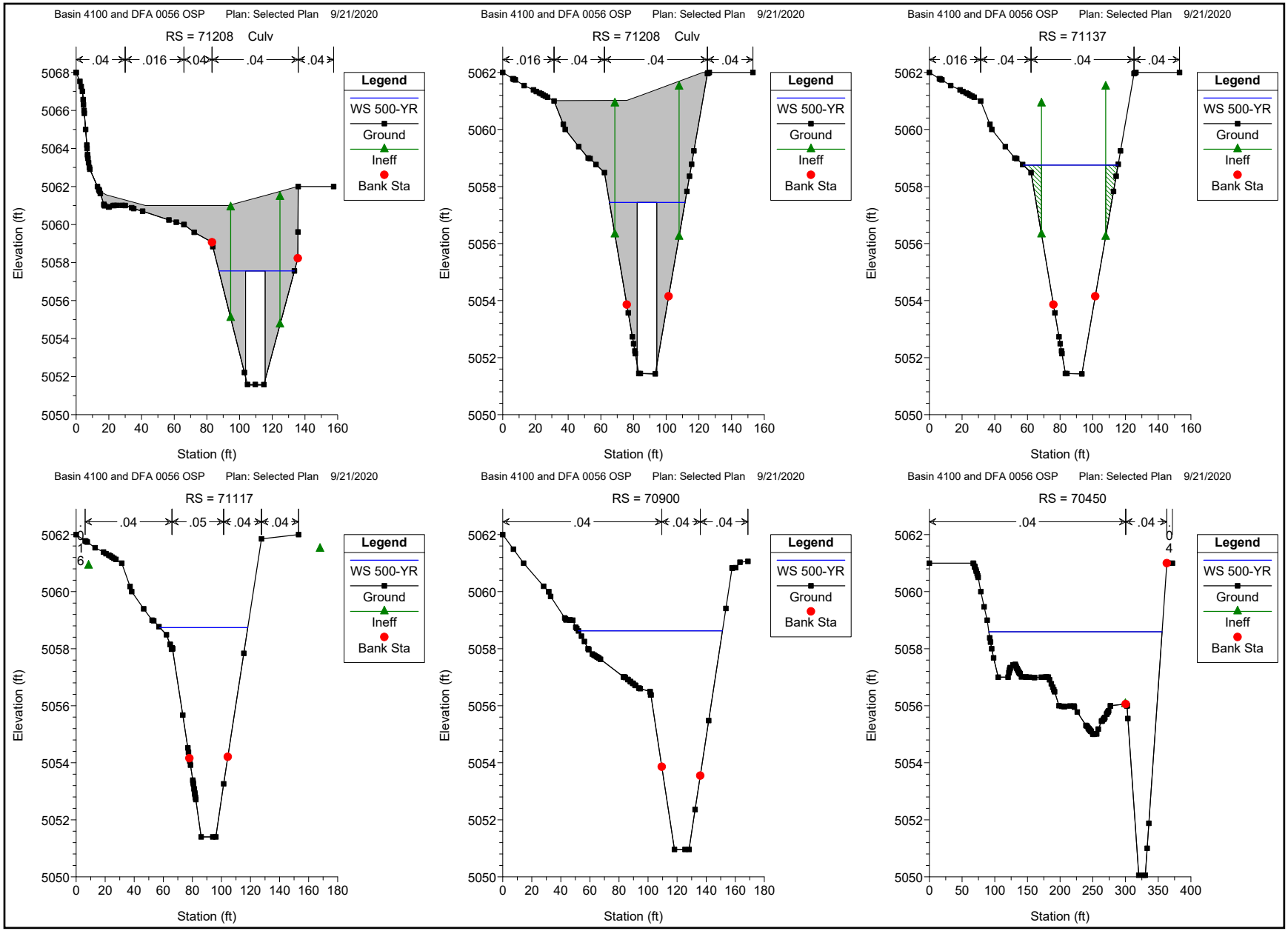

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 11039 Culv Colorado Boulevard
.06
.16
.06
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 11039 Culv Colorado Boulevard
.05
.10
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 10834
.05
.10
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 10803
.05
.16
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 10621
.05
.16
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 10599
.05
.16
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

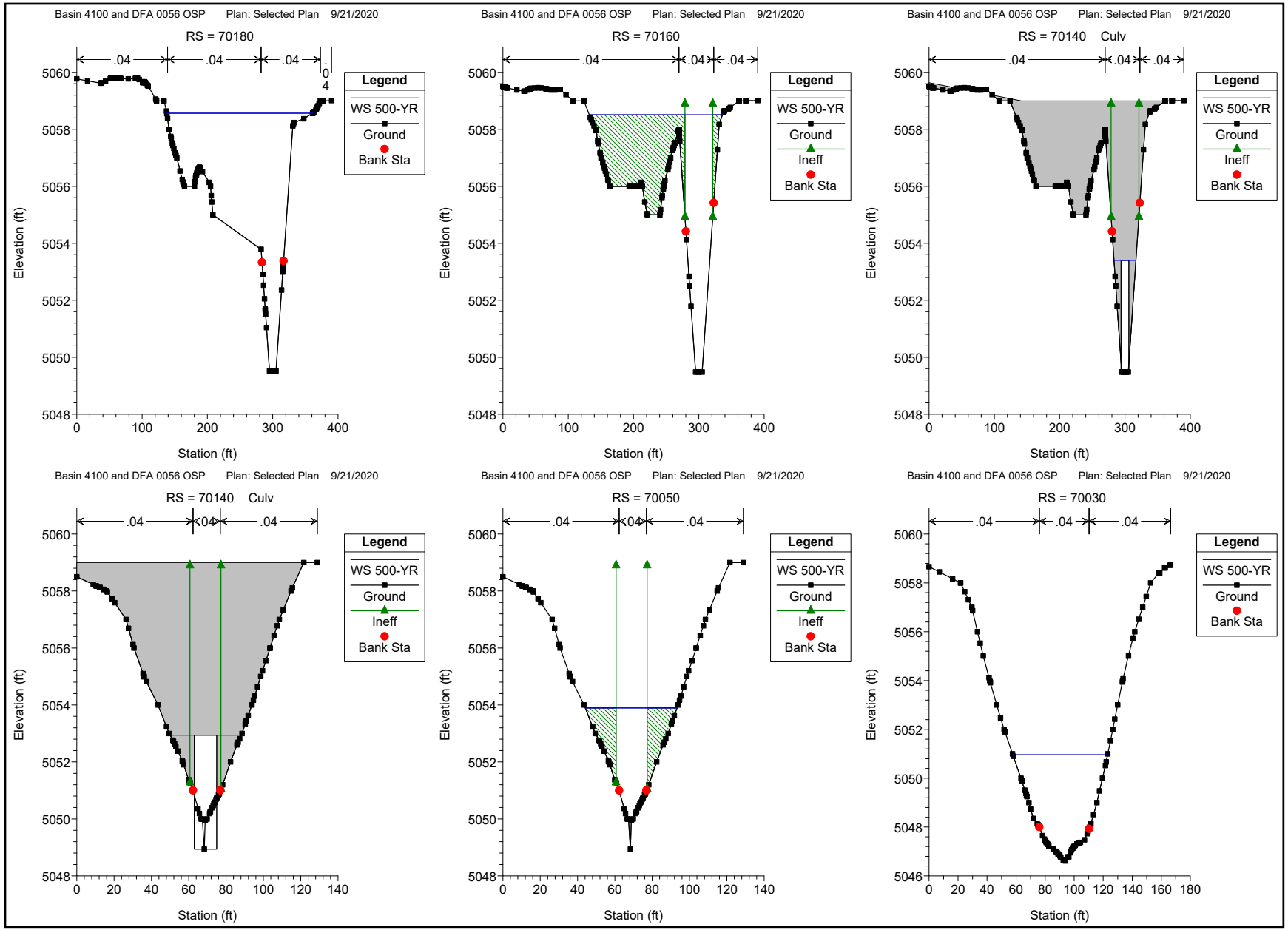

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 10512 Culv Old Riverdale Road (WQ Outlet pipe outlets a total of 51 cfs)
.05
.16
.05
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 10512 Culv Old Riverdale Road (WQ Outlet pipe outlets a total of 51 cfs)
.06
.16
.06
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 10435
.06
.16
.06
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 10378
.06
.16
.06
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 10147
.06
.16
.06
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 40882
.04
.04
.04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

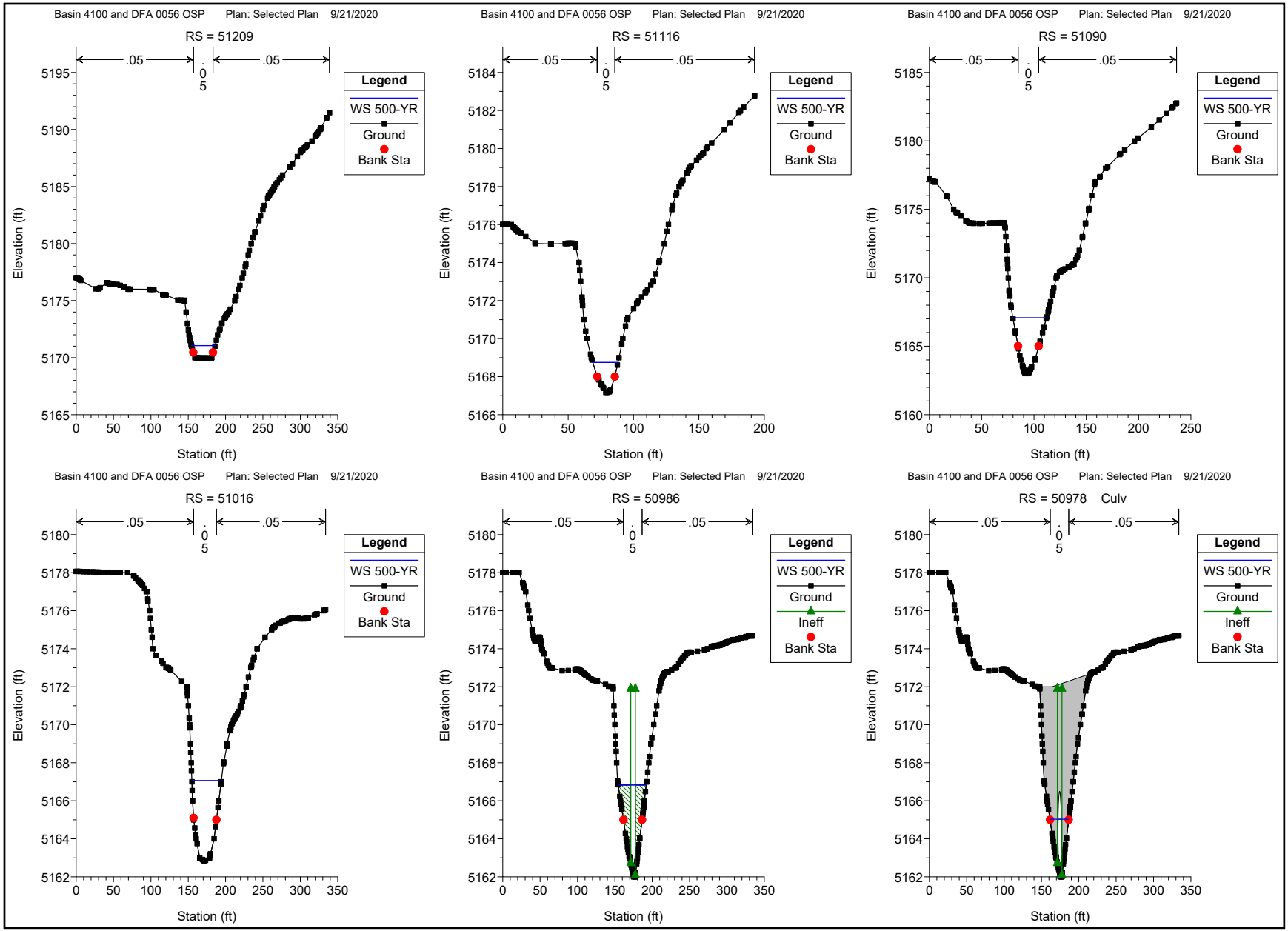

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 40566
.04 .04 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 40546
.04 .04 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 40524 Culv
.04 .04 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 40524 Culv
.04 .06 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 40438
.04 .06 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 40418
.04 .06 .04
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

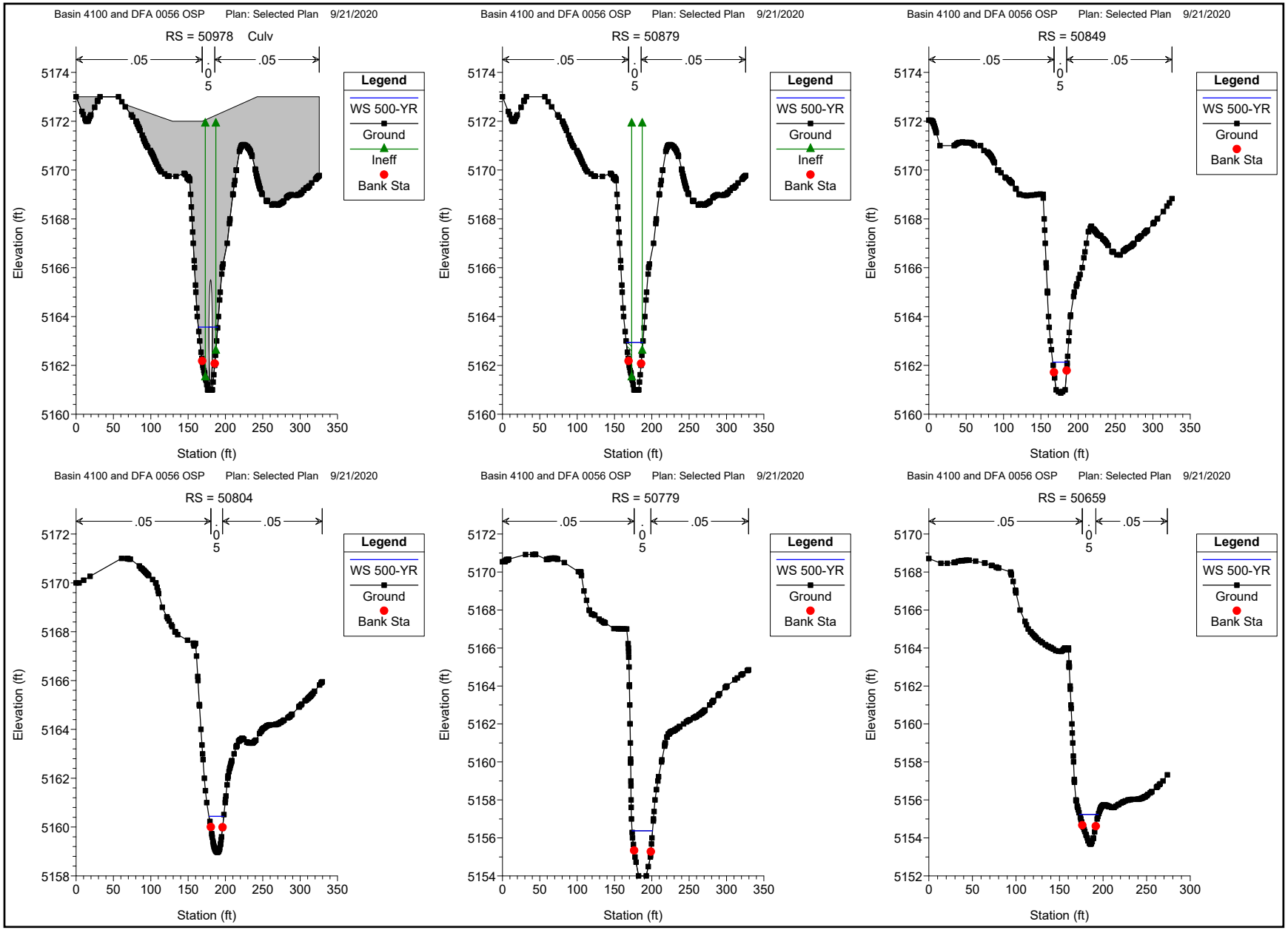

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 40353
.04
.06
.04
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 40056
.04
.06
.04
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 40026
.04
.04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 40000 Culv
.04
.04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 40000 Culv
.04
.04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 38639
.04
.04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

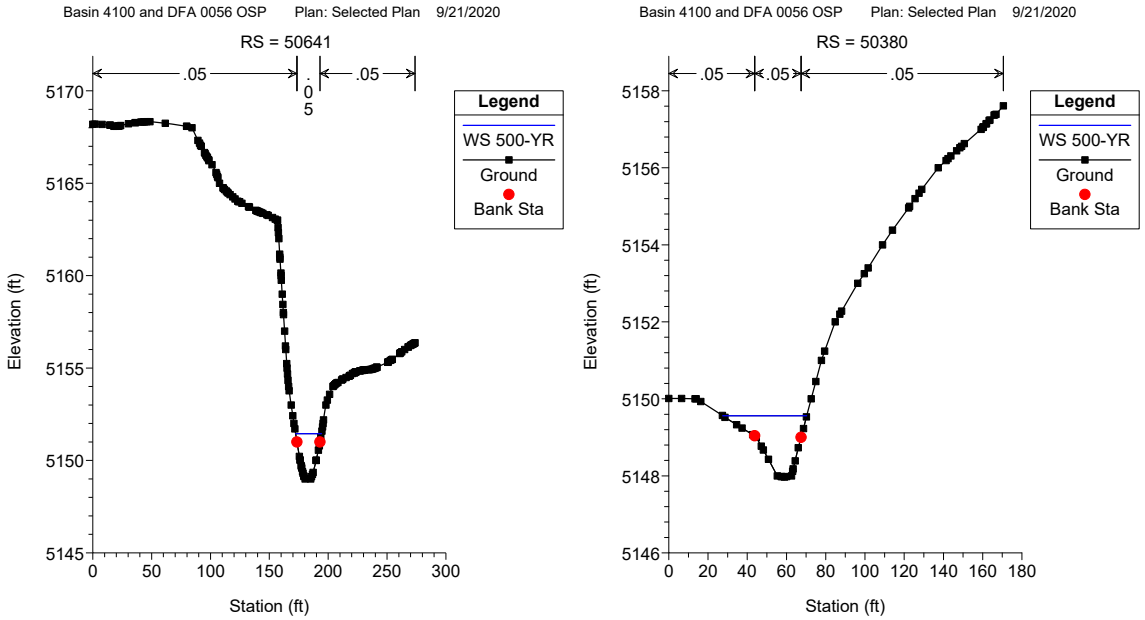

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 38609
.04
.04
.06
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 38474
.04
.04
.06
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 38343
.04
.04
.06
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 71600
.016
.04
.04
.04
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 71233
.04
.016
.04
.04
.04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 71213
.04
.016
.04
.04
.04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 71208 Culv
.04 .016 .04 .04 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 71208 Culv
.016 .04 .04 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 71137
.016 .04 .04 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 71117
.04 .05 .04 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 70900
.04 .04 .04
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 70450
.04 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 70180
.04 .04 .04 .04
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 70160
.04 .04 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 70140 Culv
.04 .04 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 70140 Culv
.04 .04 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 70050
.04 .04 .04
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 70030
.04 .04 .04
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

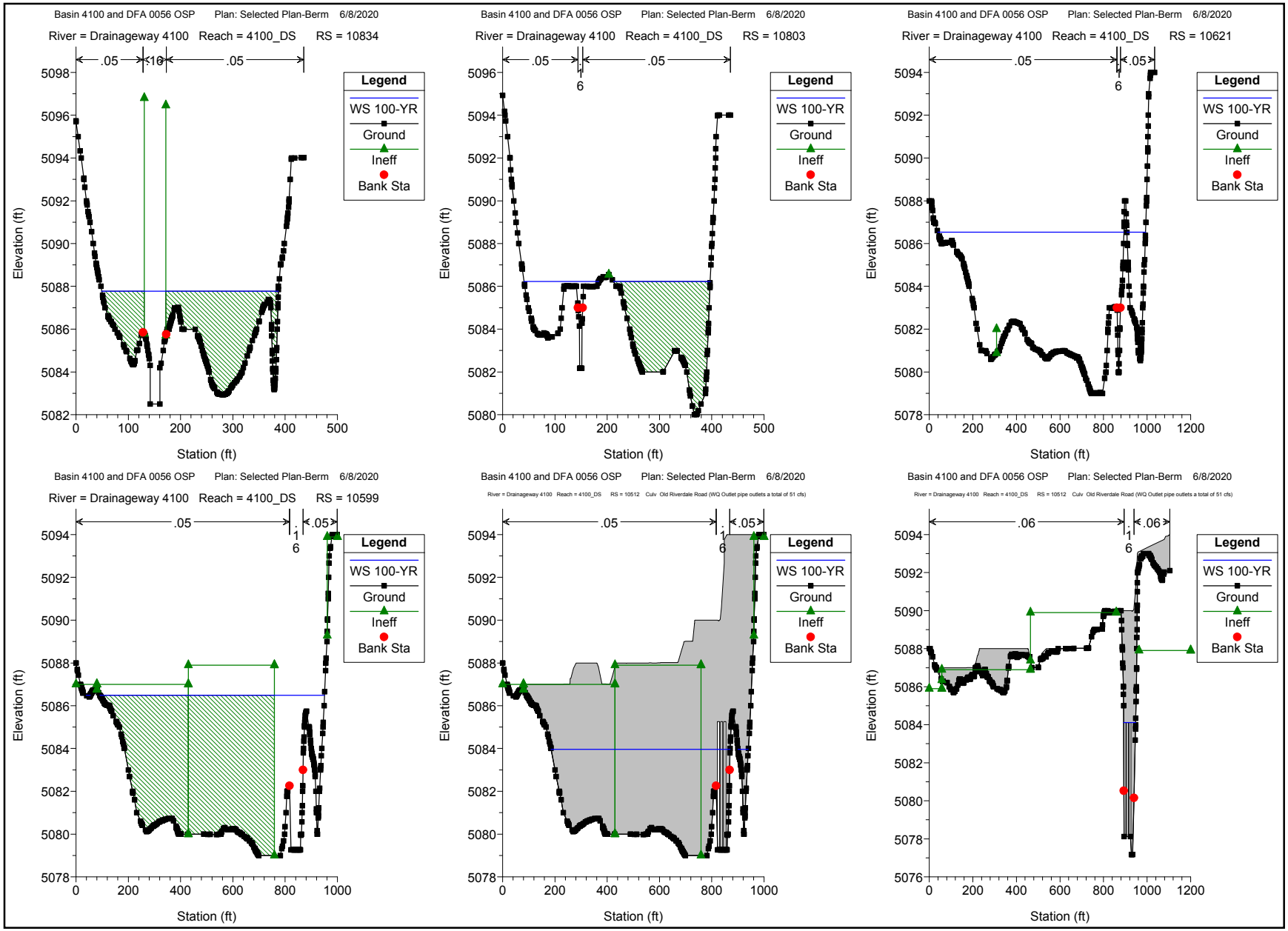

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 51209
.05
.05
.05
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 51116
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 51090
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 51016
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 50986
Ineff
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 50978 Culv
Ineff

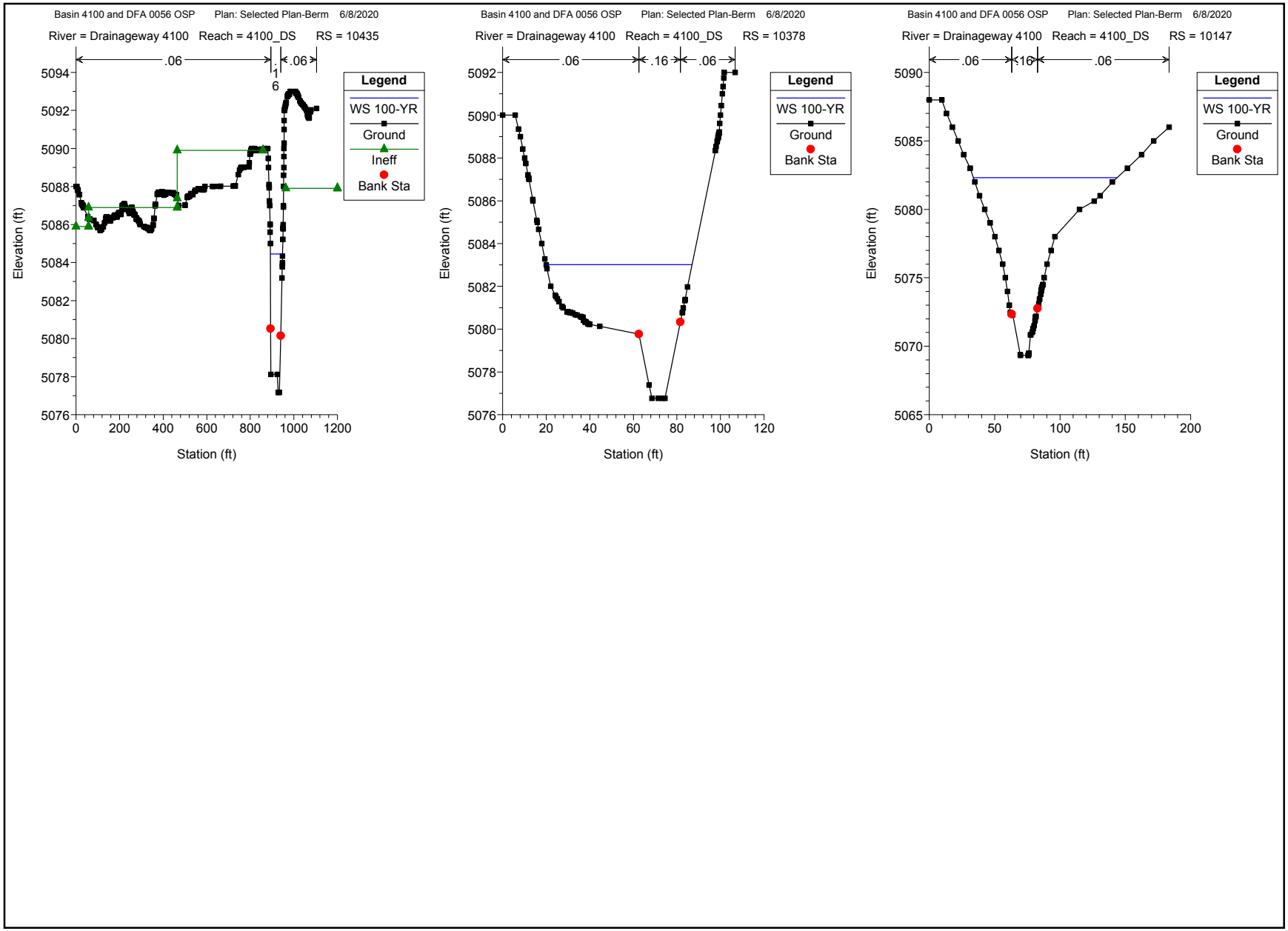

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 50978 Culv
.05
.05
.05
0
5
Legend
WS 500-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 50879
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 50849
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 50804
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 50779
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 50659

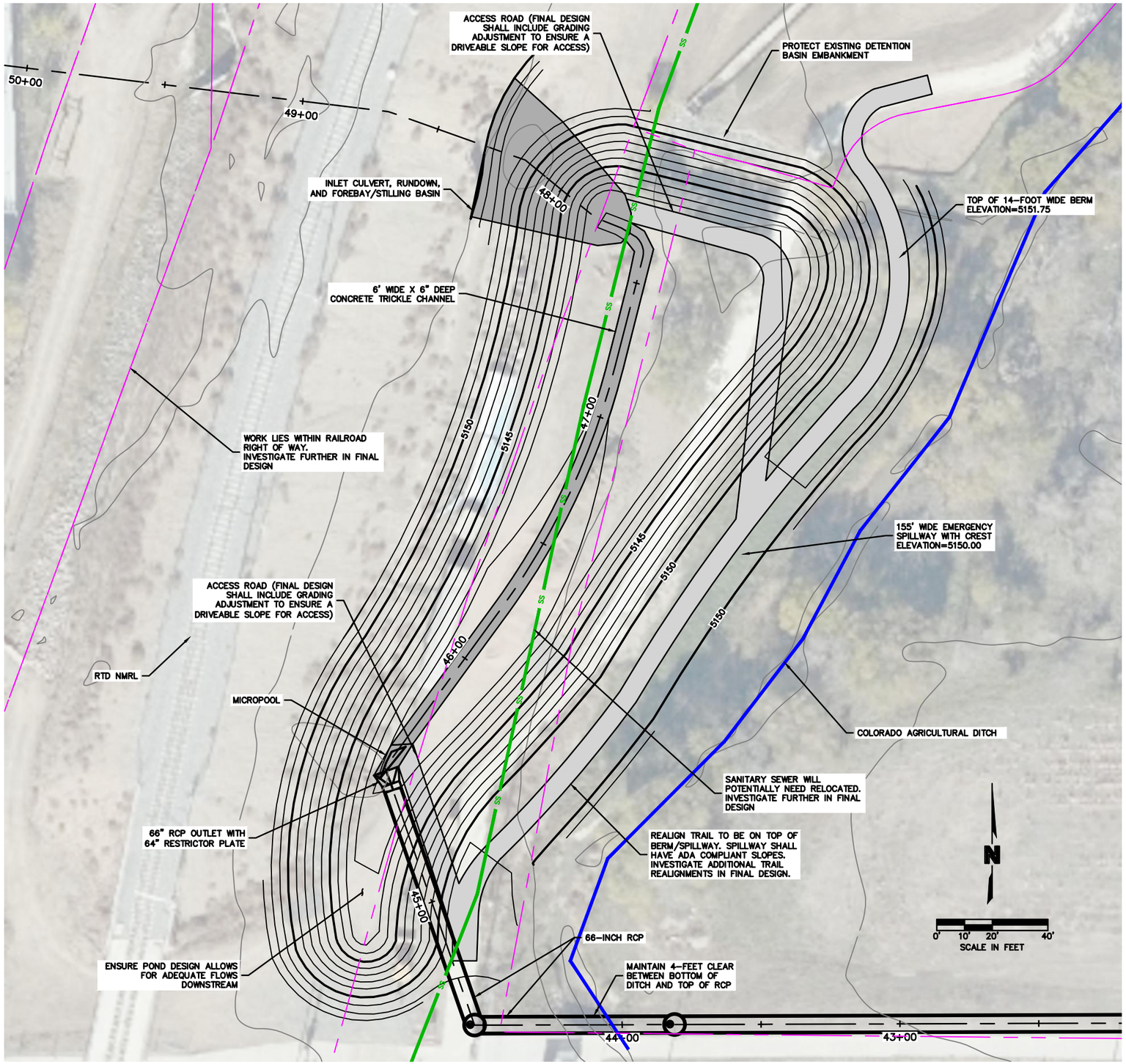

Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 50641
.05
.05
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan 9/21/2020
RS = 50380
.05
.05
.05
Legend
WS 500-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)

HEC-RAS Plan: SP_Berm River: Drainageway 4100 Reach: 4100_DS (Continued)

| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| 4100_DS | 11051 | 5-YR | 167.00 | 5084.35 | 5086.43 | 5085.68 | 5086.71 | 0.102189 | 4.23 | 39.44 | 19.00 | 0.52 |
| 4100_DS | 11051 | 10-YR | 236.00 | 5084.35 | 5086.79 | 5086.03 | 5087.20 | 0.123466 | 5.08 | 46.43 | 19.00 | 0.57 |
| 4100_DS | 11051 | 25-YR | 421.00 | 5084.35 | 5087.81 | 5086.83 | 5088.45 | 0.137135 | 6.40 | 65.79 | 19.00 | 0.61 |
| 4100_DS | 11051 | 50-YR | 541.00 | 5084.35 | 5088.50 | 5087.27 | 5089.23 | 0.133117 | 6.87 | 78.76 | 19.00 | 0.59 |
| 4100_DS | 11051 | 100-YR | 703.00 | 5084.35 | 5089.39 | 5087.83 | 5090.20 | 0.127463 | 7.23 | 97.42 | 23.23 | 0.60 |
| 4100_DS | 11051 | 500-YR | 1104.00 | 5084.35 | 5091.13 | 5089.23 | 5092.03 | 0.092713 | 7.65 | 144.73 | 31.61 | 0.54 |
| | | | | | | | | | | | | |
| 4100_DS | 11039 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | |
| 4100_DS | 10834 | 2-YR | 210.00 | 5082.50 | 5085.98 | | 5086.07 | 0.028454 | 2.42 | 86.80 | 227.10 | 0.29 |
| 4100_DS | 10834 | 5-YR | 323.00 | 5082.50 | 5086.38 | | 5086.53 | 0.037339 | 3.12 | 103.59 | 277.59 | 0.35 |
| 4100_DS | 10834 | 10-YR | 445.00 | 5082.50 | 5086.72 | | 5086.94 | 0.046704 | 3.79 | 117.39 | 295.00 | 0.40 |
| 4100_DS | 10834 | 25-YR | 783.00 | 5082.50 | 5087.32 | | 5087.79 | 0.075763 | 5.49 | 142.51 | 330.26 | 0.52 |
| 4100_DS | 10834 | 50-YR | 977.00 | 5082.50 | 5087.58 | | 5088.21 | 0.092209 | 6.37 | 153.44 | 336.22 | 0.58 |
| 4100_DS | 10834 | 100-YR | 1227.00 | 5082.50 | 5087.78 | | 5088.67 | 0.122905 | 7.60 | 161.39 | 337.91 | 0.68 |
| 4100_DS | 10834 | 500-YR | 1860.00 | 5082.50 | 5087.84 | 5087.84 | 5089.84 | 0.268466 | 11.35 | 163.86 | 338.43 | 1.01 |
| | | | | | | | | | | | | |
| 4100_DS | 10803 | 2-YR | 210.00 | 5082.18 | 5084.45 | 5084.45 | 5084.82 | 0.054199 | 2.33 | 46.88 | 218.32 | 0.31 |
| 4100_DS | 10803 | 5-YR | 323.00 | 5082.18 | 5084.72 | 5084.72 | 5085.18 | 0.045261 | 2.17 | 64.52 | 226.53 | 0.30 |
| 4100_DS | 10803 | 10-YR | 445.00 | 5082.18 | 5084.97 | 5084.97 | 5085.52 | 0.039986 | 2.10 | 82.17 | 234.14 | 0.28 |
| 4100_DS | 10803 | 25-YR | 783.00 | 5082.18 | 5085.52 | 5085.52 | 5086.25 | 0.032994 | 2.29 | 124.96 | 248.56 | 0.27 |
| 4100_DS | 10803 | 50-YR | 977.00 | 5082.18 | 5085.77 | 5085.77 | 5086.60 | 0.032203 | 2.43 | 145.51 | 255.02 | 0.27 |
| 4100_DS | 10803 | 100-YR | 1227.00 | 5082.18 | 5086.23 | 5086.23 | 5086.94 | 0.029897 | 2.62 | 197.55 | 328.07 | 0.27 |
| 4100_DS | 10803 | 500-YR | 1860.00 | 5082.18 | 5087.80 | 5086.56 | 5087.82 | 0.000326 | 0.36 | 1426.30 | 367.64 | 0.03 |
| | | | | | | | | | | | | |
| 4100_DS | 10621 | 2-YR | 210.00 | 5079.96 | 5081.61 | 5079.71 | 5081.61 | 0.000190 | 0.12 | 477.37 | 515.53 | 0.02 |
| 4100_DS | 10621 | 5-YR | 323.00 | 5079.96 | 5082.38 | 5079.93 | 5082.39 | 0.000073 | 0.10 | 979.38 | 656.07 | 0.01 |
| 4100_DS | 10621 | 10-YR | 445.00 | 5079.96 | 5083.09 | 5080.11 | 5083.09 | 0.000042 | 0.09 | 1459.77 | 733.15 | 0.01 |
| 4100_DS | 10621 | 25-YR | 783.00 | 5079.96 | 5084.65 | 5080.50 | 5084.66 | 0.000020 | 0.09 | 2654.63 | 792.75 | 0.01 |
| 4100_DS | 10621 | 50-YR | 977.00 | 5079.96 | 5085.23 | 5080.85 | 5085.23 | 0.000019 | 0.10 | 3116.46 | 815.05 | 0.01 |
| 4100_DS | 10621 | 100-YR | 1227.00 | 5079.96 | 5086.54 | 5081.07 | 5086.54 | 0.000013 | 0.10 | 4261.82 | 940.25 | 0.01 |
| 4100_DS | 10621 | 500-YR | 1860.00 | 5079.96 | 5087.81 | 5081.32 | 5087.81 | 0.000013 | 0.11 | 5483.84 | 978.65 | 0.01 |
| | | | | | | | | | | | | |
| 4100_DS | 10599 | 2-YR | 210.00 | 5079.26 | 5081.56 | 5079.98 | 5081.59 | 0.001028 | 0.47 | 206.82 | 640.34 | 0.06 |
| 4100_DS | 10599 | 5-YR | 323.00 | 5079.26 | 5082.35 | 5080.26 | 5082.38 | 0.000951 | 0.54 | 296.18 | 673.49 | 0.06 |
| 4100_DS | 10599 | 10-YR | 445.00 | 5079.26 | 5083.05 | 5080.49 | 5083.08 | 0.000762 | 0.56 | 386.76 | 692.27 | 0.05 |
| 4100_DS | 10599 | 25-YR | 783.00 | 5079.26 | 5084.61 | 5081.02 | 5084.65 | 0.000559 | 0.62 | 617.01 | 746.79 | 0.05 |
| 4100_DS | 10599 | 50-YR | 977.00 | 5079.26 | 5085.17 | 5081.28 | 5085.22 | 0.000568 | 0.67 | 711.61 | 774.50 | 0.05 |
| 4100_DS | 10599 | 100-YR | 1227.00 | 5079.26 | 5086.49 | 5081.59 | 5086.53 | 0.000370 | 0.63 | 956.37 | 874.89 | 0.04 |
| 4100_DS | 10599 | 500-YR | 1860.00 | 5079.26 | 5087.77 | 5082.26 | 5087.80 | 0.000684 | 0.96 | 1530.22 | 951.88 | 0.06 |
| | | | | | | | | | | | | |
| 4100_DS | 10512 | | Culvert | | | | | | | | | |
| | | | | | | | | | | | | |
| 4100_DS | 10435 | 2-YR | 210.00 | 5077.17 | 5081.28 | | 5081.31 | 0.004731 | 1.39 | 151.63 | 49.05 | 0.14 |
| 4100_DS | 10435 | 5-YR | 323.00 | 5077.17 | 5081.93 | | 5081.98 | 0.005924 | 1.76 | 184.20 | 50.48 | 0.16 |
| 4100_DS | 10435 | 10-YR | 445.00 | 5077.17 | 5082.48 | | 5082.55 | 0.007078 | 2.10 | 212.26 | 51.68 | 0.18 |
| 4100_DS | 10435 | 25-YR | 783.00 | 5077.17 | 5083.43 | | 5083.57 | 0.010988 | 2.98 | 262.30 | 53.77 | 0.23 |
| 4100_DS | 10435 | 50-YR | 977.00 | 5077.17 | 5083.89 | | 5084.07 | 0.012739 | 3.38 | 287.16 | 54.80 | 0.25 |
| 4100_DS | 10435 | 100-YR | 1227.00 | 5077.17 | 5084.45 | | 5084.68 | 0.014401 | 3.82 | 318.09 | 56.03 | 0.27 |
| 4100_DS | 10435 | 500-YR | 1860.00 | 5077.17 | 5085.68 | | 5086.05 | 0.017199 | 4.70 | 389.25 | 59.77 | 0.30 |
| | | | | | | | | | | | | |
| 4100_DS | 10378 | 2-YR | 210.00 | 5076.77 | 5079.29 | 5079.29 | 5080.18 | 0.348223 | 7.54 | 27.87 | 16.09 | 1.01 |
| 4100_DS | 10378 | 5-YR | 323.00 | 5076.77 | 5080.33 | 5080.33 | 5080.90 | 0.152541 | 6.22 | 54.10 | 43.58 | 0.70 |
| 4100_DS | 10378 | 10-YR | 445.00 | 5076.77 | 5080.59 | 5080.59 | 5081.31 | 0.161632 | 6.85 | 65.70 | 46.52 | 0.74 |
| 4100_DS | 10378 | 25-YR | 783.00 | 5076.77 | 5081.70 | | 5082.34 | 0.059579 | 5.24 | 127.63 | 60.79 | 0.47 |
| 4100_DS | 10378 | 50-YR | 977.00 | 5076.77 | 5082.33 | | 5082.95 | 0.037007 | 4.57 | 167.01 | 64.20 | 0.38 |
| 4100_DS | 10378 | 100-YR | 1227.00 | 5076.77 | 5083.02 | | 5083.65 | 0.025806 | 4.20 | 212.05 | 67.03 | 0.33 |
| 4100_DS | 10378 | 500-YR | 1860.00 | 5076.77 | 5084.43 | | 5085.13 | 0.016608 | 3.97 | 310.91 | 72.81 | 0.27 |
| | | | | | | | | | | | | |
| 4100_DS | 10147 | 2-YR | 210.00 | 5069.33 | 5076.66 | 5071.94 | 5076.68 | 0.001902 | 1.28 | 156.00 | 37.75 | 0.09 |
| 4100_DS | 10147 | 5-YR | 323.00 | 5069.33 | 5077.88 | 5072.62 | 5077.92 | 0.001902 | 1.44 | 206.71 | 45.06 | 0.09 |
| 4100_DS | 10147 | 10-YR | 445.00 | 5069.33 | 5078.96 | 5073.12 | 5079.00 | 0.001901 | 1.58 | 261.95 | 58.40 | 0.10 |
| 4100_DS | 10147 | 25-YR | 783.00 | 5069.33 | 5080.85 | 5074.25 | 5080.91 | 0.001901 | 1.81 | 399.53 | 89.92 | 0.10 |
| 4100_DS | 10147 | 50-YR | 977.00 | 5069.33 | 5081.55 | 5074.80 | 5081.62 | 0.001903 | 1.89 | 466.18 | 99.50 | 0.10 |
| 4100_DS | 10147 | 100-YR | 1227.00 | 5069.33 | 5082.32 | 5075.40 | 5082.40 | 0.001902 | 1.98 | 546.60 | 110.14 | 0.10 |
| 4100_DS | 10147 | 500-YR | 1860.00 | 5069.33 | 5083.87 | 5076.76 | 5083.97 | 0.001902 | 2.15 | 735.59 | 133.99 | 0.10 |


Basin 4100 and DFA 0056 OSP Plan: Selected Plan-Berm 6/8/2020
River = Drainageway 4100 Reach = 4100_DS RS = 10834
.05 .10 .05
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan-Berm 6/8/2020
River = Drainageway 4100 Reach = 4100_DS RS = 10803
.05 .05
6
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan-Berm 6/8/2020
River = Drainageway 4100 Reach = 4100_DS RS = 10621
.05 .05
6
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan-Berm 6/8/2020
River = Drainageway 4100 Reach = 4100_DS RS = 10599
.05 .05
6
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan-Berm 6/8/2020
River = Drainageway 4100 Reach = 4100_DS RS = 10512 Culv Old Riverdale Road (WQ Outlet pipe outlets a total of 51 cfs)
.05 .05
6
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan-Berm 6/8/2020
River = Drainageway 4100 Reach = 4100_DS RS = 10512 Culv Old Riverdale Road (WQ Outlet pipe outlets a total of 51 cfs)
.06 .06
6
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Basin 4100 and DFA 0056 OSP Plan: Selected Plan-Berm 6/8/2020
River = Drainageway 4100 Reach = 4100_DS RS = 10435
.06
.1
.06
6
Legend
WS 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan-Berm 6/8/2020
River = Drainageway 4100 Reach = 4100_DS RS = 10378
.06
.16
.06
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Basin 4100 and DFA 0056 OSP Plan: Selected Plan-Berm 6/8/2020
River = Drainageway 4100 Reach = 4100_DS RS = 10147
.06
.16
.06
Legend
WS 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)




# CONCEPTUAL DESIGN

BASIN 4100
SCHOOL TRIBUTARY - SELECTED
PLAN DETENTION BASIN

MILE HIGH FLOOD DISTRICT

olsson

1525 Raleigh Street
Suite 400
Denver, CO 80204
TEL 303.237.2072
FAX 303.237.2659

ADAMS COUNTY COLORADO

City of Thornton

PROPOSED SCHOOL TRIBUTARY DETENTION BASIN

$Q_{100,IN}$=319 CUBIC FEET PER SECOND (CFS)

$Q_{100,OUT}$=288 CFS

$V_{100}$=3.69 ACRE-FEET

100-YEAR WATER SURFACE ELEVATION=5149.84

100-YEAR DEPTH=9.84 FEET

THE PURPOSE OF THIS DETENTION BASIN IS TO REDUCE THE 100-YEAR PEAK FLOWS TO THE CAPACITY OF THE DOWNSTREAM EXISTING STORM DRAIN SYSTEM AT MONROE STREET. THIS SYSTEM HAS A CAPACITY OF 460 CFS (DESIGN POINT 101). THE FINAL DESIGN VOLUME, RELEASE RATE, AND DRAIN TIME FROM THE DETENTION BASIN MAY VARY FROM THIS CONCEPTUAL DESIGN. IT IS RECOMMENDED TO INCORPORATE THE DETENTION BASIN FINAL DESIGN INTO THE EPA SWMM 5.1.012 MODEL TO ENSURE THAT THE FINAL DESIGN RESULTS IN PEAK FLOWS EQUAL TO OR LESS THAN 460 CFS AT DESIGN POINT 101.

# APPENDIX G

# MASTER PLAN MAPS AND PROFILES

CLICK HERE TO VIEW FULL SIZED MAPS
CLICK HERE TO VIEW FULL SIZED PROFILES

CLICK HERE TO VIEW PRESET 11X17 PRINTABLE MAPS
CLICK HERE TO VIEW PRESET 11X17 PRINTABLE PROFILES