Comprehensive Drainage Plan
Oklahoma & South Basins
Concept Design Report

October 2023

Sponsor: City of Greeley Colorado

Consultant: Matrix

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October 10, 2023

Mr. Brian Fischer, PE
Project Manager
City of Greeley Public Works
2835 West 10th Street
Greeley, Colorado 80634

RE: Comprehensive Drainage Plan Oklahoma & South Basins
Agreement No. FW21-11-181
Concept Design Report Final

Dear Mr. Fisher:

Matrix Design Group, Inc. is pleased to submit the enclosed *Concept Design Report* for the Greeley Oklahoma & South Basins. The analysis in this report follows the previously submitted *Alternatives Analysis Report* and *Baseline Hydrology Report*. City of Greeley comments on the *Concept Design Report Draft* , received October 3, 2023, have been addressed – the full comment response documented is attached and a summary of responses included in Appendix A for your reference.

The report format and submittal are intended to follow the requirements of the City of Greeley Master Plan Procedures / Preparation Guide (2021), but there have also been efforts to include similar information to what would normally comprise a Mile High Flood District Major Drainageway Planning study. The template checklist for this *Concept Design Report* is attached.

This report provides a description of the watershed, updated hydrologic and hydraulic modeling, updated flows and velocities and detailed recommendations revolving around Low Impact Development (LID) practices. With historical rain events and flood occurring more frequently, the importance of stabilizing drainageways to reduce flood hazards, improve of water quality, and reduce aggradation and degradation from channel instability becomes more important with the increase of urban development.

We appreciate the opportunity to provide an evaluation of the proposed improvements and recommendations for management of these drainageways. Reducing the city's risk of long-term urbanized flooding is essential in protecting the health and safety of the public and in providing a higher quality of life for its residents.

Sincerely,
Matrix Design Group, Inc.

Drew Beck, PE
Officer In Charge

Benjamin Liu, PE
Project Manager

EXECUTIVE SUMMARY

This study creates a master plan framework for two drainage basins in the City of Greeley: the Oklahoma & South Basins. Recommendations are provided on how the City of Greeley can protect their water quality and preserve floodplains and natural channels to reduce future flood risks. Conceptual drainage improvements, LID practices, and expected costs are included to help guide capital planning.

An environmental investigation to determine areas of ecological significance within the City of Greeley was included in the *2060 Comprehensive Plan*. Those results showed the South Basin has moderate ecological significance, meaning it contains significant natural features which will be impacted negatively by new development in the watershed. Two public meetings were also held, one occurring in June 2022 and another occurring in November 2022. Neither meeting received significant public comments.

Updated hydrologic information on both existing and future conditions in the Oklahoma & South Basins was collected and synthesized. Three hydrologic models were developed:

1. Baseline Hydrology for existing conditions;
2. Baseline Hydrology for future full-developed conditions;
3. Master Plan Hydrology with future runoff reduction (to match undeveloped release rates).

It was decided to split the two basins into their main contributing major drainageways due to the large size of the watersheds. Major drainageways have been defined as natural runoff collection reaches that include more than 130 acres of contributing area. The South Basin is comprised of a single major drainageway 100. The Oklahoma Basin is comprised of major drainageways 200, 300, 500, 600, and 800. Each major drainageway was further divided into smaller subbasins for hydrologic calculations.

Using the Colorado Urban Hydrograph Procedure (CUHP), runoff was calculated for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storm events in both existing conditions and future conditions. Major drainageways 100 and 200 are significantly larger and have higher peak flows than the other major drainageways. Results from this study were compared to peak flows documented in the *Town of Windsor Master Drainage Plan (2003)*: some 100-year results were higher and some lower, reflecting different land use assumptions.

The Environmental Protection Agency Storm Water Management Model (EPA SWMM) was used to combine and route hydrographs created from CUHP. Runoff peak flows and volumes for existing and future conditions were calculated. Routed results showed that future conditions peak flows will be significantly higher than existing conditions peak flows, which has the potential to cause hazardous flooding and major damage to structures. Field observations and survey indicated that existing culverts and channels along these drainageways are not capable of dealing with future conditions floods.

An alternative analysis with four broad alternatives was created by the Matrix team to provide recommendations that the City of Greeley could use in preparation for future development. The four alternatives are:

1. No Action: Showing what structures and reaches are likely to fail and which are likely to be stable without any capital improvements.
2. Detention: Showing the results of proposed regional detention basins to reduce runoff.
3. Channel improvements: Showing the results of proposed channel improvements to improve the stability of the reaches.
4. Low Impact Development: Showing the results of Low Impact Development (LID) to reduce runoff.

Various combinations of these broad alternatives were developed and tested for each major drainageway's unique needs. The options were scored in eight criteria: constructability, maintenance, meeting multiple objectives, water quality, public safety, habitat and environment, aesthetics, and criteria compliance. In general, the alternatives that featured runoff reduction such as detention and LID scored higher than other alternatives in aggregate.

After evaluating the various alternatives, the City of Greeley selected Option 4: LID for all major drainageways within the Oklahoma & South Basins. Note that Option 4 focuses on green infrastructure but also includes detention and channel improvements to meet the study goals. This alternative was developed into the Conceptual Design/Master Plan improvements. Three main Goals were identified during the creation of the Master Plan:

Goal #1 – Implement LID effectively;

Goal #2 – Implement stormwater detention effectively;

Goal #3 – Implement channel improvements effectively.

For Goal #1, all new developments within the study area should implement LID practices that intercept and treat runoff from new impervious surfaces. Depending on the desired function, use, and aesthetics, multiple types of LID could be used. LID elements that are regionally accepted and recommended for use within the Oklahoma and South Basins are shown in the table below:

Lid Types	
Vegetated buffer	Green roof
Vegetated swale	Green alley
Curb cut / No-Curb	Permeable pavement
Trench drain	Greenway corridor
Bioretention - rain garden	Sand filter
Bioretention - porous landscape design	Tree filter
Rain barrel	Retention ponds/constructed wetland ponds

LIDs have minor impacts on peak flows during large storm events. For Goal #2, both regional flood detention facilities and sub-regional Excess Urban Runoff Volume (EURV) basins are proposed to reduce the peak flows and volumes for future land use conditions. Tables summarizing the required volume and surface areas of these basins are shown below:

Flood Control Pond No.	Volume (ac-ft)	Area (ac)
D134	5.4	1.1
D150	4.0	0.8
D245	10.3	1.8
D263	6.6	1.1
D510	7.5	1.3
D618	6.8	1.3
D814	2.4	0.6

EURV Basin No.	Volume (ac-ft)	Area (ac)
D121	6.2	4.0
D134	11.2	6.0
D146	1.1	0.6
D150	7.2	4.2
D225	6.3	4.1
D236	2.1	1.2
D244	5.9	3.5
D245	18.8	10.9
D256	5.0	3.2
D263	9.8	5.0
D510	12.8	7.6
D614	6.6	4.2
D618	14.2	7.1
D810	5.8	3.1
D814	28.5	10.1

These detention facilities, together with distributed LID, reduce future peak flows and volumes across the watersheds to similar levels as pre-development conditions. A comparison of the 100-year peak flows at each major drainageway outfall is provided below:

Major Drainageway	Drainage Area (ac)	Existing Conditions Q_{100} (cfs)	Future Conditions Do Nothing Q_{100} (cfs)	Concept Design Q_{100} (cfs)
100	755	1,042	1,446	990
200	1,058	1,401	2,273	1,208
300	157	258	270	267
500	292	386	613	336
600	363	525	955	481
800	274	369	848	362

For Goal #3, it is important to remember that channel improvements can range from small to large scale designs. Instead of focusing solely on the conveyance channel, proposed stream corridors must be designed to promote and incorporate natural system processes. The future major drainageways should feature multiple stages to serve multiple storm events, similar to existing natural channels. Each major drainageway was split up into reaches of similar character, with reaches generally numbered from downstream to upstream (e.g. Major Drainageway 600 is made up of Reaches 600, 614, and 618). The length and top width of the proposed stream corridors are presented in the table below:

Reach No.	Reach Length (LF)	Stream Corridor Top Width (ft)
134	2,426	108
150	1,625	101
118	1,087	114
142	1,479	101
100	3,260	146
260	2,456	62
244	4,101	130
239	288	165
241	1,092	126
232	3,274	213
224	1,810	111
200	2,511	170
500	3,358	69
618	1,661	123
614	2,214	97
600	3,459	120
800	190	63

Existing drainageway crossings occur at roadways and railroads. Each crossing location was examined, and culvert calculations performed to determine the existing performance. Only one existing crossing structure will be sufficient for future flow conditions. The concept culverts in the table below were sized to safely convey 100-year flows, but note that final designs should follow geomorphic practices where multiple barrels include floodplain relief culverts that are higher than the primary low-flow culvert:

Structure No.	Concept Design Q_{100} (cfs)	Structure Size/Type
101	990	3 -12'x4' CBC
102	990	keep existing
103	249	1 - 6'x5' CBC
104	209	1 - 6'x5' CBC
201	1,208	2 - 8'x6' CBC
202	157	2 - 4'x3' CBC
203	157	2 - 4'x3' CBC
301	267	1 - 8'x4' CBC
501	336	2 - 8'x5' CBC
601	481	2 - 8'x4' CBC
602	481	1 - 8'x6' CBC
603	234	1 -6'x5' CBC
801	362	1 - 9'x5' CBC

Estimated Master Plan costs were calculated using the MHFD UD-MP worksheets. These calculations reflect the expected costs for the City of Greeley, additional distributed costs such as LID are expected to be borne by developers or metro districts. Summaries of each major drainageway are provided below.

Major Drainageway 100 within the South Basin is split into five reaches comprising two significant tributaries and the main stem. There are four culverts; only three need improvements. The capital cost for the Master Plan improvements is estimated to be $4,250,458 while the cost of maintenance and operation for 50 years is estimated at $1,402,900.

Major Drainageway 200 within the Oklahoma Basin is split into seven reaches comprising three significant tributaries and the main stem. There are three culverts that need improvements. The capital cost for the Master Plan improvements is estimated to be $4,442,663 while the cost of maintenance and operation for 50 years is estimated to be $2,069,700.

Major Drainageway 300 within the Oklahoma Basin consists of only one reach. The existing channel is in stable condition and channel improvements for this drainageway are not needed. There is one culvert that needs improvements. The capital cost for the Master Plan improvements is estimated to be $659,947 while the cost of maintenance and operation for 50 years is estimated to be $8,800.

Major Drainageway 500 within the Oklahoma Basin also consists of only one reach. While hydraulic analysis shows that the existing channel conditions are stable, channel improvements will be necessary with new development. There is one culvert that needs improvements. The capital cost for the Master Plan improvements is estimated to be $1,444,700 while the cost of maintenance and operation for 50 years is estimated to be $134,050.

Major Drainageway 600 within the Oklahoma Basin is split into three reaches. While hydraulic analysis shows that the existing channel conditions are stable, channel improvements will be necessary with new development. There are three culverts that need improvements. The capital cost for the Master Plan improvements is estimated to be $2,373,880 while the cost of maintenance and operation for 50 years is estimated to be $485,600.

Major Drainageway 800 within the Oklahoma Basin only comprises one reach. While hydraulic analysis shows that the existing channel conditions are stable, channel improvements will be necessary with new development. There is one culvert that needs improvements. The capital cost for the Master Plan improvements is estimated to be $446,757 while the cost of maintenance and operation for 50 years is estimated to be $82,250.

Total costs for the Oklahoma and South Basins Master Plan are estimated to be $17,801,705. Continuous maintenance of the proposed drainage infrastructure is required to protect the City and will ultimately result in reduced costs compared to major reconstruction efforts. Maintenance should be done regularly and on an as-needed basis, especially after significant flood events or growth of invasive species. See the summary table below for a breakdown of expected costs along each major drainageway:

Major Drainageway	Acquisition Capital Cost	Crossing Improvement Capital Cost	Channel Improvement Capital Cost	Regional Detention Capital Cost	Total Capital Cost[a]	50-Year O & M Capital Costs	Total Cost[b]
100	$322,244	$701,976	$824,480	$685,368	$4,250,458	$1,402,900	**$5,653,358**
200	$335,717	$720,515	$308,120	$1,294,584	$4,442,663	$2,069,700	**$6,512,363**
300	-	-	-	-	$659,947	$8,800	**$668,747**
500	$14,596	$220,492	-	$609,216	$1,444,700	$134,050	**$1,578,750**
600	$77,473	$608,849	$160,000	$533,064	$2,373,880	$485,600	**$2,859,480**
800	$6,737	$98,138	-	$152,304	$446,757	$82,250	**$529,007**
ALL	$756,767	$2,349,970	$1,292,600	$3,274,536	$13,618,405	$4,183,300	**$17,801,705**

a. Total cost also includes mobilization, stormwater management/erosion control, engineering, legal/administration, construction management, and contingency estimates

b. Total cost equals includes capital cost plus operations and maintenance costs over 50 years

To conclude, Matrix recommends the following general actions for the City of Greeley:

1. Prioritize Detention and LID (runoff reduction) improvements, as both will have significant impacts on downstream channel stability and flood risk, reducing the scope of required channel improvements. LID BMPs can serve double duty to reduce runoff and capture pollutants.
2. Widespread implementation of EURV basins will result in a system that mimics the flow duration and frequencies of an undeveloped natural system.
3. Design and construct geomorphically stable channels within the proposed stream management corridors. This can be achieved through multistage cross sections and appropriate channel profiles.

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CHAPTER 1 - PRELIMINARIES

1.1 Authorization

Matrix Design Group, Inc. (Matrix) contracted with the City of Greeley (Greeley) to complete the Comprehensive Drainage Plan (CDP) for the Oklahoma & South Basins. This project is solely sponsored by Greeley. The Agreement for this CDP Oklahoma & South Basins (Agreement No. FW21-11-181) was executed March 30, 2022.

1.2 Purpose and Scope

This study provides the framework for the Oklahoma & South Basins to:

- Protect water quality from degradation due to urbanization,
- Define and preserve floodplains from encroachment prior to development,
- Preserve natural channel function, character and habitat,
- Master plan and budget drainageway improvements, and
- Program regional detention facilities, with a preference for full-spectrum detention where possible.

This study applies updated mapping and land use projections, conducts field stream assessments, develops alternative drainageway planning concepts, and prepares a concept design of facilities for implementation.

The Oklahoma & South watersheds are largely undeveloped at this time. The impact of future development on the watersheds without mitigation is expected to significantly increase the frequency and severity of stormwater runoff over existing levels. This increase in runoff will not only provide an increased threat of flooding and structural damages in the future, but also have significant negative impacts on water quality and stream stability. Alternatives have been developed to offset the impacts of future development by focusing on reducing flood magnitudes, increasing conveyance capacities, removing pollutants from the runoff, and stabilizing the stream against erosion.

This report is provided to update hydrologic information for existing and future conditions in the Oklahoma & South Basins (hereinafter called the Study Area). The hydrologic information documented in this study can be used by Greeley as a guideline for future developments within the watersheds, and provide the basis for agreements of controlled hydrology at jurisdictional boundaries.

Tasks to define existing and future drainage conditions hydrology, and evaluate proposed drainage improvement concepts include:

1. Meet regularly with the sponsors to obtain background information, present preliminary study findings, and discuss results of the planning tasks.
2. Contact agencies and/or individuals that have knowledge or specific interest in the study area.
3. Collect existing information, including previous Master Drainage Plans (MDPs) or site-specific drainage studies for proposed development.
4. Obtain GIS information from project sponsors, such as future land use mapping.
5. Inventory and compile information on the existing drainage system, including high-level geomorphic stream assessments.
6. Perform Relative Elevation Modeling (REM) to better illustrate existing valley shapes.
7. Prepare hydrologic analyses for existing and future development watershed conditions. Determine subbasin boundaries and parameters in accordance with Greeley and Mile High Flood District (MHFD) criteria. Develop existing and future (fully developed) conditions hydrologic models using CUHP 2005, version 2.0.1 and EPA SWMM 5.1, version 5.1.015. Compile this information in an interim Baseline Hydrology Report for review by project sponsors.
8. Conduct hydraulic analyses along the major drainageway to ascertain capacities of existing structures, determine location of flood hazards, and analyze hydraulic impacts of future peak discharges.
9. Develop drainageway improvement alternatives that address future drainage impacts.
10. Evaluate alternatives based on criteria, estimated construction costs, potential flood risk reduction, and planning constraints, and recommend alternatives for each reach of the drainageways. Compile this information in an interim Alternatives Analysis Report for review by project sponsors.
11. Sponsor acceptance of the selected alternative via a Selected Plan.
12. Prepare a Concept Design Report which further evaluates the feasibility of the selected improvements. Include detailed cost estimates of concept design improvements.

There are no existing regulatory floodplains within the Study Area. The major problems identified in the Oklahoma & South Basins are due to the expected significant increase in flows under future conditions without mitigation. Alternatives to protect the community include reducing the future flood hazard areas with a policy of floodplain protection and maintenance, flood insurance, structural drainage improvements or Low Impact Development practices to reduce flood magnitudes, and local protection measures.

A major component of this plan is to increase the capacity of transportation crossings along the major drainageways of Oklahoma & South Basins to 100-year capacity. Most of the major highway crossings in the lower portion of the watersheds are undersized for a major flood event, even under existing land use development conditions. Flooding problems are known to exist in the lower portion of the watersheds at the Great Western Railway embankment and State Highway 257. The existing culverts become full of debris and unable to convey more than the low flow condition. Backwater upstream of the embankments where existing culverts reach capacity could flood nearby properties.

1.3 Planning Process

A kickoff meeting with Greeley was held on March 30, 2022. Progress meetings were held once or twice per month (as needed) to update sponsors on the project status. Online public meetings were held June 29, 2022 and November 16, 2022. Meeting minutes are included in Appendix A.

Updated hydrology documented in this report represents an updated analysis of the study area using the most current version of CUHP, and version 5.1 of EPA SWMM since the CUHP multiple runs functionality does not yet work with the latest version of SWMM. The analysis examined existing, proposed and planned developments in the study area.

Hydrologic mapping and modeling were performed from scratch for this study since detailed studies did not exist for the Oklahoma & South Basins. The basin delineations were based upon 1-foot contour mapping. Subbasins were further subdivided to calculate peak flows at critical locations or that were larger than 130 acres. The Oklahoma & South Basins were modeled using a 2-hour rainfall storm, with no area corrections, per criteria.

Three hydrologic models were produced for this study:

1. Baseline hydrology for existing conditions,
2. Baseline hydrology for future fully-developed conditions,
3. Master Planned hydrology with future regional detention to the extent possible to match historic (undeveloped) release rates.

1.4 Mapping and Surveys

Mapping information for this project was provided by several agencies. Where multiple data sources existed, attempts were made to use the best available data. The following describes the various mapping components and their sources.

Topographic Contours

One-foot, LiDAR-derived topographic contour data collected, in the fall of 2018, was used to delineate drainage basin boundaries. The Colorado Water Conservation Board (CWCB), the Federal Emergency Management Agency (FEMA), and the United States Geological Survey (USGS) partnered to provide this data as part of the Colorado Hazard Mapping (CHAMP) program.

Aerial Photography

Color aerial ortho-photography from 2018 was available for the study area through Nearmap. The majority of the watershed was captured in half-foot pixel resolution.

Hydrologic Soil Groups

Soils information was obtained from the Natural Resources Conservation Service (NRCS) for the study area with an access date of July 5, 2022.

Base Mapping

Base mapping information including street centerlines, storm drainage infrastructure, parcels, existing land use, zoning, and jurisdictional boundaries were provided by Greeley. Future land use was digitized from figures published in the *City of Greeley 2060 Comprehensive Plan*. Section 2.3.3 of this report provides a more detailed discussion of existing land use data sources. Linear water features were obtained from the National Hydrography Dataset.

Coordinate System and Datum

All GIS mapping and data for this study were developed using the Colorado State Plane, North Zone coordinate system in U.S. feet. The horizontal datum is NAD83 HARN and the vertical datum is NAVD88.

Survey information

Field survey of existing roadway crossings was completed on May 19, 2022 by Matrix.

1.5 Acknowledgements

A Technical Advisory Committee (TAC) made up of the project sponsors provided guidance during the study process. The TAC met regularly during the course of the project study. Representatives who were directly involved with this study are listed below:

Table 1-1 Project Participants and Affiliations

Name	Representing	Role
Brian Fischer	City of Greeley	Project Manager
Andrew Fisher	City of Greeley	Ex-Project Manager
Karen Reynolds	City of Greeley	Stormwater Manager
Brian Hathaway	City of Greeley	Water Quality and Regulations Manager
Drew Beck	Matrix Design Group	Project Manager
Ben Liu	Matrix Design Group	Project Engineer
Megan Sawyer	Matrix Design Group	Project Engineer
Anna Grace Howard	Matrix Design Group	Project Engineer
Sabastian Ortega	Matrix Design Group	Project Engineer
Chris Martin	Matrix Design Group	GIS Manager

CHAPTER 2 - THE WHY

2.1 Overview

2.1.1 Project Area

The total project area is 4.9 square miles, with the South Basin compromising 1.2 square miles and the Oklahoma Basin compromising 3.7 square miles. This study includes the entirety of the South Basin watershed upstream of State Highway (SH) 257, while only including a portion of the Oklahoma Basin, that is east of Weld County Road (WCR) 17, corresponding to the area within City of Greeley and the Long Range Expected Growth Area (LREGA). The total area within the Oklahoma Basin is approximately 11.3 square miles. Figure 2-1 shows the project area, jurisdictional limits, and a vicinity map.

General topography of the watersheds slopes from high ground in the south towards the Cache la Poudre River in the north. Both watersheds have an average slope of approximately 2 percent. All elevations are in the vertical datum NAVD88. The highest point of the South Basin is the interchange of United States (US) Highway 34 and SH-257 at an elevation of 5035 feet above sea level; and the lowest point is the South Drainageway immediately downstream of SH-257 at an elevation of 4780 feet above sea level. The highest elevation of the Oklahoma Basin is 5060 feet above sea level; and the lowest point is the Oklahoma Drainageway immediately upstream of the SH-257 bridge at an elevation of 4755 feet above sea level.

Major drainageways have been defined as reaches that include more than 130 acres of contributing area. Figure 2-2 shows the major drainageways of this study. The South Basin includes the main drainageway, identified as 100, and one tributary, named 142. Note that this study does not include analysis of the main Oklahoma Drainageway, but does include five large tributaries. The largest tributary, identified as 200, has two tributaries of its own that qualify as major drainageways, 224 and 244. The other tributaries defined as major drainageways are 300, 500, 600, and 800.

2.1.2 History

The study area is largely undeveloped. The flatter upstream areas have historically been used for agriculture, and there are a limited number of homesteads within the study area. Plans for mixed-use developments are currently progressing for the area south of US-34 within the Oklahoma watershed. The areas immediately around the drainageways have remained natural. Field assessments indicate that the drainageways in the project area are generally stable under the existing flow regimes. However, many of these drainageways have likely experienced local instabilities, resulting in steeper banks that shift laterally and headcuts that propagate an incised drainageway upstream. Per the Colorado Oil and Gas Conservation Commission (COGCC), there are 103 oil and gas wells listed with the study area. Most of those are inactive sites, but there are several active energy extraction operations within the Oklahoma Basin. A map of the wells within the study area is included as Figure D-2 in Appendix D.

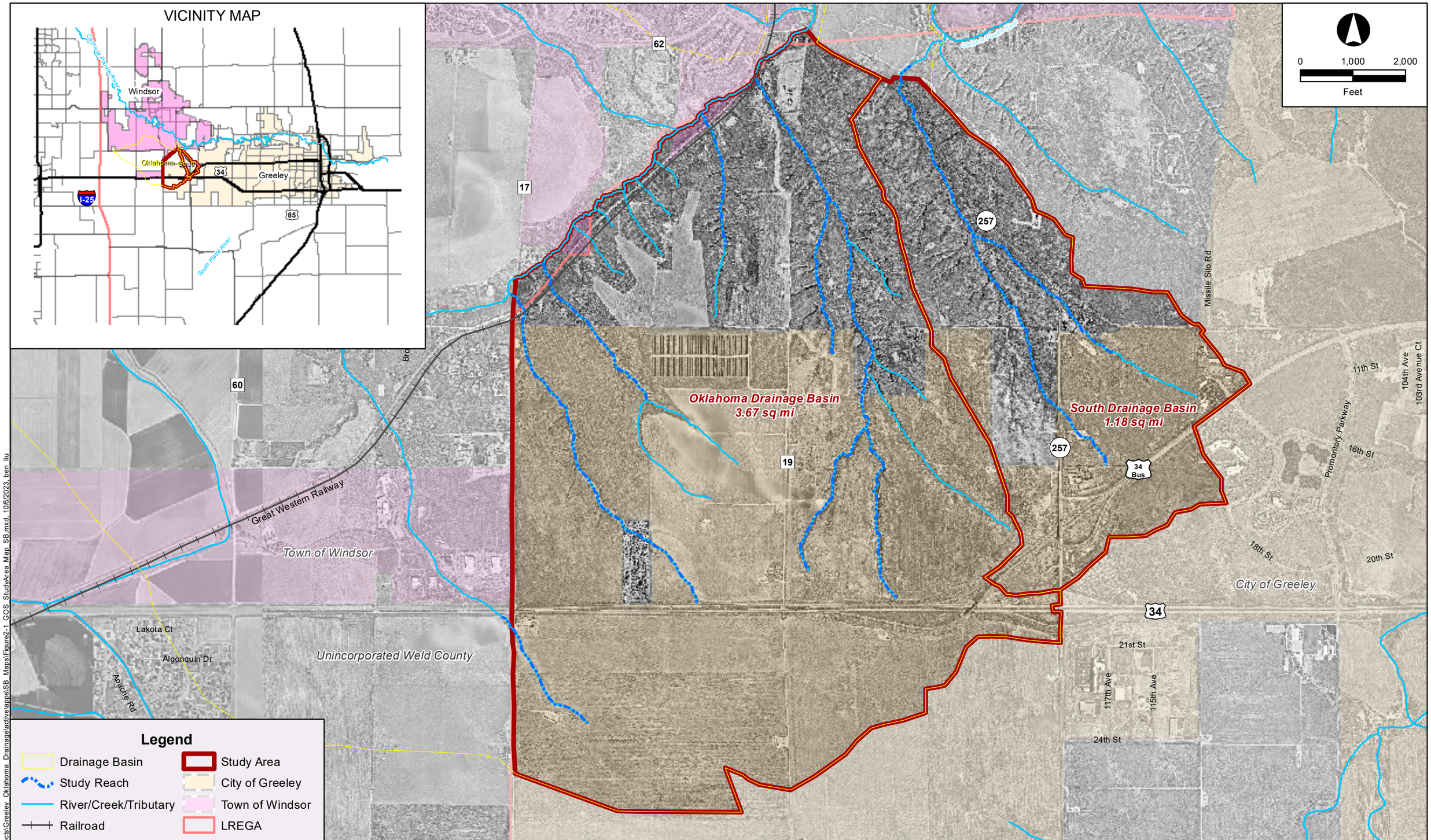
2.1.3 Relevant Information from Past Plans

Both watersheds were previously included in the Town of Windsor's growth management boundary, and the *Town of Windsor Master Drainage Plan* was completed in 2003. That previous study was performed at a much larger scale than this current study, with subbasin areas exceeding 1000 acres in the hydrologic models. The recommended master plan improvements focused on improvements to crossing structures along the South Drainageway and Oklahoma Drainageway at SH-257, the Great Western Railroad (GWR), and WCR-17. They also recommended formalizing a regional detention pond immediately west of WCR-17 along the main Oklahoma Drainageway.

2.2 Plan Horizon

This report follows the master plan developed and refined with the *Imagine Greeley process.* Future conditions for the hydrologic models reflect the anticipated land use shown in the *City of Greeley 2060 Comprehensive Plan*, which was adopted in 2018.

VICINITY MAP



Legend

- Drainage Basin
- Study Reach
- River/Creek/Tributary
- Railroad
- Study Area
- City of Greeley
- Town of Windsor
- LREGA

No.	DATE	DESCRIPTION	APPR.

Matrix Excellence by Design

designed by:
drawn by: SB
checked by: BL
project no.: 22.906.007
date: 10/07/2022

City of Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA & SOUTH BASINS

STUDY AREA MAP

FIGURE
2-1

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0 1,000 2,000
Feet

Reach 200
Reach 100
Reach 300
Reach 142
Reach 150
Reach 224
Reach 232
Reach 500
Reach 118
Reach 600
Reach 239
Reach 241
Reach 134
Reach 614
Reach 244
Reach 260
Reach 618
Reach 800

South Drainage Basin
Oklahoma Drainage Basin

62
17
15
60
257
19
34 Bus
34

Missile Silo Rd
Brookside Dr
Great Western Railway
Town of Windsor
Unincorporated Weld County
City of Greeley
Lakota Ct
Algonquin Dr
Apache Rd
Promontory Parkway
11th St
13th St
14th St
15th St
16th St
18th St
20th St
21st St
24th St
104th Ave
103rd Ave
102nd Ave
101st Avenue Ct
101st Ave
117th Ave
115th Ave

Legend

- Railroad
- River/Creek/Tributary
- Study Reach
- Study Area
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Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA & SOUTH BASINS

REACH MAP

FIGURE
2-2

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2.3 Existing Conditions

2.3.1 Reach Description

The study area has been subdivided into 17 reaches that represent the most significant drainageways. Figure 2-2 shows these reaches and current jurisdictional limits. All study reaches are within the existing city limits or the Long Range Expected Growth Area (LREGA) of Greeley. Table 2-1 provides an inventory of the existing crossing structures, and Figure 2-20 shows the locations of the existing crossing structures. All of the study reaches are in a natural state, and all of the study reaches are ephemeral with no base flows. Figure D-1 in Appendix D shows the potential wetlands and riparian zones within the study area. The following narrative provides a description of each reach.

Major Drainageway 100: South Basin Primary Tributary

Major drainageway 100 is the main drainageway for the South Basin, covering approximately 9,300 feet (Sta. 0+00 – 92+64) from the existing culvert crossing of the private road immediately downstream of the northern SH-257 culvert crossing to a short distance upstream of the eastern SH-257 culvert crossing. The downstream portion of this reach, located within the Shur View property, has a defined valley shape with established wetland and shrub riparian zones and may be an important wildlife corridor.

For the purposes of hydraulic analysis, major drainageway 100 was divided into three reaches based on stream characteristics, flow changes, or existing constraining features such as roadways or crossings. Reach 100 starts at crossing structure 101 on the private road (Sta. 0+00) and ends at the confluence with the Secondary Tributary at station 38+25. The channel throughout Reach 100 is broad with moderate side slopes. Vegetation consists primarily of native grasses with some tree clusters as seen in Figure 2-3.

Reach 118 starts at station 38+25 and ends just before SH-257 at station 77+80. The channel becomes more defined with relatively steep banks and healthy vegetation is present throughout the Reach 118 as shown in Figure 2-4. Reach 134 starts at crossing structure 104 (Sta. 77+80) and extends upstream to station 92+64. Reach 134 is best described as a broad plain with no defined flow path as seen in Figure 2-5.

Figure 2-3 Reach 100

Figure 2-4 Reach 118

Figure 2-5 Reach 134

Figure 2-6 Reach 142

Tributary 142: South Basin Secondary Tributary

Tributary 142 is a secondary drainageway, covering approximately 3,700 feet from the confluence with Reach 100 to a short distance upstream of the SH-257 culvert crossing, station 0+00 to 36+80. This reach has a defined channel shape with established wetland and shrub riparian zones and may be an important wildlife corridor. For the purposes of hydraulic analysis Tributary 142 was divided into two reaches, Reach 142 and Reach 150. Reach 142 starts at station 0+00 at the confluence with Reach 100 and extends upstream to SH-257 at station 20+56. The channel throughout the reach is confined with some steep or tall banks but is stable and healthy vegetation is present, see Figure 2-6.

Reach 150 starts at crossing 103, station 20+56, and extends upstream to station 36+80. Reach 150 has thick riparian vegetation with some Cottonwoods and the channel is more confined than Reach 142. See Figure 2-7 for typical conditions in Reach 150.

Figure 2-7 Reach 150

Major Drainageway 200: Oklahoma Basin Primary Tributary

Major drainageway 200 is the largest and easternmost drainageway within the Oklahoma Basin, covering approximately 11,300 feet (Sta. 0+00 – 113+12) from the confluence with the Oklahoma Drainageway to immediately downstream of US-34. This reach has an incised channel with limited wetland zones in the bottom of the channel. Major drainageway 200 was divided into five reaches for analysis purposes based on stream characteristics, flow changes, or existing constraining features such as roadways or crossings.

Reach 200 starts at station 0+00 near crossing 201 and extends upstream to the confluence with Reach 224 at station 26+60.The channel in this reach is confined with a wide bottom. Field observations noted signs of instability throughout the reach including headcuts, minor bank scour, and bank erosion. Most of these observations were made at tributaries or outfalls rather than on the main channel. Vegetation found in this reach is mostly native grass. Figure 2-8 shows typical channel conditions for Reach 200.

Reach 232 starts at the confluence with Reach 224 at station 26+60 and extends upstream to station 60+77 where flows from subbasin 236 and subbasin 240 enter the main drainageway. The channel in this reach is confined and mostly vegetated with grasses, see Figure 2-9.

Reach 239 starts at station 60+77 and ends at station 64+89 where subbasin 256 enters the drainageway. This reach is similar to Reach 232 but is slightly narrower. Figure 2-10 shows typical reach conditions.

Reach 241 starts at station 64+89 and ends at the confluence with Reach 244, station 75+46. Filed observations indicate this reach is stable and has good vegetation and trees present. Figure 2-11 shows an example of typical reach conditions.

Reach 260 starts at station 75+46 at the confluence with Reach 244 and extends upstream to station 113+12 near US-34. Field observations indicate the channel is stable. The channel in Reach 260 is in a narrow and confined valley with steep sides. Healthy vegetation is present throughout the reach and field observations indicate the channel is stable. Figure 2-12 shows typical channel conditions.

Reach 224: Oklahoma Basin Secondary Tributary

Reach 224 is a secondary drainageway, covering approximately 3,200 feet from the confluence with Reach 200 at station 0+00 upstream to station 32+49. This reach has an incised channel without any identified wetland or riparian zones, see Figure 2-13.

Reach 244: Oklahoma Basin Secondary Tributary

Reach 244 is a secondary drainageway, covering approximately 3,400 feet from the confluence with Reach 260 at station 0+00 upstream to a short distance downstream of US-34, station 34+01. This reach has an incised channel without any identified wetland or riparian zones. Figure 2-14 shows typical reach conditions.

Figure 2-8 Reach 200

Figure 2-9 Reach 232

Figure 2-10 Reach 239

Figure 2-11 Reach 241

Figure 2-12 Reach 260

Figure 2-13 Reach 224

Figure 2-14 Reach 244

Reach 300: Oklahoma Basin Primary Tributary

Reach 300 is the second major drainageway from the east within the Oklahoma Basin, covering approximately 2,700 feet (Sta. 0+00 – 27+30) from the confluence with the Oklahoma Drainageway upstream towards the south. Near the downstream end is an existing GWR culvert crossing. This reach has an incised channel with limited wetland zones in the bottom of the channel.

Reach 500: Oklahoma Basin Primary Tributary

Reach 500 is the third major drainageway from the east within the Oklahoma Basin, covering approximately 3,500 feet (Sta. 0+00 – 34+68) from the confluence with the Oklahoma Drainageway upstream towards the southeast. Near the downstream end is an existing GWR culvert crossing. This reach has a broad channel bottom with tall banks. There is localized bank erosion in some areas but most banks are stable. Vegetation is mainly native grasses as seen in Figure 2-15.

Figure 2-15 Reach 500

Major Drainageway 600: Oklahoma Basin Primary Tributary

Major drainageway 600 is the fourth major drainageway from the east within the Oklahoma Basin, covering approximately 6,900 feet from the confluence with the Oklahoma Drainageway to a short distance downstream of US-34. Near the downstream end are the existing WCR-17, GWR, and private driveway culvert crossings. Major drainageway 600 was divided into three reaches for analysis purposes based on stream characteristics, flow changes, or existing constraining features such as roadways or crossings.

Reach 600 starts at station 0+00 near WCR-17 and extends upstream to station 37+25. The channel in this reach is wide and shallow and vegetation consists of mostly native grasses. Figure 2-16 shows the typical channel conditions.

Reach 614 starts at station 37+25 and ends at station 54+96. The channel here is narrower than Reach 600 but still broad and shallow. The channel is mostly vegetated with native grass as seen in Figure 2-17.

Reach 618 starts at station 54+96 and ends at station 74+88 near US-34. There is an existing salvage yard with a detention pond built in the channel, see Figure 2-18. The channel becomes poorly defined upstream of the salvage yard.

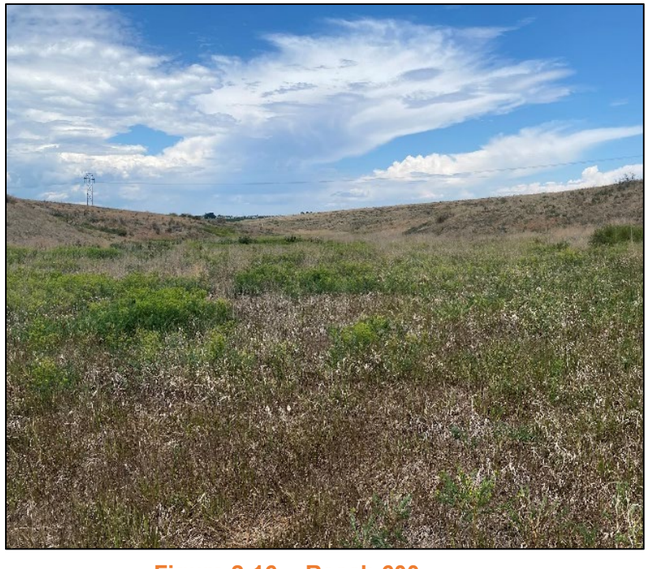


Figure 2-16 Reach 600

Figure 2-17 Reach 614

Figure 2-18 Existing Detention Basin in Reach 618

Reach 800: Oklahoma Basin Primary Tributary

Reach 800 is the fifth major drainageway from the east within the Oklahoma Basin, covering approximately 2,700 feet (Sta. 0+00 – 27+49) from the WCR-17 surface crossing upstream towards the southeast. Note that this reach continues downstream of the study area, through the Town of Windsor and Unincorporated Weld County, to eventually discharge into the Oklahoma Drainageway. The drainageway is poorly defined with limited wetland zones as shown in Figure 2-19.

Figure 2-19 Reach 800

2.3.2 Existing Crossings

Table 2-1 provides an inventory of the existing crossing structures, and Figure 2-20 shows the locations of the existing crossing structures.

2.3.3 Land Use

Existing vegetation within the study area is primarily native grasses. Existing land use within the study area is primarily rural, but includes some isolated commercial, industrial, and residential uses. The paved thoroughfares of US-34, SH-257, and WCR-17 pass through the study area, with US-34 in particular including an alternate business route and ramps that take up significant land. The City of Greeley is in the process of acquiring the 975-acre Shur View property for open space, located in the northeast section of the study area. Existing land use was compiled in ArcGIS by combining parcel, roadway, and land use data from Greeley with aerial imagery. Publicly owned land, including this future Shur View open space, is shown in Figure 2-21.

2.3.4 Flood History

No stream gage information was found for the study area. The Oklahoma and South Basins are sparsely developed – infiltration on undeveloped land is rapid, therefore past heavy rainfall has not caused major flood damages in recent history. As the watersheds develop further, future runoff will be significantly increased above past flood events if mitigation measures such as runoff reducing practices or regional detention are not implemented.

2.3.5 Environmental Assessment

The *2060 Comprehensive Plan* included an environmental investigation to determine areas of ecological significance. Reach 100 within the South Basin was shown as an area of Moderate ecological significance, which is defined as areas which contain significant natural features which would be moderately and negatively compromised by development. The potential wetlands and riparian zones from the *2060 Comprehensive Plan* have been digitized onto a watershed map for this study as Figure D-1 in Appendix D.

2.4 Public Engagement

The technical team will reach out to stakeholders and the general public at multiple points during the project timeline to solicit feedback. A public-facing website has been created to provide a basic overview of the study and how to contact Greeley staff for additional information. Two public meetings were held planned: the first occurred in June 2022, and the second occurred in November 2022. Neither meeting received significant public comments on this study.

2.5 Future Trends

This study does not intend to update or change the general future trends documented in the *2060 Comprehensive Plan.* Rather, the future trends identified in other City of Greeley planning documents were used to inform the long-range storm drainage recommendations that are the focus of this study. Although the study watersheds are located approximately 10 miles west of the downtown core of Greeley, population growth has resulted in this area already facing development pressures. The US-34 corridor in particular is likely to be developed in the near to medium future.

Metropolitan districts are increasingly being established to finance and develop site infrastructure for large master-planned mixed-use communities in Colorado. These districts result in large scale changes to the watershed. The neighboring community of the Town of Windsor has seen extensive development through metropolitan districts in recent years. Two existing metropolitan districts bordering the study area that were recently built or under construction are the Tri-Pointe/Promontory community immediately southeast of the study area (between US-34 Business and US-34) and the Water Valley community immediately north of the study area (Town of Windsor). The Poudre Heights metropolitan district, located east of the study area, north of US-34 Business, is in the planning phases and was approved for rezone and preliminary planned unit development in April 2022.

2.5.1 Near-Term Developments

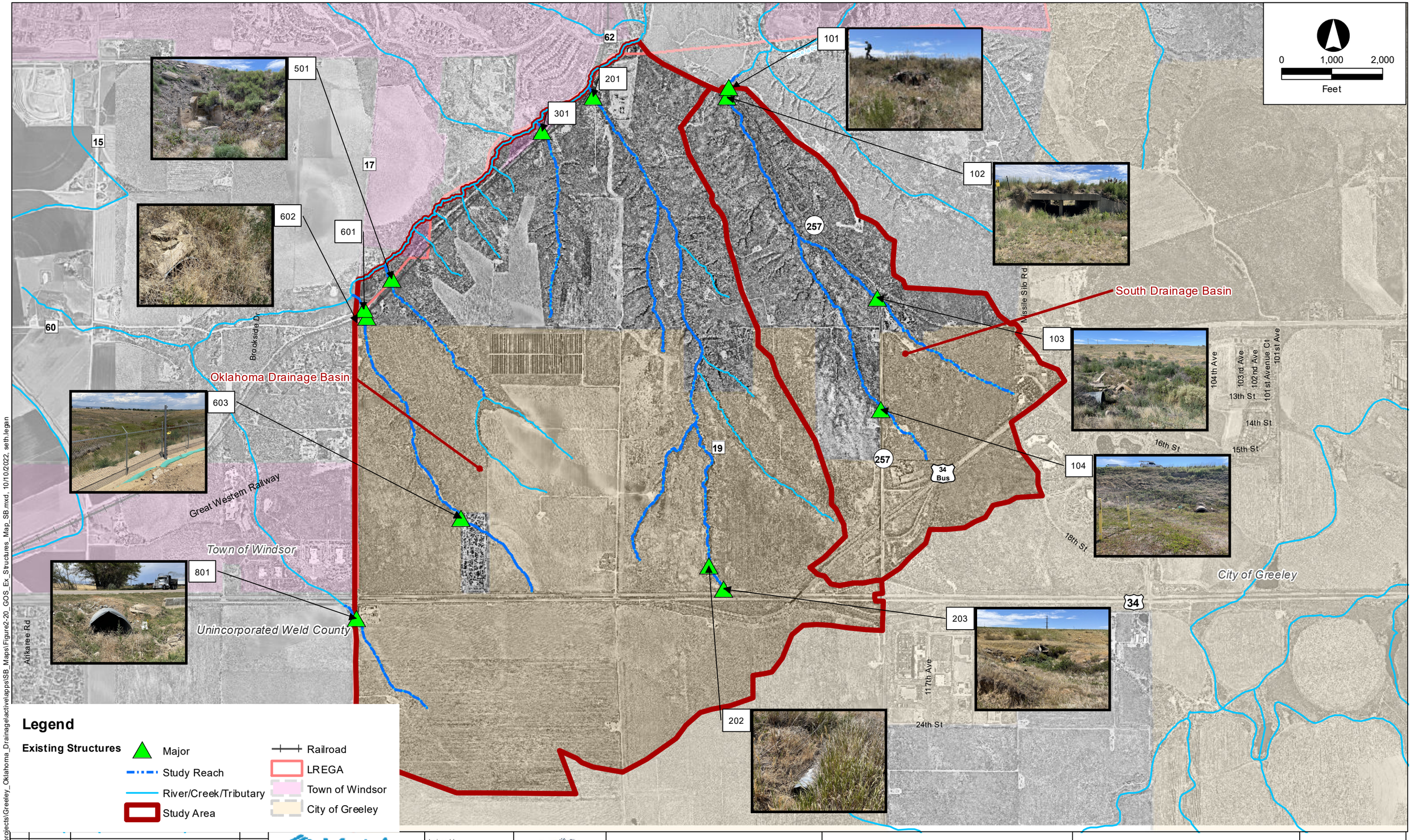
The Delantero project is an 820-acre proposed metropolitan district that is partially within the study area. Delantero is located south of US-34 between WCR-17 and SH-257, and includes 274 acres within the Oklahoma Basin. The other Delantero areas drain to the Sheep Draw and Big Thompson Basins. The *Conceptual Drainage Report for Delantero* (CWC Consulting Group, 2022) indicates that Delantero will be split into at least seven Planning Areas, with each Planning Area potentially constructed at a different time. Delantero Planning Areas 1, 5 and 6 drain north to Reaches 200 and 600 within the Oklahoma Basin, and will include detention/water quality ponds to mitigate the increased peak flows and volumes from the changed land use.

Rainbow 24-9 HZ is a proposed 26-ac well pad and production facility for 28 oil/gas wells, located north of US-34 between WCR-17 and WCR-19 (131st Avenue). The *Preliminary Drainage and Erosion Control Report for Rainbow 24-9 HZ* (609 Consulting, 2022) indicates that a stormwater detention pond, five new culverts, and multiple diversion ditches with sediment traps will be

constructed to control storm drainage and erosion on their site. This location drains to Reach 500 within the Oklahoma Basin.

Table 2-1 Major Crossing Structure Inventory

Structure Number	Reach Number	Drainage Basin	Location	Crossing Type	Structure Description	Structure Station	Existing Structure Size/Type	Approximate Culvert Length (LF)	Existing Estimated Capacity (Future Flow) [a]	Existing Q100 Capacity (CFS) [a]
101	100	South	Farm Road	Private Road	Culvert	0+00	2 - 48" CMP	40	5-year	275
102	100	South	SH-257	Roadway	Culvert	2+15	2 - 10'x6' CBC	60	100-year	1,389
103	142	South	SH-257	Roadway	Culvert	58+81	1 - 48" RCP	295	10-year	160
104	134	South	SH-257	Roadway	Culvert	77+81	1 - 36" CMP	127	< 2-year	72
201	200	Oklahoma	Farm Road	Private Road	Culvert	2+13	1-24" CMP, 2-16" CMP, 1-36"CMP	35	< 2-year	58
202	260	Oklahoma	Farm Road	Private Road	Culvert	107+68	1 - 12" CMP	60	< 2-year	4
203	260	Oklahoma	US-34	Roadway	Culvert	113+12	1 - 36" RCP	327	25-year	119
301	300	Oklahoma	Great Western Railway	Railroad	Culvert	2+44	1 - 36" CMP	36	10-year	85
501	500	Oklahoma	Great Western Railway	Railroad	Culvert	3+25	1 -40"x36" CBC	86	5-year	131
601	600	Oklahoma	Great Western Railway	Railroad	Culvert	3+92	1 - 24" RCP	120	< 2-year	85
602	600	Oklahoma	Farm Road	Private Road	Culvert	5+54	1 - 24"x40" Elliptical CMP	41	< 2-year	95
603	614	Oklahoma	Junk Yard detention	Embankment	Culvert	53+56	1 - 24" HDPE	80	< 2-year	39
801	800	Oklahoma	CR-17	Roadway	Culvert	3+50	1 - 48" Elliptical CMP	50	< 2-year	138



No.	DATE	DESCRIPTION	APPR.

Matrix Excellence by Design

designed by:
drawn by: SL
checked by: BL
project no.: 22.906.007
date: 10/07/2022

Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA & SOUTH BASINS

EXISTING STRUCTURES MAP

FIGURE
2-20

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0 1,000 2,000
Feet

Oklahoma Drainage Basin

South Drainage Basin

Great Western Railway

Brookside Dr

Missile Silo Rd

Cache La Poudre River

Town of Windsor

Unincorporated Weld County

City of Greeley

Lakota Ct

11th St
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103rd Ave
102nd Ave
101st Avenue Ct
101st Ave
117th Ave
115th Ave
Promontory Parkway

62
15
17
60
19
257
34
34 Bus

Legend

Public Land

- Colorado Dept. of Transportation
- City of Greeley

- Study Reach
- River/Creek/Tributary
- Railroad
- Study
- City of Greeley
- Town of Windsor
- LREGA

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Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA & SOUTH BASINS

PUBLIC OWNED LAND

FIGURE
2-21

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Shur View Property

Missile Site Park

0 1,000 2,000
Feet

62
15
17
60
257
19
34 Bus
34

Brookside Dr
Missile Silo Rd
Promontory Circle
Promontory Parkway
11 th St
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City of Greeley
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115th Ave
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Algonquin Dr
Apache
Unincorporated Weld County

Legend

- Study Reach
- River/Creek/Tributary
- Railroad
- Study Area
- City of Greeley
- Parks and Open Space
- LREGA

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Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA & SOUTH BASINS

PARKS AND OPEN SPACE

FIGURE
2-22

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CHAPTER 3 - THE WHAT

3.1 Hydrologic Analysis

3.1.1 Overview

The purpose of this study is to prepare a storm drainage master plan to identify major flood and drainage hazards and advise future development. Both basins contain reaches of varying stability and a small network of culverts around US-34 and SH-257.

3.1.2 Design Rainfall

The rainfall duration used with CUHP varies with the size of the watershed being analyzed. For watersheds 2 square miles or greater, there is an adjustment made to the incremental precipitation depths to consider the averaging effects of greater watershed size (area correction). From the *USDCM*, Table 5-1: Storm Duration and Area Adjustment for CUHP modeling in the *USDCM* (reproduced below at Table) recommends a 2-hour storm duration for watershed area less than 15 square miles.

Table 3-1 Storm Duration and Area Adjustment for CUHP Modeling

Design Storm	Watershed Area (square miles)	Recommended Storm Duration	Apply DRF?
2-, 5-, and 10-Year	$A \leq 2.0$	2 hours	No
	$2.0 < A < 15.0$	2 hours	Yes – Use Table 5-3
	$A \geq 15.0$	6 hours	Yes – Use Table 5-3
25-, 50-, 100-, and 500-Year	$A < 15.0$	2 hours	No
	$A \geq 15.0$	6 hours	Yes – Use Table 5-4

Both the Oklahoma and South Basins are less than 15 square miles, so the recommended 2-hour duration design storm was used. To develop a 2-hour duration design storm, the first step is to determine the 1-hour and 6-hour point rainfall depths. The one-hour and six-hour rainfall depths (Table) were read from the *NOAA Atlas 14, Volume 8, Version 2* for the project location at Latitude 40.4181º and Longitude -104.889º.

Table 3-2 Point Rainfall Depths (inch)

	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
1-Hour Point Rainfall	0.85	1.12	1.40	1.87	2.30	2.79	4.16
6-Hour Point Rainfall	1.28	1.67	2.08	2.77	3.39	4.11	6.13

Note the exact precipitation values used for the *Town of Windsor Master Drainage Plan* were not specified for comparison, but that report stated that NOAA Atlas Volume III (1973) values were used. Inspection of the Rainfall Intensity-Duration Curves presented in the *Town of Windsor Storm Drainage Design Criteria* (2020) suggests that the NOAA Atlas Volume III 100-Year, 1-Hour Rainfall was 2.58-inches.

To create a design hyetograph, the 1-hour rainfall depths were converted into 2-hour design storms by multiplying the 1-hour precipitation depths by the temporal distribution shown in the *USDCM*, Table 5-2 (reproduced below as Table). These recommended storm distributions take into account the "leading intensity" nature of storms in the Front Range are intended for use with CUHP. The rainfall distributions used for each storm event are included as Table B-1 in Appendix B.

Table 3-3 Design Storm Distributions of 1-hour Rainfall

Time Minutes	Percent of 1-hour precipitation depth (%)				
	2-Year	5-Year	10-Year	25- and 50-Year	100- and 500-Year
5	2.0	2.0	2.0	1.3	1.0
10	4.0	3.7	3.7	3.5	3.0
15	8.4	8.7	8.2	5.0	4.6
20	16.0	15.3	15.0	8.0	8.0
25	25.0	25.0	25.0	15.0	14.0
30	14.0	13.0	12.0	25.0	25.0
35	6.3	5.8	5.6	12.0	14.0
40	5.0	4.4	4.3	8.0	8.0
45	3.0	3.6	3.8	5.0	6.2
50	3.0	3.6	3.2	5.0	5.0
55	3.0	3.0	3.2	3.2	4.0
60	3.0	3.0	3.2	3.2	4.0
65	3.0	3.0	3.2	3.2	4.0
70	2.0	3.0	3.2	2.4	2.0
75	2.0	2.5	3.2	2.4	2.0
80	2.0	2.2	2.5	1.8	1.2
85	2.0	2.2	1.9	1.8	1.2
90	2.0	2.2	1.9	1.4	1.2
95	2.0	2.2	1.9	1.4	1.2
100	2.0	1.5	1.9	1.4	1.2
105	2.0	1.5	1.9	1.4	1.2
110	2.0	1.5	1.9	1.4	1.2
115	1.0	1.5	1.7	1.4	1.2
120	1.0	1.3	1.3	1.4	1.2
Totals	115.7%	115.7%	115.7%	115.6%	115.6%

3.1.3 Basin Delineations

Subbasins were defined using the digital one-foot contour mapping provided for the project. Major basin and subbasin boundaries were established based on topographic and physical drainage boundaries, such as major roadways (e.g., US-34 and SH-257). The main Oklahoma Drainageway serves as the downstream boundary for subbasins within the Oklahoma Basin. Note the railway that parallels the Oklahoma Drainageway was not used to delineate subbasin boundaries since it is so close to the respective confluences. Watershed boundaries were verified in the field.

Major basins were generally divided into subbasins with a target area of approximately 100 acres. Larger subbasins were kept in some cases, particularly in undeveloped areas, but subbasin sizes were not allowed to exceed 130 acres. Smaller subbasins were often necessary to evaluate more complicated drainage conditions where existing embankments or tributary confluences were located. Figure B-1 in Appendix B shows the subbasin delineations for the study area, and Table 3-4 presents a summary of the subbasin characteristics.

Table 3-4 Subbasin Characteristics

Watershed	Total Area (mile^2)	Subbasin Area (acre)			Number of Subbasins
		Average	Minimum	Maximum	
Oklahoma (East Portion)	3.7	69	4	123	34
South	1.2	63	20	123	12

A summary of the CUHP 2005 model input parameters can be found in Appendix B, existing conditions in Table B-2 and future conditions in Table B-4. One-foot contour mapping was used to determine the existing conditions flow path lengths and distance to centroid values.

3.1.4 Basin Imperviousness

A GIS-based approach was used to calculate the composite percent imperviousness within the watershed based on existing and future land use information. The land use data described in the previous sections was used in conjunction with Table 6-3 in the *USDCM*, to create percent impervious values for each land use type. Table 3-5 lists each land use type and the associated percent impervious values used in the analysis, and Figure 3-1 shows the limited existing impervious surfaces within the study area. GIS data representing existing and future land use was intersected with subbasin polygons to calculate area-weighted, or composite, percent impervious values for each subbasin. Percent impervious values for existing and future conditions are shown in Figure B-1 of Appendix B.

Table 3-5 Future Land Use Impervious Summary

Land Use Description	MHFD Land Use	% Imp*	Percent of Area (%)
Employment Uses, Business Parks	Business: Suburban Areas	75	31.8
Land Suitable for Future Development, Residential Low Density	Residential Lot, Single-family: 2.5 acres or larger	12	0.84
Land Suitable for Future Development, Residential Medium Density	Residential Lot, Single-family: 0.75 - 2.5 acres	20	0.03
Land Suitable for Future Development, Residential High Density	Residential Lot, Single-family: 0.25 acres or less	45	17.5
Industrial Uses, Light Industrial Parks	Industrial: Light Areas	80	3.6
Open Space, Moderately Sensitive Ecologically Significant Land	Undeveloped Areas	2	43.6
Pavement	Paved Streets	100	2.4
Gravel Road or Lot	Gravel (Packed) Streets	40	0.2

*Percent imperviousness were determined from MHFD USDCM Table 6-3

Depression losses/retention storage were determined using Table 6-6 in the *USDCM* (reproduced below as Table 3-6). An impervious depression loss of 0.1-inches was used for all subbasin in both the existing and future conditions. The pervious depression loss of 0.35-inches was used for future subbasins that are shown as developed in future land use, and a pervious depression loss of 0.4-inches was used for future subbasins that are planned to be kept as open space and existing undeveloped areas.

Table 3-6 Typical Depression Losses for Various Land Covers
(All values in inches for use with the CUHP.)

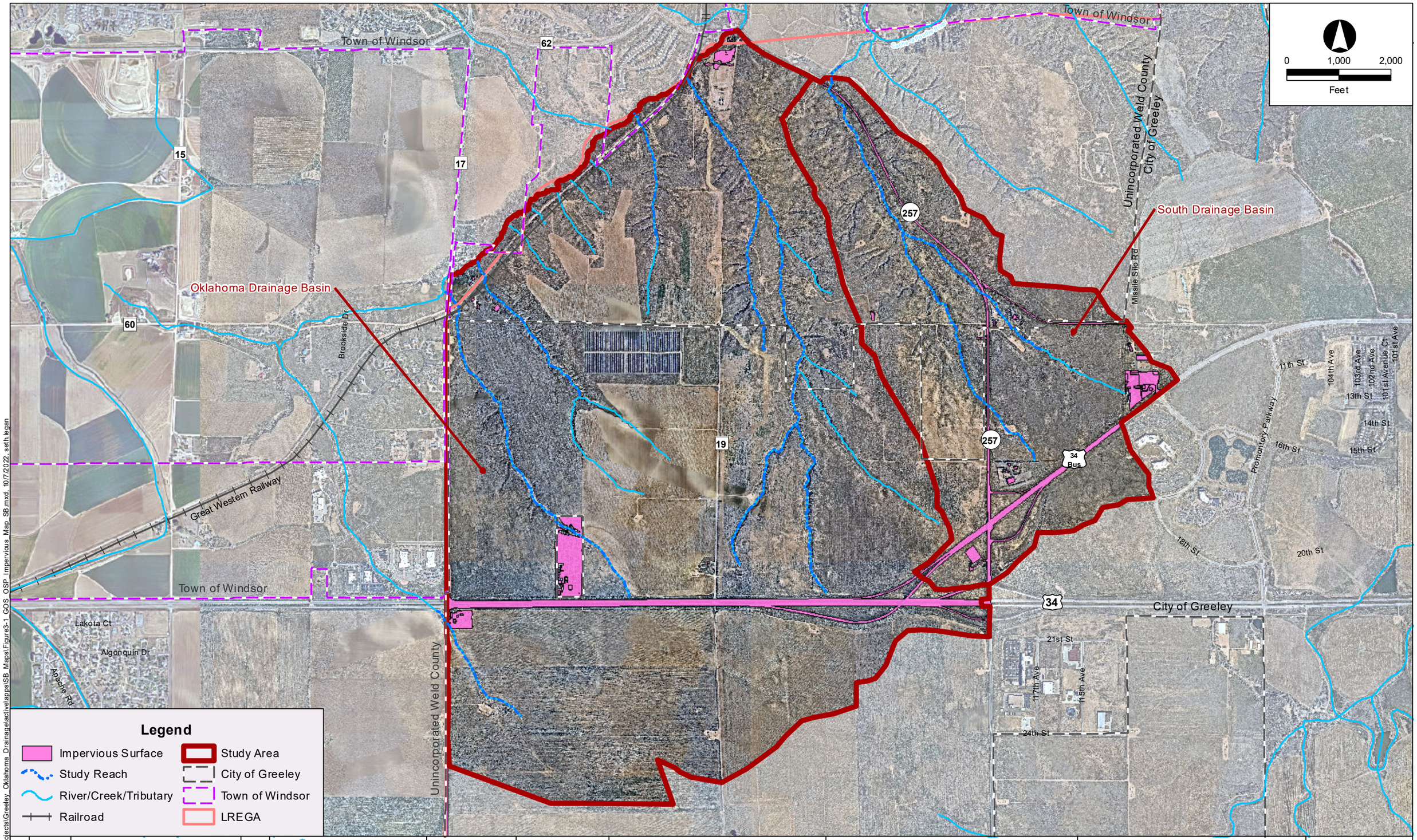
Land Cover	Range in Depression (Retention) Losses	Recommended
Impervious:		
Large paved areas	0.05 - 0.15	0.1
Roofs-flat	0.1 - 0.3	0.1
Roofs-sloped	0.05 - 0.1	0.05
Pervious:		
Lawn grass	0.2 - 0.5	0.35
Wooded areas and open fields	0.2 - 0.6	0.4

The soils in the watershed consist primarily of all four hydrologic soils group (HSG) classifications, with HSG B comprising the largest area, as defined by the NRCS. Figure B-1 in Appendix B shows the HSG distribution. HSG-A soils are generally characterized by the highest infiltration rates and HSG-D soils characterized by the lowest infiltration rates. Table 3-7 shows the HSG distribution by area within the study area.

Table 3-7 Hydrologic Soil Group Distribution

Study Area Basins Only					
HSG	A	B	C	D	Total
Infiltration Rate	High	Moderate	Low	Very Low	
Area (acre)	877	1,229	475	525	3,105
% Area	28	40	15	17	100

Initial and final infiltration rates and Horton's decay rate were determined using Table 6-7 in the *USDCM*. For HSG-A soils, the initial infiltration rate was 5.0 inches per hour, the final infiltration rate was 1.0 inches per hour, and the decay coefficient was 0.0007. For HSG-B soils, the initial infiltration rate was 4.5 inches per hour, the final infiltration rate was 0.6 inches per hour, and the decay coefficient was 0.0018. For HSG-C and HSG-D soils, the initial infiltration rate was 3.0 inches per hour, the final infiltration rate was 0.5 inches per hour, and the decay coefficient was 0.0018. The most conservative (slowest to infiltrate) HSG classification within each subbasin was used to determine the infiltration and decay rates used in the CUHP models.



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No.	DATE	DESCRIPTION	APPR.

Matrix
Excellence by Design

designed by: _____
drawn by: SB
checked by: BL
project no.: 22.906.007
date: 10/07/2022

Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA & SOUTH BASINS

IMPERVIOUS SURFACES

FIGURE
3-1

3.1.5 Detention

No detention areas were modeled for the Baseline Hydrology, pursuant to MHFD's policy to recognize only regional, publicly-owned facilities that have assurances that they will be maintained as designed. No such facilities exist within the existing watersheds. Inadvertent detention behind roadway embankments and in low depression areas occurs at several locations within the study area, but future development may eliminate these by adding culverts and increasing capacity under the highways or railways; therefore, this detention caused by undersized culverts was not included in the models.

3.1.6 Hydrograph Routing

The Manning's roughness values were determined based on the 2018 aerial imagery and supplemented by field observation. Table 3-8 shows the general rule-of-thumb for Manning's n values used for hydrograph routing (different from roughness values used for hydraulic analyses).

Table 3-8 Manning's Roughness Coefficients for SWMM

Routing Element Description	Original 'n'	Increase 'n' by 25%*
Reinforced Concrete Pipe	0.013	0.016
Asphalt Pavement	0.016	0.020
Engineered Channel, Ditch	0.035	0.044
Natural Drainageway with No Brush	0.035	0.044
Natural Drainageway with Brush	0.044 - 0.052	0.055 - 0.065
Natural Drainageway with Trees	0.060	0.075

* As recommended in USDCM Chapter 6 Section 4.2

Hydrographs from individual subbasins were routed through the drainageway system using the EPA SWMM 5.1 computer model. The drainage system was modeled using a system of channels, junction points, and direct flow elements. The conveyance element input parameters include length, slope, roughness coefficient, and cross-section geometry. The EPA SWMM input parameters are included as Table B-8 of Appendix B. A schematic of the EPA SWMM model elements, including subbasins, design points and conveyance elements is shown in Figure B-1 of Appendix B.

Existing channel elements were determined from the digital project mapping. Length, change in elevation, and cross-section shape were estimated from the one-foot interval topographic mapping and aerial imagery for each routing reach. The study area reaches were generally modeled as trapezoidal or triangular open channels. Future channel geometries are not yet known, so the existing reach geometry was also used for the future conditions routing model.

3.1.7 Sensitivity Analyses

Matrix performed a sensitivity analysis to determine the modeling impact of varying roughness values and time steps. This was done by increasing and decreasing the Manning's n roughness value by 25% in all SWMM conveyance elements. The results were compared at select locations such as drainageway outfalls and major confluences, see Figure 3-2 below.

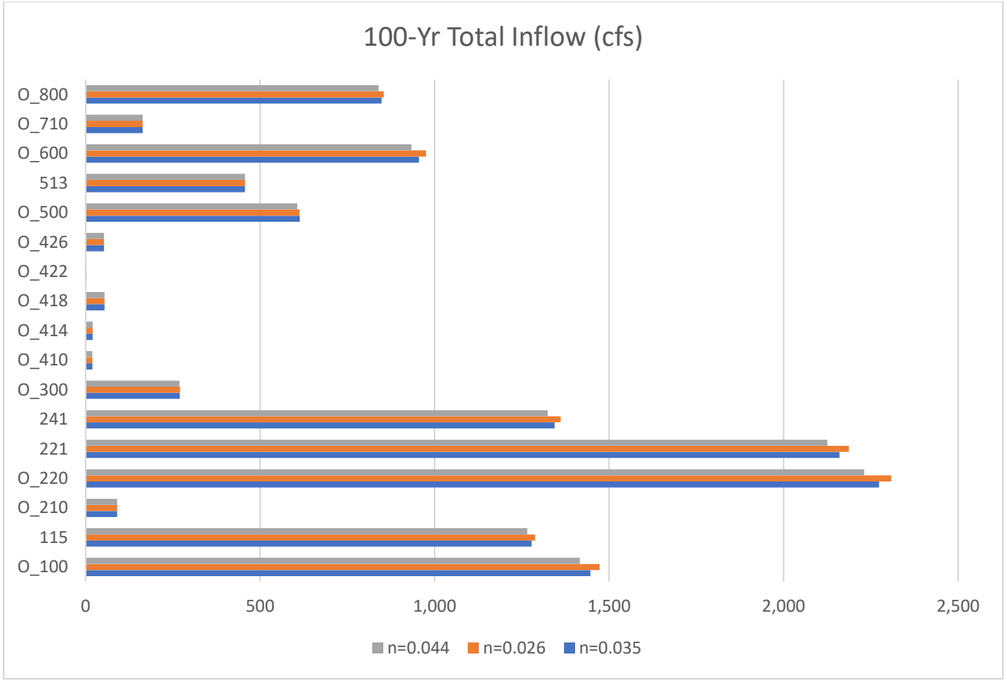


Figure 3-2 Conveyance Roughness Sensitivity Analyis

As shown in Figure 3-2, changing the roughness values by 25% resulted in 100-year peak flows of up to 2.3% different (reducing the roughness value increased peak flows and vice versa). Total modeled volumes were also compared for this sensitivity analysis: changing the roughness value by 25% resulted in 100-year total volumes to 0.6% different (reducing the roughness value decreased the total volume and vice versa). After discussing these results with the project sponsor, Matrix decided to use single set of roughness values (Original 'n' column in Table) for all SWMM models. This simplified approach is slightly conservative and allows the model results developed for alternatives analysis and concept design to be compared directly with the baseline hydrology results.

Matrix also performed a sensitivity analysis to determine whether varying the calculation time step would have an impact on results. This was done by increasing and decreasing the time step by 25% in SWMM. These time step variations resulted in 100-year peak flow and total volume changes of less than 0.5%, so the default 5-minute time step was kept.

3.1.8 Previous Studies

A direct comparison of the runoff calculated from this CDP with the runoff from the *Town of Windsor Master Drainage Plan* was performed at several key points within the same tributary areas, and the results are summarized in Table 3-9. As seen from the table, the 100-year flow rates predicted by the current model are sometimes higher and sometimes lower than the flow rates documented in the *Town of Windsor Master Drainage Plan* (2003) for both existing conditions and future conditions. This is because of differences in the land uses for the existing and future conditions models, subbasin delineations, and detention routing. Some more detailed observations of the comparison are listed below.

- This study used the Greeley *2060 Comprehensive Plan* for future land uses and impervious areas, which was not available in 2003. The *2003 Windsor MDP* stated that no changes were expected between existing and proposed conditions for the entire South Basin.
- The major basins in this study do not exactly match the major basin delineations in the *Town of Windsor Master Drainage Plan*. The *2003 Windsor MDP* was focused on the developing peak flows only for the mainline tributaries, so their SWMM model does not include routing elements within our study area.
- This study divides the major basins into many more, much smaller subbasins than the *Town of Windsor Master Drainage Plan*. As noted in Chapter 6 Section 4.2 of the *USDSM*, discretization of large catchments into smaller ones often results in increased unit discharges.
- The decreases in peak flows are most likely due to the *2003 Windsor MDP* accounting for inadvertent detention in their hydrologic models. As explained in Section 3.1.5, this study does not include detention.

3.1.9 Results of Analysis

The CUHP and SWMM models were run for the 2-, 5-, 10-, 25-, 50-, and 100-year storm events under existing conditions and future conditions, resulting in 12 hydrology scenarios. The computed baseline peak discharges and volumes for all of the EPA SWMM design points can be found in Tables B-6 and B-7 of Appendix B. Summaries of peak flow rates and runoff volumes at key design points are provided below in Table 3-10 and Table 3-11. Figure B-2 in Appendix B shows hydrographs generated by EPA SWMM 5.1 for the 10-year and 100-year storms for existing and future conditions at the outfall of each study reach. A sample SWMM output report (from the 100-year future conditions storm event) is included in Appendix B as Table B-9.

Table 3-9 Previous Studies Hydrology Comparison

Basin	Location	2003 Windsor		This Study		Existing Conditions Q_{100}			Proposed Conditions Q_{100}		
		SWMM Element	Area (ac)	SWMM Element	Area (ac)	2003 Windsor (cfs)	This Study (cfs)	Increase / (Decrease) (%)	2003 Windsor (cfs)	This Study (cfs)	Increase / (Decrease) (%)
Oklahoma	Reach 200 Outfall	0802	1,172	O_220	1,058	1,833	1,401	(24)	1,826	2,273	24
Oklahoma	Reach 300 Outfall	0803	232	O_300 O_410 O_414 O_418 O_422 O_426	270	281	406	45	281	418	49
Oklahoma	Reach 500 Outfall	0807	735	O_500 O_600	655	992	912	(8)	1,166	1,568	34
South	SH-257	S802B	813	O_100	755	1,565	1,042	(33)	1,565	1,446	(8)

Table 3-10 Peak Flows at Key Locations

Locations	Design Points / Conveyance Elements	Total Drainage Area		Station	Existing Conditions Peak Flows (cfs)						Future Conditions Peak Flow (cfs)					
		(acres)	(mi^2)	*	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
South Basin outfall, north of SH-257	O_100	755	1.18	0+00	23	72	180	493	727	1,042	133	229	379	774	1,068	1,446
South Basin confluence	115	572	0.89	2+15	26	74	167	419	604	845	158	256	390	719	968	1,278
Oklahoma Basin upstream-most outfall	O_210	49	0.08	0+00	1	7	18	45	65	90	1	7	18	45	65	90
200-reach outfall	O_220	1,058	1.65	14+23	17	75	224	653	971	1,401	263	426	660	1,261	1,707	2,273
200-reach downstream confluence	221	958	1.50	26+60	17	75	213	606	895	1,282	273	435	657	1,216	1,633	2,160
200-reach upstream confluence	241	486	0.76	75+47	12	50	127	332	481	677	230	343	477	796	1,041	1,343
300-reach outfall	O_300	157	0.25	26+85	12	20	44	125	183	258	15	24	49	133	192	270
410-reach outfall	O_410	13	0.02	40+93	0	1	3	9	13	19	0	1	3	9	13	19
414-reach outfall	O_414	12	0.02	45+99	0	1	3	9	14	20	0	1	3	9	14	20
418-reach outfall	O_418	40	0.06	50+62	1	4	10	26	38	54	1	4	10	26	38	54
422-reach outfall	O_422	4	0.01	58+46	0	0	0	0	1	3	0	0	0	0	1	3
426-reach outfall	O_426	43	0.07	65+20	1	1	7	25	37	53	1	1	7	25	37	53
500-reach outfall	O_500	292	0.46	75+30	8	31	76	192	276	386	82	131	196	350	467	613
500-reach confluence	513	168	0.26	33+58	2	15	40	105	153	214	77	116	162	271	354	456
600-reach outfall	O_600	363	0.57	87+82	9	35	91	249	367	525	140	218	313	552	730	955
710-reach outfall	O_710	43	0.07	-	3	8	16	36	51	70	37	52	68	102	129	163
800-reach outfall	O_800	274	0.43	-	3	17	59	176	260	369	162	232	314	511	662	848

Table 3-11 Runoff Volume at Key Locations

Locations	Design Points / Conveyance Elements	Total Drainage Area		Station	Existing Conditions Runoff Volume (ac-ft)						Future Conditions Runoff Volume (ac-ft)					
		(acres)	(mi^2)	*	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}
South Basin outfall, north of SH-257	O_100	755	1.18	0+00	4.2	10.7	24.3	57.4	84.4	120.3	15.2	24.5	39.3	72.1	99.7	135.0
South Basin confluence	115	572	0.89	2+15	3.6	8.9	19.2	44.2	64.4	91.5	14.1	22.2	33.8	58.3	79.5	105.9
Oklahoma Basin upstream-most outfall	O_210	49	0.08	0+00	0.1	0.5	1.3	3.4	5.1	7.5	0.1	0.5	1.3	3.4	5.1	7.5
200-reach outfall	O_220	1,058	1.65	14+23	3.6	11.6	29.7	76.1	112.9	163.3	26.9	41.4	62.9	108.6	147.3	196.4
200-reach downstream confluence	221	958	1.50	26+60	3.5	11.0	27.4	69.4	102.8	148.2	26.6	40.8	60.5	101.6	136.9	181.4
200-reach upstream confluence	241	486	0.76	75+47	1.8	6.0	14.6	35.9	52.8	75.8	18.6	27.3	38.1	58.9	77.0	99.4
300-reach outfall	O_300	157	0.25	26+85	1.3	2.1	4.1	10.8	16.1	23.4	1.5	2.3	4.4	11.1	16.4	23.7
410-reach outfall	O_410	13	0.02	40+93	0.0	0.1	0.3	0.9	1.4	2.0	0.0	0.1	0.3	0.9	1.4	2.0
414-reach outfall	O_414	12	0.02	45+99	0.0	0.1	0.3	0.8	1.2	1.8	0.0	0.1	0.3	0.8	1.2	1.8
418-reach outfall	O_418	40	0.06	50+62	0.1	0.3	1.0	2.7	4.1	6.0	0.1	0.4	1.0	2.8	4.1	6.0
422-reach outfall	O_422	4	0.01	58+46	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.2
426-reach outfall	O_426	43	0.07	65+20	0.1	0.2	0.7	2.6	4.0	6.0	0.1	0.2	0.7	2.6	4.0	6.0
500-reach outfall	O_500	292	0.46	75+30	1.1	3.7	8.8	21.5	31.9	45.7	7.2	11.5	17.5	30.1	40.8	54.3
500-reach confluence	513	168	0.26	33+58	0.2	1.5	4.3	11.6	17.5	25.5	6.2	9.2	12.9	20.2	26.5	34.1
600-reach outfall	O_600	363	0.57	87+82	1.7	5.0	11.5	27.5	40.2	57.4	12.6	18.8	26.7	42.4	55.9	72.4
710-reach outfall	O_710	43	0.07	-	0.3	0.7	1.5	3.4	4.9	7.0	2.2	3.2	4.2	6.1	7.7	9.7
800-reach outfall	O_800	274	0.43	-	0.4	1.9	6.2	18.0	27.4	40.2	12.2	17.4	23.5	35.3	45.4	58.0

3.2 Hydraulic Analysis

3.2.1 Evaluation of Existing Facilities

There are many existing culvert crossings located within the study area. Refer to Figure 2-20 for the locations of existing crossing structures. Culvert sizes and material were observed during the Matrix field assessment, but not all structures were visited due to property access constraints. One goal of the hydraulic analysis was to determine the capacity of these structures and identify structures that are undersized and will need to be replaced to safely convey the 100-year future flows. For this analysis it was assumed that any overtopping was unacceptable and proposed crossing sizes pass future flows without overtopping the embankment. Of the 13 structures analyzed, only one existing structure (Crossing Number 102 at SH-257) has 100-year capacity. Table 2-1 summarizes the existing capacities, and Table 3-19 shows the proposed culvert improvements for the study area.

Crossing 603 is a unique structure because it is the outlet to a private detention basin on Parcel 095709000009. It was included in the crossings evaluation because the basin is an inline structure on Reach 618. There was no available information on the design of the detention basin, so it was assumed that no detention was provided by the basin. The resulting proposed culvert size is more representative of an emergency spillway rather than an outlet pipe because the crossing was sized purely for capacity without any considerations for drain time or other detention features.

HY-8 version 7.7 software was used to evaluate the hydraulic capacity of crossings within the study reach. Survey data was collected for each crossing and used for the elevation inputs and crossing length inputs. LiDAR data was used to approximate the channel cross section geometry and embankment profiles. Proposed culvert improvements were assumed to have the same invert elevations and length as existing structures for the purposes of this capacity analysis. Manning's n values were chosen based on culvert material; see Table 3-12 for a summary of the Manning's n values used. Detailed HY-8 inputs and outputs for existing crossing structures can be found in Appendix C.

Table 3-12 Manning's n-Values

Culvert Material	Manning's n
Reinforced Concrete Pipe (RCP)	0.012
Corrugated Steel (CMP)	0.024
Concrete Box Culvert	0.012
Steel Pipe Arch	0.025

3.2.2 Flood Hazards

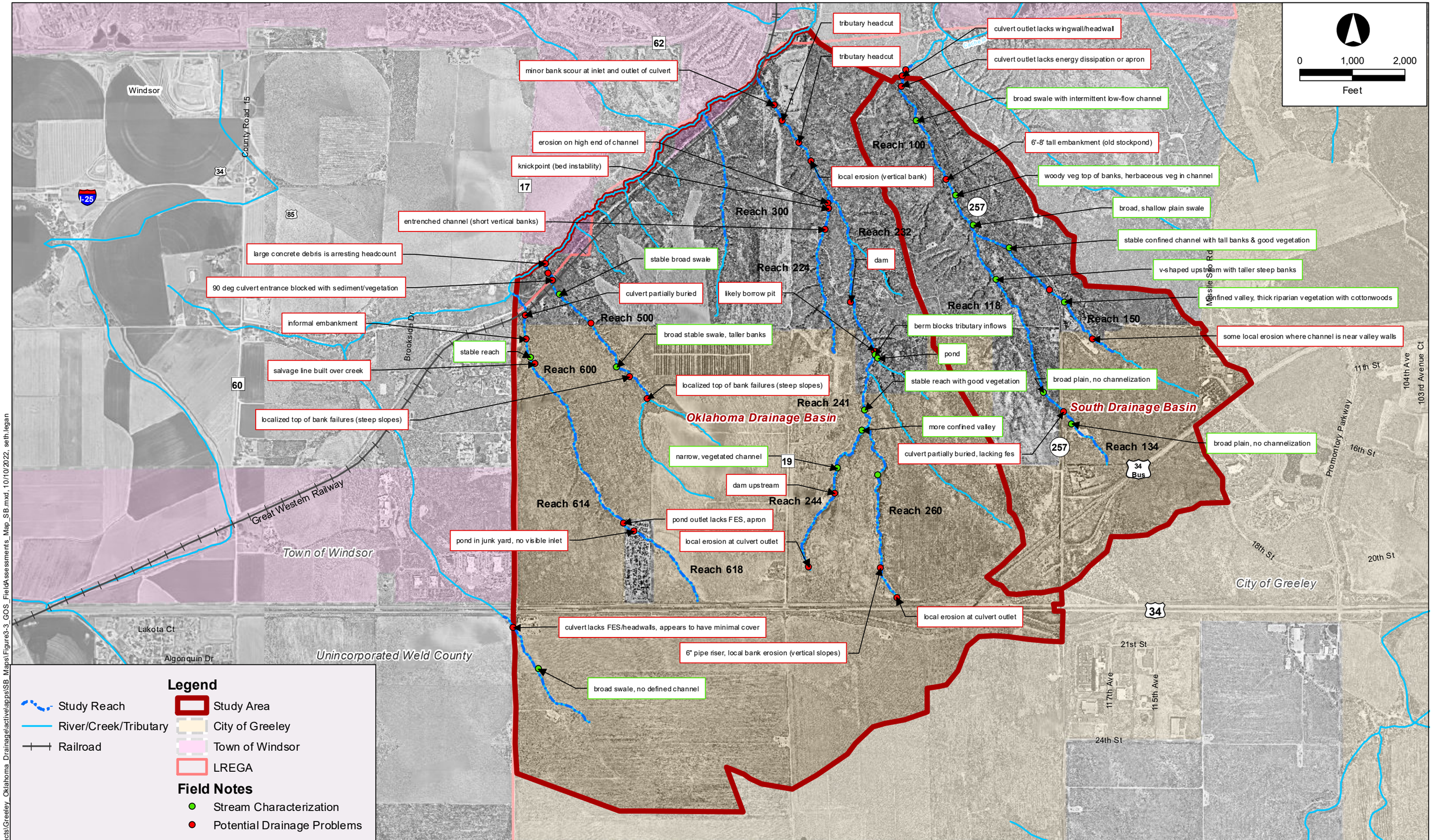
There are no existing mapped floodplain hazards within the study area. This study did not include detailed river hydraulics or flood mapping, but it did include the development of Relative Elevation Models (REMs) for all major drainageways. REMs are a visualization tool derived from a Digital Elevation Model (DEM) of the existing topography (2018 LiDAR for this study). Matrix produced REMs by defining the thalweg (lowest elevation within the channel) for each desired drainageway then calculating the relative elevation of the surrounding cells to that thalweg as one moves up and down the reach. For a more detailed discussion of how to create REMs, please refer to of the *Colorado Fluvial Hazard Zone Delineation Protocol Appendix C: Relative Elevation Model (REM) Guidance* (CWCB, 2020).

The REM output is shown in Figure E-4 in Appendix E. REMs can be used to more easily identify fluvial signatures such as alluvial terraces, relic channel/meander scars, and floodplain surfaces. In addition to the raw REM grids, Matrix created polygons that represented depth thresholds of 1-foot and 3-feet. These polygons, shown in Figures E-1 through E-3 of Appendix E, can be used as an approximation of the extents of 1-foot and 3-feet flood inundation, which roughly correspond to areas that are most likely to be subjected to concentrated flows during runoff events.

Figure 3-3 presents the observations made during field assessments. Observations were grouped into two categories: stream characterization and potential drainage problems. Detailed geomorphic analyses were not performed as part of this study, but the general health and shape of existing flood valleys were noted. Most of the drainageways observed within the study area appeared to be relatively stable – identified potential drainage problems were usually localized issues such as erosion at concentrated flow areas or existing culverts that lacked appropriate end treatments.

3.2.3 Previous Analyses

No previous hydraulic analyses of the study reaches were identified.



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No.	DATE	DESCRIPTION	APPR.

Matrix
Excellence by Design

designed by:
drawn by: SL
checked by: BL
project no.: 22.906.007
date: 10/07/2022

Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA & SOUTH BASINS

Field Assessment Map

Figure
3-3

3.3 Alternatives Analysis

3.3.1 Action Plan

Alternative Development Process

Alternative options were selected based on applicability, effectiveness, and ease of implementation. Matrix evaluated four broad classes of alternatives for every reach in the study area.

The first alternative considered was a 'no action' option. This alternative is useful for identifying existing reaches that may be stable under future flows and provides a baseline to compare other alternatives against.

The second alternative considered was detention because it can be scaled up or down based on watershed needs. Detention basins are effective at reducing the peak flows on receiving channels and can reduce or eliminate the need for channel improvements and stabilization in receiving channels. Detention basins can also provide water quality treatment to reduce pollutants that reach the Cache la Poudre River. Potential drawbacks of detention basins are the large footprint and maintenance requirements, but advanced planning and budget prioritization can minimize these concerns.

The third option considered was channel improvements. Channel improvements were defined as establishing channel geometry that can convey the 100-year event in a non-erosive manner. Channel improvements are useful for addressing reach instability at either a reach or watershed level. Channel improvements also provide the opportunity to make stream corridors into a community asset by building trail networks, parks, and open spaces.

The fourth alternative considered was implementing low impact development (LID) practices within the study area. LID, also known as green infrastructure, encompasses a wide suite of practices including bioretention/rain gardens, vegetated/green rooftops, rain barrels, permeable pavement, grass swales, and vegetated buffers. This planning study focused on vegetated buffers, which are gently sloping, grass or other dense vegetation strategically placed to break up impervious areas. Disconnecting paved areas slows runoff and increases infiltration, filters out sediment and pollutants, and reduces peak flows. Incorporating LIDs on developed land can reduce the need for structural improvements such as detention and large flood channels.

Various combinations of the alternatives presented above were evaluated in this analysis. The methods and results are discussed below.

3.3.2 Policy Recommendations

Implementing a comprehensive drainage plan along each major drainageway is necessary to achieve the sponsor goals. Isolated proposed improvements described in this study should not be constructed without considering the performance entire drainageway. For example, if a particular channel improvement is located downstream of a reach with recommended regional detention, the upstream detention must be in operation or the downstream channel will be undersized.

Multiple alternatives are presented in this report, and an alternatives evaluation matrix used to compare the benefits and drawbacks of each alternative for each reach. The highest scoring alternatives become the recommended alternatives for long-range implementation.

3.3.3 Alternatives Criteria

Major drainageways 100, 200, 300, 500, 600, and 800 were evaluated comprehensively so that the effects of upstream alternatives on downstream reaches could be determined. Combinations of the alternatives were formed into four Options. Option 1 considered only the do nothing alternative for each reach within a drainageway. Option 2 included detention and if necessary, channel improvements. Option 3 considered only using channel improvements to address reach stability. Lastly, Option 4 assumed watershed wide LID implementation and included channel improvements as necessary. The assumptions and criteria used for each alternative category are discussed below.

Do Nothing

This alternative evaluated channel stability with future hydrology if no action is taken.

Detention

Regional in-line, full spectrum extended detention basins were assumed for this analysis. Full spectrum detention (FSD) refers to a design process that seeks to control both the 100-year flood and smaller, more frequent storm events. FSD basins typically feature multistage outlet works to achieve multiple goals. Proposed detention basins were designed to reduce the future peak flow to match the existing peak flow.

Channel Improvements

Proposed channel improvements assumed a trapezoid cross section with 5H:1V side slopes. The bottom width of the channel was widened until the average 100-year velocity was below 5 ft/s. Per MHFD criteria, 1.5' of freeboard was assumed and included in corridor width recommendations.

Detention & Channel Improvements

Both detention and channel improvements were considered for this analysis.

Low Impact Development (LID)

Low impact development was defined as grass buffers between paved areas to slow runoff velocities and increase infiltration. LID practices were assumed to be applied to all new development areas.

3.3.4 Alternatives Modeling

Different combinations of the four alternatives presented above were evaluated for each major drainageway using the Environmental Protection Agency Stormwater Management Model (SWMM) version 5.1 software. The kinematic wave flow routing method was used in SWMM to perform hydraulic calculations. A summary of the alternative options and where each option was considered is provided in Table 3-13.

Table 3-13 Alternative Options Descriptions

Option No.	Option Description	Major Drainageway					
		100	200	300	500	600	800
1	Do Nothing except crossing structure upgrades	X	X	X	X	X	X
2A	Detention in all major tributaries and channel improvements	X	X		X	X	X
2B	Detention in one major tributary and channel improvements	D134	D268				
2C	Detention in one major tributary and channel improvements	D150	D248				
3	Channel only improvements	X	X		X	X	X
4	LID and channel improvements	X	X		X	X	X

As shown above, multiple configurations of detention alternatives (2B and 2C) were only considered for the largest major drainageways, 100 and 200. All of the options except 1 (Do Nothing) include some form of channel improvements, although the channel improvements may differ between each option. The specific methods used for modeling each alternative are discussed below.

Option 1 – Do Nothing

Future 100-year flows were used for the SWMM input hydrology. Hydraulic inputs for the nodes and links matched the existing and future conditions SWMM models. A channel threshold 100-year velocity criteria was set at 5 ft/s for the boundary between erosive and non-erosive flows. This threshold is typically appropriate for vegetated channels without hardened erosion protection. If 5 ft/s was exceeded the channel was deemed to be inadequate to convey future flows and no action was not considered a viable option.

Option 2 – Detention

The Mile High Flood District (MHFD) Detention workbook version 4.06 was used to design the detention basins. The workbook has an integrated CUHP model that runs and determines the necessary volume to detain. For consistency, the same CUHP inputs used to develop the hydrology were used in the detention basin worksheets. When this was not possible the inputs were kept as close as possible.

The basins were designed for full spectrum detention and had three zones: water quality capture volume (WQCV), excess urban runoff volume (EURV), and the 100-year event. The design 100-year depth for the detention basins was six feet to avoid additional requirements associated with jurisdictional dams. The WQCV, EURV, and 100-year outlet structures were assumed to be an orifice plate, vertical orifice, and weir and pipe with a restrictor plate respectively. The target release time for the 100-year event was 72 hours. Once the basin and outlet structures had been properly sized the storage curve and rating curve were imported into the SWMM model. Table 3-14 summarizes the proposed detention basin alternatives. Detailed outputs from the MHFD Detention worksheets are in Appendix E.

Table 3-14 Detention Basin Summary

Detention Facility No.	Reach Location	Contributing Subbasins	Storage Volume (acre-feet)	Drainage Area (acre)	Proposed Detention Facility (Q100 Future Sizing)		
					Size (acre)	Peak Inflow (cfs)	Peak Outflow (cfs)
D150	150	150/154	12.9	148.9	3.9	400	214
D134	134	134	16.2	136.7	5.2	469	211
D248	244	248/250	18.8	140.2	7.1	509	194
D268	260	264/268	16.0	127.4	5.4	348	152
D510	510	514/518	18.4	168.3	6.0	456	230
D618	618	618/622	21.2	156.6	8.0	544	214
D814	814	814/818	25.4	210.6	12.0	646	258

Where possible detention facilities were placed to take advantage of existing topographic features such as roadway embankments or partially enclosed areas. Typically, these features were undersized but could be expanded to meet detention needs.

Option 3 – Channel Improvements

Channel improvements were modeled in SWMM. A trapezoid with 5H:1V side slopes and a varying bottom width was assumed for channel geometry. Other link inputs were not changed. Channel size was based on meeting the threshold velocity criteria of 5 ft/s. The reported channel top widths for each alternative include 1.5 feet of freeboard per MHFD criteria. The peak discharge in each reach is dependent on upstream conditions.

For this alternatives analysis, simple trapezoidal cross sections with 5:1 (H:V) side slopes and existing longitudinal slopes were assumed. Multistage channels and grade control structures should be considered during subsequent design. A multistage section generally results in greater stream stability and is more aesthetically pleasing. However, going from a simple trapezoid to a multistage section does not drastically reduce the required corridor width since the 100-year storm event still needs to be spread out over a similar area to the simple trapezoid. Figure 3-4 depicts the modeled trapezoid channel configuration (solid lines) and also the potential bankfull and flood terrace stages (dashed lines). Future grade control could reduce longitudinal slopes and increase proposed flood depths if desired. Table 3-18 summarizes the required channel top width for each option and depth of flow during the 100-year event.

Option 4 – LID

LIDs were assumed to be grass buffers that would be implemented in parcels zoned with a developed land use. The impact of LIDs on watershed hydrology was evaluated by changing the directly connected impervious area (DCIA) input option in CUHP from 0 to 1. The DCIA input accepts 0, 1, and 2 indicating different levels of LID implementation. 0 indicates no LIDs are used, 1 indicated grass buffers or similar are used, and 2 reflects conveyance-based LIDs such as grass swales are used. To be conservative and not overestimate implementation of LIDs a DCIA values of 1 was entered for all subbasins. These LID-modified CUHP inputs and outputs are included in Appendix E.

LID practices alone did not reduce peak flows of larger storm events very much, so EURV and flood control (100-year event) detention ponds were sized in conjunction with the LID-modified CUHP results. These detention ponds were generally smaller than the regional detention ponds described in Option 2. A subsequent SWMM model was created using the revised CUHP outputs and detention rating curves developed in the MHFD detention workbooks (see Appendix E for detention workbook results) for each study reach to evaluate channel velocities and determine if further action was needed.

Table 3-15 LID Detention Basin Summary

Detention Facility No.	Reach Location	Contributing Subbasins	Drainage Area (acre)	% Future Imperv.	EURV Ponds				Flood Control (100-Yr) Ponds			
					Storage Volume (acre-feet)	Size (acre)	Peak Inflow (cfs)	Peak Outflow (cfs)	Storage Volume (acre-feet)	Size (acre)	Peak Inflow (cfs)	Peak Outflow (cfs)
D121	N/A (upstream of 118)	122/126	143.0	37%	6.2	4.0	248	245	-	-	-	-
D134	134	134/138	136.6	63%	11.2	6.0	465	376	5.4	1.1	376	210
D146	N/A (upstream of 142)	146	39.6	29%	1.1	0.6	48	48	-	-	-	-
D150	150	150/154	148.8	40%	7.2	4.2	398	369	4.0	0.8	369	249
D225	224	226/228	127.2	43%	6.3	4.1	294	277	-	-	-	-
D236	N/A (upstream of 232)	236	60.0	31%	2.1	1.2	104	105	-	-	-	-
D244	N/A (Upstream of 244)	244	90.4	54%	5.9	3.5	235	213	-	-	-	-
D245	244	248/250/252	203.3	71%	18.8	10.9	679	509	10.3	1.8	509	266
D256	N/A (Upstream of 239)	256	93.7	44%	5.0	3.2	180	168	-	-	-	-
D263	260	264/268	127.3	62%	9.8	5.0	349	302	6.6	1.1	302	137
D510	N/A (Upstream of 500)	514/518	168.3	57%	12.8	7.6	453	382	7.5	1.3	382	210
D614	N/A (Upstream of 600)	614	100.3	52%	6.6	4.2	319	284	-	-	-	-
D618	618	618/622	156.6	75%	14.2	7.1	544	415	6.8	1.3	415	234
D810	N/A (Upstream of 800)	810	63.9	77%	5.8	3.1	199	166	-	-	-	-
D814	800	814/818	210.5	65%	28.5	10.1	645	327	2.4	0.6	327	282

The hydraulic results and required channel parameters for each option are shown in Table 3-16, Table 3-17, and Table 3-18, and discussed below. Note that three separate detention scenarios were explored for major drainageways with significant tributaries: 2A represents the scenario where regional drainage features are proposed in all tributaries, 2B and 2C represent scenarios where regional drainage features are proposed in only one of the tributaries. Preliminary 100-year (future flows) sizing of crossing structures under each alternative Option is presented in Table 3-19.

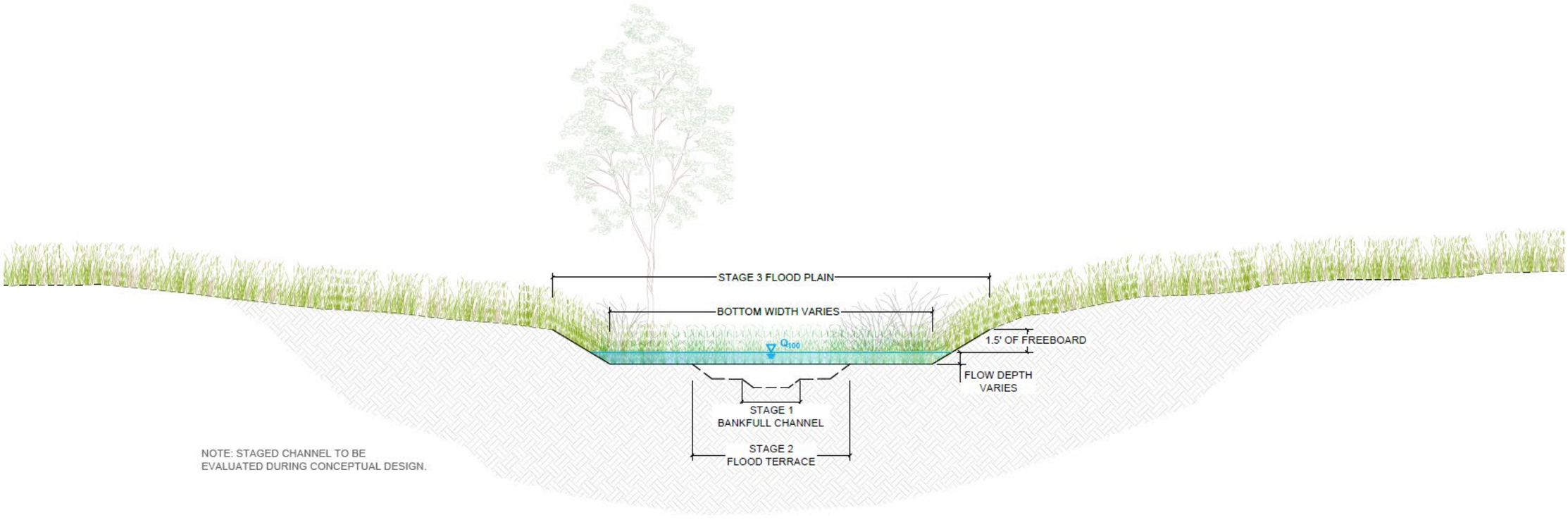

Figure 3-4 Typical Channel Cross Section

Table 3-16 100-Year Channel Velocities

100-YR Velocity (ft/s)								
Reach	SWMM Link	Existing	Option 1 Do Nothing	Option 2A Detention	Option 2B Detention	Option 2C Detention	Option 3 Channel Improvements	Option 4 LID
134	L_138	4.6	5.8	5.0	5.0	5.0	5.0	4.2
150	L_154	4.9	6.0	5.0	5.0	5.0	5.0	5.0
118	L_119	8.7	10.0	5.0	5.0	5.0	5.0	5.0
142	L_149	7.4	8.5	5.0	5.0	5.0	5.0	5.0
100	L_115	5.3	6.2	5.0	5.0	5.0	5.0	5.0
263	L_263	6.7	8.6	5.0	5.0	5.0	5.0	4.8
245	L_245	9.8	12.4	4.9	5.0	5.0	5.0	4.6
241	L_241	7.5	9.4	4.9	4.9	5.0	4.9	4.7
239	L_239	6.5	8.3	5.0	4.9	4.9	4.9	4.8
235	L_235	6.4	8.2	5.0	5.0	5.0	5.0	4.8
225	L_225	5.9	6.8	5.0	5.0	5.0	5.0	4.8
200	L_221	7.1	8.3	5.0	5.0	4.9	4.9	4.9
300	L_314	4.7	4.9	4.9	-	-	4.9	4.8
500	L_513	4.8	6.3	4.9	-	-	5.0	4.7
618	L_622	5.3	6.8	5.0	-	-	5.0	5.0
614	L_617	4.8	6.6	4.6	-	-	5.0	4.7
600	L_613	4.7	6.3	4.5	-	-	5.0	4.6
800	L_813	4.9	6.0	4.8	-	-	5.0	4.9

Note: red values exceed 5 ft/s

Table 3-17 100-Year Channel Discharges

100-YR Peak Flows (cfs)								
Reach	SWMM Link	Existing	Option 1 Do Nothing	Option 2A Detention	Option 2B Detention	Option 2C Detention	Option 3 Channel Improvements	Option 4 LID
134	L_138	172	316	312	312	312	312	305
150	L_154	179	307	304	304	304	304	302
118	L_119	476	768	470	470	755	755	462
142	L_149	268	400	214	396	214	396	249
100	L_115	830	1,233	780	834	930	1,196	806
263	L_263	171	347	151	151	338	338	136
245	L_245	299	669	304	615	304	614	261
241	L_241	676	1,342	632	928	817	1,263	561
239	L_239	772	1,524	763	1,104	980	1,439	680
235	L_235	869	1,634	864	1,195	1,100	1,510	770
225	L_225	202	295	293	293	293	293	265
200	L_221	1,277	2,139	1,253	1,657	1,562	1,961	1,113
300	L_314	149	161	161	-	-	161	159
500	L_513	211	438	228	-	-	428	208
618	L_622	148	352	351	-	-	351	350
614	L_617	235	542	213	-	-	528	233
600	L_613	393	806	344	-	-	765	365
800	L_813	287	648	258	-	-	648	281

Table 3-18 Proposed Channel Geometry

Reach No.	Reach Length (LF)	Do Nothing - Option 1		Option 2A		Option 2B		Option 2C		Option 3		Option 4	
		Top Width (FT)	Depth (FT)	Top Width (FT)	Depth (FT)	Top Width (FT)	Depth (FT)	Top Width (FT)	Depth (FT)	Top Width (FT)	Depth (FT)	Top Width (FT)	Depth (FT)
100	3,825	128	1.9	142	1.3	151	1.3	165	1.3	213	1.3	146	1.3
118	3,956	29	4.2	114	1.0	114	1.0	175	1.0	175	1.0	114	1.0
134	1,484	76	1.0	108	0.7	108	0.7	108	0.7	108	0.7	83	1.1
142	2,056	47	1.4	90	0.6	154	0.6	90	0.6	154	0.6	101	0.6
150	1,624	68	1.0	101	0.7	101	0.7	101	0.7	101	0.7	101	0.7
200	2,660	88	4.5	172	1.7	231	1.6	221	1.6	281	1.6	170	1.5
224	3,249	50	1.0	111	0.6	111	0.6	111	0.6	111	0.6	111	0.6
232	3,417	120	1.9	214	0.9	294	0.9	269	0.9	374	0.9	213	0.8
239	412	90	2.3	165	1.0	245	1.0	225	1.0	315	1.0	165	1.0
241	1,057	51	3.8	127	1.2	177	1.2	152	1.2	237	1.2	100	1.1
244	3,401	29	3.3	131	0.6	246	0.6	126	0.6	250	0.5	130	0.5
260	3,766	33	1.7	62	0.7	62	0.7	122	0.7	122	0.7	62	0.7
300	2,730	53	0.7	-	-	-	-	-	-	-	-	-	-
500	3,468	69	1.3	69	0.9	-	-	-	-	116	0.9	69	0.9
600	3,725	120	1.3	117	0.8	-	-	-	-	202	0.9	120	0.8
614	1,771	97	1.0	95	0.6	-	-	-	-	184	0.6	97	0.6
618	1,992	49	1.5	123	0.7	-	-	-	-	123	0.7	123	0.7
800	2,749	56	3.3	56	2.3	-	-	-	-	121	1.2	63	2.4

Notes: Top Width and Depth reflect future 100-yr flood widths and depths, Top Width includes 1.5-ft of freeboard

Table 3-19 Proposed Crossing Structures

Structure Number	Reach Number	Structure Size/Type						Design Q100 Capacity (CFS)[a]					
		Option 1	Option 2A	Option 2B	Option 2C	Option 3	Option 4	Option 1	Option 2A	Option 2B	Option 2C	Option 3	Option 4
101	100	3 -12'x5' CBC	2 -12'x4' CBC	2 -12'x4' CBC	2 -14'x4' CBC	3 -12'x5' CBC	3 -12'x4' CBC	1,460	780	780	930	1,196	990
102	100	2 - 10'x6' CBC	2 - 10'x6' CBC	2 - 10'x6' CBC	2 - 10'x6' CBC	2 - 10'x6' CBC	2 - 10'x6' CBC	1,389	780	780	930	1,196	990
103	142	1 -8'x5' CBC	1 - 6'x4' CBC	1 - 6'x4' CBC	1 - 6'x4' CBC	1 -8'x5' CBC	1 - 6'x5' CBC	401	214	214	214	396	249
104	134	1 -10'x5' CBC	1 - 6'x3' CBC	1 - 6'x3' CBC	1 -10'x5' CBC	1 -10'x5' CBC	1 - 6'x5' CBC	473	211	211	444	444	209
201	200	3 - 12'x5' CBC	2 - 11'x4' CBC	2 - 12'x5' CBC	2 - 12'x5' CBC	3 - 12'x5' CBC	2 - 8'x6' CBC	2,273	1,364	1,784	1,686	2,087	1,208
202	260	1 - 6'x3' CBC	1 - 6'x3' CBC	1 - 6'x3' CBC	2 - 7'x3' CBC	1 - 6'x3' CBC	2 - 4'x3' CBC	158	156	156	156	158	157
203	260	1 - 48" RCP	1 - 48" RCP	1 - 48" RCP	1 - 48" RCP	1 - 48" RCP	2 - 4'x3' CBC	158	158	158	158	158	157
301	300	1 - 8'x3' CBC	1 - 8'x3' CBC	1 - 8'x3' CBC	1 - 8'x3' CBC	1 - 8'x3' CBC	1 - 8'x4' CBC	270	270	270	270	270	2670
501	500	1 - 8'x5' CBC	1 - 8'x5' CBC	-	-	1 - 8'x5' CBC	2 - 8'x5' CBC	438	226	-	-	428	336
601	600	1 - 10'x6' CBC	1 - 8'x5' CBC	-	-	1 - 10'x6' CBC	2 - 8'x4' CBC	950	344	-	-	765	481
602	600	2 - 8'x5' CBC	1 - 8'x4' CBC	-	-	2 - 8'x5' CBC	1 - 8'x6' CBC	950	344	-	-	765	481
603	614	1 - 12'x5' CBC	1 -7'x3' CBC	-	-	1 - 12'x5' CBC	1 -6'x5' CBC	542	213	-	-	528	234
801	800	2 - 9'x5' CBC	1 - 8'x4' CBC	-	-	2 - 9'x5' CBC	1 - 9'x5' CBC	845	258	-	-	648	362

a. Crossing structures designed to convey expected future condition flows (Q100).

Major Drainageway 100

Option 1 was considered infeasible because all the reach velocities significantly exceeded 5 ft/s. Thus, improvements are needed to ensure the reach is stable under future conditions.

Major drainageway 100 is divided by SH-257 in Reach 134 and Reach 150. This creates a natural barrier that could be well suited for a detention basin. Additionally, Reaches 134 and 150 are located in the upstream portion of drainageway 100 and detention higher in the watershed allows downstream reaches to be designed for smaller peak flows. Option 2 was split into Option 2A, 2B, and 2C to model the effects of placing detention in both reaches, reach 134 alone, or reach 150 alone respectively. As seen in, Option 2A reduces peak flows more than Option 2B or 2C but all detention options still require channel improvements to protect against erosive velocities.

Option 3 has the largest channel corridors because there is no peak flows reduction.

Option 4 incorporates LIDs in developed areas of the watershed to provide water quality and minor flow reduction. Option 4 also incorporates regional flood control basins at the same two locations as Option 2A, plus four smaller EURV basins where tributaries reach major drainageway. With these detention improvements, in-channel flows are reduced to similar levels as Option 2A allowing for narrower channel corridors than Option 3.

Major Drainageway 200

Option 1 was considered infeasible because all the reach velocities significantly exceeded 5 ft/s in both existing and future conditions. Thus, improvements are needed to ensure the reach is stable under future conditions.

Option 2 was divided into Option 2A, 2B, and 2C to consider placing detention in both Reach 248 and Reach 268, only in Reach 248, and only in Reach 268 respectively. As seen in, Option 2A reduces peak flows more than Option 2B or 2C but all detention options still require channel improvements to protect against erosive velocities.

Option 3 has the largest channel corridors because there is no peak flows reduction.

Option 4 incorporates LIDs in developed areas of the watershed to provide water quality and minor flow reduction. Option 4 also incorporates regional flood control basins at the same two locations as Option 2A, plus five smaller EURV basins where tributaries reach major drainageway. With these detention improvements, in-channel flows are reduced to similar levels as Option 2A allowing for narrower channel corridors than Option 3.

Major Drainageway 300

Option 1 is an acceptable option for drainageway 300. Even with future flows the existing channel can convey the 100-year peak flow without exceeding 5 ft/s. Because no action is needed, no other options were evaluated. Note that the existing channel is sufficient largely because much of the contributing area for drainageway 300 is expected to be kept undeveloped as shown in the *2060 Comprehensive Plan.* If future land uses change Reach 300 should be reevaluated.

Major Drainageway 500

Option 1 was considered infeasible because velocities exceeded 5 ft/s. Thus, improvements were needed to ensure the reach is stable under future conditions.

Option 2 considered placing a detention basin in the upper portion of Reach 500. This detention basin reduced peak flows to pre-development levels. The channel velocities are below 5 ft/s with existing flows, so no additional channel improvements were needed in Option 2.

Option 3 requires a channel corridor width approximately double of other options to convey the 100-year event.

Option 4 incorporates LIDs in developed areas of the watershed to provide water quality and minor flow reduction. Option 4 also incorporates a regional flood control basin at the same location as Option 2, plus one smaller upstream EURV basin. With these detention improvements, Option 4 showed that LIDs reduce peak runoff enough so that downstream channel improvements are not needed.

Major Drainageway 600

Option 1 was considered infeasible because velocities exceeded 5 ft/s. Thus, improvements were needed to ensure the reach is stable under future conditions.

Option 2 considered placing a detention basin in Reach 618. This detention basin reduced peak flows to pre-development levels in downstream reaches. The channel velocities in Reach 614 and Reach 600 were below 5 ft/s with existing flows, so no additional channel improvements were needed on those reaches. However, existing flows in Reach 618 were above 5 ft/s so channel improvements were proposed for Reach 618.

Option 3 has the largest required channel corridors because there was no peak flow reduction.

Option 4 incorporates LIDs in developed areas of the watershed to provide water quality and minor flow reduction. Option 4 also incorporates a regional flood control basin at the same location as Option 2, plus two smaller upstream EURV basins. With these detention improvements, Option 4 reduces peak runoff enough to pre-development levels, however, minor channel improvements on Reach 618 were needed.

Major Drainageway 800

Option 1 was considered infeasible because velocities exceeded 5 ft/s. Thus, improvements were needed to ensure the reach is stable under future conditions.

Option 2 considered placing a detention basin in the upper portion of Reach 800. This detention basin reduced peak flows to pre-development levels. The channel velocities are below 5 ft/s with existing flows, so no additional channel improvements were needed in Option 2.

Option 3 requires a channel corridor width approximately double of other options to convey the 100-year event.

Option 4 incorporates LIDs in developed areas of the watershed to provide water quality and minor flow reduction. Option 4 also incorporates a regional flood control basin at the same location as Option 2, plus two smaller upstream EURV basins. With these detention improvements, Option 4 reduces peak runoff enough so that no downstream channel improvements are needed.

3.3.5 Alternative Costs

Costs associated with each option were estimated using the MHFD Master Plan Cost version 2.2 workbook. The sections in the cost estimate used in this analysis include:

- Concrete box culverts
- Channel improvements
- Detention/water quality facilities
- Removals
- Landscaping and maintenance improvements
- Special items
- Land acquisition
- Operation and maintenance

The special items category was used for LID options. A user entered unit cost was used for land acquisition and LID items, see Table 3-20 below. All other items used the default unit cost. The construction cost index (CCI) data for the second quarter of 2022 was used to adjust for inflation. The published CDOT CCI for 2022 Q2 was 1.67.

Table 3-20 Special Unit Costs

Item	Unit Cost	Units
Land Acquisition	$ 11,228	Acre

The cost estimate inputs were based on the proposed geometries calculated in the alternatives analysis. Detention costs were estimated based on the basin volume using the 'complete-in-place' option in the workbook. Earthwork volume was used to estimate channel improvements. The area of the detention basin and/or channel corridor was used to estimate the revegetation area. Culvert removal was assumed to be equal to the length of culvert being installed. Culvert improvements were based on the proposed culvert sizes from the HY-8 model. Land acquisition was based on the detention basin and/or channel corridor area required. LID costs were estimated based on acres of developed land use. For detailed cost estimate inputs see the MHFD MP Cost worksheets in the Appendix E.

Cost estimates associated with land acquisition were based on recent (previous 10 years) sales data for Weld County, see Table 3-21. The listed parcels were within and/or adjacent to the project area, and these parcel sales were used to generate an average cost per acre for acquisition cost estimates. Figure E-4 in Appendix shows the location of each reference parcel.

Table 3-21 Weld County Land Sales Data for Project Area

Parcel No.	Land Type	Area (acre)	Date of Sale	Sale Price	Cost/Acre
95702000004	Agricultural	890	3/29/2022	$8,500,000	$ 9,551
95704100010	Agricultural	63	5/25/2021	$ 515,000	$ 8,175
95704100011	Agricultural	45	7/22/2020	$ 375,000	$ 8,333
95709000009	Commercial	18	9/29/2020	$1,000,000	$ 55,556
95709101001	State Assessed	70	10/8/2015	$ 750,000	$ 10,714
95709401002	State Assessed	237	6/29/2016	$2,490,400	$ 10,508
95711002010	Agricultural	21	7/21/2021	$ 900,000	$ 42,857
95711100001	Commercial	21	8/8/2017	$ 475,000	$ 22,619
95711102001	Exempt	15	9/17/2014	$ 490,100	$ 32,673

Table 3-22 summarizes the cost of the alternatives options for each major drainageway. The expected capital costs to improve each drainageway for future 100-year flood protection are discussed below.

Major Drainageway 100

The hydraulic analysis showed that existing channel conditions are erosive and thus channel improvements are necessary even if peak flows are reduced to pre-development levels. Because all options require channel improvements, adding detention does not remove the cost of channel improvements causing Options 2A-2C to be more costly than Option 3. Option 4 has the lowest reported costs because distributed LID and EURV costs (both construction and maintenance) are expected to be borne by developers. Option 4 does include detention costs but these regional detention costs will be much less than Options 2A-2C since the upstream distributed facilities lessen the burden.

Major Drainageway 200

The hydraulic analysis showed that existing channel conditions are erosive and thus channel improvements are necessary even if peak flows are reduced to pre-development levels. Because all options require channel improvements, adding detention does not remove the cost of channel improvements causing Options 2A-2C to be more costly than Option 3. Option 4 has the lowest reported costs because distributed LID and EURV costs (both construction and maintenance) are expected to be borne by developers. Option 4 does include detention costs but these regional detention costs will be much less than Options 2A-2C since the upstream distributed facilities lessen the burden.

Major Drainageway 300

No cost is associated with drainageway 300 since no action is necessary.

Major Drainageway 500

Option 3 is the least expensive option that addresses channel stability. Option 2 is the most expensive due to high capital and maintenance costs. Option 4 has lower reported costs than Option 2 because distributed LID and EURV costs (both construction and maintenance) are expected to be borne by developers. Option 4 does include detention costs but these regional detention costs will be much less since the upstream distributed facilities lessen the burden.

Major Drainageway 600

Option 2 is the most expensive due to high capital and maintenance costs. Option 3 has medium costs and only address channel stability. Option 4 has the lowest reported costs because distributed LID and EURV costs (both construction and maintenance) are expected to be borne by developers. Option 4 does include detention costs but these regional detention costs will be much less than Options 2A-2C since the upstream distributed facilities lessen the burden.

Major Drainageway 800

Option 2 is the most expensive due to high capital and maintenance costs. Option 3 has medium costs and only address channel stability. Option 4 has the lowest reported costs because distributed LID and EURV costs (both construction and maintenance) are expected to be borne by developers. Option 4 does include detention costs but these regional detention costs will be much less than Options 2 since the upstream distributed facilities lessen the burden.

Table 3-22 Alternative Plan Cost Estimate Summary

Major Drainageway	Alternative	Acquisition Capital Cost	Crossing Improvement Capital Cost	Channel Improvement Capital Cost	Regional Detention Capital Cost	50 Year O & M Capital Costs	Total Cost [a]
100	Option 1: Do Nothing except crossing structure upgrades	-	$1,247,712	-	-	$47,400	**$1,761,297**
	Option 2A: Detention (D134 and D150) and channel improvements	$476,067	$574,081	$756,960	$2,216,023	$2,527,450	**$9,247,323**
	Option 2B: Detention (D134 only) and channel improvements	$487,295	$645,871	$982,880	$1,233,662	$2,038,950	**$7,605,568**
	Option 2C: Detention (D150 only) and channel improvements	$500,769	$728,380	$1,271,440	$982,361	$1,876,150	**$7,663,863**
	Option 3: Channel only improvements	$479,436	$833,437	$1,504,000	$0	$1,387,650	**$6,049,333**
	Option 4: LID, detention, and channel improvements [b]	$322,244	$574,081	$824,480	$685,368	$1,402,900	**$5,331,967**
200	Option 1: Do Nothing except crossing structure upgrades	-	$439,189	-	-	$9,500	**$758,316**
	Option 2A: Detention (D248 and D268) and channel improvements	$336,840	$277,221	$219,840	$2,665,320	$3,272,100	**$9,259,094**
	Option 2B: Detention (D268 only) and channel improvements	$572,628	$298,177	$948,760	$1,233,662	$2,382,800	**$7,404,094**
	Option 2C: Detention (D248 only) and channel improvements	$482,804	$363,911	$584,200	$1,446,888	$2,595,750	**$7,358,494**
	Option 3: Channel only improvements	$763,504	$359,162	$1,911,000	-	$1,706,450	**$6,608,231**
	Option 4: LID, detention, and channel improvements [b]	$335,717	$270,341	$308,120	$1,294,584	$2,069,700	**$6,512,363**
500	Option 1: Do Nothing except crossing structure upgrades	-	$154,718	-	-	$8,800	**$272,596**
	Option 2A: Detention (D510) and channel improvements	$70,736	$96,410	-	$1,401,197	$797,900	**$3,465,051**
	Option 3: Channel only improvements	$103,298	$110,246	$206,720	-	$529,000	**$1,223,976**
	Option 4: LID, detention, and channel improvements [b]	$14,596	$96,410	-	$609,216	$134,050	**$1,578,750**
600	Option 1: Do Nothing except crossing structure upgrades	-	$518,248	-	-	$24,100	**$907,712**
	Option 2A: Detention (D618) and channel improvements	$150,455	$319,907	$160,040	$1,614,422	$1,299,700	**$5,059,207**
	Option 3: Channel improvements	$335,717	$470,044	$678,280	-	$1,130,800	**$3,509,545**
	Option 4: LID, detention, and channel improvements [b]	$77,473	$319,907	$160,000	$533,064	$485,600	**$2,859,480**
800	Option 1: Do Nothing except crossing structure upgrades	-	$186,761	-	-	$7,100	**$325,528**
	Option 2A: Detention (D814) and channel improvements	$136,982	$84,042	-	$1,934,261	$1,535,150	**$5,157,675**
	Option 3: Channel only improvements	$62,877	$168,084	$180,320	-	$307,850	**$990,870**
	Option 4: LID, detention, and channel improvements [b]	$6,737	$84,042	-	$152,304	$82,250	**$529,007**

a. Total cost also includes mobilization, stormwater management/erosion control, engineering, legal/administration, construction management, and contingency estimates
b. Costs only reflect Greeley responsibilities; distributed LID and EURV costs are expected to be borne by developers

3.3.1 Alternative Plans

In addition to the quantitative results presented in previous sections, qualitative aspects of the local area should also be considered when selecting the most appropriate alternatives. Refer to Figure 3-3 for potential drainage issues noted during the field assessment. These potential issues can sometimes also be opportunities, especially since specific locations that have notable existing hazards should be prioritized when planning capital projects. See Table 3-23 for a summary of qualitative drainage issues and opportunities in each reach.

Table 3-23 Potential Drainage Issues and Opportunities

Major Drainageway	Reach Number	Problems	Opportunities
100	Reach 100	Severe erosion downstream of reach (1) Undersized minor roadway crossing structure (1) Missing end sections at crossing structure Stock pond embankment blocks drainageway	Lower channel and private road culvert to reduce downstream erosive forces Improve crossing capacity at private road Protect channel bed at SH-257 Formalize and expand existing stock pond into regional detention
	Reach 134	(1) Undersized major roadway crossing structure	Improve crossing capacity at SH-257
	Reach 150	(1) Undersized major roadway crossing structure Local erosion at edge of channel	Improve crossing capacity at SH-257 Stabilize banks through erosion-resistant materials or flatten bank slope
200	Reach 200	(1) Undersized minor roadway crossing structure (2) Headcuts at tributary confluences Localized bank erosion	Improve crossing capacity at private road Stabilize banks through erosion-resistant materials or flatten bank slope
	Reach 224	Knickpoints (bed instability) Entrenched low-flow channel	Stabilize channel through bed protection, low-flow channel definition, or grade control structures
	Reach 232	Existing embankment blocks drainageway Existing borrow pit in channel Existing berm blocks tributary flows from joining reach	Formalize and expand existing embankments into regional detention
	Reach 244	Existing embankment blocks drainageway Erosion at crossing culvert outlet	Formalize and expand existing embankment into regional detention Protect channel bed downstream of US-34
	Reach 260	Localized bank erosion Erosion at crossing culvert outlet	Stabilize banks through erosion-resistant materials or flatten bank slope Protect channel bed downstream of US-34
500	Reach 500	Concrete debris arresting headcut (1) Undersized railroad crossing structure Localized bank erosion	Formalize erosion protection between Oklahoma Drainageway and GWR Improve crossing capacity at GWR and/or formalize upstream detention Stabilize banks through erosion-resistant materials or flatten bank slope
600	Reach 600	(1) Undersized railroad crossing structure (1) Undersized minor roadway crossing structure Informal embankment blocks drainageway Localized bank erosion	Improve crossing capacity at GWR and private road Formalize detention upstream of private road and/or informal embankment Stabilize banks through erosion-resistant materials or flatten bank slope
	Reach 614	(1) Missing end sections at crossing structure	Protect embankment and channel bed downstream of salvage yard pond
800	Reach 800	(1) Undersized major roadway crossing structure	Improve crossing capacity at WCR-17

3.3.2 Results of Analysis

Benefit Cost Analysis

There are no regulatory floodplains within the study area, and subsequently no habitable structures within a Special Flood Hazard Area. A benefit cost analysis was not completed with this study.

Evaluation of Alternatives

The alternative options were evaluated based on the cost of improvements, hydraulic calculations and future operations and maintenance of the future stream corridors. They were also evaluated on qualitative aspects, including public safety, water quality enhancement, land use context, surrounding land redevelopment potential, and anticipated general acceptance by the community. The feasibility of each alternative with respect to qualitative aspects was evaluated based upon the hydraulic analysis of the 100-year flood. The recommended alternative provides the highest benefit when considering both quantitative and qualitative aspects of the project.

The following eight qualitative aspects were considered in the alternatives analysis:

Constructability	Public Safety
Maintenance	Habitat and Environment
Meets Multiple Objectives	Aesthetics
Water Quality	Criteria Compliance

The listed categories above were used to evaluate each alternative option on a scoring of: 0-no opportunity, 1-minimal opportunity, 2-average opportunity, and 3-high opportunity. Note that “Meets Multiple Objectives” refers to the estimated ability to serve desirable functions other than flood control, such as trails, parks, or other community amenity. A summary of the alternatives screening scores is presented in Table 3-24.

Recommended Plan

The restoration objective for these major drainageways is to promote low maintenance stream geomorphology, which is based on improving the function of reach-scale hydrology, hydraulics, and geomorphology. All of the recommended alternatives include channel improvements – successful restoration influences many of the other qualitative aspects by reducing maintenance, improving safety, promoting multi-use facilities, indirectly improving water quality, and protecting habitat and the environment. The goal of the proposed alternatives is to improve the function of the riverine system in future conditions, which is expected to undergo significant urbanization and flow alterations. The following discusses the recommended improvements for each major drainageway to best achieve this goal, and a summary of the recommended plan cost estimates is provided in Table 3-25.

Major Drainageway 100

Option 4 (LID, detention and channel improvements) is the recommended alternative. Both Option 2A (detention and channel improvements) and Option 4 scored highly, but Option 4 is expected to have a lower cost, improved constructability, better coverage of water quality, improved public safety, and better aesthetics than Option 2A. This is mostly due to the distributed nature of Option 4, implementing watershed-wide practices to increase infiltration, evapotranspiration, and reuse of stormwater allows the greatest amount of flexibility and ability to integrate smoothly with the surrounding developments.

Major Drainageway 200

Option 2A (detention and channel improvements) is the recommended alternative. Both Option 2A and Option 4 (LID, detention and channel improvements)) scored highly, but Option 2A is expected to have provide slightly more opportunities to meet multiple objectives, better opportunities to improve wildlife habitats, and improved criteria compliance. The regional detention basins at the heart of Option 2A are expected to provide both flood peak mitigation and multiple other objectives for the surrounding communities.

Major Drainageway 300

Option 1 (do nothing) is the recommended alternative. This smaller reach does not require drainageway improvements to safely convey the anticipated future flows.

Major Drainageway 500

Option 4 (LID, detention and channel improvements)) is the recommended alternative. Both Option 2A (detention and channel improvements) and Option 4 scored highly, but Option 4 is expected to have a lower cost, improved constructability, better coverage of water quality, improved public safety, and better aesthetics than Option 2A. This is mostly due to the distributed nature of Option 4, implementing watershed-wide practices to increase infiltration, evapotranspiration, and reuse of stormwater allows the greatest amount of flexibility and ability to integrate smoothly with the surrounding developments.

Major Drainageway 600

Option 2A (detention and channel improvements) is the recommended alternative. Both Option 2A and Option 4 (LID, detention and channel improvements)) scored highly. Although Options 2A is expected to have the highest cost, it also is expected to provide more opportunities to meet multiple objectives, better opportunities to improve wildlife habitats, and improved criteria compliance over Option 4. The regional detention basin at the heart of Option 2A is expected to provide both flood peak mitigation and multiple other objectives for the surrounding community.

Major Drainageway 800

Option 4 (LID, detention and channel improvements)) is the recommended alternative. Both Option 2A (detention and channel improvements) and Option 4 scored highly, but Option 4 is expected to have a lower cost, improved constructability, improved public safety, and better aesthetics than Option 2A. This is mostly due to the distributed nature of Option 4, implementing watershed-wide practices to increase infiltration, evapotranspiration, and reuse of stormwater allows the greatest amount of flexibility and ability to integrate smoothly with the surrounding developments.

Table 3-24 Alternatives Evaluation Matrix

		Constructability	Maintenance	Meets Multiple Objectives	Water Quality	Public Safety	Habitat and Environment	Aesthetics	Criteria Compliance	TOTAL WEIGHTED AVERAGE
Major Drainageway	**Alternative**	Weighting								Score
		20%	15%	15%	10%	20%	5%	5%	10%	*100%*
100	Option 1: Do Nothing except crossing structure upgrades	3	1	0	0	0	2	1	0	0.90
	Option 2A: Detention (D134 and D150) and channel improvements	1	3	3	2	2	3	2	3	2.25
	Option 2B: Detention (D134 only) and channel improvements	2	3	2	1	2	2	2	2	2.05
	Option 2C: Detention (D150 only) and channel improvements	2	3	2	1	2	2	2	2	2.05
	Option 3: Channel only improvements	2	2	2	0	1	2	3	2	1.65
	Option 4: LID, detention and channel improvements	2	2	2	3	3	2	3	2	2.35
200	Option 1: Do Nothing except crossing structure upgrades	3	1	0	0	0	2	1	0	0.90
	Option 2A: Detention (D248 and D268) and channel improvements	2	3	3	2	2	3	2	3	2.45
	Option 2B: Detention (D268 only) and channel improvements	2	3	2	1	2	2	2	2	2.05
	Option 2C: Detention (D248 only) and channel improvements	2	3	2	1	2	2	2	2	2.05
	Option 3: Channel only improvements	2	2	2	0	1	2	3	2	1.65
	Option 4: LID, detention and channel improvements	2	2	2	3	3	2	3	2	2.35
300	Option 1: Do Nothing except crossing structure upgrades	3	1	2	1	1	2	1	2	1.70
500	Option 1: Do Nothing except crossing structure upgrades	3	1	0	0	1	2	1	0	1.10
	Option 2A: Detention (D510) and channel improvements	1	3	3	2	2	3	2	3	2.25
	Option 3: Channel only improvements	2	2	2	0	2	2	3	2	1.85
	Option 4: LID, detention and channel improvements	2	2	2	3	3	2	3	2	2.35
600	Option 1: Do Nothing except crossing structure upgrades	3	1	0	0	1	2	1	0	1.10
	Option 2A: Detention (D618) and channel improvements	1	3	3	2	2	3	2	3	2.25
	Option 3: Channel improvements	2	2	2	0	2	2	3	2	1.85
	Option 4: LID, detention and channel improvements	1	2	2	3	3	2	3	2	2.15
800	Option 1: Do Nothing except crossing structure upgrades	3	1	1	1	1	2	2	0	1.40
	Option 2A: Detention (D814) and channel improvements	1	3	3	3	2	3	2	3	2.35
	Option 3: Channel only improvements	2	2	2	0	2	2	3	2	1.85
	Option 4: LID, detention and channel improvements	2	2	2	3	3	2	3	2	2.35
		Scoring:	0 - no opportunity		1 - minimal opportunity		2 - average opportunity		3 - high opportunity	

Table 3-25 Recommended Plan Cost Estimate

Major Drainageway	Recommended Alternative	Acquisition Capital Cost	Crossing Improvement Capital Cost	Channel Improvement Capital Cost	Regional Detention Capital Cost	50 Year O & M Capital Costs	Total Cost [a]
100	Option 4: LID, detention and channel improvements [b]	$322,244	$574,081	$824,480	$685,368	$1,402,900	$5,331,967
200	Option 2A: Detention (D248 and D268) and channel improvements	$336,840	$277,221	$219,840	$2,665,320	$3,272,100	$9,259,094
300	Option 1: Do Nothing except crossing structure upgrades	-	$105,325	-	-	$8,800	$114,125
500	Option 4: LID, detention and channel improvements [b]	$14,596	$96,410	-	$609,216	$134,050	$1,578,750
600	Option 2A: Detention (D618) and channel improvements	$150,455	$319,907	$160,040	$1,614,422	$1,299,700	$1,578,750
800	Option 4: LID, detention and channel improvements [b]	$6,737	$84,042	-	$152,304	$82,250	$529,007
Study Totals		**$830,872**	**$1,456,986**	**$1,204,360**	**$5,726,630**	**$6,199,800**	**$18,391,693**

a. Total cost also includes mobilization, stormwater management/erosion control, engineering, legal/administration, construction management, and contingency estimates

b. Costs only reflect Greeley responsibilities; distributed LID and EURV costs are expected to be borne by developers

3.4 Community Indicators

3.4.1 Funding

This is a long-range drainage planning document, and funding for the recommended alternatives has not been determined to our knowledge. Potential funding sources could include City of Greeley capital improvement budgets, stormwater utility fees, and private developer-paid improvements. Federal grants, such as the Building Resilient Infrastructure and Communities (BRIC) program, are also a potential funding source, but historically it has been challenging to demonstrate a sufficient benefit cost analysis for federal grants in undeveloped areas.

Regarding private development cost sharing, there are multiple ways to include developers to protect and enhance these natural drainageways in the future. Distributed options, such as LID, will likely be directly constructed and maintained by the private developments. For regional improvements such as detention basins and channel improvements the costs should be shared by everyone within the watershed instead of just the property where the facility is located. Major drainageways are vital links for the whole community. Greeley could pursue a development fee-in-lieu program for this purpose to allow specialized designers and builders to facilitate and streamline the process.

CHAPTER 4 - THE HOW

4.1 Plan Development Overview

The City of Greeley reviewed the Alternatives Analysis and Recommended Plan presented in Chapter 3, and decided to proceed with Conceptual Design featuring Option 4: LID, detention, and channel improvements for all study reaches. Refer to Appendix A for the Selected Plan letter. The Conceptual Design, also known as the Master Plan, is based on the following principal elements, goals, and objectives.

4.1.1 Mitigation of Flood Hazards

The major problems identified in the Oklahoma and South Basins are due to the expected significant increase in flows under future conditions without mitigation. The Master Plan aims to minimize future increases in flood hazard risk with a policy of targeted major drainageway protection and maintenance, together with the adoption of distributed best practices such as Low Impact Development (LID) and Excess Urban Runoff Volume (EURV) management as properties within the watershed are developed. The proposed stream management corridors and detention basins keep the highest flood risks within the limits of these drainage features.

The Master Plan also proposes increases in the capacity of road and railroad crossings. All but one of the existing major crossings in this watershed are significantly undersized for the 100-year storm event. Undersized culverts may become silted and unable to convey more than the low flow condition, potentially endangering properties located immediately upstream of the crossing embankments. The proposed culverts in the Master Plan are sized to safely convey the 100-year future conditions event.

4.1.2 General Recommendations

This report generally recommends the following:

1. Low Maintenance Stream Design: Preserve a stream management corridor and establish a high functioning and low maintenance stream. The low maintenance stream cross-section and stream management corridor shall be designed by a professional trained in fluvial geomorphology.
2. Crossing Improvements: Increase capacity of all major roadway and railroad crossing structures to convey the Master Plan 100-year flow using culvert structures or bridges. Distributed crossing layouts, where low-flows are conveyed separately from overbank flows, should be implemented in downstream reaches. Our analysis assumed that existing embankment and channel thalweg profiles would be preserved, but future projects could examine grade changes at crossings on an individual basis.
3. New land development and publicly funded projects provide to the maximum extent practicable runoff volume control practices. This includes minimizing directly connected impervious areas, employing infiltrating Best Management Practices (BMPs), and constructing EURV basins.
4. All BMPs for all new development, redevelopment, and publicly funded projects provide to the maximum extent practicable a Water Quality Capture Volume (WQCV).
5. The overall layout of a development that incorporates LID, detention facilities, and channel improvements should promote the contiguous overland connection between the various elements and areas to maximize benefits of these spaces and mitigate wildlife/human conflicts.
6. Development should promote the design of communities that incorporate existing topography and topographic features and minimize oversimplified overlot grading to promote and augment existing stormwater conveyance features and areas.
7. Development to promote stormwater conveyance should incorporate separated “undeveloped spaces” to promote the development and/or preservation of environmentally sensitive areas.
8. Natural or architectural forms and native and natural building materials should be utilized to the maximum extent possible to enhance community cohesivity and cultural character. Natural forms should be promoted over maximizing usable space within a parcel which tends to promote an unnatural square or rectangle shape.
9. Consider sun and aspect and the potential impact these may have on design elements. Incorporate and promote the inclusion and incorporation of shade trees to offer further water quality benefits.
10. Designs should consider in situ soils and incorporate considerations for amendments to increase permeability and vegetation establishment success.
11. Native vegetation should be utilized to the maximum extent possible. Successful designs will include the provision of supplemental watering to support efficient native vegetation establishment.
12. Groundwater explorations should further inform design opportunities.

4.2 Master Plan Description

The recommended plan was chosen based on a combination of quantitative and qualitative measurements. The Master Plan will minimize stormwater and flood-related damages to streams, public infrastructure, and private property. In addition, we recommend approaches to protect and enhance water quality, promote opportunities to allow runoff infiltration, and preserve the natural character of the drainageways and their terrestrial and aquatic habitat resources.

The Master Plan typical cross-section is provided in Figure 6-1. The proposed conceptual plan elements are presented in Figures G-1 through G-3 of Appendix G. The conceptual design was based on the Selected Plan, and the Master Plan improvements are intended to provide flood hazard protection to the community while adhering to the City Greeley drainage criteria. The total estimated cost of proposed capital improvements within the Oklahoma and South Basins is $17,801,705.

The Master Plan analysis generally include the following assumptions:

- CUHP version 2.0.1 with DCIA = 1 option was used to calculate the runoff reduction impact of LID practices on future peak flows. Master Plan CUHP inputs and results are provided in Appendix F-1.
- MHFD-Detention worksheet version 4.06 was used to size detention basins that reduce 100-year peak flows within each major drainageway. To provide greater flexibility for land and phasing requirements, the required EURV and 100-year flood control basins were modeled separately

instead of assuming a single full spectrum detention basin. Output from the detention worksheets is provided in Appendix F-2.

- EPA SWMM version 5.2 was used to analyze future channel stability and size recommended floodplain sections. Master Plan SWMM inputs are included in Appendix F-3, and Master Plan SWMM results are provided in Appendix F-4.
- HY-8 version 7.80.02 was used to determine the number and size of culverts required to convey the Master Plan (future conditions) 100-year peak flows. Current 100-year crossings are assumed to remain in place. The other crossings were sized to provide at least 1-ft of freeboard and a headwater/culvert height ratio less than or equal to 1.5. Master Plan HY-8 inputs and results are included in Appendix F-6.
- The cost summaries for each major drainageway are provided below in Table 4-1. Detailed cost estimates are provided in Appendix F-7.
    - Estimated earthwork quantities for channel improvements did not assume a balanced earthwork system (where soils removed from one location can be used for fill at another location). Balanced earthwork might not be feasible due to project phasing and multiple landowners within most reaches.
    - Estimated quantities to re-vegetate the channel corridor and embankments was based on the square footage of the minimum stream management corridor.
    - Additional capital improvement costs, including engineering (15% of capital improvement cost subtotal), mobilization (5%), stormwater management and erosion control (5%), legal/administrative (5%), contract administration and construction management (10%) were included in the cost estimates. A substantial contingency cost (25% of capital improvement cost subtotal) was also included, but noted that site-specific costs such as dewatering and traffic control were not explicitly defined for this study.
    - Annual maintenance of culverts, channel, regional detention and hydraulic structures was included in the total costs. Distributed LID and EURV basins are not included in the costs.

Table 4-1 Master Plan Cost Estimate Summary

Major Drainageway	Acquisition Capital Cost	Crossing Improvement Capital Cost	Channel Improvement Capital Cost	Regional Detention Capital Cost	Total Capital Cost[a]	50-Year O & M Capital Costs	Total Cost[b]
100	$322,244	$701,976	$824,480	$685,368	$4,250,458	$1,402,900	**$5,653,358**
200	$335,717	$720,515	$308,120	$1,294,584	$4,442,663	$2,069,700	**$6,512,363**
300	-	-	-	-	$659,947	$8,800	**$668,747**
500	$14,596	$220,492	-	$609,216	$1,444,700	$134,050	**$1,578,750**
600	$77,473	$608,849	$160,000	$533,064	$2,373,880	$485,600	**$2,859,480**
800	$6,737	$98,138	-	$152,304	$446,757	$82,250	**$529,007**
ALL	$756,767	$2,349,970	$1,292,600	$3,274,536	$13,618,405	$4,183,300	**$17,801,705**

a. Total cost also includes mobilization, stormwater management/erosion control, engineering, legal/administration, construction management, and contingency estimates

b. Total cost equals includes capital cost plus operations and maintenance costs over 50 years

4.2.1 Vision Statement, Goals, and Objectives

Vision Statement

The vision for the successful implementation of the Oklahoma and South Basins concept design is of a stormwater conveyance system that utilizes LID, detention, and channel improvements to promote stormwater volume reduction and water quality enhancement while achieving flood protection for the 100-year future conditions storm event.

Goals & Objectives

To achieve the vision for the Oklahoma and South Basins concept design, the following goals and corresponding objectives have been identified:

Goal #1 – Implement LID effectively

Objective #1 – Promote development that weaves in LID to uplift stormwater conveyance improvements as a community amenity.

Objective #2 – Provide guidance on LID design criteria that promotes the effective use of regional materials and supports local cultural practices but allows for creative solutions.

Objective #3 – Support long-term maintenance of LID by determining achievable performance criteria and effective planning and budgeting by LID owners.

Goal #2 – Implement stormwater detention effectively

Objective #1 – Reduce future conditions 100-year peak flows and volumes to existing conditions levels.

Objective #2 - Promote development that provides detention facilities that allow for multiple uses of the facility such as a community use area or as preserved wildlife habitat in combination with the stormwater conveyance to uplift stormwater conveyance improvements as a community amenity.

Objective #3 – Support long-term maintenance of detention facilities by determining achievable performance criteria and effective planning and budgeting by detention facility owners.

Goal #3 – Implement channel improvements effectively

Objective #1 – Safely convey future conditions 100-year flows.

Objective #2 - Promote development that uplifts stormwater conveyance improvements into community amenities by realizing the direct and indirect benefits provided by the healthy ecosystems of natural channel systems.

Objective #3 – Support long-term maintenance of channel improvements by determining achievable performance criteria and effective planning and budgeting by channel landowners.

4.2.2 Concept Design Description

This Master Plan envisions the use of a combination of LID, detention facilities, and channel improvements to achieve long-term success in conveying stormwater safely and efficiently. The proposed LID and detention elements work together to reduce future conditions runoff within the major drainageways to levels similar to existing conditions. A comparison of peak flows at major drainageway outfalls and confluences is provided below in Table 4-2. The following sections describe overall guidelines, current elements and practices to employ, definitions of elements, as well as individual guidelines for elements to achieve the concept design.

Table 4-2 Master Plan Peak Flows Summary

Design Point		Existing Conditions	Future Conditions Do Nothing	Future Conditions Concept Design
Number	Type	Q_{100} (cfs)	Q_{100} (cfs)	Q_{100} (cfs)
115	JUNCTION	845	1,278	818
221	JUNCTION	1,282	2,160	1,117
219	JUNCTION	1,401	2,273	1,208
O_100	OUTFALL	1,042	1,446	990
O_210	OUTFALL	90	90	90
O_300	OUTFALL	258	270	267
O_500	OUTFALL	386	613	336
O_600	OUTFALL	525	955	481
O_710	OUTFALL	70	163	163
O_800	OUTFALL	369	848	362

Figure 4-1 LID Single Family Residential Example

LID

LID refers to systems and practices that use or mimic natural processes that result in the infiltration, evapotranspiration, or use of stormwater in order to protect water quality and associated aquatic habitat. This often includes the management of wet weather flows that use these processes, and to refer to the patchwork of natural areas that provide habitat, flood protection, cleaner air, and cleaner water (*Compendium of MS4 Permitting Approaches*, EPA, 2022). LID is the smallest, finest scale of design elements usually implemented successfully at a site-scale. See Figure 4-1 and Figure 4-2 for example sketches from the *Low Impact Design Implementation Manual* (City of Fort Collins, 2017). Maintenance requirements tend to be higher for these elements and are typically owned by an individual owner, Homeowner's Association (HOA), Metropolitan District or similar development group/entity. Operation and maintenance of LID can be split across several beneficiaries which can make for complexity in long-term planning. LID components generally focus on water quality improvements over volume reduction capabilities.

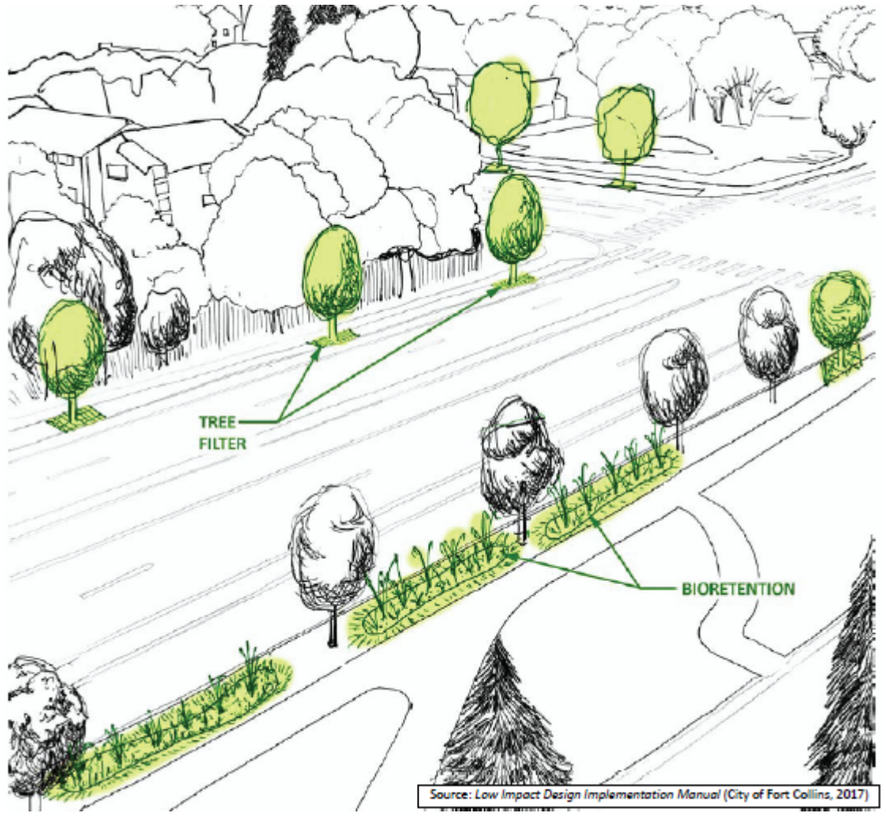

Figure 4-2 LID Street Right of Way Example

The following LID elements are regionally accepted and recommended for use within the Oklahoma and South Basins:

- **Vegetated buffer:** Areas of natural or established vegetation used to improve stormwater runoff quality by slowing down runoff velocity, promoting infiltration, and catching sediment.
- **Vegetated swale:** Ditches or channels that are densely planted with trees, shrubs, or grasses. It's designed to gather any runoff from impervious surfaces, slowing the velocity of the flow as well as filtering sediment that passes through.
- **Curb cut / no-curb:** Openings in a curb that allows stormwater runoff from impervious surfaces, like roads, to enter areas with infiltration.
- **Trench drain:** A gutter like drainage system that is placed into the ground and covered with a grate. They are used to control any excess surface water and direct it to a more desirable location.
- **Bioretention:** A treatment method, which also goes by the name rain garden or porous landscape design, that uses soil and vegetation to remove sedimentation and contaminants and reduce the volume of stormwater runoff.
- **Rain barrel:** Involves storing rain that lands on a roof in a barrel, decreasing runoff and conserving water to later be used for lawns, gardens, or indoor plants.
- **Green roof:** Involves partially or completely covering a roof with vegetation. This can decrease imperviousness and storm runoff.
- **Green alley:** Alleys that use sustainable materials, such as permeable pavement. This allows stormwater filtering to reduce runoff and improve water quality.
- **Permeable pavement:** Porous, or open space material used in the pavement mix that allows stormwater to flow though, decreasing runoff and improving water quality.
- **Greenway corridor:** Corridor of undeveloped land, used for recreational use as well as environmental protection. Helps protect important habitants as well as improving water quality.
- **Sand filter:** A type of filtration basin featuring a clean sand bed, used to treat stormwater.
- **Tree filter:** A concrete box that is placed around a tree root, allowing the soil and roots to filter stormwater and reduce runoff.
- **Retention ponds/ constructed wetland ponds:** A permanent pond that is designed for additional storage capacity for storm events. It helps treat stormwater though sedimentation and biological processes.

LID Guidelines

1. Each development should employ several and varying LID elements to increase water quality improvement potential and community appeal.
2. Operations and maintenance should be an essential element of the planning and design phase.
3. Performance and maintenance criteria should allow for some LID elements to look less "manicured", such as by allowing areas to remain unmowed or allowing standing dead vegetation material to remain overwinter, to allow for important ecosystem processes to take place and to support the cultural acceptance of this landscape appeal.
4. Point sources of stormwater found within a development, such as at rain gutter outlets or storm drain inlets, should be focused on to capitalize on this water source.
5. Utilize a mix of Colorado and North American native plant species that will tolerate both periodic flooding and drought. Nonnative plants generally will not survive without irrigation. See Figure 4-3 for an example.
6. Establish minimal distance from adjacent structures, provide a barrier, or amend in situ soils where soils with moderate to high swelling potential are present.

Figure 4-3 LID Vegetation Example

With so many types of available LID elements, implementers can choose the ones that are most suitable for the character of each development. However, not all types of LID are suitable for every application. A general guide to the applicability of each LID for various proposed land uses is provided below in Table 4-3.

Table 4-3 LID Suitability by Land Use

LID Type	Residential							Multi-Use	Civic	Business Improvement District	Commercial	Industrial
	Single Family			Multi-Family								
	Single Lot	Agriculture Holding	Metro / HOA	Multi Unit	Row	Apartment	Metro					
Vegetated buffer	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Vegetated swale	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Curb cut / No-Curb			YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Trench drain	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bioretention - rain garden	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bioretention - porous landscape design			YES				YES	YES	YES	YES	YES	YES
Rain barrel	YES	YES	YES		YES		YES					
Green roof	YES	YES	YES	YES	YES	YES	YES	YES			YES	YES
Green alley			YES				YES	YES	YES	YES	YES	YES
Permeable pavement	YES	YES	YES	YES	YES	YES	YES					
Greenway corridor			YES				YES		YES	YES		
Sand filter								YES			YES	YES
Tree filter			YES	YES	YES	YES	YES	YES	YES	YES	YES	
Retention ponds/ constructed wetland ponds			YES				YES		YES	YES		

LID Resources

For more detailed discussions of LID design in this region, please refer to the *Urban Storm Drainage Criteria Manual, Volume 3: Stormwater Quality* (MHFD, 2021), *Ultra-Urban Green Infrastructure Guidelines* (City and County of Denver, 2019), and the *Low Impact Design Implementation Manual* (City of Fort Collins, 2017) for guidelines and performance criteria for LID. For additional guidance on LID practices, the Environmental Protection Agency has developed the following recommended documents:

- *Green Infrastructure in Parks: A Guide to Collaboration, Funding, and Community Engagement*, June 2017;
- *Compendium of MS4 Permitting Approaches*, June 2022;
- *Green Streets Handbook*, March 2021;
- *Saving the Rain Green Stormwater Solutions for Congregations*, May 2020.

Stormwater Detention Facilities

Stormwater detention facilities manage stormwater quantity by attenuating peak flows during flood events. Depending on the design, they can also enhance stormwater quality by incorporating design components to promote sedimentation, infiltration, and biological uptake (MHFD, 2017). For the purposes of this study, EURV and 100-year detention facilities should focus on volume reduction capabilities over water quality improvements. A summary of the Master Plan detention sizes and results is provided in Table 4-4.

Table 4-4 Master Plan Detention Summary

Detention Facility No.	Reach Location	Master Plan Detention Facility (100-yr Event Results)							
		EURV Ponds				Flood Control Only Ponds			
		Storage Volume (acre-feet)	Size (acre)	Peak Inflow (cfs)	Peak Outflow (cfs)	Storage Volume (acre-feet)	Size (acre)	Peak Inflow (cfs)	Peak Outflow (cfs)
D121	N/A (upstream of 118)	6.2	4.0	248	245	-	-	-	-
D134	134	11.2	6.0	465	376	5.4	1.1	376	210
D146	N/A (upstream of 142)	1.1	0.6	48	48	-	-	-	-
D150	150	7.2	4.2	398	369	4.0	0.8	369	249
D225	224	6.3	4.1	294	277	-	-	-	-
D236	N/A (upstream of 232)	2.1	1.2	104	105	-	-	-	-
D244	N/A (Upstream of 244)	5.9	3.5	235	213	-	-	-	-
D245	244	18.8	10.9	679	509	10.3	1.8	509	266
D256	N/A (Upstream of 239)	5.0	3.2	180	168	-	-	-	-
D263	260	9.8	5.0	349	302	6.6	1.1	302	137
D510	N/A (Upstream of 500)	12.8	7.6	453	382	7.5	1.3	382	210
D614	N/A (Upstream of 600)	6.6	4.2	319	284	-	-	-	-
D618	618	14.2	7.1	544	415	6.8	1.3	415	234
D810	N/A (Upstream of 800)	5.8	3.1	199	166	-	-	-	-
D814	800	28.5	10.1	645	327	2.4	0.6	327	282

Greeley has a semi-arid environment with rain events tending to be high intensity and infrequent resulting in runoff events that are heavy with sediments and other accumulated pollutants that flush out. Therefore, pretreatment is essential to the long-term functionality of detention basins. The various forms of recommended pretreatment are listed below:

- **Forebays:** Natural or artificial reservoirs used to settle out coarse sediment by dissipating the energy and flow from incoming runoff.
- **Presedimentation/Sedimentation basins:** Preliminary treatment process that is used to remove sediment from the source water though settling.
- **Micropools**: Smaller permanent pools that are built in front of the outflow structure, designed to reduce potential clogging of outlets and minimize resuspension of sediment.
- **Infiltration**: The process of water from the surface flowing into the subsurface. Areas with high amount of infiltration reduce stormwater runoff which helps reduce erosion and maintenance costs.
- **Biological uptake:** Removing organic and inorganic constituents by using plants and microbes.
- **Maintenance path access**: Planned pathway for maintenance vehicles and maintenance personnel to be able to easily access structures to routinely clean them out.

On-Site and Sub-Regional Detention

On-site and sub-regional stormwater detention facilities are a small or medium scale design element typically implemented on the neighborhood or singular development (Commercial and Industrial) and are typically owned by an individual owner, Homeowner's Association (HOA), Metropolitan District or similar development group/entity. Operation and maintenance of these can be split across several beneficiaries which can make for complexity in long-term planning. Figure 4-4 shows some natural elements that can be incorporated into offline (located outside of the primary flow channel) detention basins to achieve multiple purposes. The following on-site and sub-regional detention facilities are regionally accepted and recommended for use within the Oklahoma and South Basins:

- Extended Detention Basin;
- Underground Infiltration.

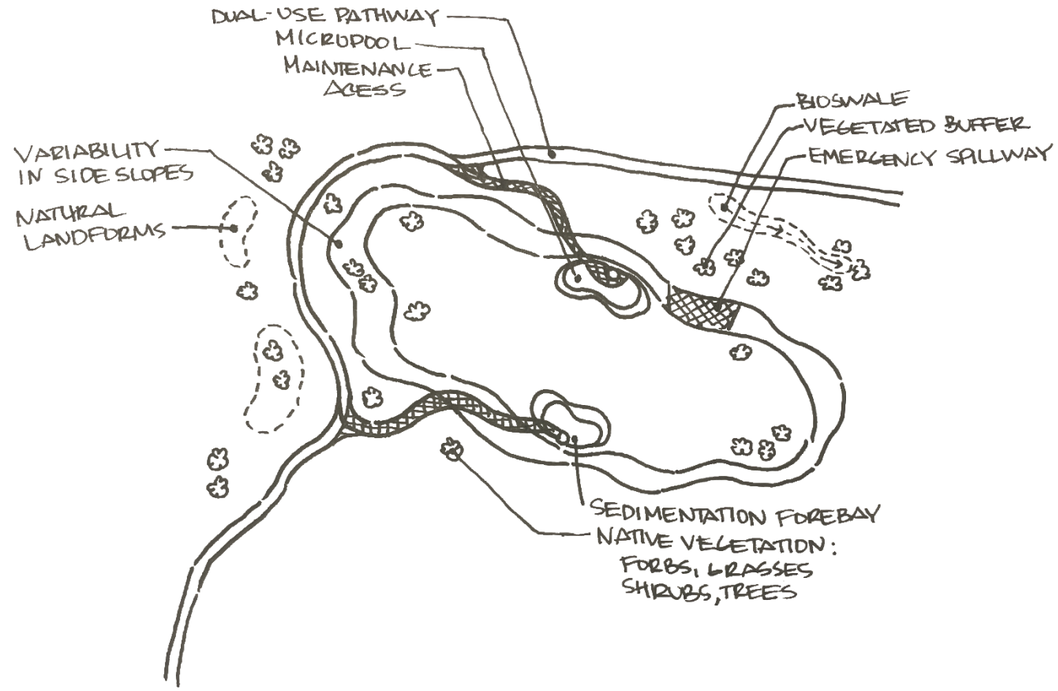

Figure 4-4 Offline basin elements

Regional

Regional stormwater detention facilities are the largest scale design element implemented on a regional level and are typically owned by a municipality. Operation and maintenance of these are typically assumed by the municipality and funded by taxpayer initiatives. Figure 4-5 shows some natural elements that can be incorporated into online (located within the primary flow channel) detention basins to achieve multiple

purposes. The following regional detention facilities are regionally accepted and recommended for use within the Oklahoma and South Basins:

- Standard (100-year flood control only);
- Full-spectrum.

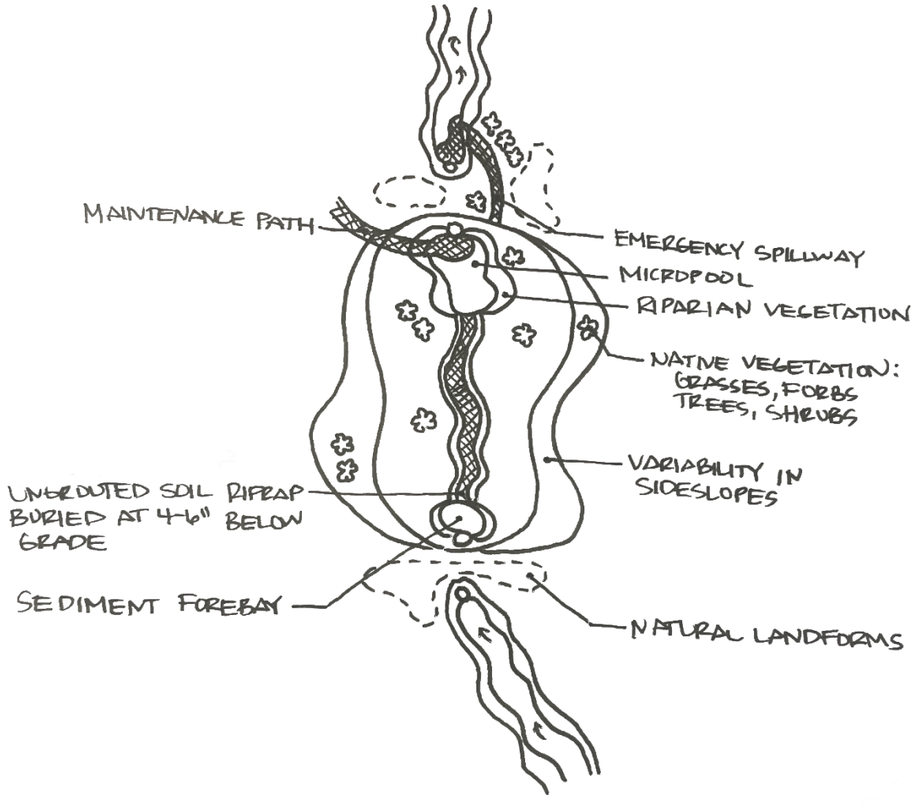

Figure 4-5 Online basin elements

Stormwater Detention Facility Guidelines

Refer to the *Design Criteria and Construction Specifications: Storm Drainage Volume II* (City of Greeley, 2008) and the *Urban Storm Drainage Criteria Manual, Volume 3: Stormwater Quality* (MHFD, 2021) for detailed guidelines and performance criteria of detention facilities. Some additional non-engineering considerations that lead to more pleasing detention spaces are listed below:

1. Stormwater detention facilities should allow for multiple uses of the facility such as a community use area or as preserved wildlife habitat in combination with the stormwater conveyance to uplift stormwater conveyance improvements as a community amenity.
2. Consider the sun and aspect and impacts on detention facility slopes. Consider incorporating elements such as a northern-facing sledding hill as an intentional design feature.
3. Incorporate a natural or architectural form in the forebay, sedimentation bay, and micropool elements.
4. Consideration should be given to water depth and length of time detained. Maximizing water detention depth and length of time thresholds can limit the plant palette opportunities that can survive during periods of extended detention.

Channel Improvements

Channel improvements can be a small to large scale design element implemented on a site to a regional scale, however the major drainageways discussed in this document are regional by nature. Ownership, operation and maintenance of these are typically assumed by the municipality and funded by taxpayer initiatives. In order of decreasing importance, channel improvements can provide flood conveyance, water quality improvements, and volume reduction capabilities. The following channel improvements are regionally accepted and promoted:

- **Constructed wetland channel:** Channel that uses dense vegetation to slow down runoff allowing for biological uptake and sedimentation to occur.
- **Rosgen stream classification:** A system that categorizes streams based on channel morphology.
- **Channel morphology:** Also known as river morphology, is the complete study of the channel from geography to channel fluid dynamics.
- **Multistage Design:** Channels that have multiple stages, with lower stages designed to minimize sediment deposition and provide ecological benefit during frequent storms, while higher stages improve bank stability and provide capacity for larger storms.
- **Grade control structures:** An earthen, wooden, concrete, or other material structure used to prevent gully development and bed erosion. It works by reducing the stream slope and flow velocity which leads to less erosion. Some forms of grade control structures are:
    - **Soil lifts:** Compacted course soil, wrapped with biodegradable fabric, used for erosion control. Usually lined around the stream banks, with the hope that vegetation growth occurs, creating a more stable bank.
    - **Riprap:** A permanent layer of large boulders or stones typically used to stabilize and protect the soil surface against erosion and scour in areas of concentrated flow or wave energy.
    - **Log / rock drop:** Layers of rock or logs placed into a section of a fast-flowing, highly eroded, and largely impermeable streambed to slow down water, recharge water tables, and create healthy riparian habitats. It also has the potential to weaken floods, filter water, sequester carbon, reestablish wetland ecosystems, and regulate microclimates.

- **Log / rock vane:** Rocks or logs placed in a way that cuts into the stream channel in an upstream direction. These features can slow the rate of water flow significantly, reducing the risk of erosion.
- **Log / rock toe:** A row of stone or logs are placed at the toe of an eroding bank, parallel to the stream. The toe is considered the bottom of the slope and supports the weight of the bank. This improvement helps with erosion control, preservation of much of the existing vegetation on the bank slope and encourages the growth of additional vegetation as the bank slope stabilizes.

A summary of the Master Plan channel design dimensions and performance is provided in Table 4-5. Note that although the concept design calculations assumed a simple trapezoidal shape to facilitate planning, it is recommended that the major drainageways use multiple stages and variable side slopes to mimic stable natural streams. It is not expected that switching to a more complex section will substantially change the require top widths.

Table 4-5 Master Plan Channel Improvements Summary

Reach	Reach Length (LF)	SWMM Link	Channel Improvements					
			Bottom Width (ft)	Side Slopes (H:V)	Q_{100} (cfs)	V_{100} (ft/s)	Depth (ft)	Top Width (ft)
134	2,426	L_138	86	5	305	4.2	0.8	108
150	1,625	L_154	79	5	302	5.0	0.7	101
118	1,087	L_119	89	5	462	5.0	1.0	114
142	1,479	L_149	80	5	249	5.0	0.6	101
100	3,260	L_115	118	5	806	5.0	1.3	146
260	2,456	L_163	40	5	136	4.8	0.7	62
244	4,101	L_245	110	5	261	4.6	0.5	130
239	288	L_239	140	5	680	4.8	1.0	165
241	1,092	L_241	100	5	562	4.7	1.1	126
232	3,274	L_235	190	5	770	4.8	0.8	213
224	1,810	L_225	90	5	265	4.8	0.6	111
200	2,511	L_221	140	5	1,113	4.9	1.5	170
500	3,358	L_513	-	-	208	4.7	0.9	69
618	1,661	L_622	101	5	350	5.0	0.7	123
614	2,214	L_617	-	-	233	4.7	0.6	97
600	3,459	L_613	-	-	365	4.6	0.8	120
800	190	L_813	-	-	282	4.9	2.4	63

Channel Guidelines

Refer to the *Design Criteria and Construction Specifications: Storm Drainage Volume II* (City of Greeley, 2008) and the *Urban Storm Drainage Criteria Manual, Volume 3: Stormwater Quality* (MHFD, 2021) for detailed guidelines and performance criteria of channels. For major drainageways, natural multistage channels are strongly preferred, see Figure 4-6 for an example typical section. Additional guidance on these types of channels can be found in *Natural Channel Design: Fundamental Concepts, Assumptions, and Methods* (Rosgen, 2011). Some additional non-engineering considerations that lead to more pleasing stream corridors are listed below:

1. Channel improvements should focus on promoting and incorporating natural system processes to support ecosystem services, the many and varied benefits to humans provided by the natural environment and healthy ecosystems.
2. Improvements to the extent possible should focus on preservation of areas within the natural channels that are in good condition to support efficient establishment of adjacent channel modifications.
3. Channel improvements should focus water quality improvements at point sources such as stormwater outfalls to capitalize on this water source.
4. While improvements should focus on enhancing and preserving natural resources, select areas of community use for nature exploration and nature play should be incorporated at key locations to promote community appeal and education while minimizing wildlife/human conflicts.
5. Culverts and outfalls should be sized and designed in a way to promote safe wildlife (terrestrial or aquatic) passage.

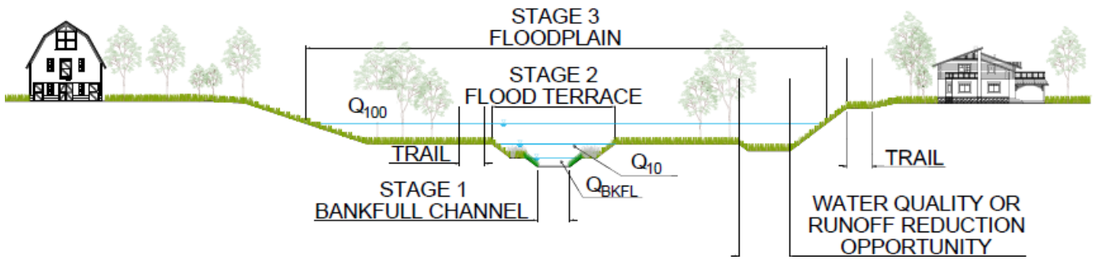

Figure 4-6 Master Plan Channel Typical

Crossing Improvements

Improved major drainageway crossing structures are proposed at all roadway and railroad crossing locations except the existing box culverts at the Reach 100 crossing of SH-257. The Master Plan culverts listed below in Table 3-19 are sized to safely convey the 100-year future conditions event. The concept design calculations assumed simple culverts with existing embankment and channel thalweg profiles to facilitate planning. When more detailed survey information is available during future design, it is recommended that grade changes and distributed layouts (where low-flows are conveyed separately from overbank flows) are explored to implement crossings that minimize maintenance requirements and ecological disruptions.

Table 4-6 Master Plan Crossing Improvements Summary

Structure Number	Reach Number	SWMM Node	Design Q_{100} (cfs)	Structure Size/Type	Outlet Vel (ft/s)
101	100	109	990	3 -12'x4' CBC	11.5
102	100	109	990	keep existing	8.4
103	142	149	249	1 - 6'x5' CBC	15.5
104	134	133	209	1 - 6'x5' CBC	14.2
201	200	219	1,208	2 - 8'x6' CBC	15.0
202	260	268	157	2 - 4'x3' CBC	17.3
203	260	268	157	2 - 4'x3' CBC	14.4
301	300	309	267	1 - 8'x4' CBC	11.0
501	500	509	336	2 - 8'x5' CBC	19.0
601	600	609	481	2 - 8'x4' CBC	14.9
602	600	609	481	1 - 8'x6' CBC	14.2
603	614	616	234	1 -6'x5' CBC	13.9
801	800	809	362	1 - 9'x5' CBC	10.9

4.2.3 Metrics

The three metrics proposed below are intended to achieve the goals of this study.

Low Impact Development: At least 80% of new impervious surface areas shall drain through pervious LID elements before connecting to rapid conveyance elements (gutters, pipes, concrete channels).

Stormwater Detention Facilities: Proposed 100-year peak flows shall be equal or less than the existing conditions 100-year peaks flows at the outfall.

Channel Improvements: Proposed major drainageways shall be stable during storm events ranging from the low-flow to the future conditions 100-year storm event. Shear stresses in the floodplain fringe should be less than 1 pound/square foot, and the channel section should be designed for the appropriate hydrologic and geomorphic regime.

4.2.4 Major Drainageway 100

Major Drainageway 100 is within the South Basin and is split into five reaches comprising two significant tributaries and the main stem. The hydraulic analysis showed that existing channel conditions are erosive and thus channel improvements are necessary even if peak flows are reduced to pre-development levels. There are four existing crossings, three at SH-257 and one at an access road. No habitable structures are within a regulatory floodplain, but there are two existing homes adjacent to Reach 150.

LID and EURV basins are recommended for all new developments, and two regional 100-year detention ponds are proposed immediately upstream of SH-257 along each tributary. See Table 4-4 for the Master Plan detention sizes.

Channel improvements include preservation and dedication of a stream management corridor, grading of a low maintenance stream, and revegetation of the stream management corridor. See Table 4-5 for the Master Plan channel improvement dimensions.

Crossing improvements include the removal and replacement of three existing culverts. See Table 4-6 for Master Plan crossing improvements. When these culverts are replaced, the appropriate headwalls, wingwalls, aprons, and energy dissipation features should be designed in detail.

The capital cost of these Master Plan improvements is estimated to be $4,250,458. The cost of maintenance and operation for 50 years is estimated to be $1,402,900. A detailed cost analysis is provided in Table 4-7.

CLICK HERE FOR MAJOR DRAINWAGEWAY 100 MAP

Table 4-7 Major Drainageway 100 Cost Estimate

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST
Concrete Box Culverts					
Box Culvert Pipe					
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)			
12	4	3	52	L.F.	$4,587.55	$238,552.00
6	5	1	296	L.F.	$1,095.56	$324,287.00
6	5	1	127	L.F.	$1,095.56	$139,137.00
Channel Improvements						
Excavation, Mid Range		20612	C.Y.	$40.00	$824,480.00
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		5	AC-FT	$76,152.00	$380,760.00
Detention Facility 2 (Complete-in-Place)		4	AC-FT	$76,152.00	$304,608.00
Removals						
Removal of culvert pipe (48"<D<84")		526	L.F.	$84.00	$44,184.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		29	ACRE	$1,670.00	$47,929.00
Land Acquisition						
Easement/ROW Acquisition		28.70	ACRE	$11,228.00	$322,244.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$701,976.00
Hydraulic Structures			$0.00
Channel Improvements			$824,480.00
Detention/Water Quality Facilities			$685,368.00
Removals			$44,184.00
Landscaping and Maintenance Improvements			$47,929.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$2,303,937.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$115,197.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$115,197.00
Subtotal Additional Capital Improvement Costs			**$230,394.00**
Land Acquisition Costs			
ROW/Easements			$322,244.00
Subtotal Land Acquisition Costs			**$322,244.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$380,150.00
Legal/Administrative	5%		$126,717.00
Contract Admin/Construction Management	10%		$253,433.00
Contingency	25%		$633,583.00
Subtotal Other Costs			**$1,393,883.00**
Total Capital Improvement Costs			**$4,250,458.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	474	L.F.	$2.00	$948.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	7450	L.F.	$3.00	$22,350.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal,	1.9	ACRE	$2,505.00	$4,760.00
Total Annual Operation and Maintenance Cost				**$28,058.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$1,402,900.00**

4.2.5 Major Drainageway 200

Major Drainageway 200 is within the Oklahoma Basin and is split into seven reaches comprising three significant tributaries and the main stem. The hydraulic analysis showed that existing channel conditions are erosive and thus channel improvements are necessary even if peak flows are reduced to pre-development levels. There are three existing crossings, one at US-34 and two at access roads. No habitable structures are within a regulatory floodplain.

LID and EURV basins are recommended for all new developments, and two regional 100-year detention ponds are proposed near where each tributary crosses the US-34 corridor. See Table 4-4 for the Master Plan detention sizes.

Channel improvements include preservation and dedication of a stream management corridor, grading of a low maintenance stream, and revegetation of the stream management corridor. See Table 4-5 for the Master Plan channel improvement dimensions.

Crossing improvements include the removal and replacement of three existing culverts. See Table 4-6 for Master Plan crossing improvements. When these culverts are replaced, the appropriate headwalls, wingwalls, aprons, and energy dissipation features should be designed in detail.

The capital cost of these Master Plan improvements is estimated to be $4,442,663. The cost of maintenance and operation for 50 years is estimated to be $2,069,700. A detailed cost analysis is provided in Table 4-7.

CLICK HERE FOR MAJOR DRAINWAGEWAY 200 MAP

Table 4-8 Major Drainageway 200 Cost Estimate

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST
Concrete Box Culverts					
Box Culvert Pipe					
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)			
8	6	2	30	L.F.	$2,643.81	$80,557.00
4	3	2	145	L.F.	$1,355.84	$196,597.00
4	3	2	327	L.F.	$1,355.84	$443,361.00
Channel Improvements						
Excavation, Mid Range		7703	C.Y.	$40.00	$308,120.00
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		7	AC-FT	$76,152.00	$533,064.00
Detention Facility 2 (Complete-in-Place)		10	AC-FT	$76,152.00	$761,520.00
Removals						
Removal of culvert pipe (48"<D<84")		422	L.F.	$84.00	$35,448.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		30	ACRE	$1,670.00	$50,100.00
Land Acquisition						
Easement/ROW Acquisition		29.90	ACRE	$11,228.00	$335,717.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$720,515.00
Hydraulic Structures			$0.00
Channel Improvements			$308,120.00
Detention/Water Quality Facilities			$1,294,584.00
Removals			$35,448.00
Landscaping and Maintenance Improvements			$50,100.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$2,408,767.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$120,438.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$120,438.00
Subtotal Additional Capital Improvement Costs			**$240,876.00**
Land Acquisition Costs			
ROW/Easements			$335,717.00
Subtotal Land Acquisition Costs			**$335,717.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$397,446.00
Legal/Administrative	5%		$132,482.00
Contract Admin/Construction Management	10%		$264,964.00
Contingency	25%		$662,411.00
Subtotal Other Costs			**$1,457,303.00**
Total Capital Improvement Costs			**$4,442,663.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	95	L.F.	$2.00	$190.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	11313	L.F.	$3.00	$33,939.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal,	2.9	ACRE	$2,505.00	$7,265.00
Total Annual Operation and Maintenance Cost				**$41,394.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$2,069,700.00**

4.2.6 Major Drainageway 300

Major Drainageway 300 is within the Oklahoma Basin and only comprises one reach. The hydraulic analysis showed that existing channel conditions are stable. There is one existing crossing at the Great Western Railway. Note that existing landowners did not allow access to this area, so we were unable to confirm existing channel or culvert dimensions in the field. No habitable structures are within a regulatory floodplain.

LID and EURV basins are recommended for all new developments. No regional detention is required for this drainageway.

Channel improvements are not proposed for this drainageway.

Crossing improvements include the removal and replacement of one existing culvert. See Table 4-6 for Master Plan crossing improvements. When this culvert is replaced, the appropriate headwalls, wingwalls, aprons, and energy dissipation features should be designed in detail.

The capital cost of these Master Plan improvements is estimated to be $659,947. The cost of maintenance and operation for 50 years is estimated to be $8,800. A detailed cost analysis is provided in Table 4-7.

CLICK HERE FOR MAJOR DRAINWAGEWAY 300 MAP

Table 4-9 Major Drainageway 300 Cost Estimate

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST
Concrete Box Culverts					
Box Culvert Pipe					
Individual Box Span (ft)	**Box Height (ft)**	**No. of Barrels**	**Length (ft)**			
8	4	1	327	L.F.	$1,183.69	$387,066.00

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$387,066.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$0.00
Subtotal Capital Improvement Costs				**$387,066.00**
Additional Capital Improvement Costs				
Dewatering			L.S.	$0.00
Mobilization	5%			$19,353.00
Traffic Control			L.S.	$0.00
Utility Coordination/Relocation			L.S.	$0.00
Stormwater Management/Erosion Control	5%			$19,353.00
Subtotal Additional Capital Improvement Costs				**$38,706.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$63,866.00
Legal/Administrative	5%			$21,289.00
Contract Admin/Construction Management	10%			$42,577.00
Contingency	25%			$106,443.00
Subtotal Other Costs				**$234,175.00**
Total Capital Improvement Costs				**$659,947.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	88	L.F.	$2.00	$176.00
Total Annual Operation and Maintenance Cost				**$176.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$8,800.00**

4.2.7 Major Drainageway 500

Major Drainageway 500 is within the Oklahoma Basin and only comprises one reach. The hydraulic analysis showed that existing channel conditions are fairly stable but channel improvements may be necessary if peak flows increase with development. There is one existing crossing at the Great Western Railway. No habitable structures are within a regulatory floodplain, but there are two existing homes near the downstream drainageway.

LID and EURV basins are recommended for all new developments, and one regional 100-year detention pond is proposed near the confluence of two smaller upstream tributaries. See Table 4-4 for the Master Plan detention sizes.

Channel improvements include preservation and dedication of a stream management corridor. See Table 4-5 for the Master Plan channel improvement details.

Crossing improvements include the removal and replacement of one existing culvert. See Table 4-6 for Master Plan crossing improvements. When these culverts are replaced, the appropriate headwalls, wingwalls, aprons, and energy dissipation features should be designed in detail.

The capital cost of these Master Plan improvements is estimated to be $1,444,700. The cost of maintenance and operation for 50 years is estimated to be $134,050. A detailed cost analysis is provided in Table 4-7.

CLICK HERE FOR MAJOR DRAINWAGEWAY 500 MAP

Table 4-10 Major Drainageway 500 Cost Estimate

DESCRIPTION		QUANTITY	UNIT	UNIT COST	COST
Concrete Box Culverts					
Box Culvert Pipe					
Individual Box Span (ft)	**Box Height (ft)**	**No. of Barrels**	**Length (ft)**			
8	5	2	88	L.F.	$2,505.59	$220,492.00
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		8	AC-FT	$76,152.00	$609,216.00
Removals						
Removal of culvert pipe (48"<D<84")		88	L.F.	$84.00	$7,392.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		1	ACRE	$1,670.00	$1,670.00
Land Acquisition						
Easement/ROW Acquisition		1.30	ACRE	$11,228.00	$14,596.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$220,492.00
Hydraulic Structures			$0.00
Channel Improvements			$0.00
Detention/Water Quality Facilities			$609,216.00
Removals			$7,392.00
Landscaping and Maintenance Improvements			$1,670.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$838,770.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$41,939.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$41,939.00
Subtotal Additional Capital Improvement Costs			**$83,878.00**
Land Acquisition Costs			
ROW/Easements			$14,596.00
Subtotal Land Acquisition Costs			**$14,596.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$138,397.00
Legal/Administrative	5%		$46,132.00
Contract Admin/Construction Management	10%		$92,265.00
Contingency	25%		$230,662.00
Subtotal Other Costs			**$507,456.00**
Total Capital Improvement Costs			**$1,444,700.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	88	L.F.	$2.00	$176.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal,	1	ACRE	$2,505.00	$2,505.00
Total Annual Operation and Maintenance Cost				**$2,681.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$134,050.00**

4.2.8 Major Drainageway 600

Major Drainageway 600 is within the Oklahoma Basin and comprises three reaches. The hydraulic analysis showed that existing channel conditions are fairly stable but channel improvements may be necessary if peak flows increase with development. There are three existing crossings, one at the Great Western Railway, one at an access road, and one at the edge of a salvage yard. No habitable structures are within a regulatory floodplain, but there are two existing homes near the downstream drainageway.

LID and EURV basins are recommended for all new developments, and one regional 100-year detention pond is proposed near the existing salvage yard. See Table 4-4 for the Master Plan detention sizes.

Channel improvements include preservation and dedication of a stream management corridor. Grading of a low maintenance stream, and revegetation of the stream management corridor is proposed for Reach 618. See Table 4-5 for the Master Plan channel improvement dimensions.

Crossing improvements include the removal and replacement of three existing culverts. See Table 4-6 for Master Plan crossing improvements. When these culverts are replaced, the appropriate headwalls, wingwalls, aprons, and energy dissipation features should be designed in detail.

The capital cost of these Master Plan improvements is estimated to be $2,373,880. The cost of maintenance and operation for 50 years is estimated to be $485,600. A detailed cost analysis is provided in Table 4-7.

CLICK HERE FOR MAJOR DRAINWAGEWAY 600 MAP

Table 4-11 Major Drainageway 600 Cost Estimate

DESCRIPTION		QUANTITY	UNIT	UNIT COST	COST
Concrete Box Culverts					
Box Culvert Pipe					
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)		
8	4	2	126	L.F.	$2,367.38	$298,289.00
8	6	1	41	L.F.	$1,321.90	$54,198.00
6	5	1	234	L.F.	$1,095.56	$256,362.00
Channel Improvements					
Excavation, Mid Range		4000	C.Y.	$40.00	$160,000.00
Detention/Water Quality Facilities					
Detention (Complete-in-Place)					
Detention Facility 1 (Complete-in-Place)		7	AC-FT	$76,152.00	$533,064.00
Removals					
Removal of culvert pipe (48"<D<84")		396	L.F.	$84.00	$33,264.00
Landscaping and Maintenance Improvements					
Reclamation & seeding (native grasses)		7	ACRE	$1,670.00	$11,690.00
Land Acquisition					
Easement/ROW Acquisition		6.90	ACRE	$11,228.00	$77,473.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$608,849.00
Hydraulic Structures			$0.00
Channel Improvements			$160,000.00
Detention/Water Quality Facilities			$533,064.00
Removals			$33,264.00
Landscaping and Maintenance Improvements			$11,690.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$1,346,867.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$67,343.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$67,343.00
Subtotal Additional Capital Improvement Costs			**$134,686.00**
Land Acquisition Costs			
ROW/Easements			$77,473.00
Subtotal Land Acquisition Costs			**$77,473.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$222,233.00
Legal/Administrative	5%		$74,078.00
Contract Admin/Construction Management	10%		$148,155.00
Contingency	25%		$370,388.00
Subtotal Other Costs			**$814,854.00**
Total Capital Improvement Costs			**$2,373,880.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	241	L.F.	$2.00	$482.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	1991	L.F.	$3.00	$5,973.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal,	1.3	ACRE	$2,505.00	$3,257.00
Total Annual Operation and Maintenance Cost				**$9,712.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$485,600.00**

4.2.9 Major Drainageway 800

Major Drainageway 800 is within the Oklahoma Basin and only comprises one reach The hydraulic analysis showed that existing channel conditions are fairly stable but channel improvements may be necessary if peak flows increase with development. There is one existing crossing at WCR-17. No habitable structures are within a regulatory floodplain, but there is one existing home adjacent to the downstream drainageway.

LID and EURV basins are recommended for all new developments, and one regional 100-year detention pond is proposed on the upstream side of WCR-17. See Table 4-4 for the Master Plan detention sizes.

Channel improvements include preservation and dedication of a stream management corridor. See Table 4-5 for the Master Plan channel improvement dimensions.

Crossing improvements include the removal and replacement of one existing culvert. See Table 4-6 for Master Plan crossing improvements. When these culverts are replaced, the appropriate headwalls, wingwalls, aprons, and energy dissipation features should be designed in detail.

The capital cost of these Master Plan improvements is estimated to be $446,757. The cost of maintenance and operation for 50 years is estimated to be $82,250. A detailed cost analysis is provided in Table 4-7.

CLICK HERE FOR MAJOR DRAINWAGEWAY 800 MAP

Table 4-12 Major Drainageway 800 Cost Estimate

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST
Concrete Box Culverts					
Box Culvert Pipe					
Individual Box Span (ft)	Box Height (ft)	No. of Barrels	Length (ft)		
9	5	1	71	L.F.	$1,382.22	$98,138.00
Detention/Water Quality Facilities					
Detention (Complete-in-Place)					
Detention Facility 1 (Complete-in-Place)		2	AC-FT	$76,152.00	$152,304.00
Removals					
Removal of culvert pipe (48"<D<84")		71	L.F.	$84.00	$5,964.00
Landscaping and Maintenance Improvements					
Reclamation & seeding (native grasses)		1	ACRE	$1,670.00	$1,670.00
Land Acquisition					
Easement/ROW Acquisition		0.60	ACRE	$11,228.00	$6,737.00

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$98,138.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$152,304.00
Removals				$5,964.00
Landscaping and Maintenance Improvements				$1,670.00
Special Items (User Defined)				$0.00
Subtotal Capital Improvement Costs				**$258,076.00**
Additional Capital Improvement Costs				
Dewatering		L.S.		$0.00
Mobilization	5%			$12,904.00
Traffic Control		L.S.		$0.00
Utility Coordination/Relocation		L.S.		$0.00
Stormwater Management/Erosion Control	5%			$12,904.00
Subtotal Additional Capital Improvement Costs				**$25,808.00**
Land Acquisition Costs				
ROW/Easements				$6,737.00
Subtotal Land Acquisition Costs				**$6,737.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$42,583.00
Legal/Administrative	5%			$14,194.00
Contract Admin/Construction Management	10%			$28,388.00
Contingency	25%			$70,971.00
Subtotal Other Costs				**$156,136.00**
Total Capital Improvement Costs				**$446,757.00**

Master Plan Operation and Maintenance Cost Summary				
Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs	71	L.F.	$2.00	$142.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal,	0.6	ACRE	$2,505.00	$1,503.00
Total Annual Operation and Maintenance Cost				**$1,645.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$82,250.00**

4.3 Prioritizing and Phasing

Since the basin is relatively undeveloped, improvements will generally be constructed commensurate with development. There is not currently a visible stream (or obvious low flow channel) in some upstream portions of the study area. Any upstream improvements, particularly along the Highway 34 corridor, will need to take this into account.

Detention and LID (runoff reduction) improvements should be prioritized due to the impact of these structural and non-structural measures on downstream channel stability and flood risk. If detention elements are not implemented, wider stream management corridors than those presented in this document may be required to protect properties from larger peak flows.

4.4 Water Quality Impacts

Since the majority of the Oklahoma and South Basins are historically agricultural or natural land uses, it will be important to protect the major drainageways from urban pollutants as development occurs. This comprehensive drainage plan addresses these water quality concerns through multiple methods. Foremost is the recommendation that LID practices be implemented throughout the watersheds. LID BMPs both reduce runoff and capture pollutants by intercepting, slowing down, and infiltrating surface flows that come from impervious sources such as roadways, buildings, and parking lots.

The Master Plan also recommends the widespread implementation of EURV basins and 100-year detention ponds. These larger scale options are primarily targeted at runoff reduction – not just peak flow reductions but also volume reductions. These controls result in a proposed system that more closely mimics the flow durations and frequencies of a natural system.

Finally, the proposed stream management corridors seek to stabilize the channels for future conditions flow events. This is primarily achieved by designing a cross section and channel profile that can resist the erosive forces of the future expected flows. By implementing stable channels, sediment loads and the assorted pollutants that attach to sediment will be better managed.

4.5 Operations and Maintenance

Regular stream management is recommended to:

1. Maintain channel/culvert/hydraulic structure conveyance by removing sediment, trash and debris, which could restrict flow;

2. Manage noxious weeds and invasive plant species.

Ongoing maintenance of low maintenance streams, detention ponds, and floodplain culverts is required to protect infrastructure and people. Maintenance is recommended at regular intervals and on an as-needed basis (after significant flood events or growth of invasive species). Critical crossings structures and detention basins may need to be cleaned out on a more frequent basis to maintenance system functionality.

Regarding detention, the regional 100-year detention basins maintained by the City of Greeley will require much less maintenance if the upstream distributed LID and EURV basins are functioning properly. While the maintenance burden of these smaller drainage features will be held by the private owners, it is recommended that Greeley implements a regular inspection program to ensure that all components of the Master Plan drainage system are kept in satisfactory condition. Overall, implementation of the improvements to provide 100-year capacity should result in reduced maintenance costs after major flood events.

4.6 Environmental and Safety Assessment

The holistic approach described in this Master Plan will result in improved environmental outcomes compared to a standard piecemeal development process. Each major drainageway should be considered as a connected system. The widespread adoption of LID practices should create in a proposed system that more closely matches the natural ecosystem. Incorporating natural system processes into detention basins and stream corridors where possible will also support a healthy ecosystem, which in turn provides many health benefits to humans.

The flood control improvements described in this Master Plan will result in improved safety within the Oklahoma and South Basins. The LID practices, EURV basins, 100-year detention ponds work together to reduce runoff, which can lessen the impacts of flood hazards to property and humans during large storm events. The stream management corridors improvements will also improve safety by stabilizing channels and more clearly defining the conveyance areas that should be avoided during floods. Lastly, the proposed crossing improvements will explicitly improve safety by conveying storm flows up to the 100-year event through culverts instead of allowing the roadway and railroad embankments to overtop.

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Appendix A – Project Correspondence

Masterplan Storm Drainage Conceptual Design Services - Oklahoma & South Basin
Project Kickoff Meeting Agenda
ZOOM Conference Call
March 30, 2022
9:00 to 10:00 AM

Key: City of Greeley notes in blue, *Matrix meeting notes in green italics*, *action items indicated in underlined red italics*

1. Introductions and Contacts

i. City of Greeley
   1. **Interim Project Manager – Andrew Fisher (here)
   2. Project Manager – Florian Fiebig
   3. Stormwater Manager – Karen Reynolds (here)
   4. Water Quality and Regulations Manager – Brian Hathaway (here)

ii. Consultant – Matrix Design Group
   1. Principal in Charge – Graham Thompson (here)
   2. Project Manager – Drew Beck (here)
   3. Project Engineer – Megan Sawyer (here)
   4. Hydrology and Hydraulics – Ben Liu (here)

**Florian will return in late April to resume PM duties

Andrew may stay on project through May. DB asked if we should wait to correspond with Florian until he gets back, AF said yes wait until he returns. Group went through introductions.

Contract received by City from Matrix 3/29. Contract still requires approval by the City.

2. PM/Contract/Correspondence Expectations

1. Progress meetings – biweekly in contract, virtual. In person progress meetings may be scheduled in lieu of two virtual progress meetings. Additional coordination not requiring a meeting encouraged.
   i. *AF expects that we will not need biweekly meetings throughout the project, and that most meetings will be online. DB proposed that we set all meetings as virtual and adjust as needed. AF noted two virtual meetings can be swapped for 1 in person meeting, as budgets allow.*
   ii. *Matrix to set first progress meeting for 4/20 at 9am virtually.*
2. Matrix will provide meeting minutes within 14 days for City approval.
   i. *AF noted that timely meeting minutes will be critical since there will be a PM handoff on this project.*
   ii. *It is okay to record virtual meetings which helps with meeting minutes.*
3. Provide 48 hours notice prior to mobilization of survey/pothole efforts. Approval in writing required prior to survey on private property or secured City property. Contact with some property owners can be a challenge.
   i. *AF wants to know if anyone will be out, some farmers may not welcome visitors. He noted that Sharktooth project had difficulties completing survey on private property. RK reminded everyone to wear reflective vests on all site visits.*
   ii. *If personnel are approached by citizens/landowners the team should direct them to AF.*
   iii. *DB noted Matrix has drone capacity for visualization of areas we do not have foot access to.*
   iv. *Matrix will provide a work plan for field data collection prior to commencing work.*
4. City has adopted a Master Plan guideline. Expectation for Master Plan to adhere to this as much as feasible without sacrificing MHFD approach
   i. Matrix will document deviations
   ii. *Matrix will be test subjects in this process, Matrix will document deviations and Greeley welcomes feedback.*
   iii. *Windsor did master plan in this area 19 years ago, Doug Roth has been AF's contact. AF to provide his contact info to Matrix.*
5. Matrix expectations on City correspondence to Matrix personnel:
   i. Provide Stakeholders
   ii. Free flow of communication
   iii. CC Drew Beck on any conversation
   iv. Follow up phone call conversations with emails
   v. Allow recording of progress meetings
   vi. *DB said phone calls will typically be followed up by emails.*
   vii. *DB asked if Greeley had preference on recording virtual meetings. KR and AF noted this would be helpful for Florian transition.*
   viii. *AF noted they have an excellent media coordinator who the project will likely need to collaborate once we get closer to the stakeholder engagement portion of the project this summer.*

3. Project Scope Review

1. Why are we doing this?
   i. Pressure for development in Greeley is moving west, including Delantero.
      1. *AF to send Matrix documentation for Delantero.*
      2. *Historically, Greeley has been very pro-developer.*

3. *KR noted new western developments will be first impression driving into Greeley, and the City wants to move towards more thoughtful development with amenities.*

ii. Provide guide for development

1. *Lessons learned that recommendations are not always strong enough – developer wanted to put arterial street on Sharktooth Draw (convert it to pipe), they want to better communicate expectations. They do have one developed who recognizes the value of stream corridors as an amenity.*
2. *KR said management has high expectations for what future development will look like, Greeley wants to give them ideas/vision of what things should be.*
3. *Greeley is more amenable to take on regional detention facilities than previously, tired of "ugly ponds."*

iii. City is moving to increase barrier of development and have higher standards and provide more ideas to shape development in line with newer vision

iv. City more amenable to regional detention facilities

v. City is tired of ugly ponds

vi. Drew mentioned lessons learned that the maintenance of large facilities is a big deal

vii. Karen mentioned that City Council recently released their Strategic Plan. Sill be shared with Matrix as appropriate

4. Project Priorities/Goals

1. Coordinate with adopted and draft Master Plans
2. Stabilize drainageways
3. Reduce flood losses
4. Improve Water Quality
    i. *AF would like to consider regional detention ponds in this MDP.*
    ii. *KR noted that new philosophy is proactive, try to plan ahead and identify recommended facilities.*
    iii. *AF would like to see us on the high side of concept design instead of us shrinking down recommendations to fit a budget.*
    iv. *Lessons learned from another regional pond is that they should have included regional conveyance – developers chose to put in small ponds instead of providing flood conveyance through their sites.*

v. *DB asked if annexations in this West side could include fees to support regional storm infrastructure, KR thought it was possible, AF said Paul (Public Works Director) said similar.*

5. Schedule and Deliverables

1. Monthly meetings – Determine DOW and time.
2. By April 7, 2022 - Data Collection (Survey and Field Assessment)
3. Baseline Hydrology April 14-June 15
    i. **June 15 - Draft Baseline Hydrology Report
    ii. **July 6 – Final Hydrology Report
4. Alt Analysis - July 7-Oct 19 – Alternative Analysis
    i. **Sept 28 - Draft Alternatives Report
    ii. **Oct 19 – Final Alternatives Report
5. Concept Design - October 29-Dec 21
    i. **November 23 – Draft Concept Design Report
    ii. **Dec 14 – Final Concept Design Report
    iii. **Dec 21 – Final TSDC

Plan for survey in within 4-6 weeks

First stakeholder meeting in mid-end June

6. City Deliverables

Source	Title	Delivered
Anderson Consulting Engineers (2003)	Town of Windsor Comprehensive Drainage Plan (Oklahoma/South included	LINK
City of Greeley	GIS Online Maps.	LINK
City of Greeley	2060 Comprehensive Plan	LINK
City of Greeley (2022)	2022 Draft Comprehensive Transportation Plan documents	
City of Greeley (2021)	Master Plan Procedures/Preparations Guide	LINK
City of Greeley, Colorado, Public Works (2015)	Design Criteria and Construction Specifications, Volume I (Streets)	LINK
City of Greeley, Colorado, Public Works (2008)	Design Criteria and Construction Specifications, Volume II (Stormwater)	LINK
City of Greeley, Colorado, Public Works (2008)	Design Criteria and Construction Specifications, Volume III (Water/Sewer)	LINK
City of Greeley, Colorado, Public Works (2011)	2035 Comprehensive Transportation Plan	LINK
Colorado Department of Transportation (2019)	Standard Specifications for Road and Bridge Construction.	LINK
Design Workshop (2016)	City of Greeley Parks, Trails and Open Lands Master Plan	LINK
Mile High Flood District (2016)	Urban Storm Drainage Criteria Manual	LINK
U.S. Federal Highway Administration (2009)	Hydraulic Engineering Circular No. 22, Urban Drainage Design Manual, 3rd Ed.	LINK
U.S. Department of Agriculture Natural Resources Conservation Service (2013)	Web Soil Survey	LINK

- *AF wants to see H&H report discuss changes from Windsor MDP. Delantero is now including some residential instead of the commercial shown in the land use plan.*
- *KR said she may be able to share the new Strategic Plan to inform team of Greeley's desired direction.*
- *AF said Greeley expects new Transportation Plan by August, draft shows new arterial near 4th Street (will require crossings). AF also noted that draft arterial typical only includes one lane each direction (same ROW), may create opportunities for storm or water quality improvements.*
- *AF noted that this MPD should include Public Engagement Summary per new guide. DB asked if Matrix would have to address/brief Council, AF confirmed that he would do that with Matrix support.*
- *Revised water/sewer design criteria about to be released.*

Notes:

- Delanatero: LINK. Please note these are not final or accepted at this time.
  - *South side of Hwy 34 Bypass and Hwy 257, developer shows detention ponds at downstream side. Intends to start grading early next year.*
- Transportation Master Plan will be finalized by August 2022, draft documents will be provided

- City's Master Plan/Procedures/Preparations Guide may not fit well with MHFD but please follow as much as feasible.
- City's Volume III (Water/Sewer) manual nearly has completed revision
- City's Volume II (Stormwater) is being revised be RESPEC now. Only intro section have been revised thus far
  - *BH said they are on schedule to complete by end of year or next year, have good draft with Sections 1 and 2, water quality section to be send to stakeholders soon.*
  - *Will require coordination with Florian to ensure Matrix's assumptions for drainage criteria are consistent with the ideas in the new unpublished manual.*
- City's Volume I (Streets) will likely be revised but has not been initiated
- Note: Original draft of Agenda included outdated Comprehensive Plan

7. Action Items – Prior to next meeting

Next meeting scheduled: *Wed April 20 every other week 9-10*

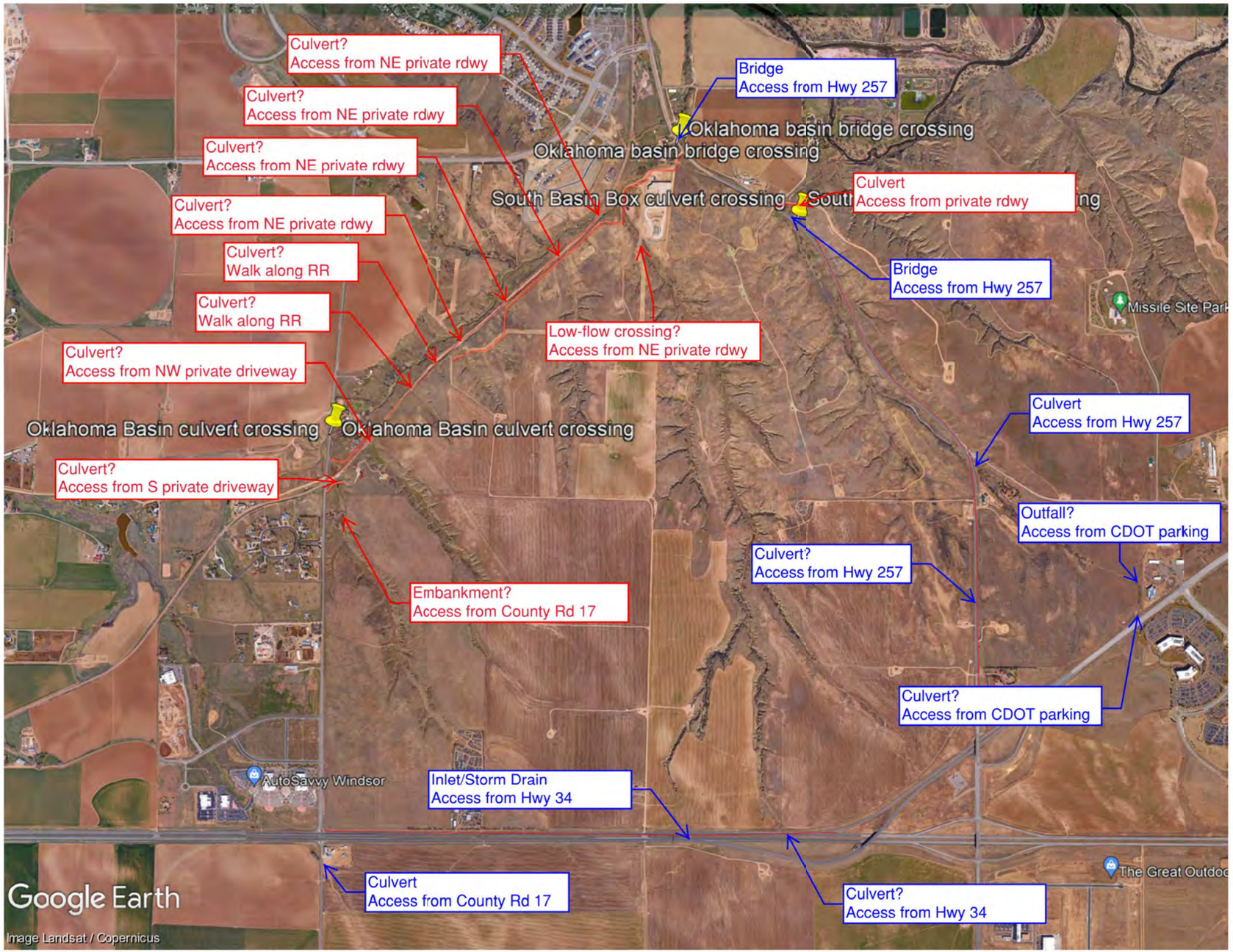
MATRIX

- *Send biweekly progress meeting invitations at 9am starting on Wednesday, April 20. Please include Karen Reynolds and Brian Hathaway in these invitations*
- *Download reference documentation from meeting minutes and let Andrew know when completed.*
- *Review materials provided by the City and contact Andrew with any questions*
- *Download applicable GIS shapefiles from City IT website. Contact Andrew if you need any assistance.*
- *Matrix to provide ideas on deliverables and format for MDP.*

CITY

- *Provide draft Stakeholder register*
- *Provide contacts with the Town of Windsor*
- *Provide updates on Standards and Specifications, Transportation Master Plan and Delantero development as appropriate*
- *Provide City Council Strategic Plan as appropriate.*

8. Matrix Questions/Requests/Ideas


Culvert?
Access from NE private rdwy
Culvert?
Access from NE private rdwy
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Access from NE private rdwy
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Access from NE private rdwy
Culvert?
Walk along RR
Culvert?
Walk along RR
Culvert?
Access from NW private driveway
Oklahoma Basin culvert crossing
Oklahoma Basin culvert crossing
Culvert?
Access from S private driveway
Embankment?
Access from County Rd 17
AutoSavvy Windsor
Inlet/Storm Drain
Access from Hwy 34
Culvert
Access from County Rd 17
Bridge
Access from Hwy 257
Oklahoma basin bridge crossing
Oklahoma basin bridge crossing
South Basin Box culvert crossing
Culvert
Access from private rdwy
Bridge
Access from Hwy 257
Low-flow crossing?
Access from NE private rdwy
Missile Site Park
Culvert
Access from Hwy 257
Outfall?
Access from CDOT parking
Culvert?
Access from Hwy 257
Culvert?
Access from CDOT parking
The Great Outdoo
Culvert?
Access from Hwy 34
Google Earth
Image Landsat / Copernicus

Masterplan Storm Drainage Conceptual Design Services - Oklahoma & South Basin
Progress Meeting Notes
ZOOM Conference Call
April 20, 2022
9:00 to 10:00 AM

Key: *Meetings notes in green italics*, *action items indicated in underlined red italics*

1. Introductions/Attendees:

Andrew Fisher, Karen Reynolds, Brian Hathaway (Greeley)

Megan Sawyer, Ben Liu (Matrix)

2. Previous Action Items

MATRIX

- *Send biweekly progress meeting invitations at 9am starting on Wednesday, April 20. Please include Karen Reynolds and Brian Hathaway in these invitations* *Completed*
- *Download reference documentation from meeting minutes and let Andrew know when completed.* *Completed*
- *Review materials provided by the City and contact Andrew with any questions* *Completed*
- *Download applicable GIS shapefiles from City IT website. Contact Andrew if you need any assistance. Matrix to provide ideas on deliverables and format for MDP.* *Completed*

CITY

- *Provide draft Stakeholder register* *Completed*
- *Provide contacts with the Town of Windsor* *Completed*
- *Provide updates on Standards and Specifications, Transportation Master Plan and Delantero development as appropriate* *Completed*
- *Provide City Council Strategic Plan as appropriate.* *Completed*

3. Schedule/Upcoming Activities

1. Reschedule next progress meeting (May 4 conflicts with MHFD Symposium)
   i. *Rescheduled for Thursday May 5, 11:00 AM*
2. Data Collection (Survey and Field Assessment)
   i. Structure Survey *AF will meet 4/21/22 with real estate manager then communicate with parcel owners. Plan on 1st week of May or later, Matrix will wait to hear from AF.*
   ii. Utility Locates *Utility Locates in road ROW okay w/o access permissions. Utility locate sub-contractor (separate from survey) scheduled to go out May 2.*
   iii. GIS data request *Greeley GIS is very short-staffed right now*
      a) *Current (existing) zoning is available as shapefile.*
         a. *Don't have direct impervious/impervious layer. Sidewalks, driveways, roadway, water, etc. available.*
         b. *Watershed boundary available.*
      b) *Do not have future land use shapefile. AF suggests digitizing from Imagine Greeley pdf.*
      c) *CWCB has 2018 or 2020 LiDAR (CHAMP, made available recently), let AF know if Matrix cannot acquire it – BL will follow up with Chris Martin to see if we have access. Aerials available for 2016 and 2018 but are lower quality, Greeley will send best available aerial to Matrix.*
      d) *Development Boundaries – Delantero is only identified planned area, Greeley does not have additional shapefiles but AF will check for future developments.*
      e) *Oil and Gas* – Should be available from COCCD, Weld County, or Windsor (parcel data).
      f) City Boundary and Long term expected growth layer has been requested from Greeley GIS.
      g) *Existing trails layer available, but not many trails in this area. No future trails shapefile, only have master trail PDF.*
      h) *Shurview property is now dedicated open space, comprises South Basin and east part of Oklahoma Basin. AF believes it is shown in parcel data (Trust for Public Land).*
      i) *Expect GIS data in ~1 week. Matrix will wait to digitize non-available data until GIS data is received from Greeley.*
   iv. Stream field assessments
      a) *Matrix plans to use REMs to help identify areas to visit.*
      b) *Schedule – Will start REM soon. Matrix to send Greeley field access plans for stream assessments.*
3. Relative Elevation Modeling *Matrix only needs surface data, can start soon.*
4. Baseline Hydrology April 14-June 15
   i. June 15 - Draft Baseline Hydrology Report
      a) Review proposed report sections and structure *MS summarized review of MHFD vs Greeley Master Plan requirements. AF wants to use Greeley format as much as possible, BL suggested using Greeley format for*

introductory sections and keep each major milestone (Baseline Hydrology, Alternatives Analysis, Concept Design) as a self-contained section.

b) *AF said to plan for ~2 week turn around on comments*

ii. July 6 – Final Hydrology Report

5. First stakeholder meeting in mid-end June

i. *Awareness of issues found, getting input from stakeholders. Will not have alternatives.*

ii. *AF to coordination communication plan with communication department.*

4. Other Questions/Requests/Ideas

5. Action Items – Prior to next meeting

CITY

- *Provide GIS layers*
- *Inform Matrix when structure survey can commence.*

MATRIX

- *Send meeting invite for May 5.*
- *Send stream assessment access plan to AF*
- *Acquire CHAMP 2018/2020 surface data from CWCB*
- *Review parcel data for Shurview property and oil/gas wells*

Masterplan Storm Drainage Conceptual Design Services - Oklahoma & South Basin
Progress Meeting Agenda
ZOOM Conference Call
May 5, 2022
11:00 AM to 12:00 PM

Key: *Meetings notes in green italics*, *action items indicated in underlined red italics*

1. Introductions

Andrew Fisher, Drew Beck, Ben Liu, Megan Sawyer

2. Previous Action Items

MATRIX

- *Send meeting invite for May 5 Completed*
- *Send stream assessment access plan to AF Pending REM Model*
- *Acquire CHAMP 2018/2020 surface data from CWCB Completed*
- *Review parcel data for Shurview property and oil/gas wells*

AF suggest pulling from COGCC – does Matrix have access?

CITY

- *Provide GIS Layers Completed*
- *Inform Matrix when structure survey can commence*

Letters sent out Tuesday 5/3/22, owners have until Friday 5/13/22 to respond. AF thinks week of 16th is likely timeframe. AF will provide surveyors with a form to carry. BL asked if we can access Shurview property without restrictions for railroad crossings, AF said we need to ask City (not fully conveyed, but City has access control). AF to coordinate directly with Natural Areas department.

3. Schedule/Upcoming Activities

1. Review of CWCB vs. 2013 LiDAR

MS proposed that use the 2013 LiDAR since the 2018 CWCB was similar but more jagged. Only notable differences are on private property outside of drainageways.

2. Relative Elevation Modeling timeline (week of May 9th)

i. Discuss Hydraulic Models

BL said REMs required flowlines and cross sections, asked if we intended to complete HEC-RAS models for these drainageways. AF said yes that was his expectations. DB explained different options (RAS, FlowMaster, SWMM, 2D). Group agreed on 1D RAS

model w/o formal floodplain model, and Matrix would spend more time developing REM model cross sections to easily transition to 1D RAS Model.
SWMM models will use trapezoidal (not irregular) cross sections with measured lengths.

3. Data Collection (Survey and Field Assessment)
    i. Structure survey/utility locate access
    ii. Stream assessment week of May 16th, pending access
    DB out of town week of May 16th, stream assessment will likely occur the following week. DB intends to be on site for stream assessment.

4. Baseline Hydrology April 14-June 15
    i. June 15 - Draft Baseline Hydrology Report
        a) Review proposed report sections and structure
    ii. July 6 – Final Hydrology Report
5. First stakeholder meeting in mid-end June
    AF reminded that Greeley's public outreach team should be involved, he is reaching out. DB mentioned that public feedback would hopefully reinforce the desired direction (open channels instead of pipes, etc.)

4. Other Questions/Requests/Ideas

- *DB brought up lessons learned from MHFD symposium; especially what Greeley wants to do differently from Sharkstooth Bluff. AF said Greeley likely does not have funds to pre-stabilize channel reaches. Team discussed possibility of quantifying cutoff for flows which would cause destabilization in current reaches, and quantifying needed regional infrastructure to calculate cost for development. AF said Greeley is open to possible solutions after hydrologic/hydraulic analysis.*
- *Should we meet with Greeley planners before digitizing Imagine Greely? AF will contact Community Development.*
- *BL asked if AF had date of aerial imagery provided – he did not but said the 2018 aerials looked browner. Matrix will investigate further.*
- *AF asked if June 15 deadline is still realistic, Matrix thought it could happen but a 1-2 week delay is more likely since we prefer to visit the field before finalizing the hydrology.*

5. Action Items – Prior to next meeting

Masterplan Storm Drainage Conceptual Design Services - Oklahoma & South Basin
Progress Meeting Notes
ZOOM Conference Call
May 18, 2022
9:00 AM to 10:00 AM

Key: *Meetings notes in green italics*, *action items indicated in underlined red italics*

1. Introductions

Andrew Fisher, Kallasandra Moran (Greeley)

Ben Liu, Megan Sawyer (Matrix)

2. Previous Action Items

MATRIX

- Send stream assessment access plan to AF *Pending REM. AF has already sent request for access to properties likely to be accessed for stream assessment.*
- Acquire and oil/gas well data from COGCC *acquired*
- Review aerials provided by city *Matrix provided aerials preferred*

CITY

- Provide Matrix with form to carry in field for survey and stream assessment.

  Access acquired for Shurview and Alexia, AF to coordinate with Justin

  7 properties have not responded.

  Can contact within the next week via phone to encourage to respond to letter. Can also provide with letter to bring on site.

  Do not approach Schmerge property without permission.

  Allow KM until Friday to contact, KM to notify AF of status, AF to notify Matrix.

- Coordinate with Natural Areas department about access to Shurview

3. Schedule/Upcoming Activities

1. Data Collection (Survey and Field Assessment)
    i. Utility locates complete
    ii. Matrix hydraulic structures field survey 5/16-5/18 with office analysis to follow
    iii. Stream assessment week of May 23rd, pending access
    Week of May 30th is preferred to give time to KM to coordinate access

2. Relative Elevation Modeling timeline (week of May 16th)

3. Baseline Hydrology April 14 – June 29
    i. Started delineations this week
    ii. June 29 - Draft Baseline Hydrology Report
    iii. July 20 – Final Hydrology Report

4. First stakeholder meeting in late June

4. Other Questions/Requests/Ideas

1. Aerial imagery (sample below)

    i. Unable to determine vintage (2018?) AF agreed that above image looks like 2018 aerials, has swaths at different resolution/vintage
    ii. Matrix can pull recent imagery from NearMap

2. Oil and Gas sites
    i. 157 sites within project area
    ii. 9 sites within 200 ft of proposed flowlines

    Matrix to check if abandoned

3. Land Use
    i. Digitized from Imagine Greeley

AF to send preliminary PUDs (Shurview and Delantero).
Another development on the south portion of the basin
West of 257 likely to see development, which is shown as open space in the Imagine Greeley plan. *AF to follow-up with Development Review regarding future land use.*

4. Progress Meetings: AF raised concerns of lengthening schedule and more progress meetings than planned. Group discussed holding meeting less frequently or limiting to 30 min in length.

5. Action Items – Prior to next meeting

AF and KM to acquire permission to access and communicate with Matrix

Matrix to evaluate budget and make recommendation for adjusting progress meetings

AF to communicate with Development Review about land use

Masterplan Storm Drainage Conceptual Design
Services - Oklahoma & South Basin
Progress Meeting Notes
ZOOM Conference Call
June 1, 2022
10:00 AM to 11:00 AM

Key: *Green italicized text is meeting notes, red italicized underlined text is action items.*

- Introductions *Andrew, Karen, James Redmond from Greeley. Drew, Ben, Megan from Matrix.*

- Previous Action Items

MATRIX

- Evaluate budget and make recommendation for adjusting progress meetings

  Matrix will evaluate the need for each progress meeting (vs emails) on the Monday preceding each planned progress meeting. Most meetings will be virtual, with in-person meetings limited to collaborative sessions.

CITY

- Acquire permission to access and communicate with Matrix
  Andrew had focused letters near RR, will need more time to reach out to upstream parcels (next week not feasible. Drew said this stream assessment work is not holding up other work yet, but if we do not complete field work by mid-July it could affect alternatives analyses. Andrew agreed to July timeframe.
- Coordinate with Development Review about future land use
  Andrew sent Excel spreadsheet with available data (plus Imagine Greeley) today. Drew asked if we could use West Greeley as a typical future land use. Andrew said there was a push at City Council level towards denser development. Drew also asked if there is a required min open space % to be maintained. Andrew said yes check code.

- Schedule/Upcoming Activities

1. Data Collection update
   i. Stream assessments week of June 3, 13, or 20 *Week of June 20 is earliest possible, target week of June 27.*
2. Relative Elevation Modeling update *Drew provided update of progress so far, intention to take more field measurements at reaches that are in decent condition and we wish to preserve, not go further with small, degraded tributaries. Andrew asked if South watershed is blending with Sharktooth watershed, Matrix said the separation seemed distinct.*
3. Baseline Hydrology April 14 – July 20
   i. Draft delineations complete (43 subbasins ranging from 4 ac to 212 ac)
   Andrew preferred to keep small basins next to RR, Drew mentioned grouping the small ones together for concept planning.
   ii. Discuss naming convention
   Matrix to review Windsor Report for established names (Anderson report). Andrew mentioned they typically name waterways based on prominent landowner, Andrew will ask around at Greeley. Drew asked about RFP requirement that Greeley be allowed to change/choose basin names. Andrew said this was a remnant from the Sharktooth Bluff study, and was not needed for this study.
   iii. June 29 - Draft Baseline Hydrology Report
   iv. July 20 – Final Hydrology Report

Ben proposed calculating a composite future land use instead of micro-dividing geographically, Matrix will develop a draft land use assumption for approval by Greeley.

4. First stakeholder meeting in late June? *Drew said first meeting is really an introduction, does not recommend getting into any numbers at this first meeting. Andrew said this might help facilitate parcel agreements (legitimize the project). James said avoid Tues, community preference is Wed or Thurs. He also said that if majority of stakeholders have professional interest in area, a day meeting may be preferred. Drew suggested June 29. James suggested reaching out to Community Development department to contact potential developers, letters would go out to landowners. James said they could create a stub to direct people, will look into whether they have Zoom account. Greeley will develop meeting notifications, Matrix will develop meeting slides by June 15. Andrew do reach out to management about type of property owners, which will determine if an AM or PM meeting.*

- Other Questions/Requests/Ideas

1. Adjust progress meeting frequency/length? *See previous action items.*
2. Map Formats
   i. Interactive or multiple maps?*Andrew worried about size of interactive exhibit and having to flatten files for easier distribution, multiple maps could be more resilient. Andrew will ask Community Development and get back to Matrix with preference by June 15.*
   ii. Within report or appendices? *Andrew said follow Master Plan guidelines, or follow MHFD if no other guidance.*

- Action Items – Prior to next meeting
  See red text above.

Masterplan Storm Drainage Conceptual Design
Services - Oklahoma & South Basin
Progress Meeting Notes
Teams Conference Call
June 24, 2022
9:00 AM to 10:00 AM

Key: *Green italicized text is meeting notes*, *red italicized underlined text is action items*.

- Introductions *Andrew, April Tamburelli, James Redmond from Greeley. Drew, Ben from Matrix*
  April introduced as Stormwater staff to lead next Masterplan

- Previous Action Items

  MATRIX
  - Matrix to review Windsor Report for established names (Anderson report) Used numbers, do not need to replicate since the study scales are so different
  - Matrix will develop public meeting slides by June 15 Completed

  CITY
  - Greeley to ask staff about watercourse names No new direction
  - Greeley to ask Community Development about interactive exhibits Yes to interactive
  - Greeley to create a website stub to direct people Has been setup, link included in owner invitations
  - Greeley to look into whether they have Zoom account for hosting public meeting Andrew setup Zoom, will try to have practice run next Wed 9am
  - Greeley will develop public meeting notifications Went out last week, been receiving responses.
  - Greeley to reach out to management about type of property owners and determine meeting time Targeting developers and property owners that could be directly impacted (smaller group than normal), general public will be able to view presentation and ask questions later.

- Schedule/Upcoming Activities
  1. Data Collection update
     i. Stream assessments 1st or 2nd week of July
     ii. Discuss any remaining access issues
  2. Baseline Hydrology April 14 – July 20
     i. CUHP and SWMM models setup
     ii. June 29 - Draft Baseline Hydrology Report
     iii. July 20 – Final Hydrology Report
  3. First stakeholder meeting June 29 4pm-6pm
     i. Discuss format
        a) James says we should target ~15 min for recording. He can cut parts out of recording, but please give transitions 3 s pause to help with this
        b) Consider creating video loop for down time?
        c) Expecting few (less than 10) participants
        d) Drew suggested we set fixed number of presentation times (every half hour)
     ii. Discuss content (slides)
        a) Vicinity map highlight highways, zoom out
        b) Keep constraints/opportunities in study area map
        c) Discuss distinction between flood hazards vs nuisance issues (Same thing? Opposites? Simply scale?)
        d) April asked if we are prepared to discuss Cache la Poudre floodplain if asked, Andrew will handle
        e) Consider image/map for study phases slide
        f) Discussion on end product of Concept Design – Drew explained that this project ends at Concept. Matrix has also been trying to move away from showing detailed designs since past experience has shown that developers want to directly take these concepts and build off the shelf, or CIP projects have run into trouble by other departments (like Parks) objecting to what appears to be an advanced design.
        g) April asked if report would have discussion of how to handle variances from recommendations, Andrew said it would come later in this process (Alternatives Analysis). Sheep Draw was brought up as example, and Andrew noted that Sheep Draw has different detention requirements than rest of Greeley basins.
        h) Two photos used agreed to be appropriate
     iii. Discuss speakers
        a) Andrew will start: slides 1-3 and 8
        b) Matrix will take over at slide 4-7
     iv. Drew asked how we will record attendees; Andrew thinks Zoom will handle this
        a) Ben suggested having our intern act as a participant at dry run

- Other Questions/Requests/Ideas

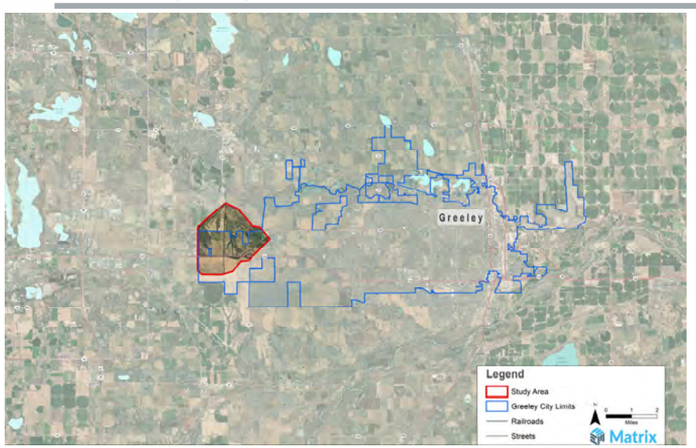
- Action Items – Prior to next meeting
  1. Andrew and Ben to prepare speeches for dry run next Wed 9am
  2. Non-public meeting topics were deferred to next progress meeting (possibly during public meeting if there is downtime) due to time

1

Vicinity Map

June 29, 2022

Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS



City of Greeley
Matrix

2

Study Purpose

June 29, 2022

Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

- **Goals:**
  - Identify major flood and drainage hazards
  - Stabilize drainageways for future runoff
  - Minimize flood hazards for future development
  - Improve water quality and reduce sedimentation
- **NOT included:**
  - Construct improvements
  - Annexation or rezoning
  - Revise the Cache la Poudre River floodplain
  - Address localized nuisance stormwater issues

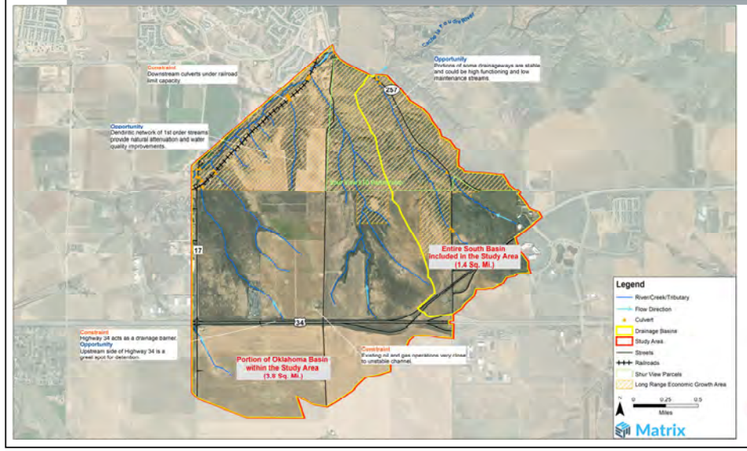
City of Greeley
Matrix

3

Overview of Study Area

June 29, 2022

Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS



City of Greeley
Matrix

4

Study Phase 2: Alternatives Analysis

June 29, 2022
Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

- **Identify problems**
- **Develop alternatives**
  - Status Quo
  - Floodplain Preservation
  - Conveyance Improvement
  - Crossing Improvement
  - Channel Stabilization
  - Regional Detention
  - Water Quality
- **Evaluate**
  - Cost
  - Constructability
  - Maintenance
  - Environmental Impact
  - Multiuse Opportunities
  - Public Opinion

City of Greeley
Matrix

6

Schedule 2022

June 29, 2022
Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

1.	**Data Collection**	**April – July**
	▪ Public Meeting #1	June 29
2.	**Baseline Hydrology**	**May – July**
3.	**Alternatives Analysis**	**July – October**
	▪ Public Meeting #2	Late October
4.	**Concept Design**	**November – December**

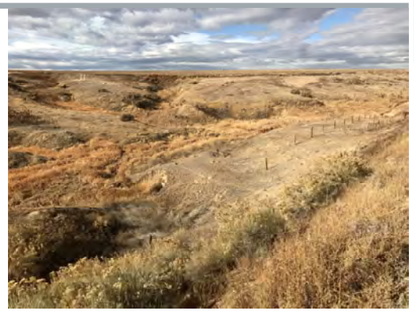
City of Greeley
Matrix

8

Study Phases

June 29, 2022
Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

1. **Data Collection**
2. **Baseline Hydrology**
3. **Alternatives Analysis**
4. **Concept Design**



City of Greeley
Matrix

7

Study Phases

June 29, 2022
Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

1. **Data Collection**
2. **Baseline Hydrology**
3. **Alternatives Analysis**
4. **Concept Design**

City of Greeley
Matrix

5

June 29, 2022

Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

Contact Information and Q & A

- **Project Website**
  - https://greeleygov.com/services/pw/projects/oklahoma-basin-drainage-plan
- **Greeley Project Manager**
  - Andrew Fisher andrew.fisher@greeleygov.com
- **Matrix Project Manager**
  - Drew Beck drew.beck@matrixdesigngroup.com
- **Questions and Comments?**

City of Greeley

Matrix

9

Shading indicates PTE status
(as of 2022-07-11)
Blue = Approved access
Yellow = Pending access
Red = No response or access prohibited

257 BEND LLC
HERMANNS FAMILY HOLDINGS CORPORATION
LEWIS JEFFREY B
ABBOTT JAMES L
POUDRE TECH METROPOLITAN DISTRICT
ANDERSON CHARLES T (80%)
TAFT VALLEY LLC
Private parking off Hwy 257
STALEY LORI A
PELMEIER DANIEL R
BRALEXIA LLC
WINDSOR TOWN OF
County Road 17
VIMA PARTNERS LLC
Private parking off Hwy 257
SHUR VIEW LTD PARTNERSHIP
Walking access along RR
WOOLDRIDGE CODY JOE
SCHMERGE TOM
County Road 19
Missle Silo Rd
KLIM ALEKSANDER
EDBLAD DAVID R & JOANNE L TRUSTEES
County Road 66
Private parking off County Rd 17
VOMBAUR BENJAMIN J
KING PAUL
CLARK ROYCE B TRUST
State Hwy 257 Spur
WINDSONG RANCH HOMEOWNERS ASSOC INC
WARNER SCOTT D
Windsong Dr
SILICON RANCH CORPORATION
USA WESTERN AREA POWER ADMINISTRATION
ROBERT STANLEY ENTERPRISES LLC
STAR ENTERPRISES LLC
NORTHERN COLORADO RV AND BOAT STORAGE LLC
COLBERG DENISE TRUST
MARINELARENA LILIANA I
PHILLIPS RONALD L
Private parking off Hwy 257
Parking Access in CDOT Lot
COLORADO DEPT OF TRANSPORTATION
BANNER HEALTH
HIGH POINTE LLC
KINNISON SARA M
SKYWAY PROPERTIES I LLC
BLANKS BRANDI
FRANKLIN HAL
Unnamed
Promontory Circle
DEPARTMENT OF TRANSPORTATION
DEPARTMENT OF TRANSPORTATION
COZY COW DAIRY LLC
LUNDVALL LLC
Private parking off County Rd 19
Parking off Hwy 257
JDM II SF NATIONAL LLC
JDM II SF NATIONAL LLC
BLASIO ELIZABETH
EXTRACTION OIL & GAS INC
KERR MCGEE OIL & GAS ONSHORE LP
HIGH POINTE LLC
Ramp
US Hwy 34 Bus
CITY CENTER WEST LP
EAGLE CROSSING DEVELOPMENT INC
EAGLE CROSSING DEVELOPMENT INC
HIGH POINTE LLC
Ramp
WOODWARD INC
203 5TH AVENUE LLC
GREELEY CITY OF
GREELEY CITY OF
TRIPOINT ACQUISITION GROUP LLC
Private parking off Hwy 34
MAX DEVELOPMENT PROPERTIES LLC
Ramp
Ramp
US Hwy 34
Ramp
State Hwy 257
Ramp
US Hwy 34
Parking off County Rd 17
PUBLIC SERVICE CO OF COLO
NOBLE ENERGY INC
GOLDEN EYE INVESTMENTS LLC
Driveway
APEX VISTA LLC
APEX VISTA LLC
HANKINS FARMS LLC
APEX V STA LLC
GREELEY CITY OF
GREELEY CITY OF

Legend

- Stream_Centerlines
- Study_Area
- Parcels_clip

Access Map Exhibit

Masterplan Storm Drainage Conceptual Design Services for the City of Greeley Comprehensive Drainage Plan Oklahoma & South Basins.

Matrix

N

0 500 1,000
Feet

Document Name: GOS_Field_Work
Document Path: G:\gis_projects\Greeley_Oklahoma_Drainage\active\apps\GOS_Field_Work.mxd
User Name: annagrace.howard
Date: 5/25/2022

Masterplan Storm Drainage Conceptual Design Services - Oklahoma & South Basin
Progress Meeting Notes
Teams Conference Call
July 20, 2022
8:30 AM to 9:30 AM

Key: *Green italicized text is meeting notes*, *red italicized underlined text is action items*.

- Introductions Andrew (Greeley), Drew, Ben (Matrix)

- Previous Action Items
  - Andrew and Ben to prepare speeches for public meeting Completed

- Schedule/Upcoming Activities
  1. Data Collection update
     i. Stream assessments July 15: Reaches 100, 200, 500, 600, 800 Ben summarized last Friday's field visit and the group reviewed some of the data (two teams, stream walks with observations and photos, culverts were measured but no survey-grade measurements were made). Field observations will be incorporated into the Alternatives Analysis section of the report.
     ii. Discuss whether Reach 300 and small culverts require additional visit Group agreed that Matrix will go back out if Schmerge and Feilmeier grant access to Reach 300, but Greeley will not invest more effort in obtaining access. Small culverts/reaches along the railroad are not big enough to warrant an additional field day alone.
  2. Baseline Hydrology: April – August
     i. July 20 - Draft Baseline Hydrology Report Matrix to submit report ASAP. Ben noted that this draft will contain numerous blank sections since the Baseline Hydrology is the only first part of a larger report.
     ii. August 17 – Final Baseline Hydrology Report Matrix would like to see Greeley's comments on the report format with the initial drafts.
  3. First stakeholder meeting June 29 4pm-6pm
  4. Alternatives Analysis: August – October Baseline Hydrology is a month behind, but Matrix hopes to catch up to original schedule during Alternatives Analysis.

- Other Questions/Requests/Ideas
  1. Proposed eliminating next week's progress meeting, next meeting will be August 10

- Action Items – Prior to next meeting See red inline items above.

Masterplan Storm Drainage Conceptual Design Services - Oklahoma & South Basin
Progress Meeting Notes
Teams Conference Call
August 10, 2022
9:00 AM to 10:00 AM

Key: Green italicized text is meeting notes, red text is action items.

- Introductions — Andrew, Brian (Greeley), Ben (Matrix)

- Previous Action Items
  - Matrix to submit Draft Baseline Hydrology Report ASAP — Done
  - Greeley to provide comments on the report format with the initial drafts — Getting close
  - Field observations will be incorporated into the Alternatives Analysis section of the report — In progress

- Schedule/Upcoming Activities
  1. Baseline Hydrology: April – August
     i. Jul 21 - Draft Baseline Hydrology Report
     ii. Aug 18 – Final Baseline Hydrology Report
        a) Discuss whether hydrology report revisions can be incorporated into Alternatives Analysis instead of separate submittal — Andrew said we can incorporate revisions into Alternatives Analysis
        b) Discuss existing crossing structures analysis — Ben summarized status of 18 existing crossing structures, said we do not have inverts for most but did not expect the culvert hydraulics to depend on pipe slope. Group discussed doing a bounds analysis but agreed that it wouldn't be necessary unless the culvert performance was very sensitive.
        c) Ben to check if Greeley sent official logo, Andrew to check preferred color/formatting
        d) Andrew questioned if Table 3-3 was necessary and why the total did not add up to 100%, Ben said it's a standard table (MHFD) and converting a 1-hr depth to a 2-hr hyetograph would not result in the exact same total precipitation.
        e) Andrew asked if we saw active (irrigated) agriculture in field, Ben said they only saw in Basin 800 but there could be more away from the study reaches. Andrew mentioned in other areas they were dealing with increased runoff from irrigated areas.
        f) Andrew asked if main Oklahoma Tributary was included in study, Ben said no. Hydrograph analyses of the main tributary are outside the current scope, but may be desirable if regional detention is recommended with this study.
        g) Andrew asked if we knew difference between COGCC "Abandoned" versus "Plugged and Abandoned", Matrix will look for more definitions.
  2. Alternatives Analysis: August – October
     i. Sept 28 - Draft Alternatives Report
        a) Andrew said that he expects 1D HEC-RAS models for the study reaches. Matrix will do that but suggests excluding Reach 800 (due to no existing channel).
        b) Brian reminded that Director wants regional (instead of piecemeal) water quality facilities where possible.
     ii. Oct 26 – Final Alternatives Report — Early November (to incorporate public comments)
     iii. Discuss Second Public Meeting: Nov 2? — Perhaps October 26 or week before? Andrew will reach out to James and Greeley PR team.
  3. Concept Design: November – December
     i. Nov 23 – Draft Concept Design Report
     ii. Dec 21 – Final Concept Design Report

- Other Questions/Requests/Ideas

- Action Items – Prior to next meeting
  See red text above

Masterplan Storm Drainage Conceptual Design Services - Oklahoma & South Basin
Progress Meeting Notes
Teams Conference Call
September 7, 2022
9:00 AM to 10:00 AM

Key: Green italicized text is meeting notes, red text is action items.

- Introductions — Andrew, Karen (Greeley) Ben, Drew (Matrix)

- Previous Action Items
  - Matrix to check if Greeley sent official logo — Matrix did not receive official logo, but downloaded an image from the website
  - Greeley to confirm preferred logo color/formatting — Logo used looks appropriate
  - Matrix will look for more COGCC "Abandoned" definitions — AL means the well was never drilled (permit was abandoned), will exclude from exhibit
  - Andrew will reach out to James and Greeley PR team — Pending

- Schedule/Upcoming Activities
  1. Baseline Hydrology: April – September
     i. Draft Baseline Hydrology Report Select Comment Discussion:
        a) Add additional public engagement sections to Chapter 2? — Identify/document key themes and priorities from our public meetings
        b) Many drainageways have likely experienced instability? — Change text to discuss risks or local instabilities
        c) Tri-Pointe/Promontory metro district? — Greeley will check with community development to confirm or deny. Matrix provided statewide database link: https://data.colorado.gov/Local-Aggregation/Metro-Districts-in-Colorado/knbf-ggf2
        d) Shur View acreage? — Andrew says news reports 975 acres, add to our text
        e) Did we study upstream reaches of 100 and 140? — No, excluded upstream reaches with contributing area < 130 ac
        f) Add CGOCC standard definitions? — Yes, see above

AL	ABANDONED LOCATION: PERMIT VACATED; PER OPERATOR: WELL HAS NOT BEEN SPUD.

  2. Alternatives Analysis: August – November — discuss project schedule
     i. Sept 28 - Draft Alternatives Report — Could push one week if needed
        a) Discuss what this will include — Ben said many of the alternatives will be hydrologic (detention) options, could have upstream detention to keep stable flows for downstream channels, or could separate WQ/EURV distributed basins from larger, 100-yr regional detention basins. Andrew would like us to discuss both options in text. Karen says Greeley management team is leaning towards regional solutions (not confident in HOAs maintaining facilities) but wary of the additional cost. Karen said it would be desirable to see cost comparison of both options. Greeley is wrestling with private vs public definition. Drew presented an alternatives screening matrix that MHFD uses and suggested that we modify it for Greeley's needs. He briefly discussed each of the criteria: constructability, maintenance, implementation with planned improvements, regional trail connectivity, multi-uses, water quality, public safety, habitat and environment, aesthetics, criteria compliance, agency acceptance, public acceptance. Drew suggests that we add more technical criteria to help differentiate. Andrew requested that Matrix send the example to Greeley and they will provide guidance/comments.
        Karen mentioned that their water quality department recently drafted a water efficiency document. Drew agreed and said that slowing water down/infiltration could be an additional category. Karen will send document to Andrew.
        b) Discuss types of expected alternatives — Drew proposed that we consider 5 types of alternatives:
           a. Do nothing
           b. Traditional detention
           c. Distributed WQ/EURV and peak shaving detention
           d. Natural/open channels
           e. Storm drains and culverts
              i. Do we want to set a threshold (like 130 ac) where piped flows are allowed? Andrew was concerned that developers were taking advantage of vague definitions in Sharkstooth.

        Andrew said they just released new street criteria. Drew said we anticipate looking at 100-yr capacity culverts for this planning document.

     ii. Oct 26 – Second Public Meeting?
     iii. Nov 9 – Final Alternatives Report — Matrix documents recommended plan at this submittal
     iv. Will Greeley authorize a Selected Plan? — Yes
  3. Concept Design: November – January
     i. Dec 14 – Draft Concept Design Report
     ii. Jan 18 – Final Concept Design Report

Group agreed that project running through January was realistic and acceptable.

- ## Other Questions/Requests/Ideas

  Drew referenced the 2060 Greeley Comprehensive Plan and how it preserved a very large region (the downstream fingers of each reach) within this project area, was this realistic? Andrew will look at this and provide additional guidance.

  Drew asked for more lessons learned from previous drainage master plans. Andrew said Greeley had trouble enforcing the documented best practices/intent (e.g., developers wanted to put excessive flows in the streets, which was technically meeting criteria). Says we should incorporate Community Development department as a stakeholder to get buyoff. Drew suggested we could provide more performance-based requirements, specifically for the open channel alternatives.

- ## Action Items – Prior to next meeting

  See red text above

Table 5-13 Screening Matrix

Screening Matrix			Constructability	Maintenance	Implementation with Planned Improvements	Regional Trail Connectivity	Multi-Use Facility	Water Quality	Public Safety	Habitat and Environment	Aesthetics	Compliance UDFCD Criteria	Agency Acceptance	Public Acceptance	TOTAL WEIGHTED AVERAGE
			Weighting												Score
Drainageway	Reaches	Options	*20%*	*5%*	*10%*	*5%*	*5%*	*5%*	*10%*	*5%*	*5%*	*10%*	*10%*	*10%*	*100%*
Sloan's Lake	Reach 1	Open Chanel													
		100-year Culvert	3	2	2	0	0	0	3	0	0	2	2	2	1.80
	Reach 2	Do Nothing	3	2	2	2	3	1	2	3	2	2	2	2	2.25
		Dredging	1	3	1	1	3	3	2	1	3	2	1	2	1.70
		Culvert Crossing	3	3	3	0	0	0	3	0	0	3	3	2	2.15
		Water Quality Improvements	2	2	2	0	3	3	2	3	3	3	3	2	2.30
	Reach 3	Culvert Crossings & Channel Improvements	3	3	3	0	0	0	3	0	0	3	3	2	2.15
		Culvert Crossing & Channel Improvements	2	3	2	1	2	2	2	2	2	3	3	2	2.20
		100-year Culvert	3	2	2	0	0	0	2	0	0	2	3	2	1.80
	Reach 4	Open Channel													
		Detention & 100-year Culvert	2	1	3	0	1	1	3	0	0	3	2	2	1.85
		100-year Culvert	3	1	2	0	1	0	2	0	0	2	2	3	1.80
	Reach 5	Open Channel & 100-year Culvert	2	2	0	2	3	2	2	2	2	3	2	1	1.85
		100-year Culvert	3	1	2	0	1	0	2	0	0	2	2	3	1.80
Pierce Street Tributary	Reach 1	Open Channel													
		100-Year Culvert	3	1	2	0	1	0	2	0	0	2	2	3	1.80
	Reach 2	Do Nothing	3	2	2	2	3	1	2	3	2	2	2	2	2.25
	Reach 3	Open Channel													
		100-Year Culvert	3	1	2	0	1	0	2	0	0	2	2	3	1.80
Ashland Drainageway	Reach 1	Open Channel													
		100-Year Culvert	3	1	2	0	1	0	2	0	0	2	2	3	1.80
	Reach 2	Open Channel													
		100-Year Culvert	3	1	2	0	1	0	2	0	0	2	2	3	1.80
Gary Street Tributary	Reach 1	Open Channel													
		100-Year Culvert	3	1	2	0	1	0	2	0	0	2	2	3	1.80

Masterplan Storm Drainage Conceptual Design Services - Oklahoma & South Basin
Progress Meeting Notes
Teams Conference Call
September 28, 2022
9:00 AM to 10:00 AM

Key: Green italicized text is meeting notes, red text is action items.

Introductions

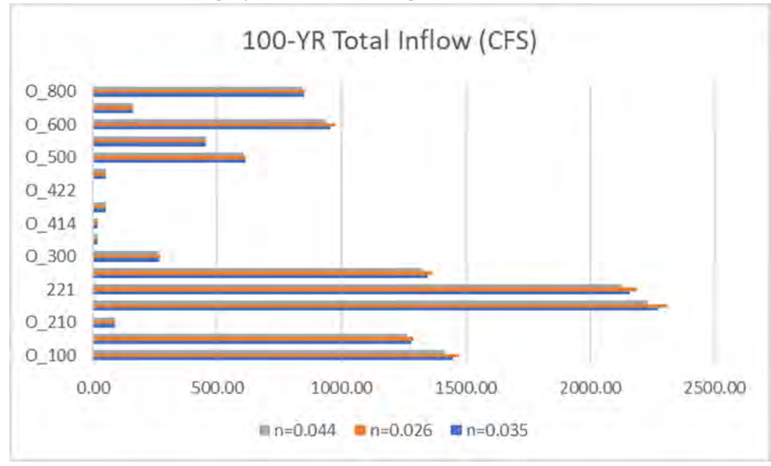
Andrew (Greeley), Ben (Matrix)

Previous Action Items

- Andrew will reach out to James and Greeley PR team re: public meeting — Pending
- Matrix to send alternatives screening matrix example to Greeley — Completed
- Greeley to provide comments/revisions of alternatives screening matrix — Greeley getting feedback from new hire (Brian Fischer), hopes to send it tomorrow
- Karen to send water efficiency document to Andrew — Pending, received but no file access yet
- Greeley will check with community development to confirm Tri-Pointe/Promontory metro district — Development Review confirmed that it is a metro district
- Andrew to confirm whether we should use preservation areas shown in 2060 Greeley Comprehensive — Andrew will confirm, Matrix to continue using

Schedule/Upcoming Activities

1. Baseline Hydrology: April – September
2. Alternatives Analysis: August – November
    i. Oct 5 - Draft Alternatives Report — New target is Oct 7
        a) Discuss types of alternatives
            a. Do nothing
            b. Detention
            Ben proposed using single detention option to simplify options since simple detention vs WQ+peak shaving detention results in very similar numbers/scoring, can explore different kinds of detention in Concept Design
            c. Channel Improvements — Ben noted their channel improvement options were coming out pretty wide due to limiting velocity < 5 ft/s with simple trapezoidal shapes, Andrew expressed hope that more complicated channel shapes/profiles could be explored in the future.
            d. LID/Green Infrastructure? — Yes, Greeley is interested. Matrix will incorporate LID alternatives using CUHP
            e. Storm drains (outside of crossings)? — Andrew asked if storm drains would be needed anywhere to address channel stability/steepness issues, Ben didn't think there were clearcut existing locations like that. Will talk about this option in report.
        b) Discuss desired report tables — Plan to have summary tables only in report, appendix will have more complicated tables
        c) Discuss desired alternatives maps — Andrew thinks pdf hyperlinks isolating each alternative type would be good
        d) Discuss sensitivity analysis — Ben suggested keeping n=0.035 for hydrology and hydraulic models (increasing roughness values by 25% results in Q100 increasing by up to 2% and Volume100 decreasing by <1%), Andrew agreed.



    ii. Oct 26 – Second Public Meeting? Andrew will verify date and whether it will be online
    iii. Nov 9 – Final Alternatives Report
3. Concept Design: November – January
    i. Dec 14 – Draft Concept Design Report
    ii. Jan 18 – Final Concept Design Report

Other Questions/Requests/Ideas

Agreed to cancel Oct 7 progress meeting, next one will be Oct 19.

Ben asked if Andrew received email notification when he added agenda to Outlook invite, Andrew said no and requested a separate email with agenda moving forward.

Action Items – Prior to next meeting

See red text above

Masterplan Storm Drainage Conceptual Design Services - Oklahoma & South Basin
Progress Meeting Notes
Teams Conference Call
November 9, 2022
9:00 AM to 10:00 AM

Key: Green italicized text is meeting notes, red text is action items.

- Introductions — Drew Beck, Ben Liu (Matrix), Andrew Fisher (Greeley)

- Previous Action Items
  - Greeley to send public meeting invites — Completed
  - Greeley to provide comments/revisions of alternatives screening matrix — Sent to Matrix Nov 8
  - Greeley to provide comments on Draft Alternatives Report — Sent to Matrix Nov 8
  - Matrix will research if Menti tool can also be used after Zoom meeting — Only useful live, would need separate method to collect comments outside of the presentation
  - Matrix will prepare draft presentation — Sent to Greeley Nov 1

- Schedule/Upcoming Activities
  1. Baseline Hydrology: April – September — Completed
  2. Alternatives Analysis: August – November
     i. Oct 7 - Draft Alternatives Report
        a) Discuss review comments — Minor comments, Matrix will address
        b) Discuss screening matrix and recommendations
           a. Drop agency acceptance (Greeley is only stakeholder)
           b. Drop public acceptance
           c. Andrew said he was trying to reduce # of scoring criteria
           d. Andrew wants to keep standards compliance criteria
           e. Condense 3 (planned improvements, trail connectivity, multiuse facility) to multi-objective criteria
           f. Matrix will produce blank screening template for Greeley approval
     ii. Oct 26 – Second Public Meeting: Nov 16
        a) Discuss content
           a. Add photos of typical feature, highlight detention
           b. Add LID slide (with photo)
           c. Add engineered channel photo
           d. Add blank scoring matrix (no weightings)
              i. Allow public feedback/scoring of alternatives
              ii. Andrew to check how to operate polls/private feedback
           e. Matrix to send updated PowerPoint by Nov 15
     iii. Nov 9 – Final Alternatives Report: Nov 23?
        a) Matrix will score alternatives after public meeting, send to Greeley for feedback before next report submittal
  3. Concept Design: December – January
     i. Dec 23 – Draft Concept Design Report
     ii. Jan 27 – Final Concept Design Report

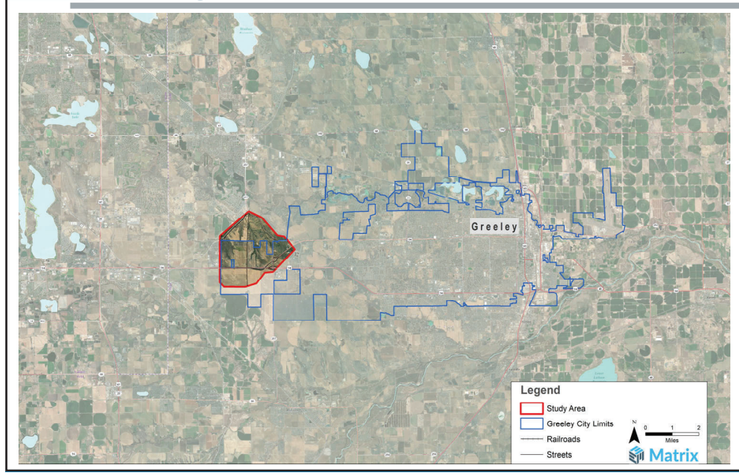
- Other Questions/Requests/Ideas

- Action Items – Prior to next meeting
  See red text above

1

Vicinity Map

November 16, 2022
Comprehensive Drainage Plan OKLAHOMA & SOUTH BASINS



City of Greeley Colorado
Matrix

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2

Study Purpose

November 16, 2022
Comprehensive Drainage Plan OKLAHOMA & SOUTH BASINS

- **Goals:**
  - Identify major flood and drainage hazards
  - Stabilize drainageways for future runoff
  - Minimize flood hazards for future development
  - Improve water quality and reduce sedimentation
- **NOT included:**
  - Construct improvements
  - Annexation or rezoning
  - Revise the Cache la Poudre River floodplain
  - Address localized nuisance stormwater issues

City of Greeley Colorado
Matrix

3

3

Study Phases & Schedule

November 16, 2022
Comprehensive Drainage Plan OKLAHOMA & SOUTH BASINS

1. Data Collection	**April – July 2022**
▪ Public Meeting #1	June 29
2. Baseline Hydrology	**May – September 2022**
3. Alternatives Analysis	**August – November 2022**
▪ Public Meeting #2	November 16
4. Concept Design	**November – January 2023**

City of Greeley Colorado
Matrix

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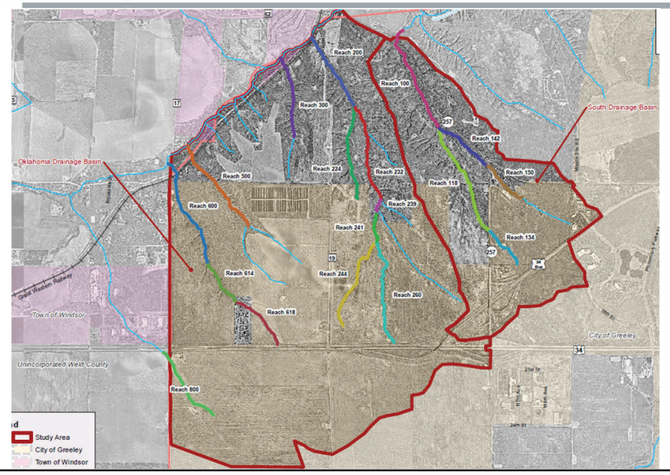
Study Reaches



November 16, 2022
Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

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Major Drainageway 100

November 16, 2022
Comprehensive Drainage Plan
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6

6

Major Drainageway 200

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7

Major Drainageway 500

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Major Drainageway 600

November 16, 2022

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Major Drainageway 800

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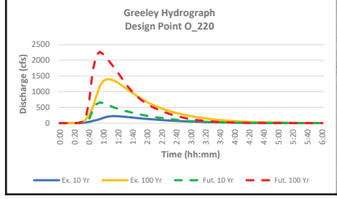
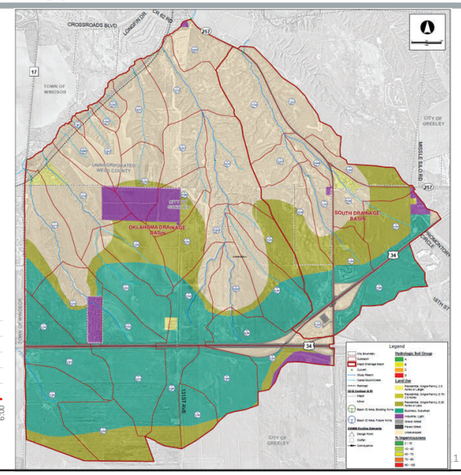
Baseline Hydrology

November 16, 2022

Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

- Delineation: 46 subbasins
- Landuse: existing & future
- Storm events: six
- Calculate: peak flows
- Calculate: peak volumes





City of Greeley Colorado

Matrix

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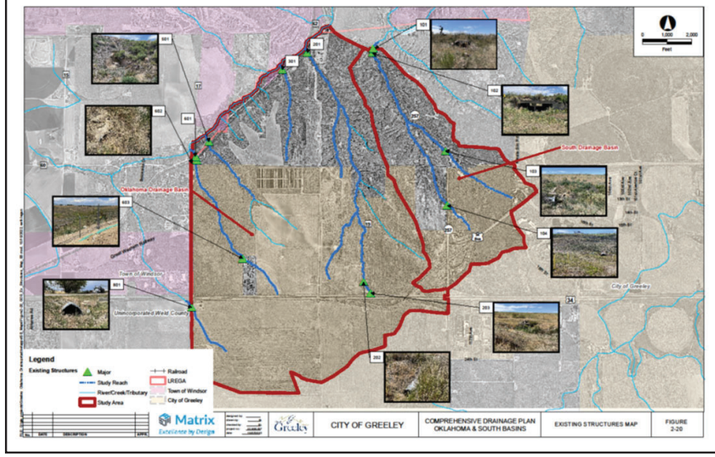
Crossing Structures

November 16, 2022

Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS



- 13 crossings
- Existing capacity
- Future sizing

City of Greeley Colorado

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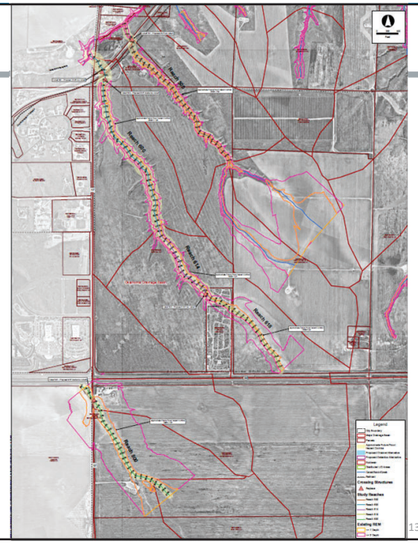
Alts Analysis

- **Type of Alternatives:**
  - Do Nothing
  - Detention
  - Channel Improvements
  - LID



November 16, 2022

Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

City of Greeley Colorado

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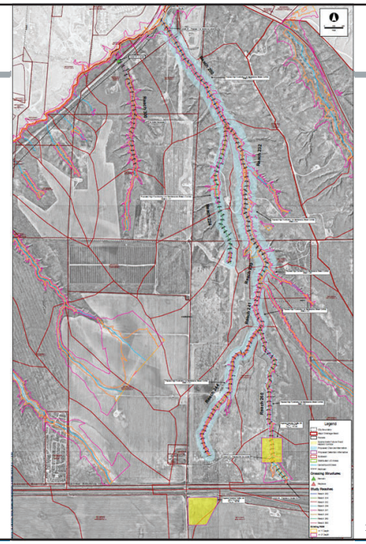
Alts Analysis

- **Type of Alternatives:**
  - Do Nothing
  - Detention
  - Channel Improvements
  - LID

Photo from MHFD Urban Storm Drainage Criteria Manual



November 16, 2022

Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

City of Greeley Colorado

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Alts Analysis

- **Type of Alternatives:**
  - Do Nothing
  - Detention
  - Channel Improvements
  - LID

Photos from MHFD Urban Storm Drainage Criteria Manual

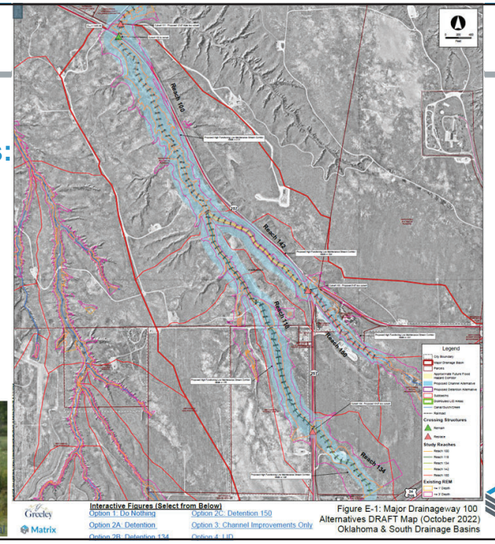

Figure E-1: Major Drainageway 100 Alternatives DRAFT Map (October 2022)
Oklahoma & South Drainage Basins

November 16, 2022

Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

City of Greeley Colorado

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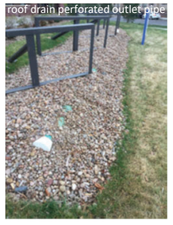
Alts Analysis

- **Type of Alternatives:**
  - Do Nothing
  - Detention
  - Channel Improvements
  - LID (Low Impact Development)

Photos from MHFD Urban Storm Drainage Criteria Manual



November 16, 2022

Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

City of Greeley Colorado

Matrix

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Alternatives Analysis

November 16, 2022
Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

Major Drainageway	Alternative	Constructability	Maintenance	Meets Multiple Objectives	Water Quality	Public Safety	Habitat and Environment	Aesthetics	Criteria Compliance	TOTAL WEIGHTED AVERAGE
		Weighting								Score
100	Option 1: Do Nothing									0.00
	Option 2: Detention									0.00
	Option 3: Channel Improvements									0.00
	Option 4: Distributed LID									0.00
200	Option 1: Do Nothing									0.00
	Option 2: Detention									0.00
	Option 3: Channel Improvements									0.00
	Option 4: Distributed LID									0.00
500	Option 1: Do Nothing									0.00
	Option 2: Detention									0.00
	Option 3: Channel Improvements									0.00
	Option 4: Distributed LID									0.00
600	Option 1: Do Nothing									0.00
	Option 2: Detention									0.00
	Option 3: Channel Improvements									0.00
	Option 4: Distributed LID									0.00
800	Option 1: Do Nothing									0.00
	Option 2: Detention									0.00
	Option 3: Channel Improvements									0.00
	Option 4: Distributed LID									0.00
		Scoring:	0 - no opportunity		1 - minimal opportunity		2 - average opportunity		3 - high opportunity	

Submit your feedback here: https://forms.gle/soBkqfWCXvAbF1eH6

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Contact Information and Q & A

November 16, 2022
Comprehensive Drainage Plan
OKLAHOMA & SOUTH BASINS

- **Project Website**
  - https://greeleygov.com/services/pw/projects/oklahoma-basin-drainage-plan
- **Greeley Project Manager**
  - Andrew Fisher andrew.fisher@greeleygov.com
- **Matrix Project Personnel**
  - Drew Beck drew.beck@matrixdesigngroup.com
  - Ben Liu ben.liu@matrixdesigngroup.com
- **Questions and Comments?**

18

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Masterplan Storm Drainage Conceptual Design Services -
Oklahoma & South Basin
Progress Meeting Notes
Teams Conference Call
December 14, 2022
9:00 AM to 10:00 AM

Key: Green italicized text is meeting notes, red text is action items.

- Introductions — Andrew Fisher (Greeley), Ben Liu (Matrix)

- Previous Action Items
  - Matrix will produce blank screening template for Greeley approval — Completed
  - Andrew to check how to operate polls/private feedback — Completed
  - Matrix to send updated PowerPoint by Nov 15 — Completed
  - Matrix will score alternatives after public meeting, send to Greeley — Completed

- Schedule/Upcoming Activities
  1. Baseline Hydrology: April – September — Completed
  2. Alternatives Analysis: August – December — Completed
     i. Oct 26 – Second Public Meeting: Nov 16
        a) Discuss feedback — No public comments
     ii. Nov 9 – Final Alternatives Report: — Submitted Dec 9
        a) Discuss review comments — Pending, Greeley will respond by Dec 30
        b) Discuss recommended plan
           1. Reviewed scoring Matrix and discussed sensitivity analysis (which categories did specific options always score highest), since scores are very close Andrew will meet with Greeley decision makers regarding LID vs regional detention preferences
           2. Matrix will proceed with Regional Detention for Drainageways 2 and 6
  3. Concept Design: December – February
     i. Jan 18 – Draft Concept Design Report — Schedule looks ok so far, will revisit in January
        a) Discuss any changes from alternatives analysis
           1. Will not show pipe designs
           2. Concept will show full composite typical section (profiles not required)
           3. Prepare a single rough grading sheet for detention basins
           4. LID prepare list of potential options
     ii. Feb 22 – Final Concept Design Report

- Other Questions/Requests/Ideas

- Action Items – Prior to next meeting
  See red text above

Masterplan Storm Drainage Conceptual Design Services - Oklahoma & South Basin
Progress Meeting Notes
Teams Conference Call
January 11, 2023
9:00 AM to 10:00 AM

Key: Green italicized text is meeting notes, red text is action items.

- Introductions — Andrew Fisher, Brian Hathaway (Greeley), Ben Liu, Drew Beck (Matrix)

- Previous Action Items
  - Andrew will meet with Greeley decision makers regarding LID vs regional detention preferences — Completed, Greeley prefers LID everywhere except Reach 244 (Delantero)
  - Greeley will provide Final Alternatives Analysis comments by Dec 30 — Pending
  - Matrix will proceed with Regional Detention for Drainageways 2 and 6 — Proceeded, will have to revisit Drainageway 2

- Schedule/Upcoming Activities
  1. Baseline Hydrology: April – September — Completed
  2. Alternatives Analysis: August – December — Completed
     i. Nov 9 – Final Alternatives Report: — Submitted Dec 9
        a) Discuss review comments — Andrew would check
        b) Discuss recommended plan
           1. Select regional detention for Reach 244 — LID everywhere else
           2. Other changes — Drainageway 6 should also utilize LID
           3. Greeley will provide a formal selected plan letter. Does not have to be overly formal, or even have a signature.
  3. Concept Design: December – Mar
     i. Feb 8 – Draft Concept Design Report
        a) Discuss any changes from alternatives analysis
           1. Will not show pipe designs
           2. Concept will show full composite typical section (profiles not required)
           3. Prepare a single rough grading sheet for detention basins
           4. LID prepare list of potential options
           5. Greeley would appreciate clear LID guidelines (since it is new), asked if we could do a training/familiarization effort for city staff
              i. Drew mentioned that MHFD Vol 3 has some good performance criteria that we should utilize (spreadsheet-based checks).
              ii. Drew also said that SWMM has LID capabilities; we could require more detailed SWMM models to prove the LID performance. Group talked about scale to require SWMM, for example Delantero (280 ac) did not complete a SWMM model. Andrew said he's only seen one SWMM model included for development.
           6. Brian mentioned design standards required for standard MS4 compliance, suggested that we prioritize control measures that could meet MS4 requirements. Drew thought this would involve a treatment train approach, LID can provide a volume reduction but would not eliminate the need for other BMPs.
           7. Drew asked what a helpful concept design for LID would look like. Andrew said we should not get site specific with recommendations. Brian brought up a treatment train. Drew suggested laying out potential components (but not spatially). Matrix will involve our Ecological Services group (ecologists, environmental scientists, landscape architect) to help flesh out the more artistic/holistic side of these recommendations.
     ii. Mar 8 – Final Concept Design Report

- Other Questions/Requests/Ideas

- Action Items – Prior to next meeting
  See red text above

Masterplan Storm Drainage Conceptual Design Services -
Oklahoma & South Basin
Progress Meeting Notes
Teams Conference Call
February 1, 2023
11:00 AM to 12:00 PM

Key: Green italicized text is meeting notes, red text is action items.

Introductions

Andrew Fisher, Greeley
Ben Liu, Megan Sawyer, Drew Beck, Matrix

Previous Action Items

- Greeley will provide a formal selected plan letter Pending resolutions of Alternatives update
- Matrix will involve Ecological Services group to flesh out the more artistic/holistic side of LID recommendations Started

Schedule/Upcoming Activities

1. Baseline Hydrology: April – September Completed
2. Alternatives Analysis: August – December Completed
   i. Nov 9 – Final Alternatives Report: Submitted Dec 9
      a) Discuss review comments No anticipated additional review comments from Greeley.
      b) Discuss recommended plan
         1. Greeley selected LID everywhere except regional detention for Reach 244
         2. Discuss corrections to the LID hydrologic results (see attached charts)
         3. Review sample alternative plan for Drainageway 500
            Example Drainageway 500 – Provide sub-regional EURV.
            - Developers can do multiple, distributed EURV ponds
            - Treatment train – LID upstream, reduce WQCV by 40%.
            - Provides partial detention of Q100
            - For larger, more complex drainageways, we may need peak shaving facility

            Andrew: Are any of these regional ponds >130 acres? Triggers ownership questions. Ben: No, subbasins delineated are <130 acres.
            Drew: Say in MDP, intent is sub-regional detention, not regional.

            Ben: MHFD ignores private EURV Ponds for hydrology. Drew: That's for mapped floodplain reasons. This area does not have mapped floodplain/floodway, and downstream flows will still be in the same channels. For channel design purposes, flow reduction caused by EURV ponds will exist and we want to consider actual outflow.

            Andrew: Greeley needs to know which basins would be considered privately maintained. Drew: Greeley would only be responsible for regional peak-shaving facilities. Noted that maintenance requirements for peak shaving ponds should be much less than full spectrum ponds.

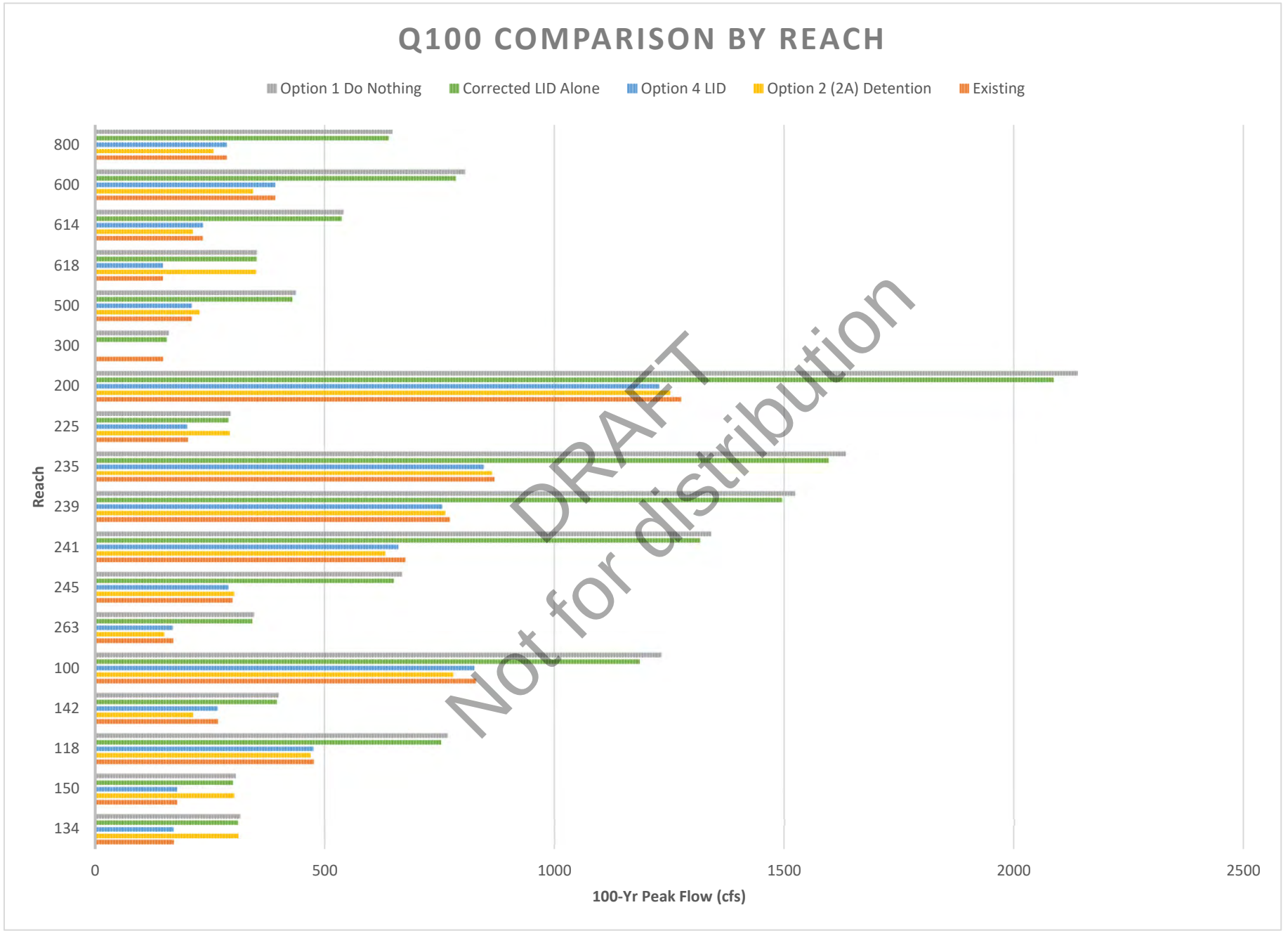
            Andrew: If EURV basins are nested within the peak shaving ponds, this would be City Maintained. Need to note in policy language of MDP. Ben: Does Greeley want to establish a maintenance program for these facilities w/ cost-sharing? Andrew: Unsure, policy is in flux.

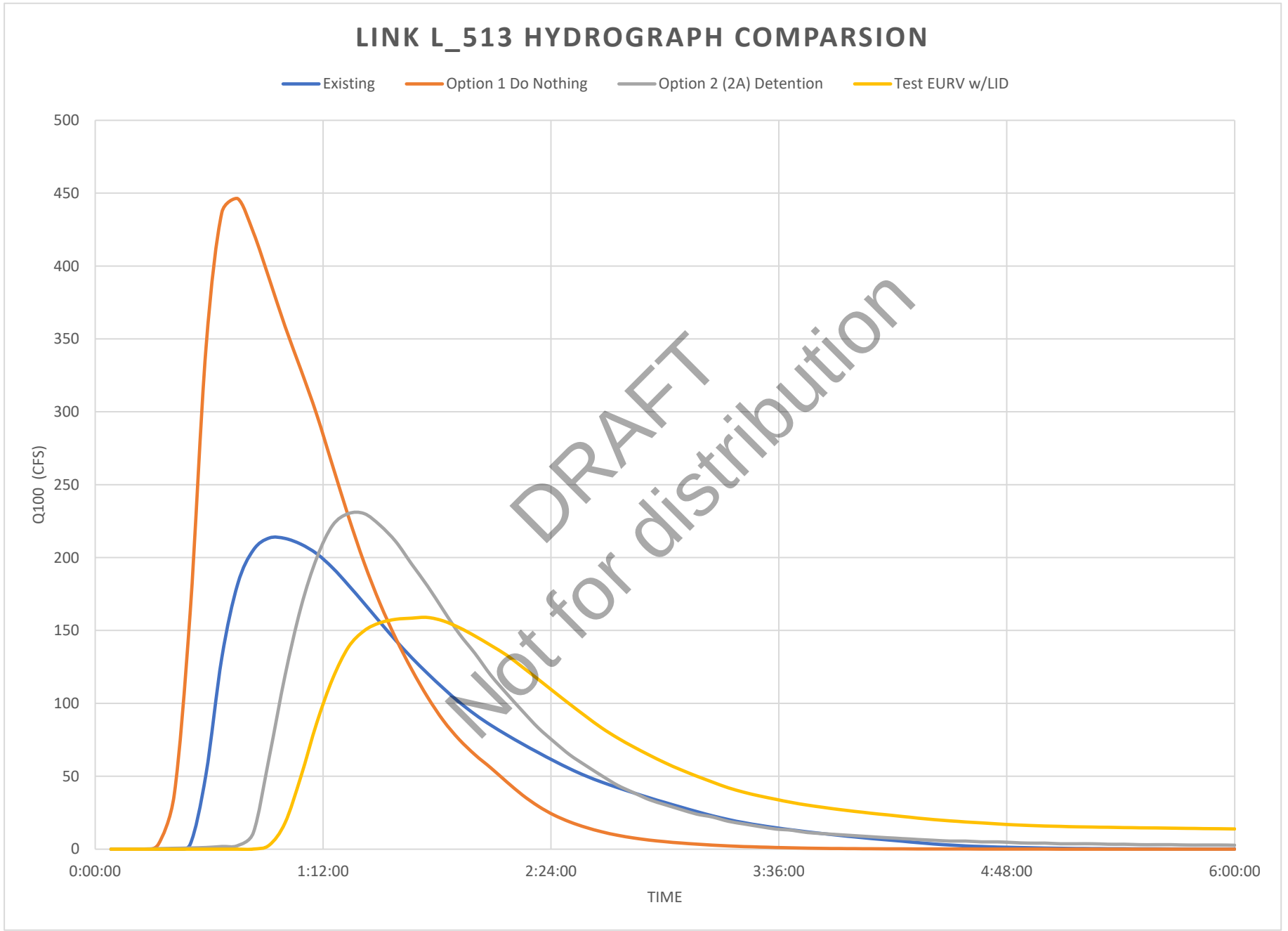
            Megan: What flow regime do we want to design to? Drew: We can increase up to what the existing channel can handle, but for MDP consideration, keep below existing flow rates. Ben: We believe LID is underestimated with our calculations tools. In future if calculations improve and LID can be better quantified by developer, that can be utilized to reduce their needed detention.
      1. Discuss what new evaluation/decision is required
         Andrew: significant change, have we re-ranked the Matrix? Not yet.
         Andrew: What is confidence for this approach? Need to discuss with board but want firmer information on approach. Drew: Unsure, Basins 100 and 200 are more complicated with different concerns on stream stability. These reaches may have different approaches. Ben: We can provide more information next week.
   2. Concept Design: December – Mar
      i. Feb 8 – Draft Concept Design Report will need to extend schedule.
         a) Discuss any changes from alternatives analysis
            1. Will not show pipe designs
            2. Concept will show full composite typical section (profiles not required)
            3. Prepare a single rough grading sheet for detention basins
            4. LID prepare list of potential components and performance criteria
               Examples of LID-conscious layout ideas (see attached charts)
               Andrew: Have colors be consistent, choose colors other than red/green
               Ben: We would appreciate review of LID concepts, will likely be an iterative process. Matrix to update concept LID layouts with revision.
      ii. Mar 8 – Final Concept Design Report

Other Questions/Requests/Ideas

Action Items – Prior to next meeting

Matrix to prepare concept feasibility for new LID/Sub-regional EURV ponds for all reaches.


Q100 COMPARISON BY REACH
Option 1 Do Nothing
Corrected LID Alone
Option 4 LID
Option 2 (2A) Detention
Existing
Reach
800
600
614
618
500
300
200
225
235
239
241
245
263
100
142
118
150
134
0
500
1000
1500
2000
2500
100-Yr Peak Flow (cfs)
DRAFT
Not for distribution


LINK L_513 HYDROGRAPH COMPARSION
Existing
Option 1 Do Nothing
Option 2 (2A) Detention
Test EURV w/LID
500
450
400
350
300
250
200
150
100
50
0
Q100 (CFS)
0:00:00
1:12:00
2:24:00
3:36:00
4:48:00
6:00:00
TIME
DRAFT
Not for distribution

TURF

IMPERVIOUS

LID

VEGETATED BUFFER / NATIVE VEGETATION

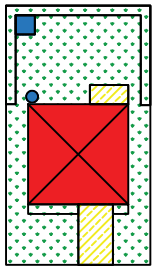
VEGETATED SWALE / TRENCH DRAIN

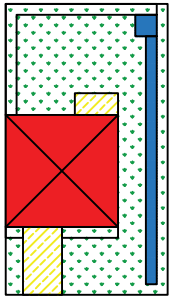
BIORETENTION - RAIN GARDEN
BIORETENTION - PLD

PERMEABLE PAVEMENT

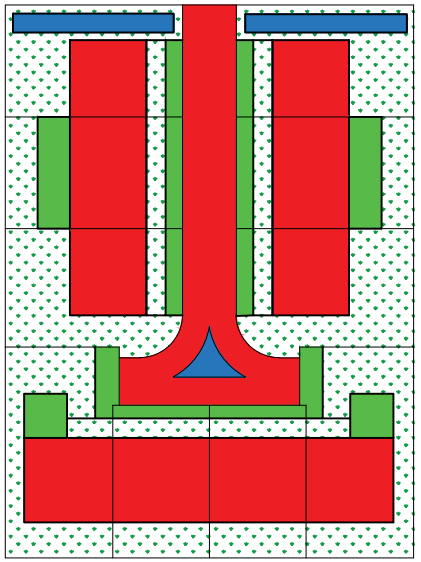
RAIN BARREL

SINGLE FAMILY - 0.25 AC LOT

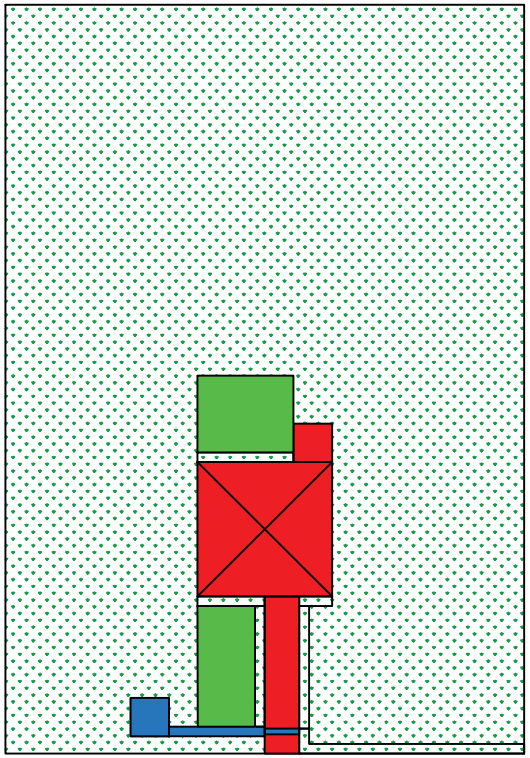


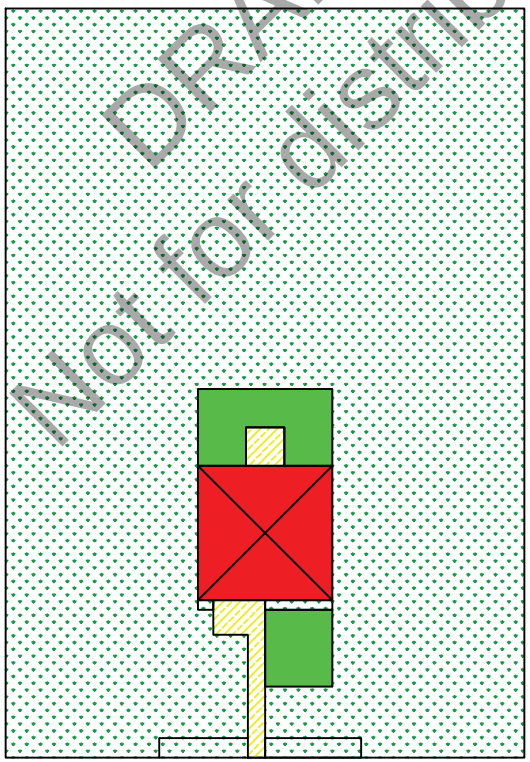


MULTI-LOT



SINGLE FAMILY - 2.5 AC LOT





DRAFT
Not for distribution

LID CONCEPTS - RESIDENTIAL

TURF

IMPERVIOUS

LID

VEGETATED BUFFER / NATIVE VEGETATION

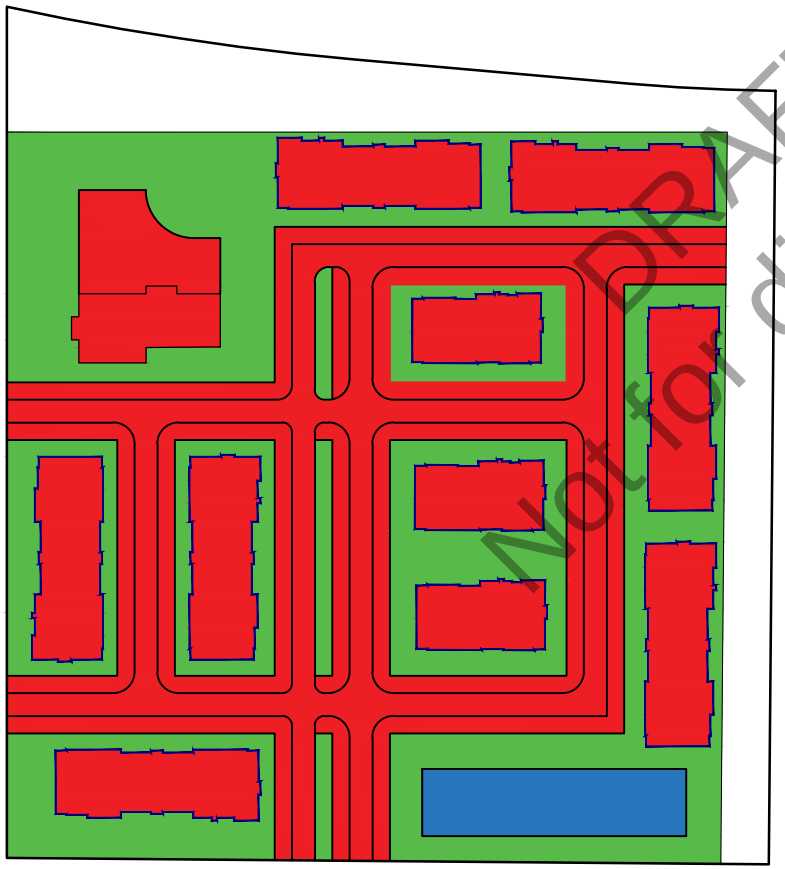
VEGETATED SWALE / TRENCH DRAIN

BIORETENTION - RAIN GARDEN
BIORETENTION - PLD

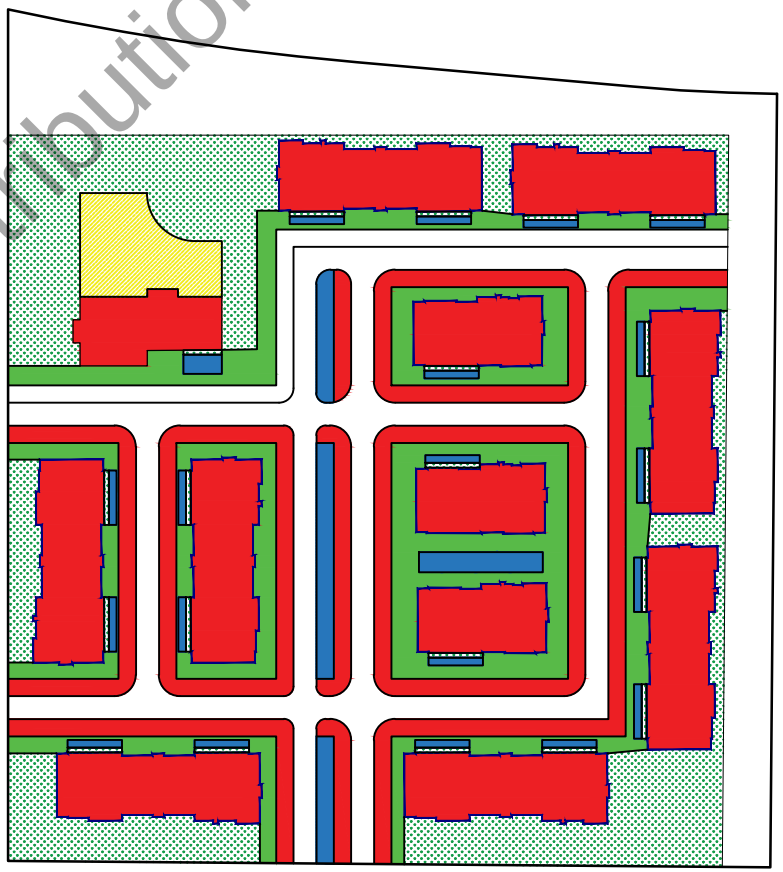
PERMEABLE PAVEMENT

RAIN BARREL

NO LID



LID



DRAFT
Not for distribution

LID CONCEPTS - COMMERCIAL

	Residential							Civic	Business Improvement District	Commercial	Multi-Use	Industrial
	Single Family			Multi-Family								
	Single lot	Ag Holding	Metro / HOA / Covenant Restricted	Multi-Unit	Row	Apartment	Metro					
Vegetated buffer	■	■	■	■	■	■	■	■	■	■	■	■
Vegetated swale	■	■	■	■	■	■	■	■	■	■	■	■
Curb cut / No-Curb			■	■	■	■	■	■	■	■	■	■
Trench drain	■	■	■	■	■	■	■	■	■	■	■	■
Bioretention - rain garden	■	■	■	■	■	■	■	■	■	■	■	■
Bioretention - porous landscape design			■				■	■	■	■	■	■
Rain barrel	■	■	■		■		■					
Green roof	■	■	■	■	■	■	■			■	■	■
Green alley			■				■	■	■	■	■	■
Permeable pavement	■	■	■	■	■	■	■					
Greenway corridor			■					■	■			
Extended detention basin							■	■	■	■	■	■
Sand filter										■	■	■
Retention ponds / constructed wetland ponds			■				■	■	■			
Constructed wetland channels			■				■	■	■			
Underground bmp			■				■	■	■			

DRAFT
Not for distribution

Masterplan Storm Drainage Conceptual Design Services - Oklahoma & South Basin
Progress Meeting Notes
Teams Conference Call
February 22, 2023
9:00 AM to 10:00 AM

Key: Green italicized text is meeting notes, red text is action items.

- Introductions

- Previous Action Items
  - Matrix to update concept LID layouts with revisions (consistent colors). Pending Selected Plan
  - Matrix to prepare concept feasibility for new LID/Sub-regional EURV ponds for all reaches. Complete

- Schedule/Upcoming Activities
  1. Baseline Hydrology: April – September Completed
  2. Alternatives Analysis: August – December Completed
     i. Nov 9 – Final Alternatives Report: Submitted Dec 9
  3. Concept Design: December – Apr
     i. Mar – Draft Concept Design Report
     ii. Apr – Final Concept Design Report

- Meeting Notes

Discussion of revised Option 4/LID results:

Option 2A

Detention Facility No.	Reach Location	Contributing Subbasins	Storage Volume (acre-feet)	Drainage Area (acre)	Proposed Detention Facility (Q100 Future Sizing)			Option 4 Flood Control		Option 4 Combined	
					Size (acre)	Peak Inflow (cfs)	Peak Outflow (cfs)	Storage Volume (acre-feet)	Size (acre)	Storage Volume (acre-feet)	Size (acre)
D150	150	150/154	12.9	148.9	3.9	400	214	4.0	0.8	11.2	5.0
D134	134	134	16.2	136.7	5.2	469	211	5.4	1.1	16.6	7.1
D248	244	248/250	18.8	140.2	7.1	509	194	10.3	1.8	29.1	12.7
D268	260	264/268	16.0	127.4	5.4	348	152	6.6	1.1	16.4	6.1
D510	510	514/518	18.4	168.3	6.0	456	230	7.5	1.3	20.3	8.9
D618	618	618/622	21.2	156.6	8.0	544	214	6.8	1.3	21.0	8.4
D814	814	814/818	25.4	210.6	12.0	646	258	2.4	0.6	30.9	10.7

1. Revised design includes regional flood control ponds at same 7 locations as Option 2A, plus 15 EURV ponds for areas with expected significant increase in impervious area.
2. Matched existing flows for lengths downstream of detention. Lengths upstream of detention will experience increased flow from existing condition.
3. Flood control are still needed in same locations, EURV was not sufficient for 100-yr protection.
4. WQ/EURV would be responsibility of developers/metro districts. Greeley would only be responsible for flood-control ponds.
5. Detention volume under Greeley would be reduced. For some reaches, combined area of EURV & Flood control areas is higher in Option 4 than Option 2 (regional detention), in some it is lower.
6. New Greeley standards: Outside of master plan areas, new development will be required to provide full-spectrum.

- Matrix to update costs and screening matrix by 2/27/2023.
  - Cost evaluation – Show only Greeley responsibility.
  - For screening matrix – consider system as a whole, including developers.
- Greeley to make Selected Plan decision by 3/10/2023.

- Other Questions/Requests/Ideas

- Action Items – Prior to next meeting

See red text above.

March 29, 2023

VIA ELECTRONIC MAIL

Matrix Design Group
Ben Liu
707 17th Street Suite 3150
Denver, CO, 80202

Re: Conceptual Alternative Selection – Oklahoma Master Plan

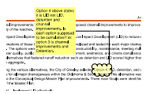
After reviewing the proposed alternatives in the Alternatives Report and associated revisions, please complete the Conceptual Design Report utilizing Alternative 4 – Low Impact Development, Detention, and Channel Improvements for all basins.

Thank you,

Andrew T. Fisher, PE, CFM
Civil Engineer III, Stormwater Management Division
2835 W 10th Street
Greeley, CO 80631
EMAIL: Andrew.Fisher@GreeleyGov.com
OFFICE: (970) 350-9797 CELL: (970) 302-0461

2023-06-30 GOS_ConceptDesign_Report_Draft -COMMENTS.pdf Markup Summary

fischerb (8)



Subject: Contractor
Page Label: 3
Author: fischerb
Date: 10/2/2023 1:36:05 PM
Status:
Color:
Layer:
Space:

Option 4 above states it is LID not LID, detention and channel improvements. Is each option supposed to be cumulative? ie: option 3 is channel improvements and Detention.

Subject: Sticky Note
Page Label: 3
Author: ben_liu
Date: 10/6/2023 8:56:51 AM
Status:
Color:
Layer:
Space:

Yes, each option focuses on a specific measure but may include other measures. Will add clarification sentence.

Subject: Contractor
Page Label: 5
Author: fischerb
Date: 10/2/2023 1:44:33 PM
Status:
Color:
Layer:
Space:

Looking at these costs and the next table it is unclear how costs are identified. I see the 50 yr cost matches but what about the CIP cost of 3.9 million, where is that in the table?

Subject: Sticky Note
Page Label: 5
Author: ben_liu
Date: 10/6/2023 9:36:57 AM
Status:
Color:
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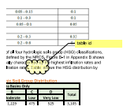
Space:

Total capital cost includes other items like mobilization and administrative costs. Will add a column to table for clarity.



Subject: Contractor
Page Label: 28
Author: fischerb
Date: 10/2/2023 1:21:27 PM
Status:
Color:
Layer:
Space:

table id

Subject: Sticky Note
Page Label: 28
Author: ben_liu
Date: 10/6/2023 3:44:51 PM
Status:
Color:
Layer:
Space:

Will revise.

Subject: Contractor
Page Label: 30
Author: fischerb
Date: 10/2/2023 1:21:52 PM
Status:
Color:
Layer:
Space:

table id

Subject: Sticky Note
Page Label: 30
Author: ben_liu
Date: 10/6/2023 3:45:26 PM
Status:
Color:
Layer:
Space:

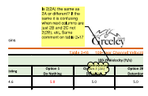
Will revise.

Subject: Contractor
Page Label: 38
Author: fischerb
Date: 10/2/2023 1:24:55 PM
Status:
Color:
Layer:
Space:

Is sentence unfinished or continued below with "Table 3-18..."?

Subject: Sticky Note
Page Label: 38
Author: ben_liu
Date: 10/6/2023 3:50:53 PM
Status:
Color:
Layer:
Space:

Continued with Table 3-18, will remove the odd line return.

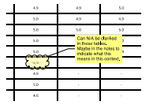


Subject: Contractor
Page Label: 40
Author: fischerb
Date: 10/6/2023 3:51:16 PM
Status:
Color:
Layer:
Space:

Is 2(2A) the same as 2A or different? If the same it is confusing when next columns are just 2B and 2C not 2(2B), etc. Same comment on table 2-17

Subject: Sticky Note
Page Label: 40
Author: ben_liu
Date: 10/6/2023 3:58:27 PM
Status:
Color:
Layer:
Space:

Same. 2A ended up being the best performing Option 2 detention scenario, but will revise to 2A to avoid confusion.

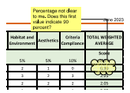


Subject: Contractor
Page Label: 40
Author: fischerb
Date: 10/2/2023 1:27:50 PM
Status:
Color:
Layer:
Space:

Can N/A be clarified in these tables. Maybe in the notes to indicate what this means in this context.

Subject: Sticky Note
Page Label: 40
Author: ben_liu
Date: 10/6/2023 4:05:58 PM
Status:
Color:
Layer:
Space:

N/A meant that proposed improvements were not required at this reach. We will revise to show the actual (same as Do Nothing) values since that is more informative.



Subject: Contractor
Page Label: 51
Author: fischerb
Date: 10/2/2023 1:31:31 PM
Status:
Color:
Layer:
Space:

Percentage not clear to me. Does this first value indicate 90 percent?

Subject: Sticky Note
Page Label: 51
Author: ben_liu
Date: 10/6/2023 4:09:34 PM
Status:
Color:
Layer:
Space:

This column is the total weighted score, not percentage. As listed in the bottom key, a 3 is the best possible score (high opportunity).

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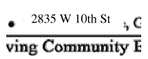
fishera (1)



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Page Label: 108
Author: fishera
Date: 4/7/2023 5:23:41 PM
Status:
Color:
Layer:
Space:

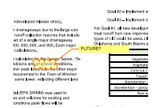
2835 W 10th St

Subject: Sticky Note
Page Label: 108
Author: ben_liu
Date: 10/6/2023 4:12:11 PM
Status:
Color:
Layer:
Space:

Will flatten this pdf comment.

---

stinesa (12)



Subject: Contractor
Page Label: 3
Author: stinesa
Date: 9/28/2023 3:55:28 PM
Status:
Color:
Layer:
Space:

FUTURE?

Subject: Sticky Note
Page Label: 3
Author: ben_liu
Date: 10/6/2023 8:57:36 AM
Status:
Color:
Layer:
Space:

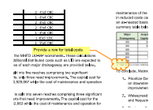
Will revise.

Subject: Contractor
Page Label: 4
Author: stinesa
Date: 9/21/2023 12:43:15 PM
Status:
Color:
Layer:
Space:

Identify the stream/channel/draw

Subject: Sticky Note
Page Label: 4
Author: ben_liu
Date: 10/6/2023 9:02:08 AM
Status:
Color:
Layer:
Space:

Will revise.



Subject: Contractor
Page Label: 5
Author: stinesa
Date: 9/21/2023 12:53:38 PM
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Provide a row for total costs

Subject: Sticky Note
Page Label: 5
Author: ben_liu
Date: 10/6/2023 9:35:32 AM
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Will revise.

Subject: Contractor
Page Label: 6
Author: stinesa
Date: 9/21/2023 1:30:12 PM
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Change chapter titles to be more descripitive of material in chapter

Subject: Sticky Note
Page Label: 6
Author: ben_liu
Date: 10/6/2023 9:41:49 AM
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We were directed to follow the section titles required by the City of Greeley Master Plan & Preparation Guide.

Subject: Contractor
Page Label: 12
Author: stinesa
Date: 9/22/2023 11:47:41 AM
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The first part of this sentence should read, "This study includes the entirety of the the South Basin watershed upstream of State Highway (SH) 257, while only including a portion of the Oklahoma Basin, that...

Subject: Sticky Note
Page Label: 12
Author: ben_liu
Date: 10/6/2023 9:44:04 AM
Status:
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Layer:
Space:

Will revise.

Subject: Contractor
Page Label: 13
Author: stinesa
Date: 9/22/2023 11:57:37 AM
Status:
Color:
Layer:
Space:

show entire drainage basin delineation in addition to study area

Subject: Sticky Note
Page Label: 13
Author: ben_liu
Date: 10/6/2023 3:37:19 PM
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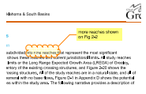
Space:

Will revise. Note that entire drainage basin is already shown in vicinity map.



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Date: 9/22/2023 12:01:48 PM
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more reaches shown on Fig 2-2

Subject: Sticky Note
Page Label: 15
Author: ben_liu
Date: 10/6/2023 3:39:52 PM
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Will revise.

Subject: Contractor
Page Label: 25
Author: stinesa
Date: 9/29/2023 11:41:01 AM
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missing fig 2-22

Subject: Sticky Note
Page Label: 25
Author: ben_liu
Date: 10/6/2023 3:42:15 PM
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Parks and Open Space figure was mislabeled, will revise to Figure 2-22

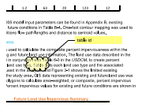

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table id

Subject: Sticky Note
Page Label: 28
Author: ben_liu
Date: 10/6/2023 3:44:43 PM
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Will revise.

Subject: Contractor
Page Label: 28
Author: stinesa
Date: 9/29/2023 11:49:20 AM
Status:
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Space:

table id

Subject: Sticky Note
Page Label: 28
Author: ben_liu
Date: 10/6/2023 3:44:34 PM
Status:
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Layer:
Space:

Will revise.

Subject: Contractor
Page Label: 37
Author: stinesa
Date: 9/29/2023 12:13:46 PM
Status:
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Missing beginning of last sentence

Subject: Sticky Note
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Author: ben_liu
Date: 10/6/2023 3:48:08 PM
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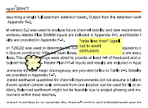
Will revise.



Subject: Contractor
Page Label: 55
Author: stinesa
Date: 9/29/2023 1:12:15 PM
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"ratio less than" (spell out to avoid confusion)

Subject: Sticky Note
Page Label: 55
Author: ben_liu
Date: 10/6/2023 4:10:29 PM
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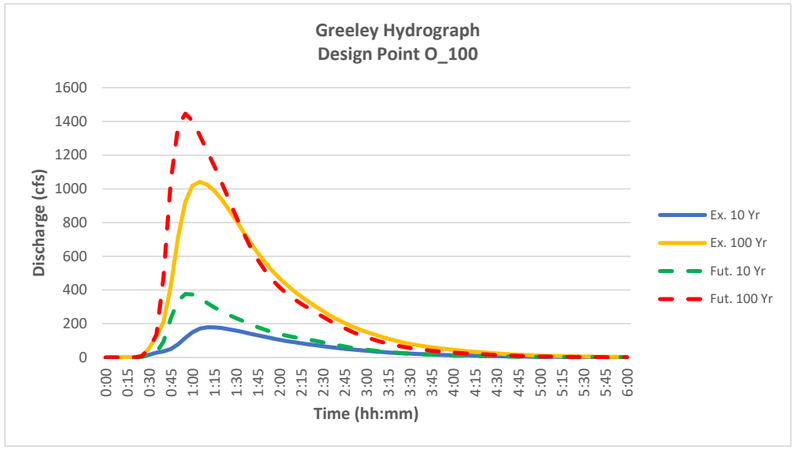
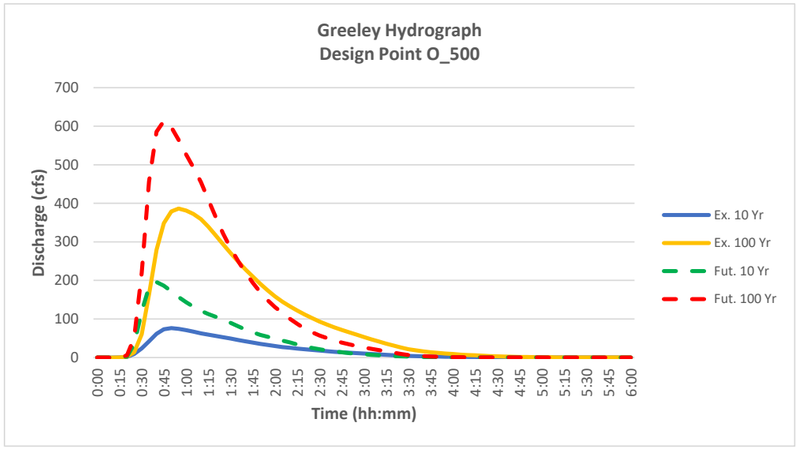
Will revise.

Appendix B – Hydrologic Analysis

Click here for Figure B-1 Hydrology Map


Greeley Hydrograph
Design Point O_100
Discharge (cfs)
Time (hh:mm)
Ex. 10 Yr
Ex. 100 Yr
Fut. 10 Yr
Fut. 100 Yr


Greeley Hydrograph
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Discharge (cfs)
Time (hh:mm)
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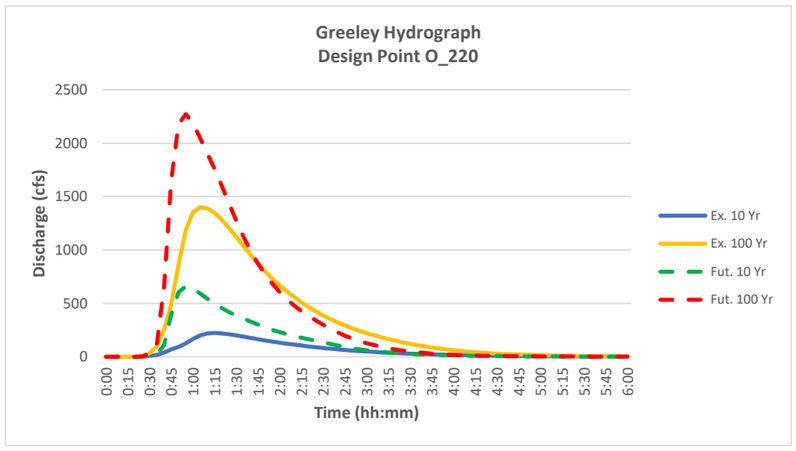
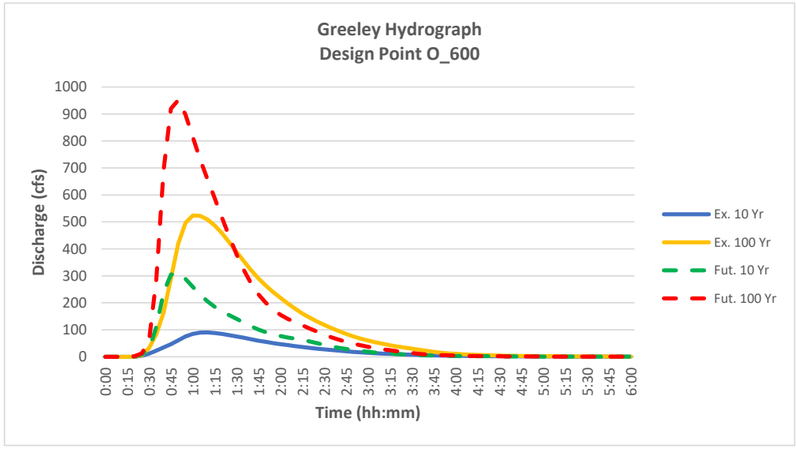
Ex. 100 Yr
Fut. 10 Yr
Fut. 100 Yr


Greeley Hydrograph
Design Point O_220
Discharge (cfs)
Time (hh:mm)
Ex. 10 Yr
Ex. 100 Yr
Fut. 10 Yr
Fut. 100 Yr


Greeley Hydrograph
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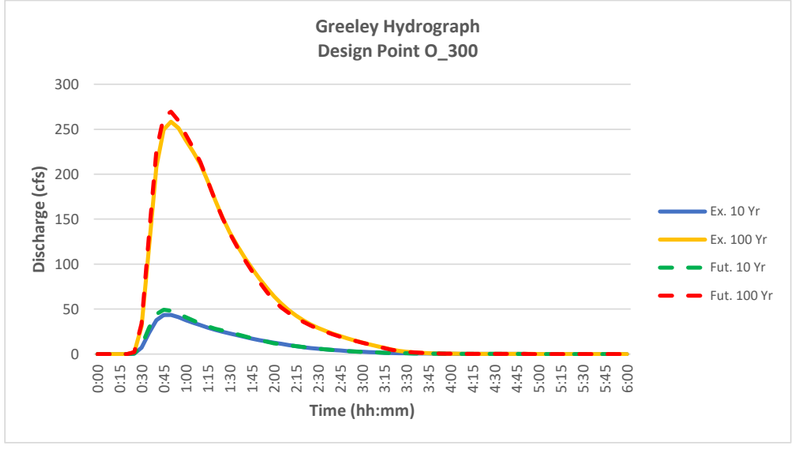
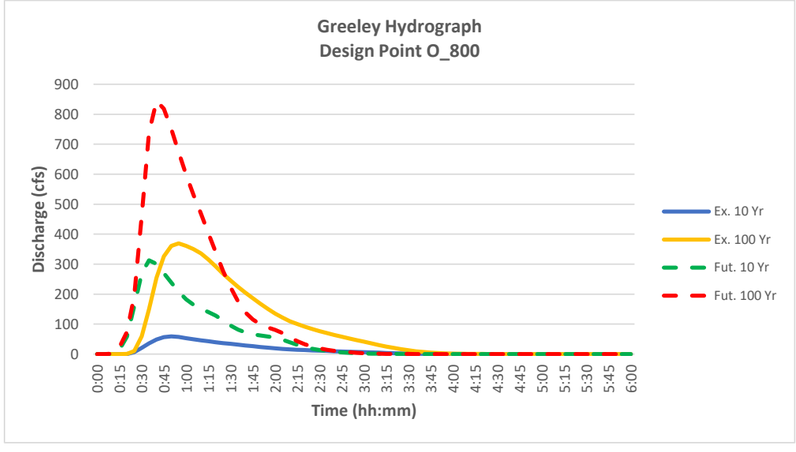
Discharge (cfs)
Time (hh:mm)
Ex. 10 Yr
Ex. 100 Yr
Fut. 10 Yr
Fut. 100 Yr


Greeley Hydrograph
Design Point O_300
Discharge (cfs)
Time (hh:mm)
Ex. 10 Yr
Ex. 100 Yr
Fut. 10 Yr
Fut. 100 Yr


Greeley Hydrograph
Design Point O_800
Discharge (cfs)
Time (hh:mm)
Ex. 10 Yr
Ex. 100 Yr
Fut. 10 Yr
Fut. 100 Yr

Return Period	2-Year
1Hr Depth	0.85
6Hr Depth	1.28
Area Adjust	0 Sq. Mi.
Time	Depth
0:05	0.02
0:10	0.03
0:15	0.07
0:20	0.14
0:25	0.21
0:30	0.12
0:35	0.05
0:40	0.04
0:45	0.03
0:50	0.03
0:55	0.03
1:00	0.03
1:05	0.03
1:10	0.02
1:15	0.02
1:20	0.02
1:25	0.02
1:30	0.02
1:35	0.02
1:40	0.02
1:45	0.02
1:50	0.02
1:55	0.01
2:00	0.01
2:05	0.00
Total Depth (in)	0.98

Return Period	5-Year
1Hr Depth	1.12
6Hr Depth	1.67
Area Adjust	0 Sq. Mi.
Time	Depth
0:05	0.02
0:10	0.04
0:15	0.10
0:20	0.17
0:25	0.28
0:25	0.15
0:35	0.06
0:40	0.05
0:45	0.04
0:50	0.04
0:55	0.03
1:00	0.03
1:05	0.03
1:10	0.03
1:15	0.03
1:20	0.02
1:25	0.02
1:30	0.02
1:35	0.02
1:40	0.02
1:45	0.02
1:50	0.02
1:55	0.02
2:00	0.01
2:05	0.00
Total Depth (in)	1.30

Return Period	10-Year
1Hr Depth	1.40
6Hr Depth	2.08
Area Adjust	0 Sq. Mi.
Time	Depth
0:05	0.03
0:10	0.05
0:15	0.11
0:20	0.21
0:25	0.35
0:30	0.17
0:35	0.08
0:40	0.06
0:45	0.05
0:50	0.04
0:55	0.04
1:00	0.04
1:05	0.04
1:10	0.04
1:15	0.04
1:20	0.03
1:25	0.03
1:30	0.03
1:35	0.03
1:40	0.03
1:45	0.03
1:50	0.03
1:55	0.02
2:00	0.02
2:05	0.00
Total Depth (in)	1.62

Return Period	25-Year
1Hr Depth	1.87
6Hr Depth	2.77
Area Adjust	0 Sq. Mi.
Time	Depth
0:05	0.02
0:10	0.07
0:15	0.09
0:20	0.15
0:25	0.28
0:30	0.47
0:35	0.22
0:40	0.15
0:45	0.09
0:50	0.09
0:55	0.06
1:00	0.06
1:05	0.06
1:10	0.04
1:15	0.04
1:20	0.03
1:25	0.03
1:30	0.03
1:35	0.03
1:40	0.03
1:45	0.03
1:50	0.03
1:55	0.03
2:00	0.03
2:05	0.00
Total Depth (in)	2.16

Return Period	50-Year
1Hr Depth	2.30
6Hr Depth	3.39
Area Adjust	0 Sq. Mi.
Time	Depth
0:05	0.03
0:10	0.08
0:15	0.11
0:20	0.18
0:25	0.35
0:30	0.57
0:35	0.28
0:40	0.18
0:45	0.11
0:50	0.11
0:55	0.07
1:00	0.07
1:05	0.07
1:10	0.06
1:15	0.06
1:20	0.04
1:25	0.04
1:30	0.03
1:35	0.03
1:40	0.03
1:45	0.03
1:50	0.03
1:55	0.03
2:00	0.03
2:05	0.00
Total Depth (in)	2.66

Return Period	100-Year
1Hr Depth	2.79
6Hr Depth	4.11
Area Adjust	0 Sq. Mi.
Time	Depth
0:05	0.03
0:10	0.08
0:15	0.13
0:20	0.22
0:25	0.39
0:30	0.70
0:35	0.39
0:40	0.22
0:45	0.17
0:50	0.14
0:55	0.11
1:00	0.11
1:05	0.11
1:10	0.06
1:15	0.06
1:20	0.03
1:25	0.03
1:30	0.03
1:35	0.03
1:40	0.03
1:45	0.03
1:50	0.03
1:55	0.03
2:00	0.03
2:05	0.00
Total Depth (in)	3.23

								Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	SWMM Node/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
110	110	GREELEY	0.111	0.506	0.975	0.027	4.8	0.35	0.10	3.00	0.50	0.0018	0.00	0.10	0.05	4.34
114	114	GREELEY	0.175	0.346	0.914	0.031	3.8	0.40	0.10	3.00	0.50	0.0018	0.00	0.08	0.04	3.41
118	118	GREELEY	0.059	0.278	0.474	0.048	2.0	0.40	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.81
122	122	GREELEY	0.192	0.486	1.184	0.027	4.4	0.35	0.10	3.00	0.50	0.0018	0.00	0.09	0.04	4.00
126	126	GREELEY	0.032	0.133	0.286	0.013	21.2	0.40	0.10	4.50	0.60	0.0018	0.00	0.42	0.13	19.74
130	130	GREELEY	0.073	0.318	0.607	0.038	7.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.16	0.08	7.20
134	134	GREELEY	0.084	0.217	0.593	0.028	11.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.22	0.10	10.16
138	138	GREELEY	0.130	0.176	0.483	0.017	23.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.47	0.14	22.55
142	142	GREELEY	0.031	0.233	0.500	0.034	11.9	0.40	0.10	3.00	0.50	0.0018	0.00	0.24	0.11	11.03
146	146	GREELEY	0.062	0.463	0.831	0.033	6.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.14	0.07	6.35
150	150	GREELEY	0.093	0.272	0.641	0.040	5.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.11	0.06	5.18
154	154	GREELEY	0.139	0.231	0.515	0.027	20.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.41	0.13	19.48
210	210	GREELEY	0.076	0.155	0.506	0.042	4.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.09	0.05	4.19
220	220	GREELEY	0.156	0.410	0.800	0.034	2.2	0.40	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.96
224	224	GREELEY	0.100	0.239	0.642	0.041	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.81
226	226	GREELEY	0.095	0.307	0.593	0.034	32.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.65	0.18	31.52
228	228	GREELEY	0.103	0.359	0.664	0.026	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.81
232	232	GREELEY	0.166	0.432	0.945	0.034	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.81
236	236	GREELEY	0.094	0.355	0.753	0.036	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.81
240	240	GREELEY	0.034	0.160	0.395	0.051	2.0	0.40	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.81
244	244	GREELEY	0.141	0.480	0.830	0.038	5.5	0.35	0.10	3.00	0.50	0.0018	0.00	0.11	0.05	4.99
248	248	GREELEY	0.151	0.284	0.543	0.016	4.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.08	0.04	3.66
250	250	GREELEY	0.068	0.120	0.339	0.022	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.81
252	252	GREELEY	0.098	0.393	0.739	0.021	5.1	0.35	0.10	3.00	0.50	0.0018	0.00	0.10	0.05	4.66
256	256	GREELEY	0.146	0.554	0.954	0.032	2.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.04	0.02	1.76
260	260	GREELEY	0.101	0.321	0.670	0.050	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.81
264	264	GREELEY	0.107	0.331	0.854	0.024	16.3	0.35	0.10	3.00	0.50	0.0018	0.00	0.33	0.12	15.23
268	268	GREELEY	0.092	0.287	0.637	0.018	17.1	0.35	0.10	3.00	0.50	0.0018	0.00	0.34	0.12	16.02
310	310	GREELEY	0.138	0.389	0.760	0.038	2.4	0.40	0.10	4.50	0.60	0.0018	0.00	0.05	0.02	2.14
314	314	GREELEY	0.108	0.245	0.526	0.038	31.3	0.35	0.10	4.50	0.60	0.0018	0.00	0.63	0.17	29.79
410	410	GREELEY	0.021	0.189	0.311	0.073	4.8	0.40	0.10	3.00	0.50	0.0018	0.00	0.10	0.05	4.41
414	414	GREELEY	0.019	0.143	0.263	0.087	2.9	0.40	0.10	3.00	0.50	0.0018	0.00	0.06	0.03	2.67
418	418	GREELEY	0.062	0.276	0.605	0.047	3.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.06	0.03	2.69
422	422	GREELEY	0.006	0.102	0.196	0.097	3.8	0.40	0.10	5.00	1.00	0.0007	0.00	0.08	0.04	3.01
426	426	GREELEY	0.068	0.320	0.635	0.046	4.7	0.35	0.10	4.50	0.60	0.0018	0.00	0.09	0.05	4.13
510	510	GREELEY	0.193	0.483	0.920	0.033	14.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.29	0.11	13.60
514	514	GREELEY	0.138	0.457	0.927	0.025	2.1	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.92
518	518	GREELEY	0.125	0.298	0.642	0.024	4.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.08	0.04	3.60
610	610	GREELEY	0.166	0.452	0.971	0.032	4.4	0.35	0.10	3.00	0.50	0.0018	0.00	0.09	0.04	3.98
614	614	GREELEY	0.157	0.330	0.607	0.036	17.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.34	0.12	15.94
618	618	GREELEY	0.084	0.185	0.446	0.026	7.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.15	0.08	6.99
622	622	GREELEY	0.161	0.336	0.673	0.019	4.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.10	0.05	4.43
710	710	GREELEY	0.068	0.192	0.421	0.017	13.3	0.35	0.10	3.00	0.50	0.0018	0.00	0.27	0.11	12.35
810	810	GREELEY	0.100	0.339	0.677	0.023	8.1	0.35	0.10	3.00	0.50	0.0018	0.00	0.16	0.08	7.45
814	814	GREELEY	0.173	0.312	0.834	0.016	2.1	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.92
818	818	GREELEY	0.156	0.361	0.569	0.023	2.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.04	0.02	1.76

Table B-3 100 Year Existing CUHP Calculated Parameters

	Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
110	0.147	0.164	71.2	10.48	37.0	7.40	17.5	47	257,766	1.84	474,044	65.0	73	473,948	1.02
114	0.150	0.206	45.3	8.65	23.5	6.11	14.4	116	406,013	1.78	722,616	50.0	157	722,227	1.41
118	0.156	0.131	43.8	5.91	22.8	4.17	9.8	40	136,996	1.76	241,055	50.0	53	241,032	1.41
122	0.148	0.208	60.8	11.24	31.6	7.94	18.7	94	445,075	1.84	816,733	60.0	143	816,692	1.16
126	0.111	0.077	39.8	3.86	20.7	2.73	6.4	24	74,154	1.84	136,604	45.0	31	136,226	1.52
130	0.136	0.127	50.1	6.39	26.1	4.52	10.7	44	169,548	1.87	317,651	50.0	63	317,702	1.34
134	0.126	0.126	41.1	5.48	21.4	3.87	9.1	61	194,175	1.91	370,693	45.0	84	370,269	1.56
138	0.107	0.145	28.3	4.65	14.7	3.29	7.8	138	301,853	2.06	620,979	40.0	177	618,981	2.13
142	0.124	0.080	58.3	5.08	30.3	3.59	8.5	16	71,765	1.88	134,597	50.0	23	134,384	1.17
146	0.139	0.120	77.7	8.69	40.4	6.14	14.5	24	143,818	1.86	267,976	65.0	38	267,866	0.96
150	0.144	0.149	42.5	6.36	22.1	4.49	10.6	66	216,576	1.85	400,486	50.0	90	400,569	1.50
154	0.111	0.150	29.8	4.94	15.5	3.49	8.2	140	323,632	2.02	653,994	40.0	181	651,551	2.03
210	0.147	0.139	31.3	4.84	16.3	3.42	8.1	73	177,186	1.84	325,543	45.0	90	324,625	1.85
220	0.156	0.202	47.5	8.88	24.7	6.28	14.8	99	363,101	1.76	639,572	50.0	134	639,193	1.34
224	0.156	0.166	38.7	6.42	20.1	4.54	10.7	77	231,887	1.81	419,386	45.0	102	419,591	1.59
226	0.098	0.146	31.3	5.01	16.3	3.54	8.3	91	221,759	2.16	479,546	45.0	124	478,284	2.03
228	0.156	0.168	52.3	8.26	27.2	5.84	13.8	59	240,005	1.81	434,068	55.0	84	433,632	1.27
232	0.156	0.208	51.7	9.77	26.9	6.90	16.3	96	384,902	1.81	696,126	55.0	138	695,900	1.30
236	0.156	0.161	53.5	8.12	27.8	5.74	13.5	53	217,622	1.81	393,586	55.0	75	393,321	1.25
240	0.156	0.102	38.8	4.55	20.2	3.22	7.6	26	79,324	1.76	139,577	45.0	33	139,239	1.52
244	0.144	0.180	53.0	8.84	27.6	6.25	14.7	80	328,035	1.85	605,870	55.0	116	605,519	1.29
248	0.149	0.191	39.9	7.37	20.8	5.21	12.3	114	350,880	1.83	642,445	50.0	152	642,127	1.58
250	0.156	0.140	28.1	4.51	14.6	3.19	7.5	73	158,220	1.81	286,153	40.0	87	285,200	1.99
252	0.146	0.154	62.0	8.85	32.2	6.25	14.7	48	228,783	1.84	421,629	55.0	71	421,403	1.13
256	0.156	0.197	62.7	11.00	32.6	7.77	18.3	70	339,970	1.64	556,195	60.0	97	556,053	1.03
260	0.156	0.167	43.1	7.02	22.4	4.96	11.7	70	234,503	1.81	424,117	50.0	95	424,079	1.47
264	0.117	0.136	53.9	7.13	28.0	5.04	11.9	60	249,635	1.97	491,827	50.0	90	491,671	1.31
268	0.116	0.126	49.8	6.33	25.9	4.47	10.5	55	212,597	1.98	420,867	50.0	82	420,987	1.39
310	0.155	0.190	46.6	8.30	24.2	5.87	13.8	89	319,565	1.59	508,872	50.0	111	508,663	1.26
314	0.100	0.149	25.7	4.45	13.4	3.14	7.4	126	251,527	2.02	507,147	40.0	155	505,865	2.24
410	0.147	0.077	42.8	4.04	22.3	2.86	6.7	15	48,596	1.79	87,101	45.0	19	86,893	1.43
414	0.153	0.077	34.7	3.55	18.0	2.51	5.9	16	43,852	1.77	77,639	45.0	20	77,363	1.64

Table B-3 100 Year Existing CUHP Calculated Parameters

	Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
418	0.153	0.131	48.3	6.36	25.1	4.50	10.6	38	143,829	1.82	261,646	50.0	54	261,733	1.35
422	0.152	0.047	40.3	2.96	21.0	2.09	4.9	5	15,040	0.70	10,471	40.0	3	10,387	0.69
426	0.148	0.132	51.1	6.69	26.6	4.73	11.2	40	157,878	1.67	263,342	50.0	53	263,415	1.21
510	0.120	0.176	48.9	8.12	25.4	5.74	13.5	118	448,125	1.95	874,094	50.0	174	873,574	1.41
514	0.156	0.192	61.0	10.48	31.7	7.40	17.5	68	321,518	1.81	581,890	60.0	101	581,784	1.14
518	0.150	0.176	44.1	7.45	22.9	5.27	12.4	85	289,290	1.83	529,451	50.0	117	528,990	1.47
610	0.148	0.198	54.0	9.72	28.1	6.87	16.2	92	384,646	1.83	705,726	55.0	135	705,522	1.27
614	0.116	0.161	34.8	5.80	18.1	4.10	9.7	135	364,132	1.98	720,484	45.0	182	719,833	1.82
618	0.137	0.136	34.4	5.09	17.9	3.60	8.5	73	195,193	1.87	365,211	45.0	95	364,539	1.76
622	0.147	0.193	45.2	8.21	23.5	5.80	13.7	107	373,312	1.84	686,948	50.0	149	686,419	1.45
710	0.122	0.113	39.9	4.96	20.8	3.51	8.3	51	157,595	1.94	305,039	45.0	70	304,343	1.60
810	0.135	0.146	53.1	7.43	27.6	5.25	12.4	56	231,804	1.88	434,992	50.0	82	434,769	1.29
814	0.156	0.212	48.9	9.46	25.5	6.68	15.8	106	401,392	1.81	726,457	55.0	150	725,839	1.35
818	0.156	0.203	42.0	8.04	21.8	5.68	13.4	112	362,834	1.64	593,601	50.0	140	592,881	1.40

Table B-4 CUHP Input Parameters - Future

								Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	SWMM Node/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con't Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
110	110	GREELEY	0.111	0.506	0.975	0.027	4.8	0.35	0.10	3.00	0.50	0.0018	0.00	0.10	0.05	4.39
114	114	GREELEY	0.175	0.346	0.914	0.031	3.8	0.40	0.10	3.00	0.50	0.0018	0.00	0.08	0.04	3.41
118	118	GREELEY	0.059	0.278	0.474	0.048	2.0	0.40	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.81
122	122	GREELEY	0.192	0.486	1.184	0.027	39.3	0.35	0.10	3.00	0.50	0.0018	0.00	0.79	0.20	38.34
126	126	GREELEY	0.032	0.133	0.286	0.013	21.2	0.40	0.10	4.50	0.60	0.0018	0.00	0.42	0.13	19.74
130	130	GREELEY	0.073	0.318	0.607	0.038	14.3	0.35	0.10	3.00	0.50	0.0018	0.00	0.29	0.11	13.35
134	134	GREELEY	0.084	0.217	0.593	0.028	53.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.87	0.25	53.10
138	138	GREELEY	0.130	0.176	0.483	0.017	69.3	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.30	68.69
142	142	GREELEY	0.031	0.233	0.500	0.034	11.9	0.40	0.10	3.00	0.50	0.0018	0.00	0.24	0.11	11.03
146	146	GREELEY	0.062	0.463	0.831	0.033	28.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.57	0.16	27.49
150	150	GREELEY	0.093	0.272	0.641	0.040	20.1	0.35	0.10	3.00	0.50	0.0018	0.00	0.40	0.13	19.00
154	154	GREELEY	0.139	0.231	0.515	0.027	53.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.86	0.24	52.16
210	210	GREELEY	0.076	0.155	0.506	0.042	4.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.09	0.05	4.19
220	220	GREELEY	0.156	0.410	0.800	0.034	2.2	0.40	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.99
224	224	GREELEY	0.100	0.239	0.642	0.041	2.8	0.35	0.10	3.00	0.50	0.0018	0.00	0.06	0.03	2.54
226	226	GREELEY	0.095	0.307	0.593	0.034	44.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.82	0.21	43.72
228	228	GREELEY	0.103	0.359	0.664	0.026	40.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.80	0.20	39.98
232	232	GREELEY	0.166	0.432	0.945	0.034	3.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.07	0.04	3.29
236	236	GREELEY	0.094	0.355	0.753	0.036	31.5	0.35	0.10	3.00	0.50	0.0018	0.00	0.63	0.17	30.34
240	240	GREELEY	0.034	0.160	0.395	0.051	2.2	0.40	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.99
244	244	GREELEY	0.141	0.480	0.830	0.038	53.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.87	0.25	53.04
248	248	GREELEY	0.151	0.284	0.543	0.016	75.5	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.88
250	250	GREELEY	0.068	0.120	0.339	0.022	66.1	0.35	0.10	3.00	0.50	0.0018	0.00	0.91	0.29	65.38
252	252	GREELEY	0.098	0.393	0.739	0.021	68.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.30	67.96
256	256	GREELEY	0.146	0.554	0.954	0.032	43.8	0.35	0.10	4.50	0.60	0.0018	0.00	0.82	0.21	42.69
260	260	GREELEY	0.101	0.321	0.670	0.050	9.8	0.35	0.10	3.00	0.50	0.0018	0.00	0.20	0.10	9.05
264	264	GREELEY	0.107	0.331	0.854	0.024	66.3	0.35	0.10	3.00	0.50	0.0018	0.00	0.91	0.29	65.65
268	268	GREELEY	0.092	0.287	0.637	0.018	57.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.88	0.26	56.21
310	310	GREELEY	0.138	0.389	0.760	0.038	2.4	0.40	0.10	4.50	0.60	0.0018	0.00	0.05	0.02	2.14
314	314	GREELEY	0.108	0.245	0.526	0.038	35.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.70	0.18	33.61
410	410	GREELEY	0.021	0.189	0.311	0.073	4.8	0.40	0.10	3.00	0.50	0.0018	0.00	0.10	0.05	4.41
414	414	GREELEY	0.019	0.143	0.263	0.087	2.9	0.40	0.10	3.00	0.50	0.0018	0.00	0.06	0.03	2.67
418	418	GREELEY	0.062	0.276	0.605	0.047	3.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.07	0.04	3.35
422	422	GREELEY	0.006	0.102	0.196	0.097	4.0	0.40	0.10	5.00	1.00	0.0007	0.00	0.08	0.04	3.16
426	426	GREELEY	0.068	0.320	0.635	0.046	4.7	0.35	0.10	4.50	0.60	0.0018	0.00	0.09	0.05	4.13
510	510	GREELEY	0.193	0.483	0.920	0.033	14.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.30	0.11	13.94
514	514	GREELEY	0.138	0.457	0.927	0.025	60.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.90	0.27	60.16
518	518	GREELEY	0.125	0.298	0.642	0.024	51.8	0.35	0.10	3.00	0.50	0.0018	0.00	0.86	0.24	51.00
610	610	GREELEY	0.166	0.452	0.971	0.032	16.8	0.35	0.10	3.00	0.50	0.0018	0.00	0.34	0.12	15.79
614	614	GREELEY	0.157	0.330	0.607	0.036	52.4	0.35	0.10	3.00	0.50	0.0018	0.00	0.86	0.24	51.55
618	618	GREELEY	0.084	0.185	0.446	0.026	76.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	76.31
622	622	GREELEY	0.161	0.336	0.673	0.019	74.5	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.31	73.87
710	710	GREELEY	0.068	0.192	0.421	0.017	77.2	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	76.62
810	810	GREELEY	0.100	0.339	0.677	0.023	76.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	76.16
814	814	GREELEY	0.173	0.312	0.834	0.016	68.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.30	67.95
818	818	GREELEY	0.156	0.361	0.569	0.023	60.0	0.35	0.10	4.50	0.60	0.0018	0.00	0.90	0.27	59.12

Table B-5 100 Year Future CUHP Calculated Parameters

	Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
110	0.147	0.164	71.2	10.46	37.0	7.39	17.4	47	257,766	1.84	474,217	65.0	73	474,118	1.02
114	0.150	0.206	45.3	8.65	23.5	6.11	14.4	116	406,013	1.78	722,616	50.0	157	722,227	1.41
118	0.156	0.131	43.8	5.91	22.8	4.17	9.8	40	136,996	1.76	241,055	50.0	53	241,032	1.41
122	0.094	0.221	36.3	7.67	18.9	5.42	12.8	158	445,075	2.24	997,480	45.0	235	997,044	1.92
126	0.111	0.077	39.8	3.86	20.7	2.73	6.4	24	74,154	1.84	136,604	45.0	31	136,226	1.52
130	0.120	0.116	48.5	5.82	25.2	4.11	9.7	45	169,548	1.95	330,199	50.0	65	330,051	1.40
134	0.087	0.183	19.6	4.25	10.2	3.00	7.1	128	194,175	2.41	468,921	35.0	159	465,903	2.98
138	0.081	0.246	12.5	3.87	6.5	2.73	6.4	311	301,853	2.60	784,559	35.0	336	768,545	4.04
142	0.124	0.080	58.3	5.08	30.3	3.59	8.5	16	71,765	1.88	134,597	50.0	23	134,384	1.17
146	0.102	0.111	61.8	6.75	32.2	4.77	11.3	30	143,818	2.12	304,228	55.0	49	304,292	1.23
150	0.112	0.126	39.1	5.28	20.3	3.73	8.8	71	216,576	2.02	436,422	45.0	100	435,614	1.67
154	0.087	0.229	15.4	4.20	8.0	2.97	7.0	272	323,632	2.40	777,953	35.0	316	775,954	3.55
210	0.147	0.139	31.3	4.84	16.3	3.42	8.1	73	177,186	1.84	325,543	45.0	90	324,625	1.85
220	0.156	0.202	47.5	8.88	24.7	6.27	14.8	99	363,101	1.76	639,699	50.0	134	639,319	1.34
224	0.154	0.163	38.6	6.34	20.1	4.48	10.6	77	231,887	1.82	421,418	45.0	102	421,597	1.60
226	0.091	0.177	24.0	4.76	12.5	3.36	7.9	119	221,759	2.30	511,028	40.0	157	509,840	2.57
228	0.093	0.174	30.1	5.53	15.7	3.91	9.2	103	240,005	2.26	542,481	40.0	143	541,487	2.16
232	0.151	0.201	51.6	9.48	26.8	6.70	15.8	96	384,902	1.83	703,012	55.0	139	702,732	1.31
236	0.099	0.141	38.7	5.70	20.1	4.03	9.5	73	217,622	2.15	467,589	45.0	106	467,188	1.76
240	0.156	0.102	38.8	4.54	20.2	3.21	7.6	26	79,324	1.76	139,756	45.0	33	139,419	1.53
244	0.087	0.232	24.8	5.91	12.9	4.18	9.8	171	328,035	2.41	791,952	40.0	237	791,106	2.62
248	0.079	0.270	14.9	4.59	7.7	3.24	7.6	304	350,880	2.67	937,745	35.0	372	935,833	3.85
250	0.082	0.181	11.3	3.07	5.9	2.17	5.1	180	158,220	2.56	405,007	35.0	182	395,380	4.17
252	0.081	0.216	24.5	5.57	12.7	3.94	9.3	120	228,783	2.59	592,665	40.0	173	591,856	2.74
256	0.092	0.212	34.3	7.08	17.8	5.00	11.8	128	339,970	2.19	743,565	45.0	183	742,632	1.95
260	0.129	0.141	42.3	6.07	22.0	4.29	10.1	72	234,503	1.90	444,526	50.0	99	444,535	1.53
264	0.082	0.223	23.0	5.42	11.9	3.83	9.0	140	249,635	2.56	639,828	40.0	196	639,310	2.84
268	0.085	0.196	23.7	5.06	12.3	3.57	8.4	116	212,597	2.45	521,161	40.0	158	520,104	2.70
310	0.155	0.190	46.6	8.30	24.2	5.87	13.8	89	319,565	1.59	508,872	50.0	111	508,663	1.26
314	0.097	0.160	23.2	4.36	12.1	3.08	7.3	140	251,527	2.07	519,856	40.0	168	518,128	2.43
410	0.147	0.077	42.8	4.04	22.3	2.86	6.7	15	48,596	1.79	87,101	45.0	19	86,893	1.43
414	0.153	0.077	34.7	3.55	18.0	2.51	5.9	16	43,852	1.77	77,639	45.0	20	77,363	1.64
418	0.151	0.129	48.3	6.29	25.1	4.44	10.5	38	143,829	1.83	262,791	50.0	54	262,861	1.36
422	0.151	0.047	40.3	2.95	21.0	2.09	4.9	5	15,040	0.70	10,522	40.0	3	10,437	0.70

Table B-5 100 Year Future CUHP Calculated Parameters

	Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
426	0.148	0.132	51.1	6.69	26.6	4.73	11.2	40	157,878	1.67	263,342	50.0	53	263,415	1.21
510	0.119	0.176	48.8	8.09	25.4	5.72	13.5	119	448,125	1.95	875,916	50.0	175	875,407	1.42
514	0.084	0.242	26.0	6.32	13.5	4.47	10.5	160	321,518	2.50	803,112	40.0	229	801,722	2.59
518	0.088	0.215	21.1	4.99	11.0	3.53	8.3	177	289,290	2.39	691,491	40.0	227	688,176	2.85
610	0.116	0.165	50.9	7.95	26.5	5.62	13.3	98	384,646	1.98	760,376	50.0	146	759,926	1.38
614	0.087	0.240	17.6	4.74	9.1	3.35	7.9	267	364,132	2.40	872,731	35.0	322	868,005	3.21
618	0.078	0.208	12.8	3.55	6.7	2.51	5.9	197	195,193	2.69	524,983	35.0	217	513,071	4.03
622	0.079	0.276	17.0	5.11	8.9	3.61	8.5	283	373,312	2.66	993,228	35.0	359	986,212	3.50
710	0.078	0.189	15.3	3.72	7.9	2.63	6.2	133	157,595	2.69	424,437	35.0	163	422,116	3.77
810	0.078	0.225	19.8	4.92	10.3	3.48	8.2	151	231,804	2.69	623,033	35.0	200	618,003	3.13
814	0.081	0.279	19.3	5.63	10.0	3.98	9.4	269	401,392	2.59	1,039,755	40.0	350	1,035,386	3.17
818	0.084	0.254	18.1	5.02	9.4	3.55	8.4	259	362,834	2.41	874,036	35.0	312	869,515	3.12

Table B-6 Peak Discharges (All Design Points)

Design Point		Drainage Area	Existing Conditions Peak Flows (cfs)						Future Conditions Peak Flow (cfs)					
Number	Type	(acres)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
109	JUNCTION	755	23	72	180	493	727	1,042	133	229	379	774	1,068	1,446
110	BASIN	71	1	5	13	35	51	73	1	5	13	35	51	73
113	JUNCTION	684	23	68	169	460	677	969	132	224	366	739	1,018	1,375
114	BASIN	112	2	6	26	75	111	157	2	6	26	75	111	157
115	JUNCTION	572	26	74	167	419	604	845	158	256	390	719	968	1,278
117	JUNCTION	364	15	43	101	259	375	527	105	168	253	463	623	821
118	BASIN	38	0	2	8	25	37	53	0	2	8	25	37	53
119	JUNCTION	326	15	42	94	236	341	477	105	167	245	439	587	770
121	JUNCTION	143	3	11	29	80	117	168	28	47	72	136	186	251
122	BASIN	123	2	10	27	69	101	143	28	46	71	132	178	235
126	BASIN	20	2	3	6	15	22	31	2	3	6	15	22	31
129	JUNCTION	183	13	32	66	157	225	312	78	121	174	304	402	523
130	BASIN	47	2	5	13	31	45	63	3	7	15	34	47	65
133	JUNCTION	137	13	30	59	132	185	255	83	124	172	282	368	473
134	BASIN	53	3	9	18	43	61	84	26	40	57	94	124	159
138	BASIN	83	13	27	47	96	133	177	71	101	135	205	262	336
139	JUNCTION	208	13	34	72	167	237	326	57	94	144	263	354	465
141	JUNCTION	188	12	33	68	156	220	303	56	92	140	252	338	444
142	BASIN	20	1	2	4	11	17	23	1	2	4	11	17	23
146	BASIN	40	1	3	7	18	27	38	4	7	13	26	36	49
149	JUNCTION	149	12	30	61	138	195	268	53	86	129	229	306	401
150	BASIN	60	2	7	18	45	64	90	6	14	25	53	73	100
154	BASIN	89	12	26	46	97	135	181	51	78	113	186	245	316
210	BASIN	49	1	7	18	45	65	90	1	7	18	45	65	90
219	JUNCTION	1,058	17	75	224	653	971	1,401	263	426	660	1,261	1,707	2,273
220	BASIN	100	1	4	21	63	94	134	1	4	21	63	94	134
221	JUNCTION	958	17	75	213	606	895	1,282	273	435	657	1,216	1,633	2,160
223	JUNCTION	191	12	31	65	154	218	302	38	68	111	217	297	397
224	BASIN	64	1	7	19	50	73	102	1	7	20	50	73	102
225	JUNCTION	127	12	26	48	105	148	202	38	62	94	169	227	297
226	BASIN	61	12	22	36	69	94	124	21	34	51	90	120	157
228	BASIN	66	1	5	15	41	60	84	18	29	45	81	109	143

Table B-6 Peak Discharges (All Design Points)

Design Point		Drainage Area	Existing Conditions Peak Flows (cfs)						Future Conditions Peak Flow (cfs)					
Number	Type	(acres)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
231	JUNCTION	767	11	54	163	472	699	1,002	239	374	555	1,008	1,346	1,772
232	BASIN	106	1	9	25	67	97	138	2	10	26	68	98	139
235	JUNCTION	661	13	56	154	423	619	877	262	393	562	969	1,278	1,663
236	BASIN	60	0	5	14	36	53	75	10	18	29	57	79	106
237	JUNCTION	601	13	52	142	388	567	803	252	376	533	911	1,200	1,558
239	JUNCTION	579	13	51	138	374	546	772	252	375	528	896	1,177	1,525
240	BASIN	22	0	1	5	16	23	33	0	1	5	16	23	33
241	JUNCTION	486	12	50	127	332	481	677	230	343	477	796	1,041	1,343
243	JUNCTION	294	4	26	74	200	293	414	166	243	331	540	702	901
244	BASIN	90	2	9	22	57	82	116	38	58	83	140	184	237
245	JUNCTION	203	3	20	55	147	214	302	137	196	262	414	533	680
247	JUNCTION	140	2	15	42	112	164	232	102	146	196	309	398	509
248	BASIN	97	2	11	30	75	109	152	83	117	154	232	295	372
250	BASIN	44	1	6	17	43	63	87	37	53	72	109	141	182
252	BASIN	63	1	5	13	35	51	71	35	50	67	106	136	173
256	BASIN	94	1	1	12	44	66	97	24	34	53	102	138	183
259	JUNCTION	192	8	24	54	132	188	263	64	100	146	257	341	445
260	BASIN	65	1	6	18	47	68	95	3	10	21	50	71	99
263	JUNCTION	127	9	20	39	88	124	171	64	94	129	211	274	351
264	BASIN	69	5	11	21	47	65	90	38	55	74	119	153	196
268	BASIN	59	4	10	19	42	59	82	27	40	56	94	123	158
309	JUNCTION	157	12	20	44	125	183	258	15	24	49	133	192	270
310	BASIN	88	1	1	10	49	75	111	1	1	10	49	75	111
314	BASIN	69	14	22	39	83	115	155	18	26	45	92	126	168
410	BASIN	13	0	1	3	9	13	19	0	1	3	9	13	19
414	BASIN	12	0	1	3	9	14	20	0	1	3	9	14	20
418	BASIN	40	1	4	10	26	38	54	1	4	10	26	38	54
422	BASIN	4	0	0	0	0	1	3	0	0	0	0	1	3
426	BASIN	43	1	1	7	25	37	53	1	1	7	25	37	53
509	JUNCTION	292	8	31	76	192	276	386	82	131	196	350	467	613
510	BASIN	123	8	20	39	90	126	174	8	20	40	90	127	175
513	JUNCTION	168	2	15	40	105	153	214	77	116	162	271	354	456

Design Point		Drainage Area	Existing Conditions Peak Flows (cfs)						Future Conditions Peak Flow (cfs)					
Number	Type	(acres)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
514	BASIN	89	1	6	18	49	71	101	41	61	84	138	179	229
518	BASIN	80	1	9	22	58	83	117	36	55	78	133	175	227
609	JUNCTION	363	9	35	91	249	367	525	140	218	313	552	730	955
610	BASIN	106	2	10	25	66	95	135	8	18	34	76	106	146
613	JUNCTION	257	10	31	76	199	288	405	153	226	311	511	664	852
614	BASIN	100	10	23	44	95	133	182	51	78	114	189	250	322
617	JUNCTION	157	4	18	46	118	170	238	119	168	223	343	439	554
618	BASIN	54	2	9	20	48	68	95	50	70	91	134	170	217
622	BASIN	103	2	11	29	74	107	149	79	111	148	224	286	359
710	BASIN	43	3	8	16	36	51	70	37	52	68	102	129	163
809	JUNCTION	274	3	17	59	176	260	369	162	232	314	511	662	848
810	BASIN	64	2	7	17	41	59	82	45	63	83	125	159	200
813	JUNCTION	211	1	10	43	136	201	287	119	171	235	388	506	650
814	BASIN	111	1	10	27	73	106	150	71	101	136	214	275	350
818	BASIN	100	1	2	18	65	97	140	56	79	111	185	244	312
O_100	OUTFALL	755	23	72	180	493	727	1,042	133	229	379	774	1,068	1,446
O_210	OUTFALL	49	1	7	18	45	65	90	1	7	18	45	65	90
O_220	OUTFALL	1,058	17	75	224	653	971	1,401	263	426	660	1,261	1,707	2,273
O_300	OUTFALL	157	12	20	44	125	183	258	15	24	49	133	192	270
O_410	OUTFALL	13	0	1	3	9	13	19	0	1	3	9	13	19
O_414	OUTFALL	12	0	1	3	9	14	20	0	1	3	9	14	20
O_418	OUTFALL	40	1	4	10	26	38	54	1	4	10	26	38	54
O_422	OUTFALL	4	0	0	0	0	1	3	0	0	0	0	1	3
O_426	OUTFALL	43	1	1	7	25	37	53	1	1	7	25	37	53
O_500	OUTFALL	292	8	31	76	192	276	386	82	131	196	350	467	613
O_600	OUTFALL	363	9	35	91	249	367	525	140	218	313	552	730	955
O_710	OUTFALL	43	3	8	16	36	51	70	37	52	68	102	129	163
O_800	OUTFALL	274	3	17	59	176	260	369	162	232	314	511	662	848

Table B-7 Peak Volumes (All Design Points)

Design Point		Drainage Area	Existing Conditions Peak Volume (ac-ft)						Future Conditions Peak Volume (ac-ft)					
Number	Type	(acres)	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}
109	JUNCTION	755	4	11	24	57	84	120	15	24	39	72	100	135
110	BASIN	71	0	1	2	5	8	11	0	1	2	5	8	11
113	JUNCTION	684	4	10	22	52	77	109	15	24	37	67	92	124
114	BASIN	112	0	1	3	7	11	17	0	1	3	7	11	17
115	JUNCTION	572	4	9	19	44	64	91	14	22	34	58	79	106
117	JUNCTION	364	2	5	12	28	41	58	10	15	22	38	51	68
118	BASIN	38	0	0	1	2	4	6	0	0	1	2	4	6
119	JUNCTION	326	2	5	11	25	37	52	9	15	21	35	47	62
121	JUNCTION	143	0	2	4	10	15	22	3	5	8	14	20	26
122	BASIN	123	0	1	3	9	13	19	3	5	7	13	17	23
126	BASIN	20	0	0	1	1	2	3	0	0	1	1	2	3
129	JUNCTION	183	2	4	7	15	22	30	6	9	13	21	28	36
130	BASIN	47	0	1	1	3	5	7	0	1	2	4	5	8
133	JUNCTION	137	1	3	6	12	16	23	6	8	11	17	22	28
134	BASIN	53	0	1	2	4	6	8	2	3	4	6	8	11
138	BASIN	83	1	2	4	7	10	14	4	5	7	11	14	18
139	JUNCTION	208	1	3	7	16	24	33	5	7	12	21	28	38
141	JUNCTION	188	1	3	7	15	22	30	4	7	11	19	26	35
142	BASIN	20	0	0	1	1	2	3	0	0	1	1	2	3
146	BASIN	40	0	0	1	3	4	6	1	1	2	4	5	7
149	JUNCTION	149	1	3	5	12	17	24	4	6	9	15	21	28
150	BASIN	60	0	1	2	4	6	9	1	1	2	5	7	10
154	BASIN	89	1	2	4	8	11	15	3	5	7	10	14	18
210	BASIN	49	0	0	1	3	5	7	0	0	1	3	5	7
219	JUNCTION	1,058	4	12	30	76	113	163	27	41	63	109	147	196
220	BASIN	100	0	0	2	6	10	15	0	0	2	6	10	15
221	JUNCTION	958	3	11	27	69	103	148	27	41	60	102	137	181
223	JUNCTION	191	1	3	7	15	22	31	4	6	10	18	25	34
224	BASIN	64	0	1	2	4	7	10	0	1	2	4	7	10
225	JUNCTION	127	1	3	5	10	15	21	3	5	8	14	18	24
226	BASIN	61	1	2	3	6	8	11	2	3	4	7	9	12
228	BASIN	66	0	1	2	5	7	10	2	3	4	7	9	12

Design Point		Drainage Area	Existing Conditions Peak Volume (ac-ft)						Future Conditions Peak Volume (ac-ft)					
Number	Type	(acres)	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}
231	JUNCTION	767	2	8	21	55	81	118	23	35	51	84	112	148
232	BASIN	106	0	1	3	7	11	16	0	1	3	7	11	16
235	JUNCTION	661	2	7	18	47	70	101	22	33	47	75	100	130
236	BASIN	60	0	0	1	4	6	9	1	2	3	6	8	11
237	JUNCTION	601	2	6	16	43	64	92	21	31	44	70	92	120
239	JUNCTION	579	2	6	16	41	61	89	21	31	44	68	90	117
240	BASIN	22	0	0	0	1	2	3	0	0	0	1	2	3
241	JUNCTION	486	2	6	15	36	53	76	19	27	38	59	77	99
243	JUNCTION	294	1	3	8	21	31	45	13	19	25	38	49	63
244	BASIN	90	0	1	3	6	10	14	3	5	7	11	14	18
245	JUNCTION	203	0	2	5	14	21	31	10	14	19	27	35	44
247	JUNCTION	140	0	1	4	10	15	21	7	10	13	19	24	31
248	BASIN	97	0	1	3	7	10	15	5	7	9	13	17	21
250	BASIN	44	0	0	1	3	4	7	2	3	4	5	7	9
252	BASIN	63	0	1	2	4	7	10	3	4	6	8	11	14
256	BASIN	94	0	0	1	5	8	13	3	4	5	9	13	17
259	JUNCTION	192	1	3	7	15	22	31	6	9	13	21	28	37
260	BASIN	65	0	1	2	4	7	10	0	1	2	5	7	10
263	JUNCTION	127	1	2	5	10	15	21	5	8	10	16	21	27
264	BASIN	69	1	1	3	6	8	11	3	4	6	9	12	15
268	BASIN	59	1	1	2	5	7	10	2	3	5	7	9	12
309	JUNCTION	157	1	2	4	11	16	23	2	2	4	11	16	24
310	BASIN	88	0	0	1	5	8	12	0	0	1	5	8	12
314	BASIN	69	1	2	3	6	8	12	1	2	3	6	9	12
410	BASIN	13	0	0	0	1	1	2	0	0	0	1	1	2
414	BASIN	12	0	0	0	1	1	2	0	0	0	1	1	2
418	BASIN	40	0	0	1	3	4	6	0	0	1	3	4	6
422	BASIN	4	0	0	0	0	0	0	0	0	0	0	0	0
426	BASIN	43	0	0	1	3	4	6	0	0	1	3	4	6
509	JUNCTION	292	1	4	9	22	32	46	7	12	17	30	41	54
510	BASIN	123	1	2	4	10	14	20	1	2	5	10	14	20
513	JUNCTION	168	0	1	4	12	17	25	6	9	13	20	26	34

Table B-7 Peak Volumes (All Design Points)

Design Point		Drainage Area	Existing Conditions Peak Volume (ac-ft)						Future Conditions Peak Volume (ac-ft)					
Number	Type	(acres)	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}
514	BASIN	89	0	1	2	6	9	13	4	5	7	11	14	18
518	BASIN	80	0	1	2	6	8	12	3	4	6	9	12	16
609	JUNCTION	363	2	5	12	27	40	57	13	19	27	42	56	72
610	BASIN	106	0	1	3	7	11	16	1	2	4	9	12	17
613	JUNCTION	257	1	4	8	20	29	41	11	16	22	33	43	55
614	BASIN	100	1	2	4	8	12	17	3	5	7	12	15	20
617	JUNCTION	157	0	2	4	11	17	24	8	11	15	21	27	34
618	BASIN	54	0	1	2	4	6	8	3	4	5	7	9	12
622	BASIN	103	0	1	3	7	11	16	5	7	10	14	18	23
710	BASIN	43	0	1	2	3	5	7	2	3	4	6	8	10
809	JUNCTION	274	0	2	6	18	27	40	12	17	24	35	45	58
810	BASIN	64	0	1	2	5	7	10	3	5	6	9	11	14
813	JUNCTION	211	0	1	4	13	20	30	9	13	17	26	34	44
814	BASIN	111	0	1	3	8	11	17	5	7	10	15	19	24
818	BASIN	100	0	0	1	6	9	14	4	5	8	12	15	20
O_100	OUTFALL	755	4	11	24	57	84	120	15	24	39	72	100	135
O_210	OUTFALL	49	0	0	1	3	5	7	0	0	1	3	5	7
O_220	OUTFALL	1,058	4	12	30	76	113	163	27	41	63	109	147	196
O_300	OUTFALL	157	1	2	4	11	16	23	2	2	4	11	16	24
O_410	OUTFALL	13	0	0	0	1	1	2	0	0	0	1	1	2
O_414	OUTFALL	12	0	0	0	1	1	2	0	0	0	1	1	2
O_418	OUTFALL	40	0	0	1	3	4	6	0	0	1	3	4	6
O_422	OUTFALL	4	0	0	0	0	0	0	0	0	0	0	0	0
O_426	OUTFALL	43	0	0	1	3	4	6	0	0	1	3	4	6
O_500	OUTFALL	292	1	4	9	22	32	46	7	12	17	30	41	54
O_600	OUTFALL	363	2	5	12	27	40	57	13	19	27	42	56	72
O_710	OUTFALL	43	0	1	2	3	5	7	2	3	4	6	8	10
O_800	OUTFALL	274	0	2	6	18	27	40	12	17	24	35	45	58

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[TITLE]
;;Project Title/Notes
City of Greeley
Comprehensive Drainage Plan
Oklahoma and South Basins Baseline Hydrology
Matrix Design Group, Inc. 2022
Scenario ID = 15_Fut_100yr_0mi^2_GOS_Hydrology

[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             12:00:00
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         0:00:20
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         12.566
MAX_TRIALS           8
HEAD_TOLERANCE       0.005
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[FILES]
;;Interfacing Files
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Models\CUHP_SWMM\CUHP\15_Fut_100yr_0mi^2_GreeleyOS.txt"

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
CONSTANT         0.0
DRY_ONLY         NO

[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
109              4779       0          0          0          0
110              4794       0          0          0          0
113              4795       0          0          0          0
114              4798       0          0          0          0
115              4816.7     0          0          0          0
117              4818       0          0          0          0
118              4830       0          0          0          0
119              4834       0          0          0          0
121              4835       0          0          0          0
122              4983       0          0          0          0
126              4999       0          0          0          0
129              4835       0          0          0          0
130              4910       0          0          0          0
133              4939       0          0          0          0
134              4945       0          0          0          0
138              4989       0          0          0          0
139              4817       0          0          0          0
141              4827       0          0          0          0
142              4820       0          0          0          0
146              4849       0          0          0          0
149              4885       0          0          0          0
150              4890       0          0          0          0
154              4904       0          0          0          0
210              4770       0          0          0          0
219              4772       0          0          0          0
220              4777       0          0          0          0
221              4790.6     0          0          0          0
223              4793       0          0          0          0
224              4810       0          0          0          0
225              4840       0          0          0          0
226              4850       0          0          0          0
228              4864       0          0          0          0
231              4790.8     0          0          0          0
232              4810       0          0          0          0
235              4845       0          0          0          0
236              4847       0          0          0          0
237              4846       0          0          0          0
239              4850       0          0          0          0
240              4849       0          0          0          0
241              4862       0          0          0          0
243              4863       0          0          0          0
244              4894       0          0          0          0
245              4980       0          0          0          0
247              4981       0          0          0          0
248              4986       0          0          0          0
250              5015       0          0          0          0
252              4990       0          0          0          0
256              4851       0          0          0          0
259              4863       0          0          0          0
260              4905       0          0          0          0
263              4922       0          0          0          0
264              4960       0          0          0          0
268              4991       0          0          0          0
309              4778       0          0          0          0
310              4779       0          0          0          0
314              4839       0          0          0          0
410              4793       0          0          0          0
414              4796       0          0          0          0
418              4802       0          0          0          0
422              4800       0          0          0          0
426              4810       0          0          0          0
509              4812       0          0          0          0
510              4856       0          0          0          0
513              4880       0          0          0          0
514              4931       0          0          0          0
518              4940       0          0          0          0
609              4850       0          0          0          0
610              4858       0          0          0          0
613              4888       0          0          0          0
614              4899       0          0          0          0
617              4942       0          0          0          0
618              4950       0          0          0          0
622              4996       0          0          0          0
710              4975       0          0          0          0
809              4965       0          0          0          0
810              4969       0          0          0          0
813              4967       0          0          0          0
814              4970       0          0          0          0
818              4990       0          0          0          0
```

```
[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
O_100            4785       FREE                        NO
O_210            4754       FREE                        NO
O_220            4769       FREE                        NO
O_300            4775       FREE                        NO
O_410            4779       FREE                        NO
O_414            4781       FREE                        NO
O_418            4784       FREE                        NO
O_422            4789       FREE                        NO
O_426            4793       FREE                        NO
O_500            4804       FREE                        NO
O_600            4849       FREE                        NO
O_710            4961       FREE                        NO
O_800            4967       FREE                        NO

[CONDUITS]
;;Name           From Node        To Node          Length     Roughness  InOffset   OutOffset  InitFlow   MaxFlow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- --------
DL_109           109              O_100            11.88      0.01       0          0          0          0
DL_110           110              109              157.65     0.01       0          0          0          0
DL_114           114              113              299.75     0.01       0          0          0          0
DL_118           118              117              163.54     0.01       0          0          0          0
DL_121           121              119              71.39      0.01       0          0          0          0
DL_122           122              121              314.61     0.01       0          0          0          0
DL_129           129              119              51.02      0.01       0          0          0          0
DL_130           130              129              235.94     0.01       0          0          0          0
DL_134           134              133              214.69     0.01       0          0          0          0
DL_142           142              139              112.30     0.01       0          0          0          0
DL_150           150              149              280.05     0.01       0          0          0          0
DL_210           210              O_210            198.34     0.01       0          0          0          0
DL_219           219              O_220            12.79      0.01       0          0          0          0
DL_220           220              219              239.57     0.01       0          0          0          0
DL_223           223              221              55.56      0.01       0          0          0          0
DL_224           224              223              150.97     0.01       0          0          0          0
DL_226           226              225              235.05     0.01       0          0          0          0
DL_231           231              221              59.69      0.01       0          0          0          0
DL_232           232              231              238.21     0.01       0          0          0          0
DL_236           236              235              18.27      0.01       0          0          0          0
DL_237           237              235              21.32      0.01       0          0          0          0
DL_240           240              237              121.37     0.01       0          0          0          0
DL_243           243              241              54.47      0.01       0          0          0          0
DL_244           244              243              238.80     0.01       0          0          0          0
DL_247           247              245              23.77      0.01       0          0          0          0
DL_248           248              247              146.80     0.01       0          0          0          0
DL_252           252              245              191.47     0.01       0          0          0          0
DL_256           256              239              29.90      0.035      0          0          0          0
DL_259           259              241              41.68      0.01       0          0          0          0
DL_260           260              259              177.64     0.01       0          0          0          0
DL_264           264              263              240.21     0.01       0          0          0          0
DL_309           309              O_300            10.54      0.01       0          0          0          0
DL_310           310              309              116.14     0.01       0          0          0          0
DL_410           410              O_410            110.50     0.01       0          0          0          0
DL_414           414              O_414            95.89      0.01       0          0          0          0
DL_418           418              O_418            213.42     0.01       0          0          0          0
DL_422           422              O_422            87.13      0.01       0          0          0          0
DL_426           426              O_426            204.94     0.01       0          0          0          0
DL_509           509              O_500            10         0.01       0          0          0          0
DL_510           510              509              125.31     0.01       0          0          0          0
DL_514           514              513              289.06     0.01       0          0          0          0
DL_518           518              513              320.57     0.01       0          0          0          0
DL_609           609              O_600            11.67      0.01       0          0          0          0
DL_610           610              609              118.83     0.01       0          0          0          0
DL_614           614              613              298.82     0.01       0          0          0          0
DL_618           618              617              238.73     0.01       0          0          0          0
DL_710           710              O_710            202.60     0.01       0          0          0          0
DL_809           809              O_800            15.11      0.01       0          0          0          0
DL_810           810              809              133.38     0.01       0          0          0          0
DL_814           814              813              463.70     0.01       0          0          0          0
L_114            113              109              144        0.035      0          0          0          0
L_115            115              113              3260       0.035      0          0          0          0
L_117            117              115              86         0.01       0          0          0          0
L_119            119              117              1087       0.035      0          0          0          0
L_126            126              121              5178       0.035      0          0          0          0
L_133            133              129              2743       0.035      0          0          0          0
L_138            138              133              2426       0.035      0          0          0          0
L_139            139              115              73         0.01       0          0          0          0
L_141            141              139              542        0.01       0          0          0          0
L_146            146              141              165        0.035      0          0          0          0
L_149            149              141              1479       0.035      0          0          0          0
L_154            154              149              1625       0.035      0          0          0          0
L_221            221              219              2511       0.035      0          0          0          0
L_225            225              223              1810       0.035      0          0          0          0
L_228            228              225              847        0.035      0          0          0          0
L_235            235              231              3274       0.035      0          0          0          0
L_239            239              237              288        0.035      0          0          0          0
L_241            241              239              1092       0.035      0          0          0          0
L_245            245              243              4101       0.035      0          0          0          0
L_250            250              247              2063       0.035      0          0          0          0
L_263            263              259              2459       0.035      0          0          0          0
L_268            268              263              1464       0.035      0          0          0          0
L_314            314              309              2623       0.035      0          0          0          0
L_513            513              509              3358       0.01       0          0          0          0
L_613            613              609              3459       0.035      0          0          0          0
L_617            617              613              2214       0.035      0          0          0          0
L_622            622              617              1661       0.035      0          0          0          0
L_813            813              809              190        0.035      0          0          0          0
L_818            818              813              1740       0.035      0          0          0          0

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels    Culvert
;;-------------- ------------ ---------------- ---------- ---------- ---------- ---------- ----------
DL_109           DUMMY        0                0          0          0          1
DL_110           DUMMY        0                0          0          0          1
DL_114           DUMMY        0                0          0          0          1
DL_118           DUMMY        0                0          0          0          1
DL_121           DUMMY        0                0          0          0          1
DL_122           DUMMY        0                0          0          0          1
DL_129           DUMMY        0                0          0          0          1
DL_130           DUMMY        0                0          0          0          1
DL_134           DUMMY        0                0          0          0          1
DL_142           DUMMY        0                0          0          0          1
DL_150           DUMMY        0                0          0          0          1
DL_210           DUMMY        0                0          0          0          1
DL_219           DUMMY        0                0          0          0          1
DL_220           DUMMY        0                0          0          0          1
DL_223           DUMMY        0                0          0          0          1
DL_224           DUMMY        0                0          0          0          1
DL_226           DUMMY        0                0          0          0          1
DL_231           DUMMY        0                0          0          0          1
DL_232           DUMMY        0                0          0          0          1
DL_236           DUMMY        0                0          0          0          1
DL_237           DUMMY        0                0          0          0          1
DL_240           DUMMY        0                0          0          0          1
DL_243           DUMMY        0                0          0          0          1
DL_244           DUMMY        0                0          0          0          1
DL_247           DUMMY        0                0          0          0          1
DL_248           DUMMY        0                0          0          0          1
DL_252           DUMMY        0                0          0          0          1
DL_256           DUMMY        0                0          0          0          1
DL_259           DUMMY        0                0          0          0          1
DL_260           DUMMY        0                0          0          0          1
DL_264           DUMMY        0                0          0          0          1
DL_309           DUMMY        0                0          0          0          1
DL_310           DUMMY        0                0          0          0          1
DL_410           DUMMY        0                0          0          0          1
DL_414           DUMMY        0                0          0          0          1
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DL_418          DUMMY       0               0         0         0         1
DL_422          DUMMY       0               0         0         0         1
DL_426          DUMMY       0               0         0         0         1
DL_509          DUMMY       0               0         0         0         1
DL_510          DUMMY       0               0         0         0         1
DL_514          DUMMY       0               0         0         0         1
DL_518          DUMMY       0               0         0         0         1
DL_609          DUMMY       0               0         0         0         1
DL_610          DUMMY       0               0         0         0         1
DL_614          DUMMY       0               0         0         0         1
DL_618          DUMMY       0               0         0         0         1
DL_710          DUMMY       0               0         0         0         1
DL_809          DUMMY       0               0         0         0         1
DL_810          DUMMY       0               0         0         0         1
DL_814          DUMMY       0               0         0         0         1
L_114           TRIANGULAR  10              200       0         0         1
L_115           TRAPEZOIDAL 10              100       5         5         1
L_117           TRAPEZOIDAL 10              10        2         2         1
L_119           TRAPEZOIDAL 10              10        2         2         1
L_126           TRAPEZOIDAL 10              30        2         2         1
L_133           TRAPEZOIDAL 10              75        10        10        1
L_138           TRAPEZOIDAL 10              50        8         8         1
L_139           TRAPEZOIDAL 10              20        2         2         1
L_141           TRAPEZOIDAL 10              20        2         2         1
L_146           TRAPEZOIDAL 10              20        10        10        1
L_149           TRAPEZOIDAL 10              20        2         2         1
L_154           TRAPEZOIDAL 10              40        2         2         1
L_221           TRAPEZOIDAL 10              40        4         4         1
L_225           TRAPEZOIDAL 10              40        2         2         1
L_228           TRAPEZOIDAL 10              20        2         2         1
L_235           TRAPEZOIDAL 10              100       3         3         1
L_239           TRAPEZOIDAL 10              75        2         2         1
L_241           TRAPEZOIDAL 10              30        2         2         1
L_245           TRAPEZOIDAL 10              10        2         2         1
L_250           TRAPEZOIDAL 10              10        50        50        1
L_263           TRAPEZOIDAL 10              20        2         2         1
L_268           TRAPEZOIDAL 10              20        2         2         1
L_314           TRAPEZOIDAL 10              50        2         2         1
L_513           TRAPEZOIDAL 10              60        2         2         1
L_613           TRAPEZOIDAL 10              50        5         5         1
L_617           TRAPEZOIDAL 10              80        2         2         1
L_622           TRAPEZOIDAL 10              30        8         8         1
L_813           TRIANGULAR  10              200       0         0         1
L_818           TRAPEZOIDAL 10              20        12        12        1

[REPORT]
;;Reporting Options
INPUT      YES
CONTROLS   YES
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS 0.000 0.000 10000.000 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
109              5102.566           6684.379
110              5239.481           6606.235
113              5099.162           6645.950
114              4946.247           6388.140
115              5455.307           5936.453
117              5459.502           5892.031
118              5393.226           5742.525
119              5584.348           5675.863
121              5588.201           5604.578
122              5390.914           5359.510
126              5835.196           4448.324
129              5608.238           5630.780
130              5814.773           5516.723
133              5874.302           5074.022
134              6082.961           5023.505
138              6053.073           4613.128
139              5481.851           5918.234
141              5586.592           5875.000
142              5558.916           5836.544
146              5641.061           5888.617
149              5867.318           5620.461
150              5955.032           5354.501
154              6148.045           5356.145
210              4613.128           6728.003
219              4397.696           6681.739
220              4413.147           6442.663
221              4737.430           6129.888
223              4741.638           6074.484
224              4626.040           5977.381
225              4713.895           5639.835
226              4561.305           5461.043
228              4769.382           5447.172
231              4777.088           6085.273
232              4995.954           5991.253
235              4968.403           5326.564
236              4980.734           5313.078
237              4954.531           5310.381
239              4932.182           5235.627
240              4838.933           5273.389
241              4932.953           4990.559
243              4898.274           4948.559
244              4713.317           4797.511
245              4711.390           4094.747
247              4718.711           4072.133
248              4856.273           4020.885
250              4826.816           3603.701
252              4541.461           4006.507
256              4960.697           5231.389
259              4946.825           4951.256
260              5080.533           4834.309
263              4999.302           4427.200
264              5177.636           4266.266
268              5105.447           4097.591
309              4131.983           6508.642
310              4245.916           6486.109
314              4240.223           5865.922
410              3935.754           6190.992
414              3846.369           6111.383
418              3782.123           5931.215
422              3685.754           6016.411
426              3600.559           5792.947
509              3353.701           5776.274
510              3478.537           5787.198
513              3854.749           5117.318
514              3795.083           4834.478
518              4172.703           5076.463
609              3219.186           5620.030
610              3325.755           5567.466
613              3512.570           4814.944
614              3482.198           4517.667
617              3867.318           4429.469
618              4100.262           4377.240
622              4099.162           4095.670
710              3302.327           4304.182
809              3213.687           3986.208
810              3339.820           4029.579
813              3240.223           3939.246
814              3658.196           3738.446
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818             3491.620          3597.940
O_100           5103.352          6696.229
O_210           4629.888          6925.628
O_220           4389.665          6691.690
O_300           4125.698          6517.109
O_410           3896.648          6294.344
O_414           3805.168          6197.975
O_418           3747.207          6141.760
O_422           3607.542          6054.818
O_426           3497.905          5970.321
O_500           3351.955          5783.170
O_600           3208.799          5625.349
O_710           3202.514          4372.207
O_800           3201.117          3994.588

[VERTICES]
;;Link          X-Coord           Y-Coord
;;--------------- ------------------ ------------------
DL_256          4952.219          5236.398
L_115           5434.183          5971.238
L_115           5424.406          5997.774
L_115           5404.853          6008.947
L_115           5388.094          6031.294
L_115           5371.334          6073.193
L_115           5351.781          6110.903
L_115           5348.987          6145.819
L_115           5337.814          6156.992
L_115           5336.418          6172.355
L_115           5321.054          6189.115
L_115           5316.865          6211.461
L_115           5308.485          6231.014
L_115           5295.915          6236.601
L_115           5272.172          6268.724
L_115           5272.172          6285.484
L_115           5255.412          6299.450
L_115           5249.825          6362.299
L_115           5234.462          6377.662
L_115           5228.876          6411.182
L_115           5209.323          6439.115
L_115           5189.770          6462.858
L_115           5171.613          6493.584
L_115           5160.440          6500.567
L_115           5168.820          6529.897
L_115           5164.630          6556.433
L_115           5142.284          6564.813
L_115           5119.937          6588.556
L_115           5117.144          6603.919
L_115           5103.177          6615.093
L_115           5092.004          6626.266
L_119           5538.879          5725.570
L_119           5519.613          5759.479
L_119           5472.603          5820.361
L_119           5471.062          5862.747
L_126           5736.167          4561.883
L_126           5736.167          4662.068
L_126           5766.993          4709.849
L_126           5777.782          4751.464
L_126           5756.204          4836.236
L_126           5740.791          4916.384
L_126           5723.836          4924.091
L_126           5696.093          4982.660
L_126           5688.386          5004.239
L_126           5643.688          5055.102
L_126           5642.147          5096.717
L_126           5657.560          5159.911
L_126           5646.771          5221.563
L_126           5654.477          5277.050
L_126           5635.982          5330.996
L_126           5611.321          5381.859
L_126           5592.825          5420.391
L_126           5583.577          5529.824
L_126           5571.247          5546.779
L_126           5577.412          5574.522
L_133           5846.369          5101.955
L_133           5824.022          5110.335
L_133           5787.709          5182.961
L_133           5768.156          5244.413
L_133           5743.017          5319.832
L_133           5731.844          5398.045
L_133           5717.877          5420.391
L_133           5717.877          5445.531
L_133           5673.184          5554.469
L_133           5656.425          5576.816
L_133           5631.285          5579.609
L_138           6047.486          4632.682
L_138           6081.006          4677.374
L_138           6122.905          4705.307
L_138           6142.458          4727.654
L_138           6139.665          4766.760
L_138           6108.939          4800.279
L_138           6106.145          4842.179
L_138           6047.486          4898.045
L_138           6036.313          4925.978
L_138           5991.620          4939.944
L_138           5958.101          4962.291
L_138           5932.961          5020.950
L_138           5913.408          5043.296
L_141           5536.969          5896.517
L_141           5510.552          5906.447
L_141           5489.382          5913.753
L_149           5844.058          5634.633
L_149           5828.645          5643.881
L_149           5790.883          5682.414
L_149           5767.764          5710.928
L_149           5747.727          5722.488
L_149           5732.314          5731.736
L_149           5714.588          5748.690
L_149           5693.010          5770.268
L_149           5640.606          5818.819
L_149           5625.193          5851.187
L_149           5611.321          5862.747
L_154           6111.732          5364.525
L_154           6089.385          5384.078
L_154           6022.346          5425.978
L_154           6013.966          5448.324
L_154           5980.447          5481.844
L_154           5958.101          5509.777
L_154           5930.168          5546.089
L_154           5913.408          5576.816
L_154           5888.268          5596.369
L_221           4708.624          6187.369
L_221           4690.468          6218.095
L_221           4669.518          6261.391
L_221           4638.792          6320.051
L_221           4633.205          6341.000
L_221           4589.909          6378.710
L_221           4580.133          6398.263
L_221           4567.563          6412.229
L_221           4546.613          6454.129
L_221           4525.663          6469.492
L_221           4480.971          6549.101
L_221           4455.831          6592.397
L_221           4441.865          6606.363
L_221           4426.501          6645.470
L_221           4411.138          6656.643
L_225           4707.730          5659.101
L_225           4707.730          5677.597
L_225           4690.775          5726.919
L_225           4690.775          5773.158
L_225           4696.941          5779.323
```

L_225	4690.775	5799.360
L_225	4681.527	5813.232
L_225	4703.106	5891.839
L_225	4726.225	5955.032
L_225	4735.473	5992.024
L_225	4744.721	6041.346
L_228	4766.299	5472.603
L_228	4758.593	5489.558
L_228	4746.262	5515.760
L_228	4737.014	5537.338
L_228	4716.977	5555.834
L_228	4720.060	5572.788
L_228	4729.308	5595.908
L_228	4724.684	5614.404
L_235	4968.211	5371.648
L_235	4946.632	5411.722
L_235	4923.513	5428.676
L_235	4908.100	5457.961
L_235	4888.063	5491.870
L_235	4875.732	5516.531
L_235	4864.943	5550.439
L_235	4872.650	5581.265
L_235	4852.613	5632.129
L_235	4846.447	5649.083
L_235	4854.154	5672.203
L_235	4849.530	5741.561
L_235	4858.778	5766.222
L_235	4858.778	5857.159
L_235	4843.365	5889.527
L_235	4834.117	5968.133
L_235	4810.997	6009.749
L_235	4797.125	6034.410
L_235	4792.502	6060.612
L_235	4792.502	6072.942
L_239	4927.559	5257.976
L_239	4936.806	5278.013
L_239	4943.742	5292.656
L_241	4944.513	5016.762
L_241	4932.953	5034.487
L_241	4921.393	5052.982
L_241	4915.228	5095.368
L_241	4913.687	5127.736
L_241	4920.623	5157.791
L_241	4925.247	5204.031
L_241	4933.724	5217.902
L_245	4650.123	4284.256
L_245	4614.673	4375.193
L_245	4613.132	4413.725
L_245	4628.545	4441.469
L_245	4645.499	4478.460
L_245	4679.408	4535.489
L_245	4711.776	4574.021
L_245	4728.730	4592.517
L_245	4754.932	4624.884
L_245	4771.887	4641.839
L_245	4765.721	4666.500
L_245	4771.887	4735.859
L_245	4779.593	4786.722
L_245	4785.758	4817.548
L_245	4801.171	4839.126
L_245	4825.832	4851.457
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L_245	4884.402	4920.815
L_250	4844.972	3642.458
L_250	4839.385	3949.721
L_250	4801.676	3974.860
L_250	4763.966	3998.603
L_250	4722.067	4029.330
L_263	4994.413	4465.258
L_263	4979.050	4480.622
L_263	4979.050	4533.694
L_263	4991.620	4554.644
L_263	4979.050	4579.784
L_263	4981.844	4648.219
L_263	4970.670	4671.962
L_263	4990.223	4697.102
L_263	4986.034	4743.191
L_263	5019.553	4787.884
L_263	5019.553	4813.024
L_263	4984.637	4838.163
L_263	4977.654	4859.113
L_263	4955.307	4874.476
L_263	4962.291	4910.789
L_263	4946.927	4928.946
L_268	5082.402	4144.029
L_268	5037.709	4199.895
L_268	5020.950	4215.258
L_268	5004.190	4258.554
L_268	4998.603	4275.314
L_268	5006.983	4297.661
L_268	4998.603	4314.420
L_268	4998.603	4360.510
L_268	4993.017	4371.683
L_268	4994.413	4395.426
L_314	4240.573	5898.045
L_314	4228.003	5942.737
L_314	4222.416	6043.296
L_314	4216.830	6061.453
L_314	4229.399	6100.559
L_314	4232.193	6150.838
L_314	4246.159	6173.184
L_314	4232.193	6206.704
L_314	4232.193	6286.313
L_314	4219.623	6294.693
L_314	4214.036	6331.006
L_314	4202.863	6346.369
L_314	4188.897	6400.838
L_314	4184.707	6427.374
L_314	4158.170	6460.894
L_314	4152.584	6476.257
L_314	4144.204	6481.844
L_314	4145.601	6497.207
L_513	3850.010	5159.482
L_513	3820.034	5187.959
L_513	3805.046	5205.945
L_513	3797.552	5217.935
L_513	3782.564	5225.429
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L_513	3761.581	5250.909
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L_513	3704.626	5292.875
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L_513	3685.142	5348.331
L_513	3658.163	5378.307
L_513	3619.194	5426.268
L_513	3601.209	5445.753
L_513	3574.230	5495.213
L_513	3539.758	5523.690
L_513	3500.789	5558.163
L_513	3473.811	5583.642
L_513	3464.818	5592.635
L_513	3443.835	5598.630
L_513	3412.360	5627.108
L_513	3398.871	5660.081
L_513	3388.379	5681.065
L_513	3392.876	5706.544

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L_513            3386.880          5718.535
L_513            3358.403          5750.009
L_613            3499.127          4890.931
L_613            3501.920          4956.573
L_613            3485.161          4973.333
L_613            3482.367          5008.249
L_613            3462.814          5052.942
L_613            3461.418          5085.065
L_613            3437.675          5094.841
L_613            3426.501          5126.964
L_613            3388.792          5156.294
L_613            3359.462          5195.400
L_613            3349.686          5207.970
L_613            3327.339          5221.936
L_613            3316.166          5233.109
L_613            3299.406          5255.456
L_613            3285.440          5298.752
L_613            3272.870          5340.651
L_613            3261.697          5381.154
L_613            3250.524          5446.796
L_613            3251.920          5501.266
L_613            3263.094          5529.199
L_613            3260.300          5558.528
L_613            3243.541          5582.271
L_613            3228.177          5600.428
L_617            3843.575          4435.143
L_617            3803.073          4470.059
L_617            3772.346          4471.456
L_617            3734.637          4502.182
L_617            3737.430          4524.529
L_617            3709.497          4542.685
L_617            3694.134          4548.272
L_617            3663.408          4581.791
L_617            3643.855          4583.188
L_617            3618.715          4630.674
L_617            3621.508          4647.434
L_617            3613.128          4660.003
L_617            3593.575          4690.730
L_617            3587.989          4704.696
L_617            3569.832          4734.026
L_617            3568.436          4741.009
L_617            3548.883          4754.976
L_617            3526.536          4778.719
L_622            4100.559          4153.020
L_622            4069.832          4213.076
L_622            4011.173          4271.735
L_622            3993.017          4316.428
L_622            3956.704          4363.914
L_622            3917.598          4391.847
L_622            3899.441          4394.640
L_818            3470.670          3615.223
L_818            3417.598          3625.000
L_818            3399.441          3625.000
L_818            3395.251          3647.346
L_818            3384.078          3651.536
L_818            3368.715          3678.073
L_818            3344.972          3719.972
L_818            3339.385          3746.508
L_818            3317.039          3777.235
L_818            3311.453          3802.374
L_818            3298.883          3813.547
L_818            3283.520          3848.464
L_818            3251.397          3884.777
L_818            3244.413          3895.950


[BACKDROP]
FILE       "Backgrounds\Background_basemap.jpg"
DIMENSIONS 0.000 2873.094 10000.000 7126.906
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EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)
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City of Greeley
Comprehensive Drainage Plan
Oklahoma and South Basins Baseline Hydrology


*************
Element Count
*************
Number of rain gages ...... 0
Number of subcatchments ... 0
Number of nodes ........... 92
Number of links ........... 79
Number of pollutants ...... 0
Number of land uses ....... 0


************
Node Summary
************
                                    Invert      Max.    Ponded    External
Name                Type             Elev.     Depth      Area    Inflow
-------------------------------------------------------------------------
109                 JUNCTION       4779.00     10.00       0.0
110                 JUNCTION       4794.00      0.00       0.0
113                 JUNCTION       4795.00     10.00       0.0
114                 JUNCTION       4798.00      0.00       0.0
115                 JUNCTION       4816.70     10.00       0.0
117                 JUNCTION       4818.00     10.00       0.0
118                 JUNCTION       4830.00      0.00       0.0
119                 JUNCTION       4834.00     10.00       0.0
121                 JUNCTION       4835.00     10.00       0.0
122                 JUNCTION       4983.00      0.00       0.0
126                 JUNCTION       4999.00     10.00       0.0
129                 JUNCTION       4835.00     10.00       0.0
130                 JUNCTION       4910.00      0.00       0.0
133                 JUNCTION       4939.00     10.00       0.0
134                 JUNCTION       4945.00      0.00       0.0
138                 JUNCTION       4989.00     10.00       0.0
139                 JUNCTION       4817.00     10.00       0.0
141                 JUNCTION       4827.00     10.00       0.0
142                 JUNCTION       4820.00      0.00       0.0
146                 JUNCTION       4849.00     10.00       0.0
149                 JUNCTION       4885.00     10.00       0.0
150                 JUNCTION       4890.00      0.00       0.0
154                 JUNCTION       4904.00     10.00       0.0
210                 JUNCTION       4770.00      0.00       0.0
219                 JUNCTION       4772.00     10.00       0.0
220                 JUNCTION       4777.00      0.00       0.0
221                 JUNCTION       4790.60     10.00       0.0
223                 JUNCTION       4793.00     10.00       0.0
224                 JUNCTION       4810.00      0.00       0.0
225                 JUNCTION       4840.00     10.00       0.0
226                 JUNCTION       4850.00      0.00       0.0
228                 JUNCTION       4864.00     10.00       0.0
231                 JUNCTION       4790.80     10.00       0.0
232                 JUNCTION       4810.00      0.00       0.0
235                 JUNCTION       4845.00     10.00       0.0
236                 JUNCTION       4847.00      0.00       0.0
237                 JUNCTION       4846.00     10.00       0.0
239                 JUNCTION       4850.00     10.00       0.0
240                 JUNCTION       4849.00      0.00       0.0
241                 JUNCTION       4862.00     10.00       0.0
243                 JUNCTION       4863.00     10.00       0.0
244                 JUNCTION       4894.00      0.00       0.0
245                 JUNCTION       4980.00     10.00       0.0
247                 JUNCTION       4981.00     10.00       0.0
248                 JUNCTION       4986.00      0.00       0.0
250                 JUNCTION       5015.00     10.00       0.0
252                 JUNCTION       4990.00      0.00       0.0
256                 JUNCTION       4851.00      0.00       0.0
259                 JUNCTION       4863.00     10.00       0.0
260                 JUNCTION       4905.00      0.00       0.0
263                 JUNCTION       4922.00     10.00       0.0
264                 JUNCTION       4960.00      0.00       0.0
268                 JUNCTION       4991.00     10.00       0.0
309                 JUNCTION       4778.00     10.00       0.0
310                 JUNCTION       4779.00      0.00       0.0
314                 JUNCTION       4839.00     10.00       0.0
410                 JUNCTION       4793.00      0.00       0.0
414                 JUNCTION       4796.00      0.00       0.0
418                 JUNCTION       4802.00      0.00       0.0
422                 JUNCTION       4800.00      0.00       0.0
426                 JUNCTION       4810.00      0.00       0.0
509                 JUNCTION       4812.00     10.00       0.0
510                 JUNCTION       4856.00      0.00       0.0
513                 JUNCTION       4880.00     10.00       0.0
514                 JUNCTION       4931.00      0.00       0.0
518                 JUNCTION       4940.00      0.00       0.0
609                 JUNCTION       4850.00     10.00       0.0
610                 JUNCTION       4858.00      0.00       0.0
613                 JUNCTION       4888.00     10.00       0.0
614                 JUNCTION       4899.00      0.00       0.0
617                 JUNCTION       4942.00     10.00       0.0
618                 JUNCTION       4950.00      0.00       0.0
622                 JUNCTION       4996.00     10.00       0.0
710                 JUNCTION       4975.00      0.00       0.0
809                 JUNCTION       4965.00     10.00       0.0
810                 JUNCTION       4969.00      0.00       0.0
813                 JUNCTION       4967.00     10.00       0.0
814                 JUNCTION       4970.00      0.00       0.0
818                 JUNCTION       4990.00     10.00       0.0
O_100               OUTFALL        4785.00      0.00       0.0
O_210               OUTFALL        4754.00      0.00       0.0
O_220               OUTFALL        4769.00      0.00       0.0
O_300               OUTFALL        4775.00      0.00       0.0
O_410               OUTFALL        4779.00      0.00       0.0
O_414               OUTFALL        4781.00      0.00       0.0
O_418               OUTFALL        4784.00      0.00       0.0
O_422               OUTFALL        4789.00      0.00       0.0
O_426               OUTFALL        4793.00      0.00       0.0
O_500               OUTFALL        4804.00      0.00       0.0
O_600               OUTFALL        4849.00      0.00       0.0
O_710               OUTFALL        4961.00      0.00       0.0
O_800               OUTFALL        4967.00      0.00       0.0


************
Link Summary
************
Name                From Node        To Node          Type           Length    %Slope Roughness
-----------------------------------------------------------------------------------------------
DL_109              109              O_100            CONDUIT          11.9  -58.5166    0.0100
DL_110              110              109              CONDUIT         157.7    9.5581    0.0100
DL_114              114              113              CONDUIT         299.8    1.0009    0.0100
DL_118              118              117              CONDUIT         163.5    7.3575    0.0100
DL_121              121              119              CONDUIT          71.4    1.4009    0.0100
DL_122              122              121              CONDUIT         314.6   53.3094    0.0100
DL_129              129              119              CONDUIT          51.0    1.9604    0.0100
DL_130              130              129              CONDUIT         235.9   33.5267    0.0100
DL_134              134              133              CONDUIT         214.7    2.7958    0.0100
DL_142              142              139              CONDUIT         112.3    2.6724    0.0100
DL_150              150              149              CONDUIT         280.1    1.7857    0.0100
DL_210              210              O_210            CONDUIT         198.3    8.0933    0.0100
DL_219              219              O_220            CONDUIT          12.8   24.1290    0.0100
DL_220              220              219              CONDUIT         239.6    2.0875    0.0100
DL_223              223              221              CONDUIT          55.6    4.3237    0.0100
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DL_224	224	223	CONDUIT	151.0	11.3326	0.0100
DL_226	226	225	CONDUIT	235.1	4.2583	0.0100
DL_231	231	221	CONDUIT	59.7	0.3351	0.0100
DL_232	232	231	CONDUIT	238.2	8.0864	0.0100
DL_236	236	235	CONDUIT	18.3	11.0131	0.0100
DL_237	237	235	CONDUIT	21.3	4.6956	0.0100
DL_240	240	237	CONDUIT	121.4	2.4725	0.0100
DL_243	243	241	CONDUIT	54.5	1.8362	0.0100
DL_244	244	243	CONDUIT	238.8	13.0924	0.0100
DL_247	247	245	CONDUIT	23.8	4.2107	0.0100
DL_248	248	247	CONDUIT	146.8	3.4080	0.0100
DL_252	252	245	CONDUIT	191.5	5.2299	0.0100
DL_256	256	239	CONDUIT	29.9	3.3464	0.0350
DL_259	259	241	CONDUIT	41.7	2.3999	0.0100
DL_260	260	259	CONDUIT	177.6	24.3332	0.0100
DL_264	264	263	CONDUIT	240.2	16.0212	0.0100
DL_309	309	O_300	CONDUIT	10.5	29.6911	0.0100
DL_310	310	309	CONDUIT	116.1	0.8611	0.0100
DL_410	410	O_410	CONDUIT	110.5	12.7726	0.0100
DL_414	414	O_414	CONDUIT	95.9	15.8379	0.0100
DL_418	418	O_418	CONDUIT	213.4	8.4642	0.0100
DL_422	422	O_422	CONDUIT	87.1	12.7266	0.0100
DL_426	426	O_426	CONDUIT	204.9	8.3238	0.0100
DL_509	509	O_500	CONDUIT	10.0	133.3333	0.0100
DL_510	510	509	CONDUIT	125.3	37.5007	0.0100
DL_514	514	513	CONDUIT	289.1	17.9246	0.0100
DL_518	518	513	CONDUIT	320.6	19.0534	0.0100
DL_609	609	O_600	CONDUIT	11.7	8.6006	0.0100
DL_610	610	609	CONDUIT	118.8	6.7476	0.0100
DL_614	614	613	CONDUIT	298.8	3.6836	0.0100
DL_618	618	617	CONDUIT	238.7	3.3529	0.0100
DL_710	710	O_710	CONDUIT	202.6	6.9267	0.0100
DL_809	809	O_800	CONDUIT	15.1	-13.3538	0.0100
DL_810	810	809	CONDUIT	133.4	3.0003	0.0100
DL_814	814	813	CONDUIT	463.7	0.6470	0.0100
L_114	113	109	CONDUIT	144.0	11.1803	0.0350
L_115	115	113	CONDUIT	3260.0	0.6657	0.0350
L_117	117	115	CONDUIT	86.0	1.5118	0.0100
L_119	119	117	CONDUIT	1087.0	1.4721	0.0350
L_126	126	121	CONDUIT	5178.0	3.1688	0.0350
L_133	133	129	CONDUIT	2743.0	3.7942	0.0350
L_138	138	133	CONDUIT	2426.0	2.0614	0.0350
L_139	139	115	CONDUIT	73.0	0.4110	0.0100
L_141	141	139	CONDUIT	542.0	1.8453	0.0100
L_146	146	141	CONDUIT	165.0	13.4535	0.0350
L_149	149	141	CONDUIT	1479.0	3.9246	0.0350
L_154	154	149	CONDUIT	1625.0	1.1693	0.0350
L_221	221	219	CONDUIT	2511.0	0.7408	0.0350
L_225	225	223	CONDUIT	1810.0	2.5976	0.0350
L_228	228	225	CONDUIT	847.0	2.8347	0.0350
L_235	235	231	CONDUIT	3274.0	1.6557	0.0350
L_239	239	237	CONDUIT	288.0	1.3890	0.0350
L_241	241	239	CONDUIT	1092.0	1.0990	0.0350
L_245	245	243	CONDUIT	4101.0	2.8541	0.0350
L_250	250	247	CONDUIT	2063.0	1.6483	0.0350
L_263	263	259	CONDUIT	2459.0	2.4000	0.0350
L_268	268	263	CONDUIT	1464.0	4.7184	0.0350
L_314	314	309	CONDUIT	2623.0	2.3262	0.0350
L_513	513	509	CONDUIT	3358.0	2.0254	0.0100
L_613	613	609	CONDUIT	3459.0	1.0986	0.0350
L_617	617	613	CONDUIT	2214.0	2.4398	0.0350
L_622	622	617	CONDUIT	1661.0	3.2528	0.0350
L_813	813	809	CONDUIT	190.0	1.0527	0.0350
L_818	818	813	CONDUIT	1740.0	1.3220	0.0350

****
Cross Section Summary
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Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
DL_109	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_110	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_114	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_118	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_121	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_122	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_129	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_130	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_134	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_142	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_150	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_210	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_219	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_220	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_223	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_224	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_226	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_231	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_232	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_236	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_237	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_240	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_243	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_244	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_247	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_248	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_252	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_256	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_259	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_260	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_264	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_309	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_310	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_410	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_414	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_418	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_422	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_426	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_509	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_510	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_514	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_518	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_609	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_610	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_614	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_618	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_710	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_809	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_810	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_814	DUMMY	0.00	0.00	0.00	0.00	1	0.00
L_114	TRIANGULAR	10.00	1000.00	4.98	200.00	1	41373.08
L_115	TRAPEZOIDAL	10.00	1500.00	7.43	200.00	1	19778.31
L_117	TRAPEZOIDAL	10.00	300.00	5.48	50.00	1	17042.38
L_119	TRAPEZOIDAL	10.00	300.00	5.48	50.00	1	4804.89
L_126	TRAPEZOIDAL	10.00	500.00	6.69	70.00	1	13419.02
L_133	TRAPEZOIDAL	10.00	1750.00	6.34	275.00	1	49579.71
L_138	TRAPEZOIDAL	10.00	1300.00	6.15	210.00	1	26612.41
L_139	TRAPEZOIDAL	10.00	400.00	6.18	60.00	1	12832.80
L_141	TRAPEZOIDAL	10.00	400.00	6.18	60.00	1	27193.04
L_146	TRAPEZOIDAL	10.00	1200.00	5.43	220.00	1	57731.32
L_149	TRAPEZOIDAL	10.00	400.00	6.18	60.00	1	11330.51
L_154	TRAPEZOIDAL	10.00	600.00	7.08	80.00	1	10158.72
L_221	TRAPEZOIDAL	10.00	800.00	6.53	120.00	1	10215.79
L_225	TRAPEZOIDAL	10.00	600.00	7.08	80.00	1	15141.09
L_228	TRAPEZOIDAL	10.00	400.00	6.18	60.00	1	9629.49
L_235	TRAPEZOIDAL	10.00	1300.00	7.96	160.00	1	28321.67
L_239	TRAPEZOIDAL	10.00	950.00	7.94	115.00	1	18911.69

L_241	TRAPEZOIDAL	10.00	500.00	6.69	70.00	1	7902.48
L_245	TRAPEZOIDAL	10.00	300.00	5.48	50.00	1	6690.39
L_250	TRAPEZOIDAL	10.00	5100.00	5.05	1010.00	1	81811.71
L_263	TRAPEZOIDAL	10.00	400.00	6.18	60.00	1	8860.57
L_268	TRAPEZOIDAL	10.00	400.00	6.18	60.00	1	12423.61
L_314	TRAPEZOIDAL	10.00	700.00	7.39	90.00	1	17197.82
L_513	TRAPEZOIDAL	10.00	800.00	7.64	100.00	1	65625.19
L_613	TRAPEZOIDAL	10.00	1000.00	6.58	150.00	1	15626.27
L_617	TRAPEZOIDAL	10.00	1000.00	8.02	120.00	1	26566.21
L_622	TRAPEZOIDAL	10.00	1100.00	5.75	190.00	1	27039.90
L_813	TRIANGULAR	10.00	1000.00	4.98	200.00	1	12695.23
L_818	TRAPEZOIDAL	10.00	1400.00	5.37	260.00	1	20950.70

```
*********************************************************
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 12:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Routing Time Step ........ 20.00 sec


*********************
Control Actions Taken
*********************


*************************        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 ..........       568.337       185.201
External Outflow .........       573.236       186.797
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 ......         0.084         0.027
Continuity Error (%) .....        -0.877


*******************************
Highest Flow Instability Indexes
*******************************
All links are stable.


************************
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Routing Time Step Summary
*************************
Minimum Time Step           :    20.00 sec
Average Time Step           :    20.00 sec
Maximum Time Step           :    20.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00
Percent Not Converging      :     0.00


******************
Node Depth Summary
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Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days	Time of Max Occurrence hr:min	Reported Max Depth Feet
109	JUNCTION	0.59	2.79	4781.79	0	00:55	2.79
110	JUNCTION	0.00	0.00	4794.00	0	00:00	0.00
113	JUNCTION	0.59	2.79	4797.79	0	00:54	2.79
114	JUNCTION	0.00	0.00	4798.00	0	00:00	0.00
115	JUNCTION	0.29	2.25	4818.95	0	00:47	2.23
117	JUNCTION	0.55	4.20	4822.20	0	00:47	4.17
118	JUNCTION	0.00	0.00	4830.00	0	00:00	0.00
119	JUNCTION	0.54	4.20	4838.20	0	00:45	4.20
121	JUNCTION	0.05	0.28	4835.28	0	01:10	0.28
122	JUNCTION	0.00	0.00	4983.00	0	00:00	0.00
126	JUNCTION	0.04	0.30	4999.30	0	00:45	0.30
129	JUNCTION	0.08	0.81	4835.81	0	00:45	0.81
130	JUNCTION	0.00	0.00	4910.00	0	00:00	0.00
133	JUNCTION	0.09	0.99	4939.99	0	00:40	0.99
134	JUNCTION	0.00	0.00	4945.00	0	00:00	0.00
138	JUNCTION	0.08	1.02	4990.02	0	00:35	1.02
139	JUNCTION	0.20	1.66	4818.66	0	00:43	1.66
141	JUNCTION	0.17	1.64	4828.64	0	00:42	1.62
142	JUNCTION	0.00	0.00	4820.00	0	00:00	0.00
146	JUNCTION	0.06	0.32	4849.32	0	00:55	0.32
149	JUNCTION	0.17	1.64	4886.64	0	00:40	1.64
150	JUNCTION	0.00	0.00	4890.00	0	00:00	0.00
154	JUNCTION	0.11	1.37	4905.37	0	00:35	1.36
210	JUNCTION	0.00	0.00	4770.00	0	00:00	0.00
219	JUNCTION	0.59	4.49	4776.49	0	00:54	4.49
220	JUNCTION	0.00	0.00	4777.00	0	00:00	0.00
221	JUNCTION	0.58	4.51	4795.11	0	00:50	4.51
223	JUNCTION	0.12	1.04	4794.04	0	00:45	1.04
224	JUNCTION	0.00	0.00	4810.00	0	00:00	0.00
225	JUNCTION	0.12	1.04	4841.04	0	00:41	1.04
226	JUNCTION	0.00	0.00	4850.00	0	00:00	0.00
228	JUNCTION	0.12	0.99	4864.99	0	00:40	0.98
231	JUNCTION	0.23	1.91	4792.71	0	00:50	1.91
232	JUNCTION	0.00	0.00	4810.00	0	00:00	0.00
235	JUNCTION	0.22	1.93	4846.93	0	00:45	1.93
236	JUNCTION	0.00	0.00	4847.00	0	00:00	0.00
237	JUNCTION	0.25	2.30	4848.30	0	00:45	2.30
239	JUNCTION	0.42	3.81	4853.81	0	00:45	3.81
240	JUNCTION	0.00	0.00	4849.00	0	00:00	0.00
241	JUNCTION	0.41	3.81	4865.81	0	00:43	3.81
243	JUNCTION	0.34	3.30	4866.30	0	00:43	3.29
244	JUNCTION	0.00	0.00	4894.00	0	00:00	0.00
245	JUNCTION	0.33	3.33	4983.33	0	00:40	3.33
247	JUNCTION	0.09	0.89	4981.89	0	00:42	0.88
248	JUNCTION	0.00	0.00	4986.00	0	00:00	0.00
250	JUNCTION	0.08	0.93	5015.93	0	00:35	0.93
252	JUNCTION	0.00	0.00	4990.00	0	00:00	0.00
256	JUNCTION	0.00	0.00	4851.00	0	00:00	0.00
259	JUNCTION	0.19	1.74	4864.74	0	00:44	1.74
260	JUNCTION	0.00	0.00	4905.00	0	00:00	0.00
263	JUNCTION	0.19	1.75	4923.75	0	00:41	1.74

264	JUNCTION	0.00	0.00	4960.00	0	00:00	0.00
268	JUNCTION	0.09	0.90	4991.90	0	00:40	0.90
309	JUNCTION	0.07	0.66	4778.66	0	00:47	0.65
310	JUNCTION	0.00	0.00	4779.00	0	00:00	0.00
314	JUNCTION	0.06	0.67	4839.67	0	00:40	0.67
410	JUNCTION	0.00	0.00	4793.00	0	00:00	0.00
414	JUNCTION	0.00	0.00	4796.00	0	00:00	0.00
418	JUNCTION	0.00	0.00	4802.00	0	00:00	0.00
422	JUNCTION	0.00	0.00	4800.00	0	00:00	0.00
426	JUNCTION	0.00	0.00	4810.00	0	00:00	0.00
509	JUNCTION	0.06	0.54	4812.54	0	00:42	0.53
510	JUNCTION	0.00	0.00	4856.00	0	00:00	0.00
513	JUNCTION	0.06	0.54	4880.54	0	00:40	0.54
514	JUNCTION	0.00	0.00	4931.00	0	00:00	0.00
518	JUNCTION	0.00	0.00	4940.00	0	00:00	0.00
609	JUNCTION	0.22	2.07	4852.07	0	00:48	2.06
610	JUNCTION	0.00	0.00	4858.00	0	00:00	0.00
613	JUNCTION	0.21	2.13	4890.13	0	00:40	2.13
614	JUNCTION	0.00	0.00	4899.00	0	00:00	0.00
617	JUNCTION	0.12	1.20	4943.20	0	00:40	1.20
618	JUNCTION	0.00	0.00	4950.00	0	00:00	0.00
622	JUNCTION	0.11	1.21	4997.21	0	00:35	1.20
710	JUNCTION	0.00	0.00	4975.00	0	00:00	0.00
809	JUNCTION	0.43	3.28	4968.28	0	00:41	3.27
810	JUNCTION	0.00	0.00	4969.00	0	00:00	0.00
813	JUNCTION	0.43	3.28	4970.28	0	00:41	3.28
814	JUNCTION	0.00	0.00	4970.00	0	00:00	0.00
818	JUNCTION	0.15	1.58	4991.58	0	00:35	1.57
O_100	OUTFALL	0.00	0.00	4785.00	0	00:00	0.00
O_210	OUTFALL	0.00	0.00	4754.00	0	00:00	0.00
O_220	OUTFALL	0.00	0.00	4769.00	0	00:00	0.00
O_300	OUTFALL	0.00	0.00	4775.00	0	00:00	0.00
O_410	OUTFALL	0.00	0.00	4779.00	0	00:00	0.00
O_414	OUTFALL	0.00	0.00	4781.00	0	00:00	0.00
O_418	OUTFALL	0.00	0.00	4784.00	0	00:00	0.00
O_422	OUTFALL	0.00	0.00	4789.00	0	00:00	0.00
O_426	OUTFALL	0.00	0.00	4793.00	0	00:00	0.00
O_500	OUTFALL	0.00	0.00	4804.00	0	00:00	0.00
O_600	OUTFALL	0.00	0.00	4849.00	0	00:00	0.00
O_710	OUTFALL	0.00	0.00	4961.00	0	00:00	0.00
O_800	OUTFALL	0.00	0.00	4967.00	0	00:00	0.00

****
Node Inflow Summary
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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
109	JUNCTION	0.00	1445.99	0 00:55	0	44	0.000
110	JUNCTION	72.62	72.62	0 01:05	3.55	3.55	0.000
113	JUNCTION	0.00	1374.88	0 00:54	0	40.5	0.000
114	JUNCTION	157.30	157.30	0 00:50	5.4	5.4	0.000
115	JUNCTION	0.00	1277.98	0 00:46	0	34.5	0.000
117	JUNCTION	0.00	821.46	0 00:47	0	22.2	0.000
118	JUNCTION	53.02	53.02	0 00:50	1.8	1.8	0.000
119	JUNCTION	0.00	770.24	0 00:45	0	20.3	0.000
121	JUNCTION	0.00	250.65	0 00:50	0	8.55	0.000
122	JUNCTION	235.38	235.38	0 00:45	7.46	7.46	0.000
126	JUNCTION	31.01	31.01	0 00:45	1.02	1.02	0.000
129	JUNCTION	0.00	523.26	0 00:45	0	11.8	0.000
130	JUNCTION	65.49	65.49	0 00:50	2.47	2.47	0.000
133	JUNCTION	0.00	473.33	0 00:40	0	9.28	-0.000
134	JUNCTION	159.32	159.32	0 00:35	3.48	3.48	0.000
138	JUNCTION	336.11	336.11	0 00:35	5.75	5.75	0.000
139	JUNCTION	0.00	464.96	0 00:43	0	12.4	0.000
141	JUNCTION	0.00	443.51	0 00:42	0	11.4	0.000
142	JUNCTION	23.12	23.12	0 00:50	1.01	1.01	0.000
146	JUNCTION	48.81	48.81	0 00:55	2.28	2.28	0.000
149	JUNCTION	0.00	400.70	0 00:40	0	9.09	0.000
150	JUNCTION	99.87	99.87	0 00:45	3.26	3.26	0.000
154	JUNCTION	316.19	316.19	0 00:35	5.8	5.8	0.000
210	JUNCTION	90.08	90.08	0 00:45	2.43	2.43	0.000
219	JUNCTION	0.00	2273.28	0 00:54	0	64	0.000
220	JUNCTION	134.31	134.31	0 00:50	4.78	4.78	0.000
221	JUNCTION	0.00	2159.63	0 00:50	0	59.1	0.000
223	JUNCTION	0.00	397.28	0 00:45	0	11	0.000
224	JUNCTION	102.13	102.13	0 00:45	3.15	3.15	0.000
225	JUNCTION	0.00	297.42	0 00:41	0	7.87	0.000
226	JUNCTION	157.08	157.08	0 00:40	3.81	3.81	0.000
228	JUNCTION	142.96	142.96	0 00:40	4.05	4.05	0.000
231	JUNCTION	0.00	1771.84	0 00:50	0	48.1	0.000
232	JUNCTION	138.79	138.79	0 00:55	5.26	5.26	0.000
235	JUNCTION	0.00	1663.11	0 00:45	0	42.5	0.000
236	JUNCTION	105.63	105.63	0 00:45	3.49	3.49	0.000
237	JUNCTION	0.00	1557.59	0 00:45	0	39	0.000
239	JUNCTION	0.00	1524.53	0 00:45	0	38	0.000
240	JUNCTION	33.33	33.33	0 00:45	1.04	1.04	0.000
241	JUNCTION	0.00	1343.38	0 00:43	0	32.4	0.000
243	JUNCTION	0.00	900.77	0 00:43	0	20.4	0.000
244	JUNCTION	237.04	237.04	0 00:40	5.92	5.92	0.000
245	JUNCTION	0.00	680.47	0 00:40	0	14.4	0.000
247	JUNCTION	0.00	509.02	0 00:39	0	9.99	0.000
248	JUNCTION	372.42	372.42	0 00:35	7	7	0.000
250	JUNCTION	181.64	181.64	0 00:35	2.96	2.96	0.000
252	JUNCTION	172.98	172.98	0 00:40	4.43	4.43	0.000
256	JUNCTION	182.91	182.91	0 00:45	5.55	5.55	0.000
259	JUNCTION	0.00	444.89	0 00:45	0	12	0.000
260	JUNCTION	98.74	98.74	0 00:50	3.33	3.33	0.000
263	JUNCTION	0.00	350.78	0 00:41	0	8.68	0.000
264	JUNCTION	195.65	195.65	0 00:40	4.78	4.78	0.000
268	JUNCTION	158.12	158.12	0 00:40	3.89	3.89	0.000
309	JUNCTION	0.00	269.56	0 00:49	0	7.72	0.000
310	JUNCTION	110.61	110.61	0 00:50	3.8	3.8	0.000
314	JUNCTION	168.04	168.04	0 00:40	3.88	3.88	0.000
410	JUNCTION	19.09	19.09	0 00:45	0.65	0.65	0.000
414	JUNCTION	19.85	19.85	0 00:45	0.579	0.579	0.000
418	JUNCTION	53.79	53.79	0 00:50	1.97	1.97	0.000
422	JUNCTION	2.89	2.89	0 00:40	0.0781	0.0781	0.000
426	JUNCTION	52.54	52.54	0 00:50	1.97	1.97	0.000
509	JUNCTION	0.00	613.49	0 00:45	0	17.7	0.000
510	JUNCTION	174.84	174.84	0 00:50	6.55	6.55	0.000
513	JUNCTION	0.00	456.02	0 00:40	0	11.1	0.000
514	JUNCTION	229.26	229.26	0 00:40	6	6	0.000
518	JUNCTION	226.75	226.75	0 00:40	5.15	5.15	0.000
609	JUNCTION	0.00	954.57	0 00:48	0	23.6	0.000
610	JUNCTION	145.90	145.90	0 00:50	5.68	5.68	0.000
613	JUNCTION	0.00	851.81	0 00:40	0	17.8	0.000
614	JUNCTION	321.94	321.94	0 00:35	6.49	6.49	0.000
617	JUNCTION	0.00	554.23	0 00:38	0	11.2	0.000
618	JUNCTION	216.70	216.70	0 00:35	3.84	3.84	0.000
622	JUNCTION	359.48	359.48	0 00:35	7.38	7.38	0.000
710	JUNCTION	163.49	163.49	0 00:35	3.16	3.16	0.000
809	JUNCTION	0.00	847.59	0 00:40	0	18.9	0.000
810	JUNCTION	199.58	199.58	0 00:35	4.62	4.62	0.000
813	JUNCTION	0.00	649.92	0 00:41	0	14.3	0.000
814	JUNCTION	350.41	350.41	0 00:40	7.74	7.74	0.000
818	JUNCTION	312.24	312.24	0 00:35	6.5	6.5	0.000
O_100	OUTFALL	0.00	1445.99	0 00:55	0	44	0.000
O_210	OUTFALL	0.00	90.08	0 00:45	0	2.43	0.000
O_220	OUTFALL	0.00	2273.28	0 00:54	0	64	0.000
O_300	OUTFALL	0.00	269.56	0 00:49	0	7.72	0.000
O_410	OUTFALL	0.00	19.09	0 00:45	0	0.65	0.000
O_414	OUTFALL	0.00	19.85	0 00:45	0	0.579	0.000
O_418	OUTFALL	0.00	53.79	0 00:50	0	1.97	0.000
O_422	OUTFALL	0.00	2.89	0 00:40	0	0.0781	0.000

O_426	OUTFALL	0.00	52.54	0	00:50	0	1.97	0.000
O_500	OUTFALL	0.00	613.49	0	00:45	0	17.7	0.000
O_600	OUTFALL	0.00	954.57	0	00:48	0	23.6	0.000
O_710	OUTFALL	0.00	163.49	0	00:35	0	3.16	0.000
O_800	OUTFALL	0.00	847.59	0	00:40	0	18.9	0.000

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
O_100	98.56	138.20	1445.99	44.016
O_210	31.02	24.23	90.08	2.428
O_220	98.52	201.07	2273.28	64.011
O_300	62.45	38.25	269.56	7.720
O_410	35.37	5.69	19.09	0.650
O_414	30.79	5.82	19.85	0.579
O_418	38.80	15.68	53.79	1.966
O_422	27.41	0.88	2.89	0.078
O_426	40.23	15.16	52.54	1.970
O_500	41.02	133.65	613.49	17.715
O_600	99.26	73.59	954.57	23.603
O_710	23.56	41.47	163.49	3.157
O_800	43.89	133.20	847.59	18.891
System	51.61	826.88	6520.67	186.784

****
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
DL_109	DUMMY	1445.99	0 00:55			
DL_110	DUMMY	72.62	0 01:05			
DL_114	DUMMY	157.30	0 00:50			
DL_118	DUMMY	53.02	0 00:50			
DL_121	DUMMY	250.65	0 00:50			
DL_122	DUMMY	235.38	0 00:45			
DL_129	DUMMY	523.26	0 00:45			
DL_130	DUMMY	65.49	0 00:50			
DL_134	DUMMY	159.32	0 00:35			
DL_142	DUMMY	23.12	0 00:50			
DL_150	DUMMY	99.87	0 00:45			
DL_210	DUMMY	90.08	0 00:45			
DL_219	DUMMY	2273.28	0 00:54			
DL_220	DUMMY	134.31	0 00:50			
DL_223	DUMMY	397.28	0 00:45			
DL_224	DUMMY	102.13	0 00:45			
DL_226	DUMMY	157.08	0 00:40			
DL_231	DUMMY	1771.84	0 00:50			
DL_232	DUMMY	138.79	0 00:55			
DL_236	DUMMY	105.63	0 00:45			
DL_237	DUMMY	1557.59	0 00:45			
DL_240	DUMMY	33.33	0 00:45			
DL_243	DUMMY	900.77	0 00:43			
DL_244	DUMMY	237.04	0 00:40			
DL_247	DUMMY	509.02	0 00:39			
DL_248	DUMMY	372.42	0 00:35			
DL_252	DUMMY	172.98	0 00:40			
DL_256	DUMMY	182.91	0 00:45			
DL_259	DUMMY	444.89	0 00:45			
DL_260	DUMMY	98.74	0 00:50			
DL_264	DUMMY	195.65	0 00:40			
DL_309	DUMMY	269.56	0 00:49			
DL_310	DUMMY	110.61	0 00:50			
DL_410	DUMMY	19.09	0 00:45			
DL_414	DUMMY	19.85	0 00:45			
DL_418	DUMMY	53.79	0 00:50			
DL_422	DUMMY	2.89	0 00:40			
DL_426	DUMMY	52.54	0 00:50			
DL_509	DUMMY	613.49	0 00:45			
DL_510	DUMMY	174.84	0 00:50			
DL_514	DUMMY	229.26	0 00:40			
DL_518	DUMMY	226.75	0 00:40			
DL_609	DUMMY	954.57	0 00:48			
DL_610	DUMMY	145.90	0 00:50			
DL_614	DUMMY	321.94	0 00:35			
DL_618	DUMMY	216.70	0 00:35			
DL_710	DUMMY	163.49	0 00:35			
DL_809	DUMMY	847.59	0 00:40			
DL_810	DUMMY	199.58	0 00:35			
DL_814	DUMMY	350.41	0 00:40			
L_114	CONDUIT	1374.89	0 00:55	17.66	0.03	0.28
L_115	CONDUIT	1219.47	0 00:55	5.42	0.06	0.21
L_117	CONDUIT	821.43	0 00:47	25.24	0.05	0.22
L_119	CONDUIT	768.82	0 00:47	9.97	0.16	0.42
L_126	CONDUIT	27.69	0 01:10	3.37	0.00	0.03
L_133	CONDUIT	459.10	0 00:45	6.90	0.01	0.08
L_138	CONDUIT	315.62	0 00:40	5.68	0.01	0.10
L_139	CONDUIT	464.95	0 00:43	12.00	0.04	0.17
L_141	CONDUIT	443.46	0 00:43	19.28	0.02	0.10
L_146	CONDUIT	48.80	0 00:55	6.64	0.00	0.03
L_149	CONDUIT	399.83	0 00:42	10.53	0.04	0.16
L_154	CONDUIT	304.89	0 00:39	5.38	0.03	0.13
L_221	CONDUIT	2139.31	0 00:54	8.30	0.21	0.45
L_225	CONDUIT	295.21	0 00:45	6.78	0.02	0.10
L_228	CONDUIT	142.74	0 00:45	6.61	0.01	0.10
L_235	CONDUIT	1634.24	0 00:50	8.17	0.06	0.19
L_239	CONDUIT	1524.30	0 00:45	8.33	0.08	0.23
L_241	CONDUIT	1341.72	0 00:45	9.38	0.17	0.38
L_245	CONDUIT	668.69	0 00:43	12.41	0.10	0.33
L_250	CONDUIT	162.58	0 00:42	3.61	0.00	0.09
L_263	CONDUIT	346.98	0 00:44	8.56	0.04	0.17
L_268	CONDUIT	156.99	0 00:42	8.06	0.01	0.09
L_314	CONDUIT	161.26	0 00:47	4.86	0.01	0.07
L_513	CONDUIT	450.91	0 00:42	13.81	0.01	0.05
L_613	CONDUIT	810.77	0 00:48	6.66	0.05	0.21
L_617	CONDUIT	544.37	0 00:42	6.63	0.02	0.10
L_622	CONDUIT	352.91	0 00:40	7.53	0.01	0.12
L_813	CONDUIT	649.82	0 00:41	6.04	0.05	0.33
L_818	CONDUIT	306.02	0 00:42	5.13	0.01	0.16

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Wed Jul 20 14:47:48 2022
Analysis ended on: Wed Jul 20 14:47:49 2022
Total elapsed time: 00:00:01

Appendix C – Hydraulic Analysis

Culvert Data: Structure#101

Site Data - Structure#101

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4778.22 ft
Outlet Station: 52.00 ft
Outlet Elevation: 4777.89 ft
Number of Barrels: 2

Culvert Data Summary - Structure#101

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting (Ke=0.9)
Inlet Depression: None

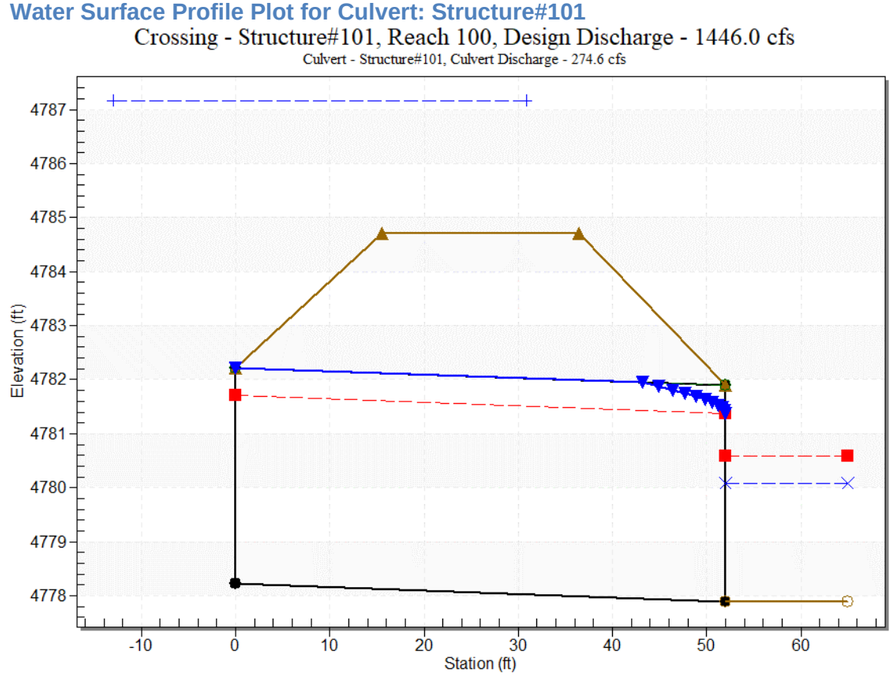
Table 21 - Culvert Summary Table: Structure#101

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	5.18 cfs	5.18 cfs	4778.95	0.67	0.733	2-M2c	0.55	0.46	0.46	0.27	3.19	2.44
100 Year	1446.00 cfs	274.58 cfs	4787.16	8.94	8.585	7-M2c	4.00	3.48	3.48	2.20	11.82	9.99

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4778.22 ft,
Outlet Elevation (invert): 4777.89 ft
Culvert Length: 52.00 ft,
Culvert Slope: 0.0063

Water Surface Profile Plot for Culvert: Structure#101



Tailwater Data for Crossing: Structure#101, Reach 100

Table 22 - Downstream Channel Rating Curve (Crossing: Structure#101, Reach 100)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
5.18	4778.16	0.27	2.44	0.38	1.18
1446.00	4780.09	2.20	9.99	3.15	1.68

Tailwater Channel Data - Structure#101, Reach 100

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 30.00 (_:1)
Channel Slope: 0.0230
Channel Manning's n: 0.0240
Channel Invert Elevation: 4777.89 ft

Roadway Data for Crossing: Structure#101, Reach 100

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4784.70 ft
Roadway Surface: Paved
Roadway Top Width: 21.00 ft

Culvert Data: Structure#102

Site Data - Structure#102

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4782.03 ft
Outlet Station: 60.00 ft
Outlet Elevation: 4781.65 ft
Number of Barrels: 2

Culvert Data Summary - Structure#102

Barrel Shape: Concrete Box
Barrel Span: 10.00 ft
Barrel Rise: 6.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

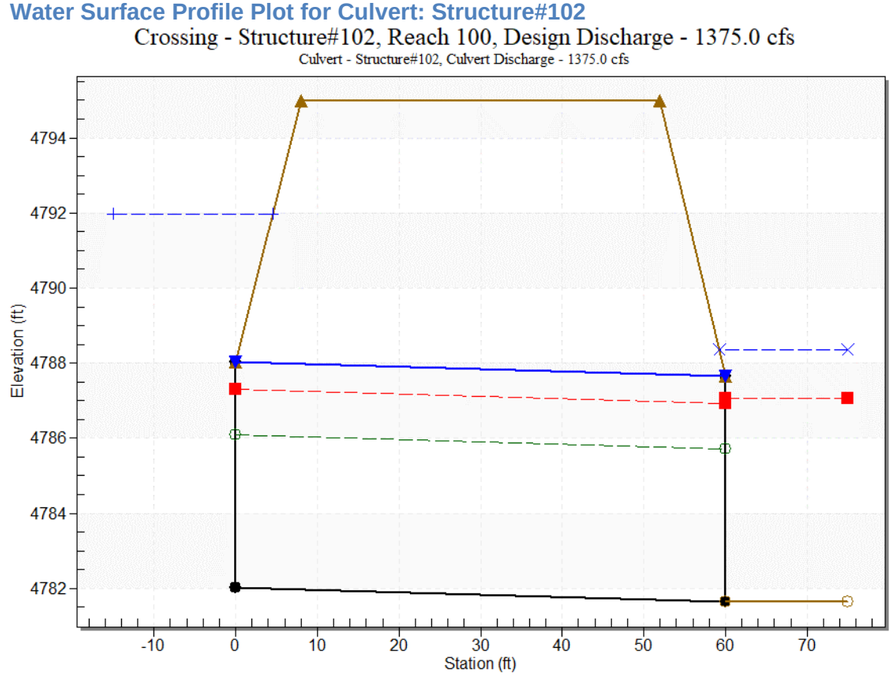
Table 19 - Culvert Summary Table: Structure#102

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
	cfs	cfs										
5 Year	6.28 cfs	6.28 cfs	4782.55	0.25	0.516	1-S1t	0.11	0.15	0.89	0.89	0.35	1.59
100 Year	1375.00	1375.00	4791.98	9.95	9.608	4-FFf	4.06	5.28	6.00	6.71	11.46	6.11

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4782.03 ft,
Outlet Elevation (invert): 4781.65 ft
Culvert Length: 60.00 ft,
Culvert Slope: 0.0063

Water Surface Profile Plot for Culvert: Structure#102



Tailwater Data for Crossing: Structure#102, Reach 100

Table 20 - Downstream Channel Rating Curve (Crossing: Structure#102, Reach 100)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
6.28	4782.54	0.89	1.59	0.39	0.42
1375.00	4788.36	6.71	6.11	2.93	0.59

Tailwater Channel Data - Structure#102, Reach 100

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 5.00 (_:1)
Channel Slope: 0.0070
Channel Manning's n: 0.0450
Channel Invert Elevation: 4781.65 ft

Roadway Data for Crossing: Structure#102, Reach 100

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4794.98 ft
Roadway Surface: Paved
Roadway Top Width: 44.00 ft

Culvert Data: Structure#103

Site Data - Structure#103

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4864.72 ft
Outlet Station: 295.00 ft
Outlet Elevation: 4858.55 ft
Number of Barrels: 1

Culvert Data Summary - Structure#103

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

Table 13 - Culvert Summary Table: Structure#103

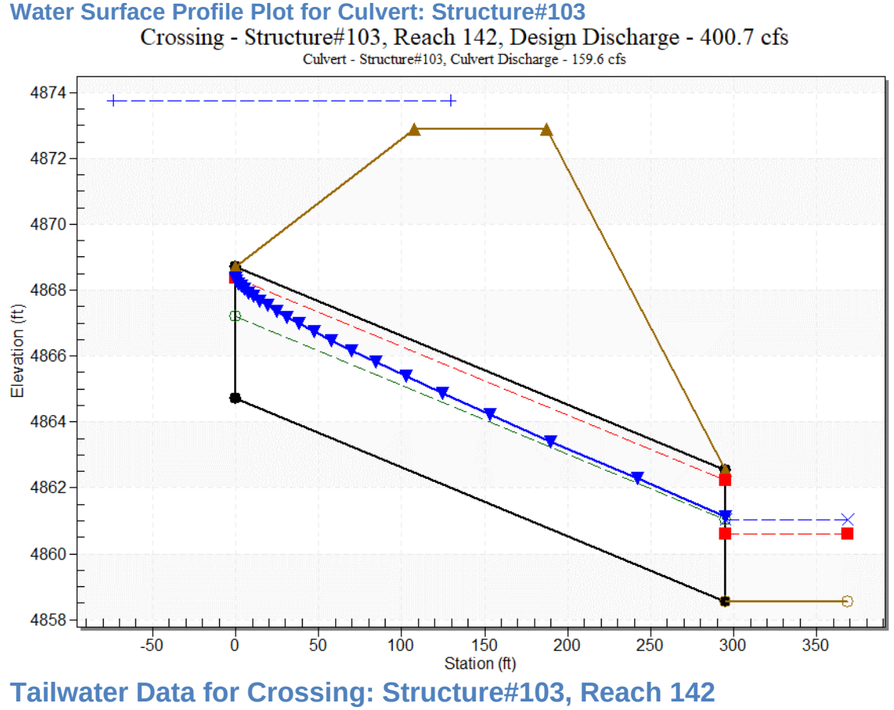
Discharge Names	Total Discharge (cfs)	Culvert Discharge	Headwater Elevation (ft)	Inlet Control Dept h (ft)	Outlet Control Dept h (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	85.77 cfs	85.77 cfs	4869.23	4.51	0.0*	5-S2n	1.71	2.81	1.75	1.18	16.19	3.21
100 Year	400.70 cfs	159.58 cfs	4873.74	9.02	4.504	5-S2n	2.48	3.66	2.58	2.48	18.61	4.86

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4864.72 ft,
Outlet Elevation (invert): 4858.55 ft
Culvert Length: 295.06 ft,
Culvert Slope: 0.0209

Water Surface Profile Plot for Culvert: Structure#103



Tailwater Data for Crossing: Structure#103, Reach 142

Table 14 - Downstream Channel Rating Curve (Crossing: Structure#103, Reach 142)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
85.77	4859.73	1.18	3.21	0.91	0.62
400.70	4861.03	2.48	4.86	1.91	0.69

Tailwater Channel Data - Structure#103, Reach 142

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 12.70 ft
Side Slope (H:V): 8.30 (_:1)
Channel Slope: 0.0123
Channel Manning's n: 0.0450
Channel Invert Elevation: 4858.55 ft

Roadway Data for Crossing: Structure#103, Reach 142

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4872.88 ft
Roadway Surface: Paved
Roadway Top Width: 80.00 ft

Culvert Data: Structure#104

Site Data - Structure#104

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4921.39 ft
Outlet Station: 127.00 ft
Outlet Elevation: 4919.92 ft
Number of Barrels: 1

Culvert Data Summary - Structure#104

Barrel Shape: Circular
Barrel Diameter: 3.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting (Ke=0.9)
Inlet Depression: None

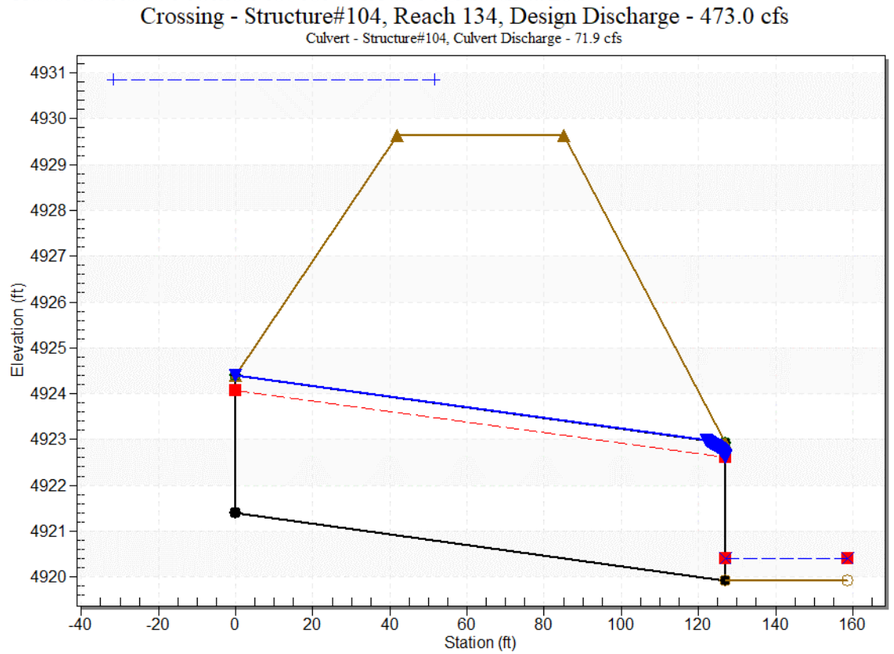
Table 11 - Culvert Summary Table: Structure#104

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	124.36 cfs	68.01 cfs	4929.97	6.86	8.577	7-M2c	3.00	2.63	2.63	0.26	10.35	2.12
100 Year	473.00 cfs	71.94 cfs	4930.84	7.47	9.454	7-M2c	3.00	2.68	2.68	0.47	10.79	3.00

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4921.39 ft,
Outlet Elevation (invert): 4919.92 ft
Culvert Length: 127.01 ft,
Culvert Slope: 0.0116

Water Surface Profile Plot for Culvert: Structure#104



Tailwater Data for Crossing: Structure#104, Reach 134

Table 12 - Downstream Channel Rating Curve (Crossing: Structure#104, Reach 134)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
124.36	4920.18	0.26	2.12	0.74	0.92
473.00	4920.39	0.47	3.00	1.35	1.01

Tailwater Channel Data - Structure#104, Reach 134

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 100.00 ft
Side Slope (H:V): 500.00 (_:1)
Channel Slope: 0.0460
Channel Manning's n: 0.0450
Channel Invert Elevation: 4919.92 ft

Roadway Data for Crossing: Structure#104, Reach 134

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4929.64 ft
Roadway Surface: Paved
Roadway Top Width: 43.00 ft

Culvert Data: Structure#105

Site Data - Structure#105

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4844.62 ft
Outlet Station: 88.00 ft
Outlet Elevation: 4840.85 ft
Number of Barrels: 1

Culvert Data Summary - Structure#105

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting (Ke=0.9)
Inlet Depression: None

Table 17 - Culvert Summary Table: Structure#105

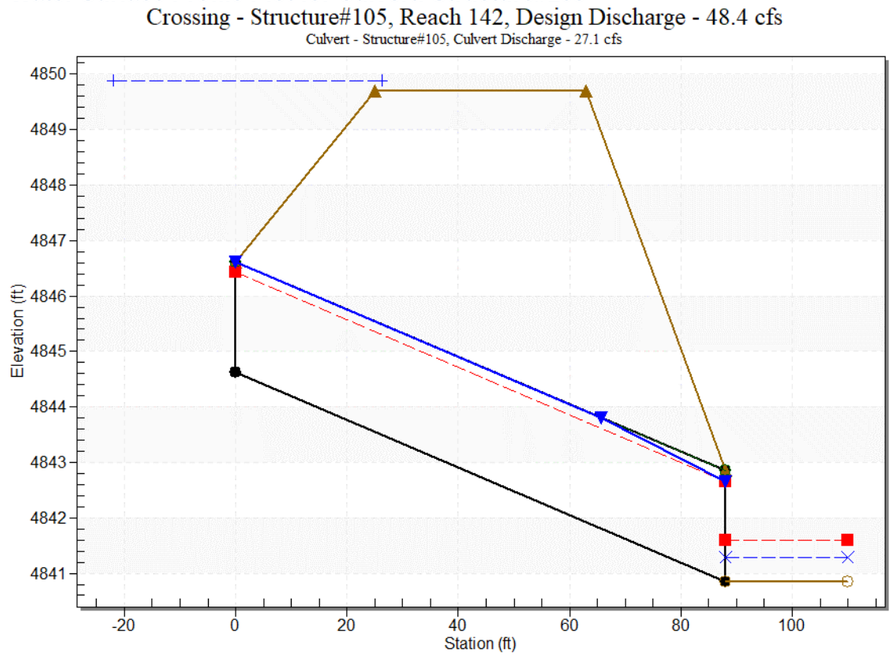
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	7.46 cfs	7.46 cfs	4846.09	1.47	0.0*	1-S2n	0.74	0.97	0.74	0.15	7.03	4.54
100 Year	48.41 cfs	27.12 cfs	4849.88	5.26	4.585	7-M2c	2.00	1.81	1.81	0.43	9.07	8.54

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4844.62 ft,
Outlet Elevation (invert): 4840.85 ft
Culvert Length: 88.08 ft,
Culvert Slope: 0.0428

Water Surface Profile Plot for Culvert: Structure#105



Tailwater Data for Crossing: Structure#105, Reach 142

Table 18 - Downstream Channel Rating Curve (Crossing: Structure#105, Reach 142)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
7.46	4841.00	0.15	4.54	2.51	2.17
48.41	4841.28	0.43	8.54	7.32	2.54

Tailwater Channel Data - Structure#105, Reach 142

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 7.00 (_:1)
Channel Slope: 0.2700
Channel Manning's n: 0.0450
Channel Invert Elevation: 4840.85 ft

Roadway Data for Crossing: Structure#105, Reach 142

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4849.70 ft
Roadway Surface: Paved
Roadway Top Width: 38.00 ft

Culvert Data: Structure#106

Site Data - Structure#106

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4870.42 ft
Outlet Station: 100.00 ft
Outlet Elevation: 4867.47 ft
Number of Barrels: 1

Culvert Data Summary - Structure#106

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

Table 15 - Culvert Summary Table: Structure#106

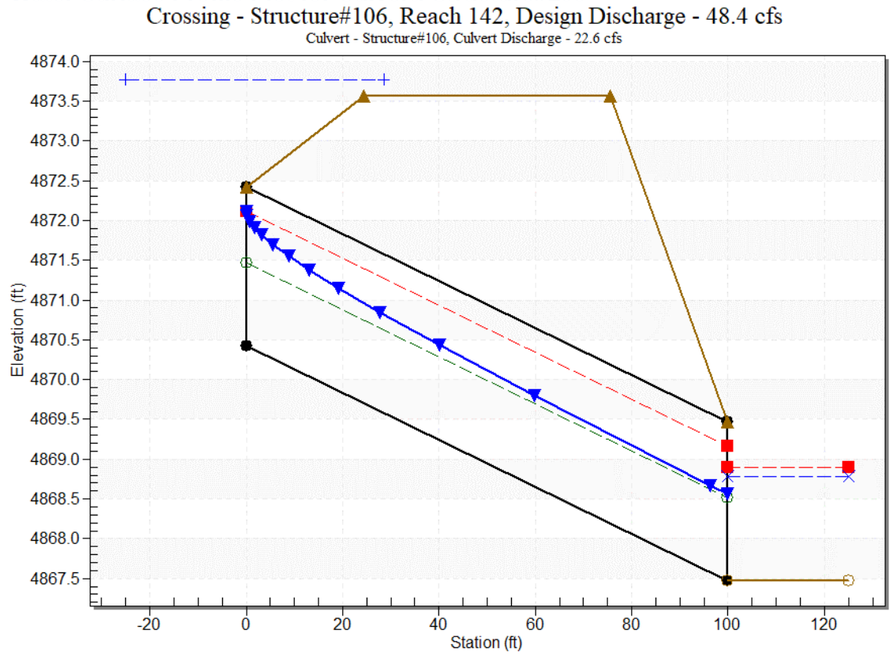
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5	1.74 cfs	1.74 cfs	4871.03	0.61	0.0*	1-S2n	0.28	0.46	0.28	0.37	6.63	2.48
100	48.41 cfs	22.55 cfs	4873.76	3.34	0.941	5-S2n	1.04	1.69	1.09	1.30	12.87	5.69

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4870.42 ft,
Outlet Elevation (invert): 4867.47 ft
Culvert Length: 100.04 ft,
Culvert Slope: 0.0295

Water Surface Profile Plot for Culvert: Structure#106



Tailwater Data for Crossing: Structure#106, Reach 142

Table 16 - Downstream Channel Rating Curve (Crossing: Structure#106, Reach 142)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
1.74	4867.85	0.37	2.48	1.26	1.01
48.41	4868.78	1.30	5.69	4.39	1.24

Tailwater Channel Data - Structure#106, Reach 142

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 5.00 (_:1)
Channel Slope: 0.0540
Channel Manning's n: 0.0450
Channel Invert Elevation: 4867.47 ft

Roadway Data for Crossing: Structure#106, Reach 142

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4873.57 ft
Roadway Surface: Paved
Roadway Top Width: 51.00 ft

Culvert Data: Structure#107

Site Data - Structure#107

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4970.37 ft
Outlet Station: 228.00 ft
Outlet Elevation: 4967.06 ft
Number of Barrels: 1

Culvert Data Summary - Structure#107

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

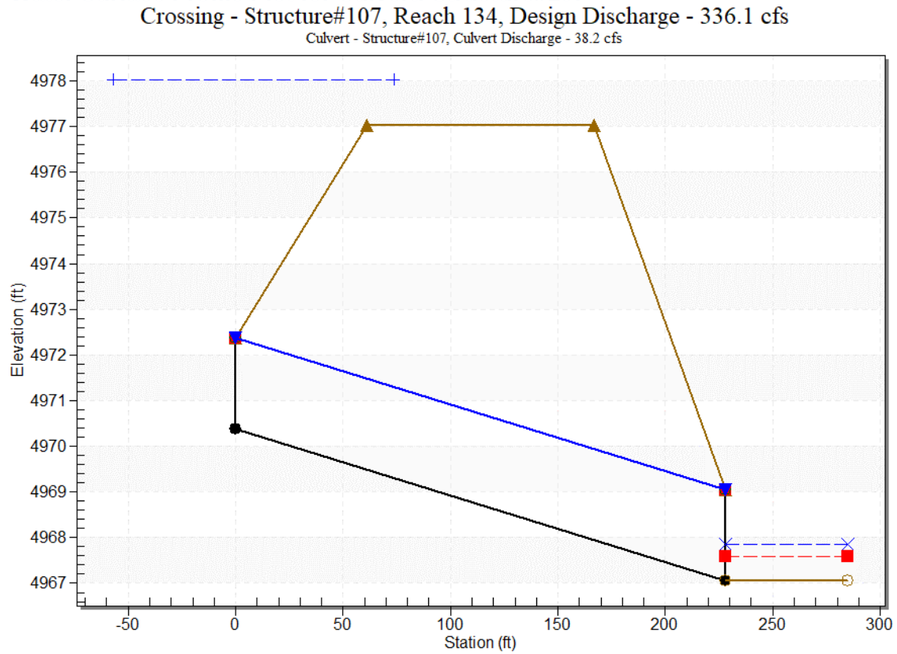
Table 9 - Culvert Summary Table: Structure#107

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	101.20 cfs	36.84 cfs	4977.39	6.84	7.018	7-M2c	2.00	1.69	1.69	0.48	13.00	1.08
100 Year	336.11 cfs	38.21 cfs	4978.02	7.29	7.648	6-FFc	2.00	2.00	2.00	0.79	12.16	1.47

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4970.37 ft,
Outlet Elevation (invert): 4967.06 ft
Culvert Length: 228.02 ft,
Culvert Slope: 0.0145

Water Surface Profile Plot for Culvert: Structure#107



Tailwater Data for Crossing: Structure#107, Reach 134

Table 10 - Downstream Channel Rating Curve (Crossing: Structure#107, Reach 134)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
101.20	4967.54	0.48	1.08	0.18	0.36
336.11	4967.85	0.79	1.47	0.30	0.39

Tailwater Channel Data - Structure#107, Reach 134

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 302.00 (_:1)
Channel Slope: 0.0060
Channel Manning's n: 0.0450
Channel Invert Elevation: 4967.06 ft

Roadway Data for Crossing: Structure#107, Reach 134

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4977.03 ft
Roadway Surface: Paved
Roadway Top Width: 106.00 ft

Culvert Data: Structure#108

Site Data - Structure#108

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4982.36 ft
Outlet Station: 76.00 ft
Outlet Elevation: 4981.67 ft
Number of Barrels: 1

Culvert Data Summary - Structure#108

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

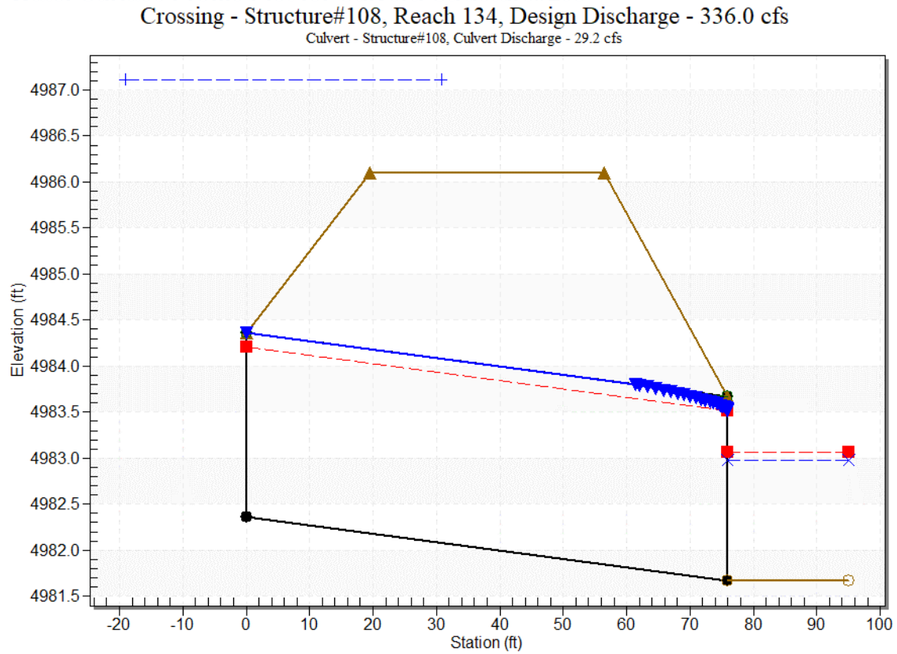
Table 7 - Culvert Summary Table: Structure#108

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5	101.00 cfs	26.47 cfs	4986.49	4.13	3.701	7-M2c	2.00	1.80	1.80	0.72	8.90	4.25
100	336.00 cfs	29.18 cfs	4987.11	4.75	4.317	7-M2c	2.00	1.85	1.85	1.31	9.62	5.91

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4982.36 ft,
Outlet Elevation (invert): 4981.67 ft
Culvert Length: 76.00 ft,
Culvert Slope: 0.0091

Water Surface Profile Plot for Culvert: Structure#108



Tailwater Data for Crossing: Structure#108, Reach 134

Table 8 - Downstream Channel Rating Curve (Crossing: Structure#108, Reach 134)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
101.00	4982.39	0.72	4.25	1.80	1.04
336.00	4982.98	1.31	5.91	3.26	1.13

Tailwater Channel Data - Structure#108, Reach 134

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 20.00 ft
Side Slope (H:V): 18.00 (_:1)
Channel Slope: 0.0400
Channel Manning's n: 0.0450
Channel Invert Elevation: 4981.67 ft

Roadway Data for Crossing: Structure#108, Reach 134

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4986.10 ft
Roadway Surface: Paved
Roadway Top Width: 37.00 ft

Culvert Data: Structure#109

Site Data - Structure#109

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4982.18 ft
Outlet Station: 137.00 ft
Outlet Elevation: 4978.92 ft
Number of Barrels: 1

Culvert Data Summary - Structure#109

Barrel Shape: Circular
Barrel Diameter: 2.50 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

Table 5 - Culvert Summary Table: Structure#109

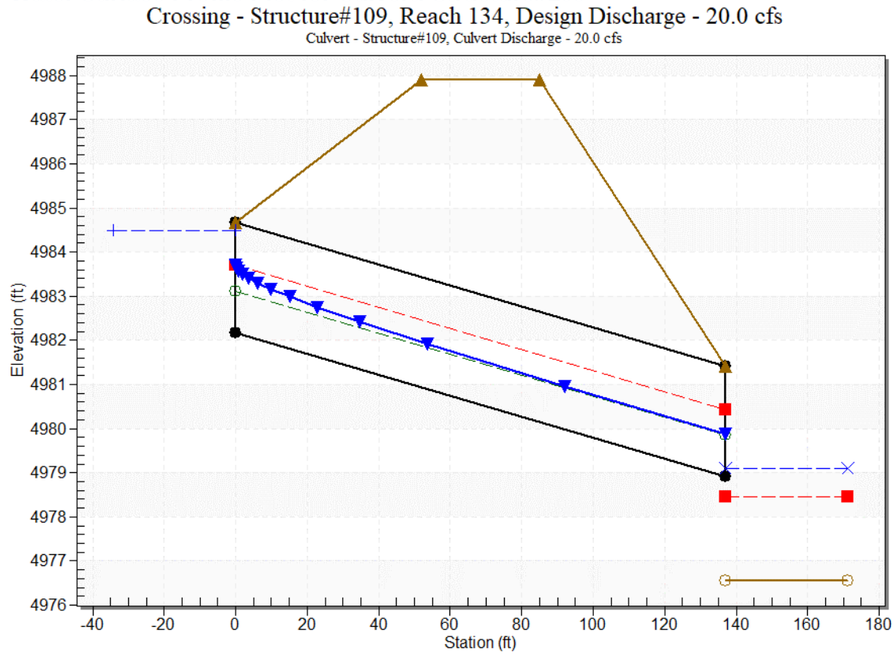
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	5.00 cfs	5.00 cfs	4983.17	1.00	0.0*	1-S2n	0.46	0.74	0.46	1.51	8.16	2.20
100 Year	20.00 cfs	20.00 cfs	4984.47	2.30	0.0*	1-S2n	0.92	1.52	0.96	2.53	11.60	3.11

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4982.18 ft,
Outlet Elevation (invert): 4978.92 ft
Culvert Length: 137.04 ft,
Culvert Slope: 0.0238

Water Surface Profile Plot for Culvert: Structure#109



Tailwater Data for Crossing: Structure#109, Reach 134

Table 6 - Downstream Channel Rating Curve (Crossing: Structure#109, Reach 134)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
5.00	4978.06	1.51	2.20	0.97	0.45
20.00	4979.09	2.53	3.11	1.63	0.49

Tailwater Channel Data - Structure#109, Reach 134

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 1.00 (_:1)
Channel Slope: 0.0103
Channel Manning's n: 0.0450
Channel Invert Elevation: 4976.56 ft

Roadway Data for Crossing: Structure#109, Reach 134

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4987.90 ft
Roadway Surface: Paved
Roadway Top Width: 33.00 ft

Culvert Data: Structure#201

Site Data - Structure#201

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4770.52 ft
Outlet Station: 30.46 ft
Outlet Elevation: 4770.40 ft
Number of Barrels: 4

Culvert Data Summary - Structure#201

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting (Ke=0.9)
Inlet Depression: None

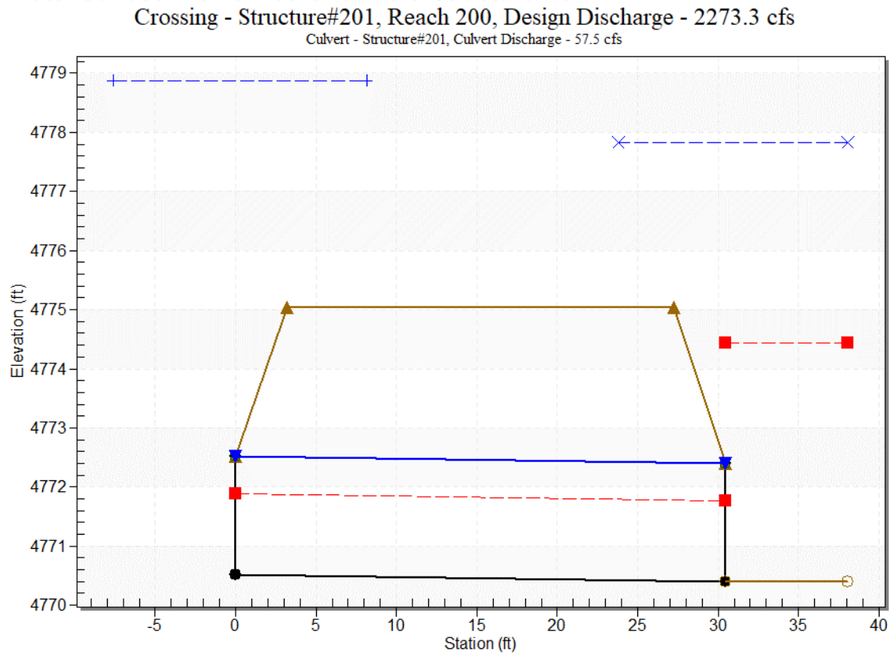
Table 35 - Culvert Summary Table: Structure#201

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	5.00 cfs	5.00 cfs	4771.15	0.57	0.632	2-M2c	0.54	0.39	0.39	0.23	2.94	0.54
100 Year	2273.28 cfs	57.47 cfs	4778.87	2.43	8.347	4-FFf	2.00	1.37	2.00	7.43	4.57	4.39

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4770.52 ft,
Outlet Elevation (invert): 4770.40 ft
Culvert Length: 30.46 ft,
Culvert Slope: 0.0039

Water Surface Profile Plot for Culvert: Structure#201



Tailwater Data for Crossing: Structure#201, Reach 200

Table 36 - Downstream Channel Rating Curve (Crossing: Structure#201, Reach 200)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
5.00	4770.63	0.23	0.54	0.03	0.20
2273.28	4777.83	7.43	4.39	0.93	0.34

Tailwater Channel Data - Structure#201, Reach 200

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 40.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0020
Channel Manning's n: 0.0450
Channel Invert Elevation: 4770.40 ft

Roadway Data for Crossing: Structure#201, Reach 200

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4775.04 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

Culvert Data: Structure#202

Site Data - Structure#202

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4952.72 ft
Outlet Station: 100.00 ft
Outlet Elevation: 4947.32 ft
Number of Barrels: 1

Culvert Data Summary - Structure#202

Barrel Shape: Circular
Barrel Diameter: 1.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting (Ke=0.9)
Inlet Depression: None

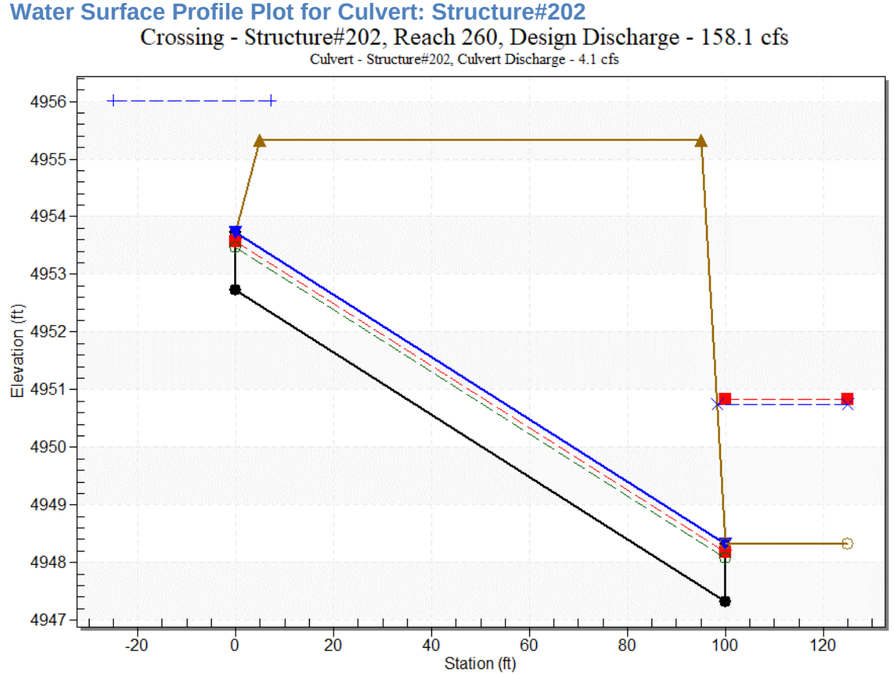
Table 3 - Culvert Summary Table: Structure#202

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5	40.39 cfs	4.35 cfs	4955.59	2.26	2.871	4-FFf	0.79	0.88	1.00	1.31	5.54	5.11
100	158.12 cfs	4.09 cfs	4956.01	2.06	3.286	4-FFf	0.75	0.86	1.00	2.41	5.21	7.64

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4952.72 ft,
Outlet Elevation (invert): 4947.32 ft
Culvert Length: 100.15 ft,
Culvert Slope: 0.0540

Water Surface Profile Plot for Culvert: Structure#202



Tailwater Data for Crossing: Structure#202, Reach 260

Table 4 - Downstream Channel Rating Curve (Crossing: Structure#202, Reach 260)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
40.39	4949.63	1.31	5.11	2.68	0.99
158.12	4950.74	2.41	7.64	4.96	1.08

Tailwater Channel Data - Structure#202, Reach 260

Tailwater Channel Option: Irregular Channel
Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	4962.30	0.0450
2	3.23	4962.09	0.0450
3	6.47	4961.86	0.0450
4	9.70	4961.61	0.0450
5	12.93	4961.41	0.0450
6	16.17	4961.22	0.0450
7	19.40	4960.97	0.0450
8	22.64	4960.70	0.0450

9	25.87	4960.41	0.0450
10	29.10	4960.10	0.0450
11	32.34	4959.84	0.0450
12	35.57	4959.59	0.0450
13	38.80	4959.34	0.0450
14	42.04	4959.06	0.0450
15	45.27	4958.74	0.0450
16	48.50	4958.41	0.0450
17	51.74	4958.07	0.0450
18	54.97	4957.68	0.0450
19	58.20	4957.27	0.0450
20	61.44	4956.89	0.0450
21	64.67	4956.54	0.0450
22	67.91	4956.23	0.0450
23	71.14	4955.85	0.0450
24	74.37	4955.38	0.0450
25	77.61	4954.97	0.0450
26	80.84	4954.70	0.0450
27	84.07	4954.43	0.0450
28	87.31	4954.23	0.0450
29	90.54	4954.07	0.0450
30	93.77	4953.94	0.0450
31	97.01	4953.82	0.0450
32	100.24	4953.72	0.0450
33	103.47	4953.55	0.0450
34	106.71	4953.08	0.0450
35	109.94	4952.92	0.0450
36	113.17	4953.12	0.0450
37	116.41	4951.97	0.0450
38	119.64	4950.01	0.0450
39	122.88	4948.73	0.0450
40	126.11	4948.32	0.0450
41	129.34	4949.03	0.0450
42	132.58	4951.36	0.0450
43	135.81	4953.47	0.0450
44	139.04	4955.07	0.0450
45	142.28	4956.11	0.0450
46	145.51	4956.75	0.0450
47	148.75	4956.69	0.0450
48	151.98	4955.86	0.0450
49	155.21	4954.91	0.0450
50	158.45	4954.71	0.0450
51	161.68	4954.76	0.0450
52	164.91	4954.65	0.0450
53	168.15	4954.77	0.0450
54	171.38	4955.49	0.0450
55	174.61	4956.04	0.0450
56	177.85	4956.47	0.0450
57	181.08	4957.05	0.0450
58	184.31	4957.49	0.0450
59	187.55	4957.86	0.0450
60	190.78	4958.15	0.0450
61	194.01	4958.40	0.0450
62	197.25	4958.70	0.0450
63	200.48	4958.98	0.0450
64	203.72	4959.11	0.0450
65	206.95	4959.15	0.0450
66	210.18	4959.21	0.0450
67	213.42	4959.31	0.0450
68	216.65	4959.39	0.0450
69	219.88	4959.50	0.0450
70	223.12	4959.56	0.0000

Roadway Data for Crossing: Structure#202, Reach 260

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4955.33 ft
Roadway Surface: Gravel
Roadway Top Width: 90.00 ft

Culvert Data: Structure#203

Site Data - Structure#203

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4979.58 ft
Outlet Station: 327.00 ft
Outlet Elevation: 4970.79 ft
Number of Barrels: 1

Culvert Data Summary - Structure#203

Barrel Shape: Circular
Barrel Diameter: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

Table 1 - Culvert Summary Table: Structure#203

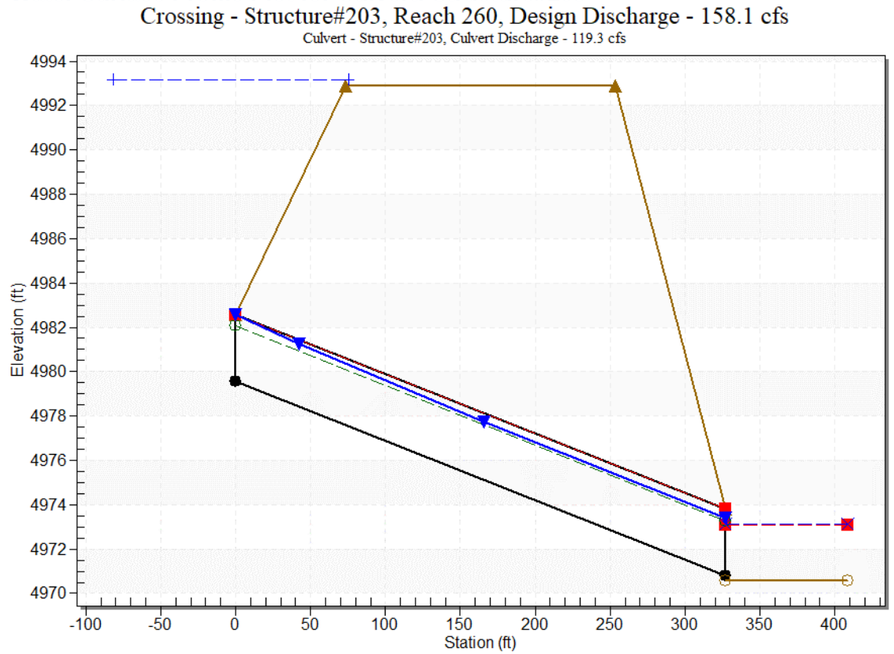
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5-year	40.39 cfs	40.39 cfs	4982.87	3.29	0.0*	5-S2n	1.21	2.07	1.21	1.52	15.19	4.35
100-year	158.12 cfs	119.28 cfs	4993.15	13.57	9.706	5-S2n	2.47	3.00	2.59	2.54	18.38	6.12

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4979.58 ft,
Outlet Elevation (invert): 4970.79 ft
Culvert Length: 327.12 ft,
Culvert Slope: 0.0269

Water Surface Profile Plot for Culvert: Structure#203



Tailwater Data for Crossing: Structure#203, Reach 260

Table 2 - Downstream Channel Rating Curve (Crossing: Structure#203, Reach 260)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
40.39	4972.10	1.52	4.35	2.47	0.88
158.12	4973.12	2.54	6.12	4.12	0.96

Tailwater Channel Data - Structure#203, Reach 260

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0260
Channel Manning's n: 0.0450
Channel Invert Elevation: 4970.58 ft

Roadway Data for Crossing: Structure#203, Reach 260

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4992.89 ft
Roadway Surface: Paved
Roadway Top Width: 180.00 ft

Culvert Data: Structure#301

Site Data - Structure#301

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4786.49 ft
Outlet Station: 35.60 ft
Outlet Elevation: 4786.34 ft
Number of Barrels: 1

Culvert Data Summary - Structure#301

Barrel Shape: Circular
Barrel Diameter: 3.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting (Ke=0.9)
Inlet Depression: None

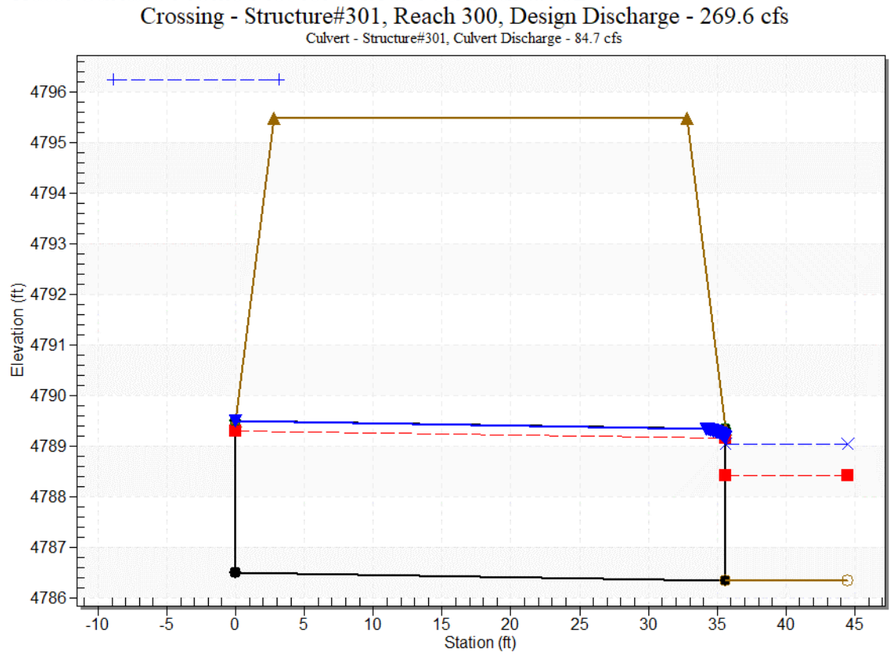
Table 33 - Culvert Summary Table: Structure#301

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	23.55 cfs	23.55 cfs	4789.14	2.47	2.652	2-M2c	2.47	1.56	1.56	0.78	6.32	2.25
100 Year	269.56 cfs	84.65 cfs	4796.23	9.74	8.955	7-M2c	3.00	2.81	2.81	2.71	12.30	4.49

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4786.49 ft,
Outlet Elevation (invert): 4786.34 ft
Culvert Length: 35.60 ft,
Culvert Slope: 0.0042

Water Surface Profile Plot for Culvert: Structure#301



Tailwater Data for Crossing: Structure#301, Reach 300

Table 34 - Downstream Channel Rating Curve (Crossing: Structure#301, Reach 300)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
23.55	4787.12	0.78	2.25	0.44	0.51
269.56	4789.05	2.71	4.49	1.52	0.60

Tailwater Channel Data - Structure#301, Reach 300

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 4.50 (_:1)
Channel Slope: 0.0090
Channel Manning's n: 0.0450
Channel Invert Elevation: 4786.34 ft

Roadway Data for Crossing: Structure#301, Reach 300

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4795.47 ft
Roadway Surface: Gravel
Roadway Top Width: 30.00 ft

Culvert Data: Structure#501

Site Data - Structure#501

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4824.39 ft
Outlet Station: 88.00 ft
Outlet Elevation: 4816.39 ft
Number of Barrels: 1

Culvert Data Summary - Structure#501

Barrel Shape: Concrete Box
Barrel Span: 3.33 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 23 - Culvert Summary Table: Structure#501

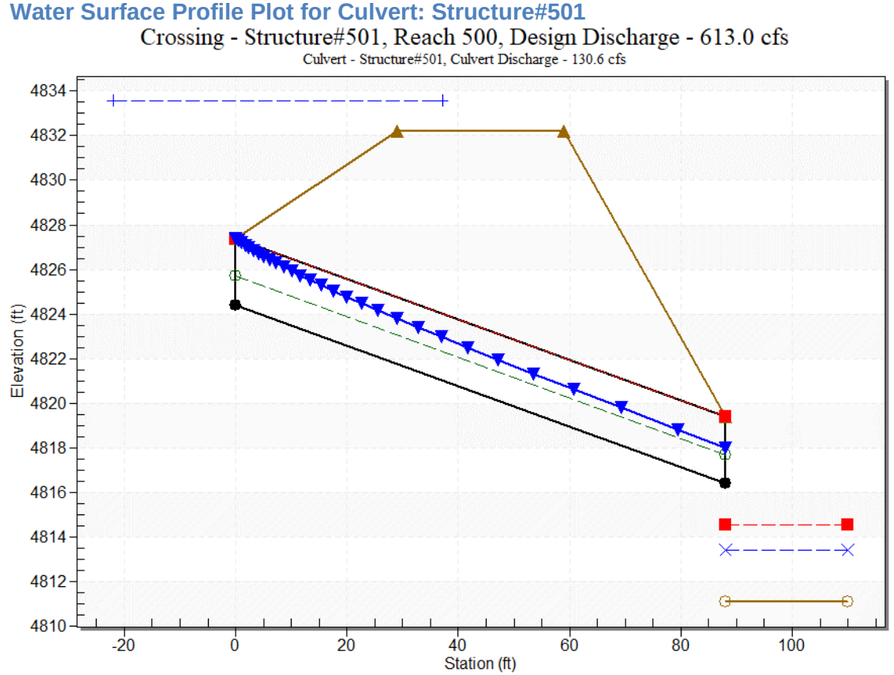
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	19.99 cfs	19.99 cfs	4826.03	1.64	0.0*	1-S2n	0.36	1.04	0.36	0.64	16.68	7.02
100 Year	613.00 cfs	130.57 cfs	4833.55	9.16	0.321	5-S2n	1.29	3.00	1.61	2.30	24.28	16.51

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4824.39 ft,
Outlet Elevation (invert): 4816.39 ft
Culvert Length: 88.36 ft,
Culvert Slope: 0.0909

Water Surface Profile Plot for Culvert: Structure#501



Tailwater Data for Crossing: Structure#501, Reach 500

Table 24 - Downstream Channel Rating Curve (Crossing: Structure#501, Reach 500)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
19.99	4811.74	0.64	7.02	8.36	2.19
613.00	4813.40	2.30	16.51	30.18	2.71

Tailwater Channel Data - Structure#501, Reach 500

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 7.00 (_:1)
Channel Slope: 0.2100
Channel Manning's n: 0.0450
Channel Invert Elevation: 4811.10 ft

Roadway Data for Crossing: Structure#501, Reach 500

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4832.19 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Culvert Data: Structure#601

Site Data - Structure#601

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4827.99 ft
Outlet Station: 120.50 ft
Outlet Elevation: 4825.15 ft
Number of Barrels: 1

Culvert Data Summary - Structure#601

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

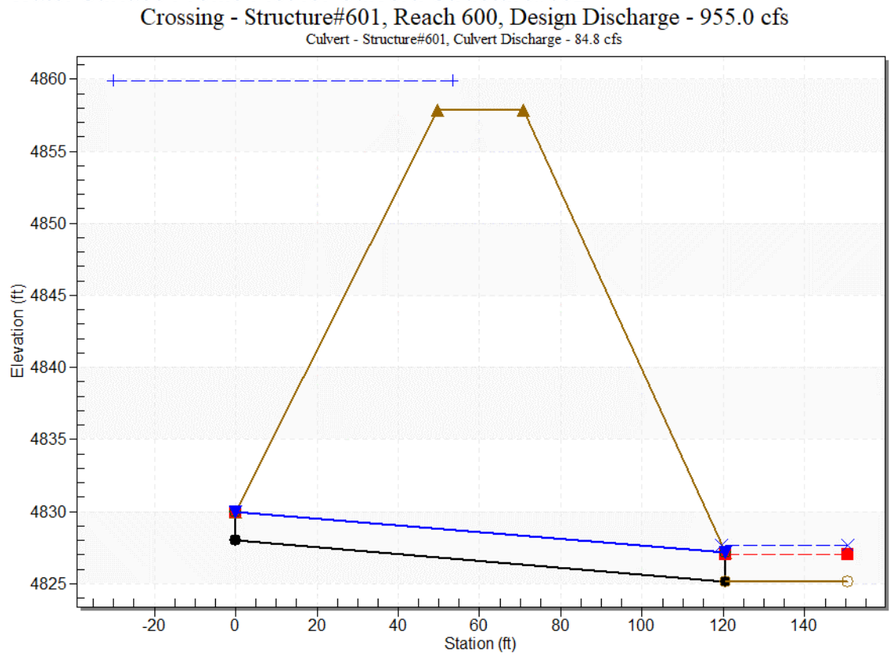
Table 31 - Culvert Summary Table: Structure#601

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	17.62 cfs	17.62 cfs	4830.56	2.57	0.268	5-S2n	0.96	1.51	0.99	0.31	11.31	1.20
100 Year	955.00 cfs	84.77 cfs	4859.86	31.87	30.998	4-FFf	2.00	2.00	2.00	2.54	26.98	3.92

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4827.99 ft,
Outlet Elevation (invert): 4825.15 ft
Culvert Length: 120.53 ft,
Culvert Slope: 0.0236

Water Surface Profile Plot for Culvert: Structure#601



Tailwater Data for Crossing: Structure#601, Reach 600

Table 32 - Downstream Channel Rating Curve (Crossing: Structure#601, Reach 600)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
17.62	4825.46	0.31	1.20	0.15	0.41
955.00	4827.69	2.54	3.92	1.19	0.55

Tailwater Channel Data - Structure#601, Reach 600

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 40.00 ft
Side Slope (H:V): 21.90 (_:1)
Channel Slope: 0.0075
Channel Manning's n: 0.0450
Channel Invert Elevation: 4825.15 ft

Roadway Data for Crossing: Structure#601, Reach 600

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4857.82 ft
Roadway Surface: Gravel
Roadway Top Width: 21.00 ft

Culvert Data: Structure#602

Site Data - Structure#602

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4832.02 ft
Outlet Station: 41.00 ft
Outlet Elevation: 4832.33 ft
Number of Barrels: 1

Culvert Data Summary - Structure#602

Barrel Shape: Pipe Arch
Barrel Span: 42.00 in
Barrel Rise: 29.00 in
Barrel Material: Steel or Aluminum
Embedment: 0.00 in
Barrel Manning's n: 0.0250
Culvert Type: Straight
Inlet Configuration: Projecting (Ke=0.9)
Inlet Depression: None

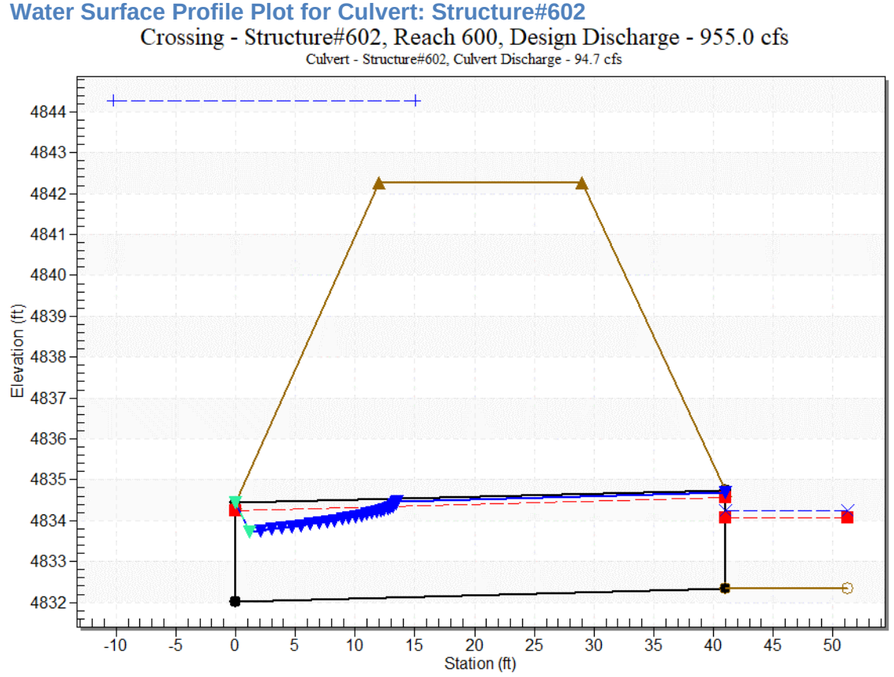
Table 27 - Culvert Summary Table: Structure#602

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	17.62 cfs	17.62 cfs	4834.17	1.76	2.155	7-A2c	-1.00	1.05	1.05	0.21	5.46	1.52
100 Year	955.00 cfs	94.69 cfs	4844.26	12.24	0.000	7-A2t	-1.00	2.22	2.22	1.91	14.45	5.54

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4832.02 ft,
Outlet Elevation (invert): 4832.33 ft
Culvert Length: 41.00 ft,
Culvert Slope: -0.0076

Water Surface Profile Plot for Culvert: Structure#602



Tailwater Data for Crossing: Structure#602, Reach 600

Table 28 - Downstream Channel Rating Curve (Crossing: Structure#602, Reach 600)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
17.62	4832.54	0.21	1.52	0.25	0.61
955.00	4834.24	1.91	5.54	2.27	0.84

Tailwater Channel Data - Structure#602, Reach 600

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 52.00 ft
Side Slope (H:V): 20.00 (_:1)
Channel Slope: 0.0190
Channel Manning's n: 0.0450
Channel Invert Elevation: 4832.33 ft

Roadway Data for Crossing: Structure#602, Reach 600

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4842.26 ft
Roadway Surface: Paved
Roadway Top Width: 17.00 ft

Culvert Data: Structure#603

Site Data - Structure#603

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4918.96 ft
Outlet Station: 234.00 ft
Outlet Elevation: 4917.04 ft
Number of Barrels: 1

Culvert Data Summary - Structure#603

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

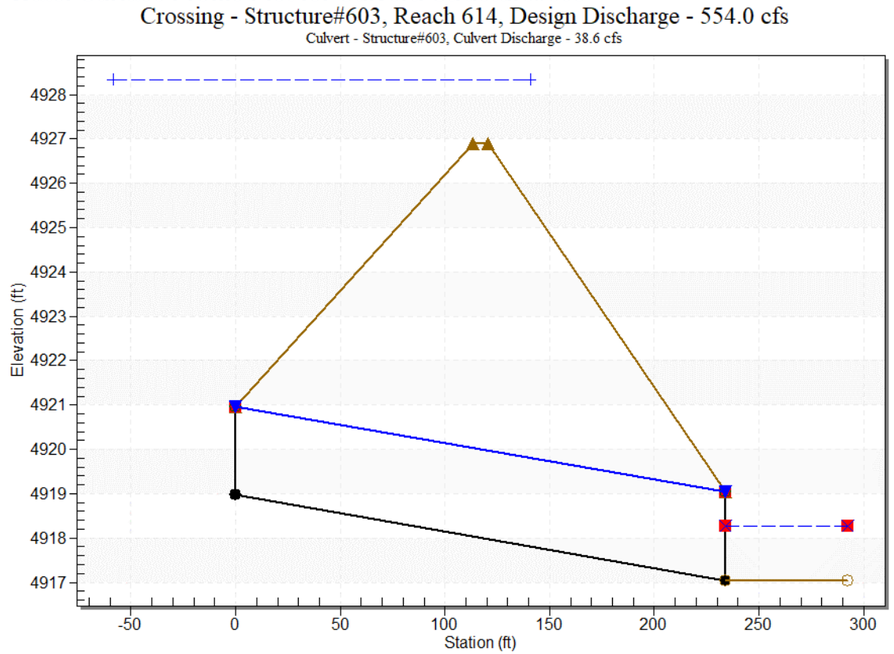
Table 25 - Culvert Summary Table: Structure#603

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	78.44 cfs	36.16 cfs	4927.19	6.64	8.226	7-M2c	2.00	1.78	1.78	0.38	12.22	2.88
100 Year	554.00 cfs	38.60 cfs	4928.33	7.42	9.364	6-FFc	2.00	2.00	2.00	1.24	12.29	6.18

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4918.96 ft,
Outlet Elevation (invert): 4917.04 ft
Culvert Length: 234.01 ft,
Culvert Slope: 0.0082

Water Surface Profile Plot for Culvert: Structure#603



Tailwater Data for Crossing: Structure#603, Reach 614

Table 26 - Downstream Channel Rating Curve (Crossing: Structure#603, Reach 614)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
78.44	4917.42	0.38	2.88	0.67	0.82
554.00	4918.28	1.24	6.18	2.15	0.99

Tailwater Channel Data - Structure#603, Reach 614

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 70.00 ft
Side Slope (H:V): 2.00 (_:1)
Channel Slope: 0.0278
Channel Manning's n: 0.0450
Channel Invert Elevation: 4917.04 ft

Roadway Data for Crossing: Structure#603, Reach 614

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4926.90 ft
Roadway Surface: Gravel
Roadway Top Width: 7.00 ft

Culvert Data: Structure#801

Site Data - Structure#801

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4960.15 ft
Outlet Station: 71.00 ft
Outlet Elevation: 4960.01 ft
Number of Barrels: 1

Culvert Data Summary - Structure#801

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting (Ke=0.9)
Inlet Depression: None

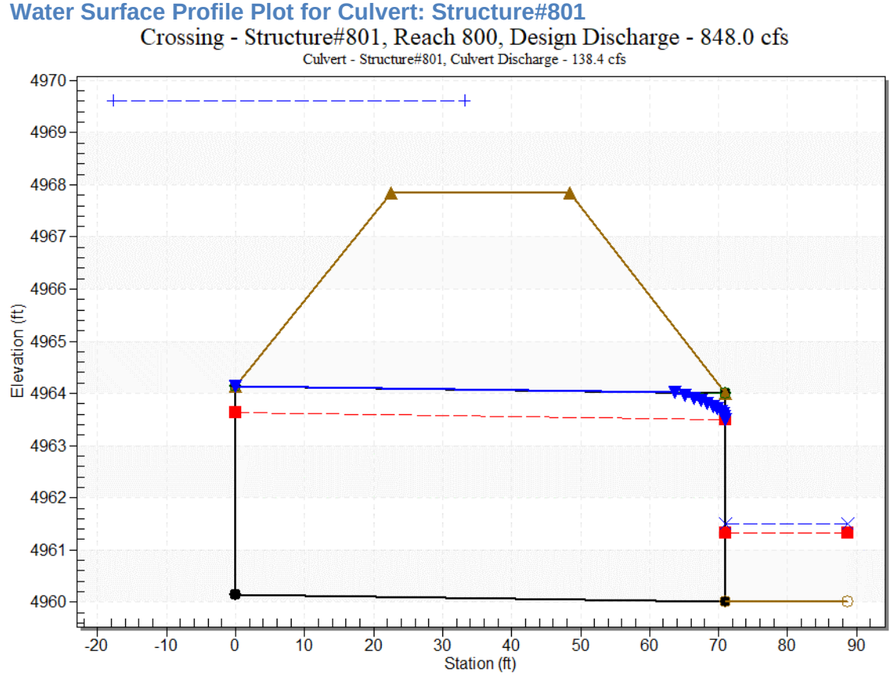
Table 29 - Culvert Summary Table: Structure#801

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	62.87 cfs	62.87 cfs	4964.41	3.95	4.262	7-M2c	4.00	2.39	2.39	0.31	8.02	2.04
100 Year	848.00 cfs	138.37 cfs	4969.60	9.05	9.459	7-M2c	4.00	3.50	3.50	1.48	11.88	5.72

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4960.15 ft,
Outlet Elevation (invert): 4960.01 ft
Culvert Length: 71.00 ft,
Culvert Slope: 0.0019

Water Surface Profile Plot for Culvert: Structure#801



Tailwater Data for Crossing: Structure#801, Reach 800

Table 30 - Downstream Channel Rating Curve (Crossing: Structure#801, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
62.87	4960.32	0.31	2.04	0.36	0.65
848.00	4961.49	1.48	5.72	1.71	0.83

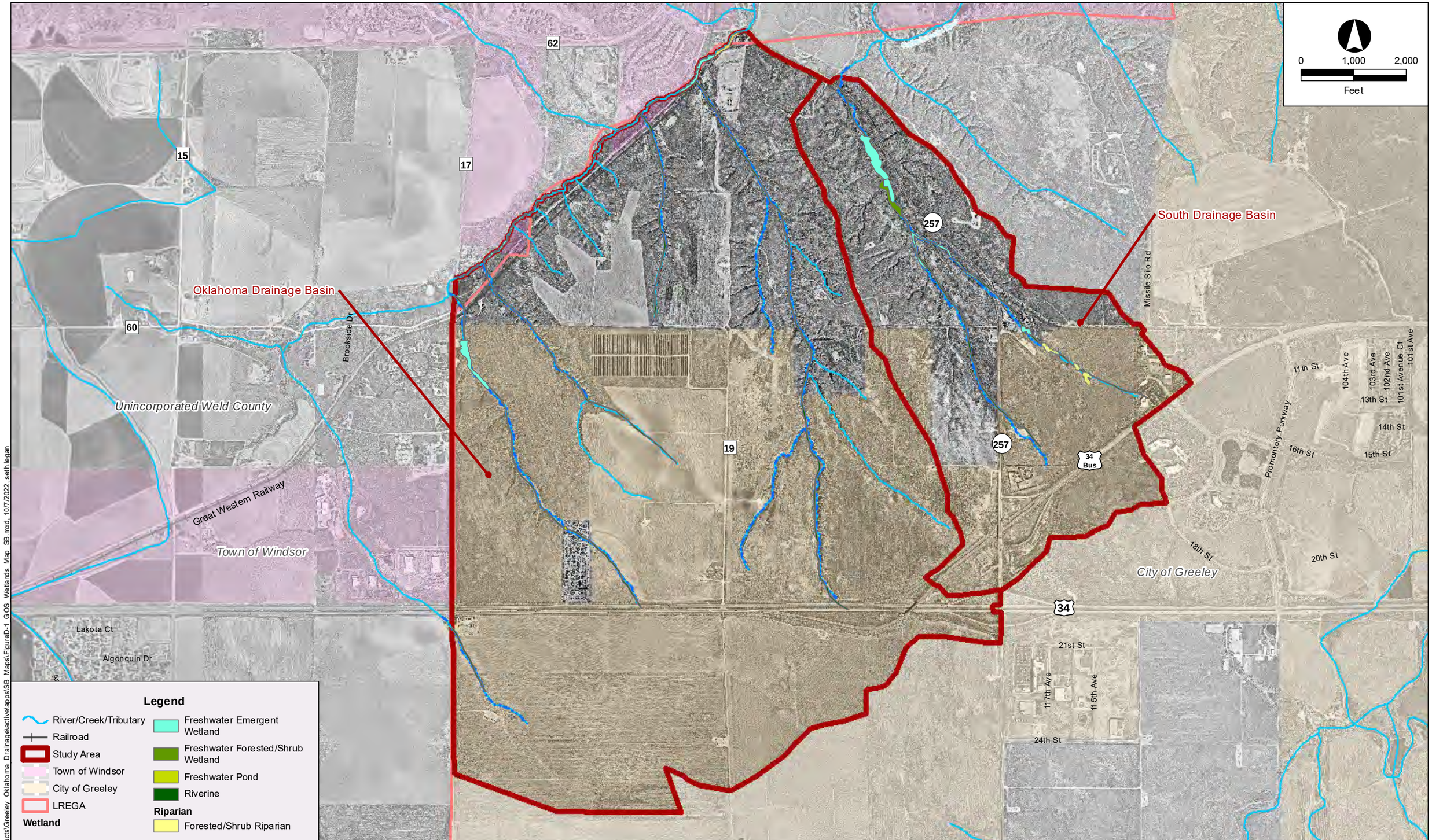
Tailwater Channel Data - Structure#801, Reach 800

Tailwater Channel Option: Rectangular Channel
Bottom Width: 100.00 ft
Channel Slope: 0.0185
Channel Manning's n: 0.0450
Channel Invert Elevation: 4960.01 ft

Roadway Data for Crossing: Structure#801, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4967.84 ft
Roadway Surface: Paved
Roadway Top Width: 26.00 ft

Appendix D – Wetland and Riparian Inventory



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No.	DATE	DESCRIPTION	APPR.

Matrix
Excellence by Design

designed by:
drawn by: SB
checked by: BL
project no.: 22.906.007
date: 10/07/2022

Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA & SOUTH BASINS

POTENTIAL WETLANDS AND
RIPARIAN ZONES MAP

FIGURE
D-1

Town of Windsor

Town of Windsor

Unincorporated Weld County

City of Greeley

Missile Site Rd

South Drainage Basin

Oklahoma Drainage Basin

Brookside Dr

Great Western Railway

Town of Windsor

Lakota Ct

Unincorporated Weld County

City of Greeley

11th St

104th Ave

103rd Ave

102nd Ave

101st Avenue Ct

101st Ave

13th St

14th St

Promontory Parkway

16th St

15th St

18th St

20th St

21st St

117th Ave

115th Ave

24th St

62

15

17

60

19

257

257

34 Bus

34

0 1,000 2,000

Feet

Legend

COGCC Well

- Abandoned Location
- Plugged and Abandoned
- Producing
- Shut In

- Study Reach
- River/Creek/Tributary
- Railroad
- Study Area
- City of Greeley
- Town of Windsor
- LREGA

Abandoned Location: Permit Vacated; Per Operator: Well has not been spud

Shut-In Well: Completed well is not producing but is mechanically capable of production

No.	DATE	DESCRIPTION	APPR.

Matrix Excellence by Design

designed by:
drawn by: SB
checked by: BL
project no.: 22.906.007
date: 10/07/2022

Greeley

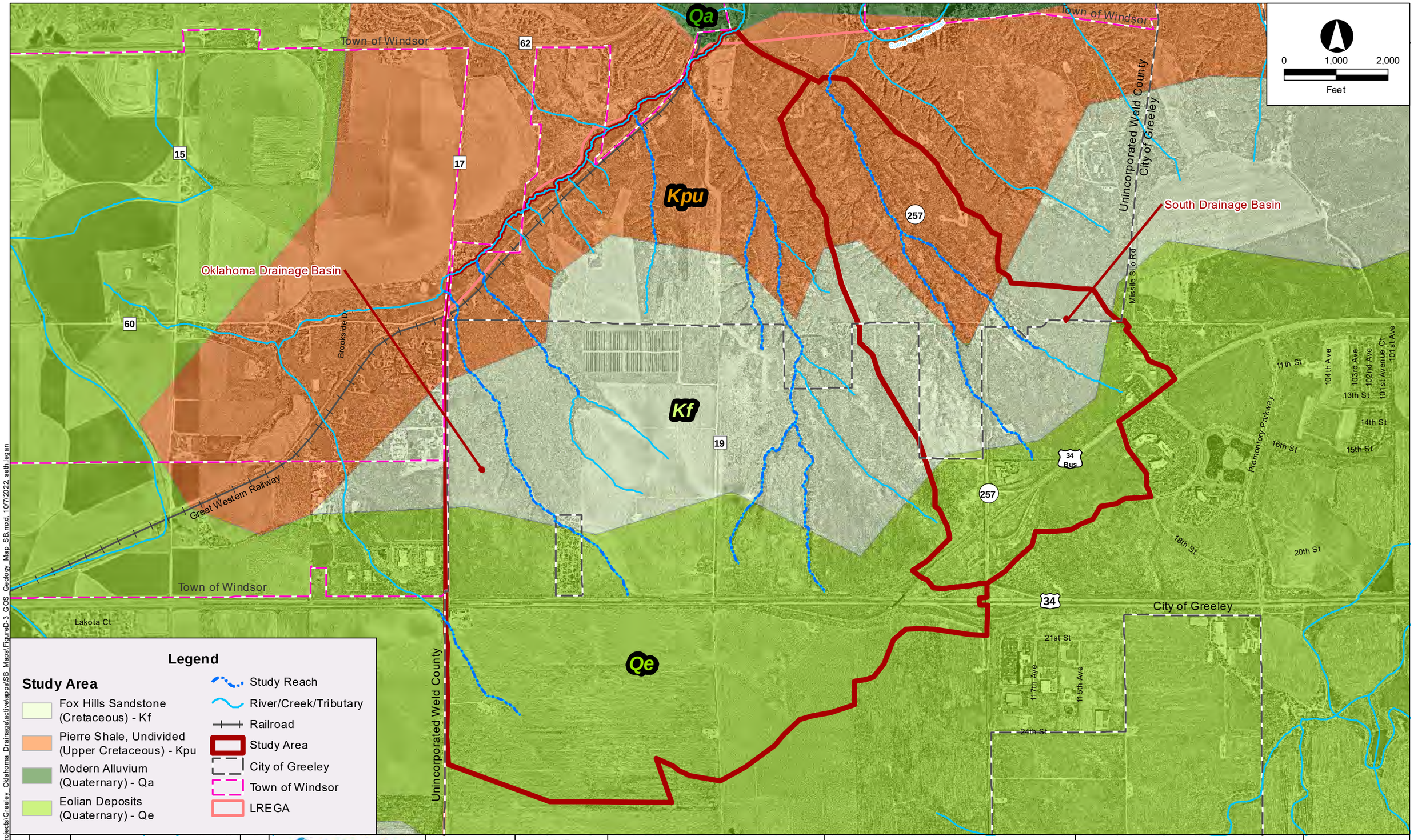
CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA & SOUTH BASINS

WELLS

FIGURE
D-2

FILE: G:\gis projects\Greeley_Oklahoma_Drainage\active\apps\SB_Maps\FigureD-2_GOS_Oil_Gas_Map_SB.mxd, 10/7/2022, seth.legan



Legend

Study Area

- Fox Hills Sandstone (Cretaceous) - Kf
- Pierre Shale, Undivided (Upper Cretaceous) - Kpu
- Modern Alluvium (Quaternary) - Qa
- Eolian Deposits (Quaternary) - Qe

- Study Reach
- River/Creek/Tributary
- Railroad
- Study Area
- City of Greeley
- Town of Windsor
- LREGA

No.	DATE	DESCRIPTION	APPR.

Matrix
Excellence by Design

designed by:
drawn by: SB
checked by: BL
project no.: 22.906.007
date: 10/07/2022

Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA & SOUTH BASINS

GEOLOGIC MAP

FIGURE
D-3

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Appendix E – Alternatives Analysis

Click here for Figure E-1: Major Drainageway 100

Click here for Figure E-2: Major Drainageways 200, 300

Click here for Figure E-3: Major Drainageways 500, 600, 800

Appendix E-2
MHFD Detention Workbooks

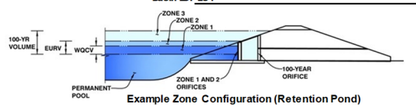
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greely - Oklaoma Basin

Basin ID: 134



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	136.70	acres
Watershed Length =	3,476	ft
Watershed Length to Centroid =	1,780	ft
Watershed Slope =	0.021	ft/ft
Watershed Imperviousness =	63.30%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	2.822	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	8.342	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	5.693	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	8.300	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	11.371	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	17.233	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	22.403	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	28.637	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	45.569	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	5.296	acre-feet		
Approximate 5-yr Detention Volume =	7.918	acre-feet		
Approximate 10-yr Detention Volume =	9.695	acre-feet		
Approximate 25-yr Detention Volume =	12.103	acre-feet		
Approximate 50-yr Detention Volume =	13.629	acre-feet		
Approximate 100-yr Detention Volume =	16.193	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	2.822	acre-feet
Zone 2 Volume (EURV - Zone 1)	5.520	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	7.851	acre-feet
Total Detention Basin Volume =	16.193	acre-feet
Initial Surcharge Volume (ISV) =	369	ft^3
Initial Surcharge Depth (ISD) =	0.33	ft
Total Available Detention Depth (H_{total}) =	6.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	1,118	ft^2
Surcharge Volume Length (L_{ISV}) =	33.4	ft
Surcharge Volume Width (W_{ISV}) =	33.4	ft
Depth of Basin Floor (H_{FLOOR}) =	2.95	ft
Length of Basin Floor (L_{FLOOR}) =	635.2	ft
Width of Basin Floor (W_{FLOOR}) =	328.4	ft
Area of Basin Floor (A_{FLOOR}) =	208,628	ft^2
Volume of Basin Floor (V_{FLOOR}) =	221,265	ft^3
Depth of Main Basin (H_{MAIN}) =	2.22	ft
Length of Main Basin (L_{MAIN}) =	653.0	ft
Width of Main Basin (W_{MAIN}) =	346.2	ft
Area of Main Basin (A_{MAIN}) =	226,058	ft^2
Volume of Main Basin (V_{MAIN}) =	482,372	ft^3
Calculated Total Basin Volume (V_{total}) =	**16.175**	acre-feet

Depth Increment = 0.50 ft

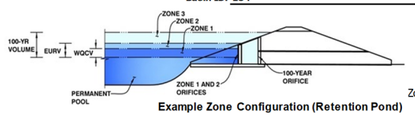
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		33.4	33.4	1,118		0.026		
ISV	0.33		33.4	33.4	1,118		0.026	369	0.008
	0.50		33.4	33.4	1,118		0.026	559	0.013
	1.00		68.1	50.4	3,435		0.079	1,298	0.030
	1.50		170.1	100.4	17,084		0.392	6,002	0.138
	2.00		272.1	150.4	40,933		0.940	20,082	0.461
	2.50		374.1	200.4	74,983		1.721	48,636	1.117
	3.00		476.1	250.4	119,232		2.737	96,764	2.221
Zone 1 (WQCV)	3.21		518.9	271.4	140,858		3.234	124,042	2.848
	3.50		578.1	300.4	173,681		3.987	169,568	3.893
Floor	3.78		635.2	328.4	208,628		4.789	223,016	5.120
	4.00		637.0	330.2	210,327		4.828	269,101	6.178
Zone 2 (EURV)	4.45		640.6	333.8	213,822		4.909	364,534	8.369
	4.50		641.0	334.2	214,212		4.918	375,235	8.614
	5.00		645.0	338.2	218,129		5.008	483,318	11.095
	5.50		649.0	342.2	222,077		5.098	593,369	13.622
Zone 3 (100-year)	6.00		653.0	346.2	226,058		5.190	705,401	16.194
	6.50		657.0	350.2	230,071		5.282	819,432	18.812
	7.00		661.0	354.2	234,116		5.375	935,477	21.476
	7.50		665.0	358.2	238,192		5.468	1,053,553	24.186
	8.00		669.0	362.2	242,301		5.562	1,173,675	26.944
	8.50		673.0	366.2	246,442		5.658	1,295,859	29.749
	9.00		677.0	370.2	250,614		5.753	1,420,122	32.602
	9.50		681.0	374.2	254,819		5.850	1,546,479	35.502
	10.00		685.0	378.2	259,056		5.947	1,674,946	38.451
	10.50		689.0	382.2	263,325		6.045	1,805,540	41.449
	11.00		693.0	386.2	267,625		6.144	1,938,276	44.497
	11.50		697.0	390.2	271,958		6.243	2,073,171	47.593
	12.00		701.0	394.2	276,323		6.343	2,210,240	50.740
	12.50		705.0	398.2	280,719		6.444	2,349,499	53.937
	13.00		709.0	402.2	285,148		6.546	2,490,964	57.185
	13.50		713.0	406.2	289,609		6.649	2,634,652	60.483
	14.00		717.0	410.2	294,102		6.752	2,780,578	63.833
	14.50		721.0	414.2	298,626		6.856	2,928,759	67.235
	15.00		725.0	418.2	303,183		6.960	3,079,210	70.689
	15.50		729.0	422.2	307,772		7.065	3,231,947	74.195
	16.00		733.0	426.2	312,392		7.172	3,386,987	77.755
	16.50		737.0	430.2	317,045		7.278	3,544,345	81.367
	17.00		741.0	434.2	321,730		7.386	3,704,037	85.033
	17.50		745.0	438.2	326,447		7.494	3,866,080	88.753
	18.00		749.0	442.2	331,195		7.603	4,030,489	92.527
	18.50		753.0	446.2	335,976		7.713	4,197,281	96.356
	19.00		757.0	450.2	340,789		7.823	4,366,471	100.240
	19.50		761.0	454.2	345,633		7.935	4,538,075	104.180
	20.00		765.0	458.2	350,510		8.047	4,712,109	108.175
	20.50		769.0	462.2	355,419		8.159	4,888,590	112.227
	21.00		773.0	466.2	360,360		8.273	5,067,534	116.335
	21.50		777.0	470.2	365,332		8.387	5,248,955	120.499
	22.00		781.0	474.2	370,337		8.502	5,432,871	124.722
	22.50		785.0	478.2	375,374		8.617	5,619,298	129.001
	23.00		789.0	482.2	380,442		8.734	5,808,250	133.339
	23.50		793.0	486.2	385,543		8.851	5,999,745	137.735
	24.00		797.0	490.2	390,676		8.969	6,193,799	142.190
	24.50		801.0	494.2	395,841		9.087	6,390,427	146.704
	25.00		805.0	498.2	401,037		9.207	6,589,645	151.277
	25.50		809.0	502.2	406,266		9.327	6,791,469	155.911
	26.00		813.0	506.2	411,527		9.447	6,995,916	160.604
	26.50		817.0	510.2	416,819		9.569	7,203,001	165.358
	27.00		821.0	514.2	422,144		9.691	7,412,741	170.173
	27.50		825.0	518.2	427,501		9.814	7,625,151	175.049
	28.00		829.0	522.2	432,890		9.938	7,840,247	179.987
	28.50		833.0	526.2	438,310		10.062	8,058,046	184.987
	29.00		837.0	530.2	443,763		10.187	8,278,563	190.050
	29.50		841.0	534.2	449,248		10.313	8,501,814	195.175
	30.00		845.0	538.2	454,764		10.440	8,727,816	200.363

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greely - Oklaoma Basin

Basin ID: 134



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.21	2.822	Orifice Plate
Zone 2 (EURV)	4.45	5.520	Rectangular Orifice
Zone 3 (100-year)	6.00	7.851	Weir&Pipe (Restrict)
Total (all zones)		16.193	

Clear Input Parameters (Including Tables)

Orifice Plate | Vertical Orifice (Rectangular) | Weir and Pipe (w/ Restrictor Plate)

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

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

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)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	7.014E-02	ft^2
Depth at top of Zone using Orifice Plate =	4.45	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	17.80	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	10.10	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.48	2.97					
Orifice Area (sq. inches)	10.10	10.10	10.10					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangula	Not Selected		Calculated Parameters for Vertical Orifice	Zone 2 Rectangula	Not Selected	
Invert of Vertical Orifice =	3.21	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.17	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	4.45	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.08	N/A	feet
Vertical Orifice Height =	2.00	N/A	inches				
Vertical Orifice Width =	11.89		inches				

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.45	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	7.78	N/A	feet
Overflow Weir Front Edge Length =	250.00	N/A	feet	Overflow Weir Slope Length =	10.54	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	72.85	N/A	
Horiz. Length of Weir Sides =	10.00	N/A	feet	Overflow Grate Open Area w/o Debris =	1834.12	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	917.06	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	25.18	N/A	ft^2
Outlet Pipe Diameter =	72.00	N/A	inches	Outlet Orifice Centroid =	2.70	N/A	feet
Restrictor Plate Height Above Pipe Invert =	60.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.30	N/A	radians

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	6.05	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	1.98	feet
Spillway Crest Length =	50.00	feet	Stage at Top of Freeboard =	9.03	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	5.76	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	32.77	acre-ft

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

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	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	2.822	8.342	5.693	8.300	11.371	17.233	22.403	28.637	45.569
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	5.693	8.300	11.371	17.233	22.403	28.637	45.569
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.4	14.4	40.2	106.4	154.2	216.7	371.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.10	0.29	0.78	1.13	1.59	2.72
Peak Inflow Q (cfs) =	N/A	N/A	89.7	131.3	181.2	286.8	372.8	473.9	743.7
Peak Outflow Q (cfs) =	1.2	2.6	2.1	2.5	21.4	82.5	140.8	224.8	397.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.5	0.8	0.9	1.0	1.1
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.0	0.1	0.1	0.1
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) =	38	68	57	68	71	68	66	63	56
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	60	73	76	75	74	73	70
Maximum Ponding Depth (ft) =	3.21	4.45	3.83	4.35	4.73	5.20	5.53	5.92	6.96
Area at Maximum Ponding Depth (acres) =	3.23	4.91	4.80	4.89	4.96	5.04	5.10	5.17	5.37
Maximum Volume Stored (acre-ft) =	2.848	8.369	5.359	7.879	9.750	12.050	13.724	15.779	21.261

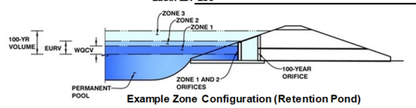
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greely - OK Basin

Basin ID: 150



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	148.90	acres
Watershed Length =	3,715	ft
Watershed Length to Centroid =	2,085	ft
Watershed Slope =	0.032	ft/ft
Watershed Imperviousness =	40.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	2.232	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	5.535	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	3.732	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	5.984	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	9.050	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	15.486	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	20.997	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	27.899	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	46.299	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	3.428	acre-feet		
Approximate 5-yr Detention Volume =	5.632	acre-feet		
Approximate 10-yr Detention Volume =	6.905	acre-feet		
Approximate 25-yr Detention Volume =	8.869	acre-feet		
Approximate 50-yr Detention Volume =	10.094	acre-feet		
Approximate 100-yr Detention Volume =	12.852	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	2.232	acre-feet
Zone 2 Volume (EURV - Zone 1)	3.304	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	7.317	acre-feet
Total Detention Basin Volume =	12.852	acre-feet
Initial Surcharge Volume (ISV) =	292	ft^3
Initial Surcharge Depth (ISD) =	0.33	ft
Total Available Detention Depth (H_{total}) =	6.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	

Initial Surcharge Area (A_{ISV}) =	884	ft^2
Surcharge Volume Length (L_{ISV}) =	29.7	ft
Surcharge Volume Width (W_{ISV}) =	29.7	ft
Depth of Basin Floor (H_{FLOOR}) =	2.49	ft
Length of Basin Floor (L_{FLOOR}) =	537.7	ft
Width of Basin Floor (W_{FLOOR}) =	278.7	ft
Area of Basin Floor (A_{FLOOR}) =	149,868	ft^2
Volume of Basin Floor (V_{FLOOR}) =	134,675	ft^3
Depth of Main Basin (H_{MAIN}) =	2.68	ft
Length of Main Basin (L_{MAIN}) =	559.1	ft
Width of Main Basin (W_{MAIN}) =	300.2	ft
Area of Main Basin (A_{MAIN}) =	167,831	ft^2
Volume of Main Basin (V_{MAIN}) =	425,490	ft^3
Calculated Total Basin Volume (V_{total}) =	**12.876**	acre-feet

Depth Increment = 0.50 ft

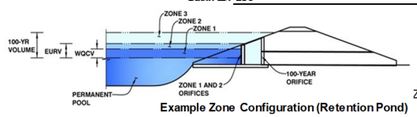
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		29.7	29.7	884		0.020		
ISV	0.33		29.7	29.7	884		0.020	292	0.007
	0.50		29.7	29.7	884		0.020	442	0.010
	1.00		64.4	46.7	3,010		0.069	1,048	0.024
	1.50		166.4	96.7	16,096		0.370	5,399	0.124
	2.00		268.4	146.7	39,382		0.904	18,844	0.433
	2.50		370.4	196.7	72,869		1.673	46,481	1.067
	3.00		472.4	246.7	116,555		2.676	93,413	2.144
Zone 1 (WQCV)	3.04		480.6	250.7	120,491		2.766	98,153	2.253
Floor	3.32		537.7	278.7	149,868		3.440	135,929	3.120
	3.50		539.1	280.2	151,045		3.468	163,011	3.742
	4.00		543.1	284.2	154,339		3.543	239,356	5.495
Zone 2 (EURV)	4.02		543.3	284.3	154,471		3.546	242,444	5.566
	4.50		547.1	288.2	157,664		3.619	317,355	7.285
	5.00		551.1	292.2	161,021		3.697	397,025	9.114
	5.50		555.1	296.2	164,410		3.774	478,381	10.982
Zone 3 (100-year)	6.00		559.1	300.2	167,831		3.853	561,440	12.889
	6.50		563.1	304.2	171,284		3.932	646,218	14.835
	7.00		567.1	308.2	174,770		4.012	732,730	16.821
	7.50		571.1	312.2	178,287		4.093	820,993	18.847
	8.00		575.1	316.2	181,836		4.174	911,022	20.914
	8.50		579.1	320.2	185,417		4.257	1,002,834	23.022
	9.00		583.1	324.2	189,030		4.340	1,096,444	25.171
	9.50		587.1	328.2	192,675		4.423	1,191,870	27.362
	10.00		591.1	332.2	196,353		4.508	1,289,125	29.594
	10.50		595.1	336.2	200,062		4.593	1,388,228	31.869
	11.00		599.1	340.2	203,803		4.679	1,489,192	34.187
	11.50		603.1	344.2	207,576		4.765	1,592,036	36.548
	12.00		607.1	348.2	211,381		4.853	1,696,774	38.953
	12.50		611.1	352.2	215,219		4.941	1,803,423	41.401
	13.00		615.1	356.2	219,088		5.030	1,911,998	43.893
	13.50		619.1	360.2	222,989		5.119	2,022,516	46.431
	14.00		623.1	364.2	226,922		5.209	2,134,992	49.013
	14.50		627.1	368.2	230,887		5.300	2,249,443	51.640
	15.00		631.1	372.2	234,884		5.392	2,365,885	54.313
	15.50		635.1	376.2	238,914		5.485	2,484,333	57.032
	16.00		639.1	380.2	242,975		5.578	2,604,803	59.798
	16.50		643.1	384.2	247,068		5.672	2,727,313	62.610
	17.00		647.1	388.2	251,193		5.767	2,851,877	65.470
	17.50		651.1	392.2	255,350		5.862	2,978,511	68.377
	18.00		655.1	396.2	259,539		5.958	3,107,232	71.332
	18.50		659.1	400.2	263,761		6.055	3,238,056	74.336
	19.00		663.1	404.2	268,014		6.153	3,370,998	77.387
	19.50		667.1	408.2	272,299		6.251	3,506,075	80.488
	20.00		671.1	412.2	276,616		6.350	3,643,303	83.639
	20.50		675.1	416.2	280,965		6.450	3,782,697	86.839
	21.00		679.1	420.2	285,346		6.551	3,924,273	90.089
	21.50		683.1	424.2	289,760		6.652	4,068,048	93.390
	22.00		687.1	428.2	294,205		6.754	4,214,038	96.741
	22.50		691.1	432.2	298,682		6.857	4,362,259	100.144
	23.00		695.1	436.2	303,191		6.960	4,512,726	103.598
	23.50		699.1	440.2	307,732		7.065	4,665,455	107.104
	24.00		703.1	444.2	312,306		7.170	4,820,463	110.663
	24.50		707.1	448.2	316,911		7.275	4,977,766	114.274
	25.00		711.1	452.2	321,548		7.382	5,137,379	117.938
	25.50		715.1	456.2	326,217		7.489	5,299,319	121.656
	26.00		719.1	460.2	330,918		7.597	5,463,602	125.427
	26.50		723.1	464.2	335,651		7.705	5,630,243	129.253
	27.00		727.1	468.2	340,417		7.815	5,799,258	133.133
	27.50		731.1	472.2	345,214		7.925	5,970,665	137.068
	28.00		735.1	476.2	350,043		8.036	6,144,477	141.058
	28.50		739.1	480.2	354,904		8.147	6,320,713	145.104
	29.00		743.1	484.2	359,797		8.260	6,499,387	149.205
	29.50		747.1	488.2	364,722		8.373	6,680,515	153.364
	30.00		751.1	492.2	369,680		8.487	6,864,115	157.578

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greely - OK Basin

Basin ID: 150



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.04	2.232	Orifice Plate	Orifice Plate
Zone 2 (EURV)	4.02	3.304	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 3 (100-year)	6.00	7.317	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Total (all zones)		12.852		

Clear Input Parameters (Including Tables)

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

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

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)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	4.472E-02	ft^2
Depth at top of Zone using Orifice Plate =	3.04	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	12.20	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	6.44	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.01	2.03					
Orifice Area (sq. inches)	6.44	6.44	6.44					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangula	Not Selected		Calculated Parameters for Vertical Orifice	Zone 2 Rectangula	Not Selected	
Invert of Vertical Orifice =	3.04	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.07	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	4.02	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.08	N/A	feet
Vertical Orifice Height =	2.00	N/A	inches				
Vertical Orifice Width =	5.29		inches				

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.02	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	7.35	N/A	feet
Overflow Weir Front Edge Length =	146.00	N/A	feet	Overflow Weir Slope Length =	10.54	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	45.96	N/A	
Horiz. Length of Weir Sides =	10.00	N/A	feet	Overflow Grate Open Area w/o Debris =	1071.13	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	535.56	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	23.31	N/A	ft^2
Outlet Pipe Diameter =	84.00	N/A	inches	Outlet Orifice Centroid =	2.32	N/A	feet
Restrictor Plate Height Above Pipe Invert =	49.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.74	N/A	radians

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	6.15	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.98	feet
Spillway Crest Length =	132.00	feet	Stage at Top of Freeboard =	8.13	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	4.20	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	21.46	acre-ft

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

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	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	2.232	5.535	3.732	5.984	9.050	15.486	20.997	27.899	46.299
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.732	5.984	9.050	15.486	20.997	27.899	46.299
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.5	15.9	44.5	117.6	170.4	239.4	410.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.11	0.30	0.79	1.14	1.61	2.75
Peak Inflow Q (cfs) =	N/A	N/A	48.7	81.0	124.0	224.8	301.8	395.8	640.7
Peak Outflow Q (cfs) =	0.9	1.4	1.2	2.0	24.0	87.7	144.5	227.3	485.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.5	0.7	0.8	0.9	1.2
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.0	0.0	0.1	0.1	0.2	0.2
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) =	38	69	55	72	72	68	65	61	52
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	57	76	77	75	74	72	68
Maximum Ponding Depth (ft) =	3.04	4.02	3.43	4.06	4.48	5.14	5.58	6.12	6.85
Area at Maximum Ponding Depth (acres) =	2.77	3.55	3.46	3.55	3.62	3.72	3.79	3.87	3.99
Maximum Volume Stored (acre-ft) =	2.253	5.566	3.500	5.672	7.213	9.596	11.247	13.352	16.221

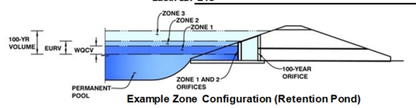
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley-Oklahoma

Basin ID: 248



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	140.20	acres
Watershed Length =	3,613	ft
Watershed Length to Centroid =	1,652	ft
Watershed Slope =	0.019	ft/ft
Watershed Imperviousness =	72.58%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	3.355	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	9.918	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	6.851	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	9.719	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	13.001	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	19.029	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	24.412	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	30.796	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	48.268	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	6.380	acre-feet		
Approximate 5-yr Detention Volume =	9.244	acre-feet		
Approximate 10-yr Detention Volume =	11.364	acre-feet		
Approximate 25-yr Detention Volume =	14.112	acre-feet		
Approximate 50-yr Detention Volume =	15.836	acre-feet		
Approximate 100-yr Detention Volume =	18.413	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	3.355	acre-feet
Zone 2 Volume (EURV - Zone 1)	6.563	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	8.495	acre-feet
Total Detention Basin Volume =	18.413	acre-feet
Initial Surcharge Volume (ISV) =	438	ft^3
Initial Surcharge Depth (ISD) =	0.33	ft
Total Available Detention Depth (H_{total}) =	6.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	1,329	ft^2
Surcharge Volume Length (L_{ISV}) =	36.5	ft
Surcharge Volume Width (W_{ISV}) =	36.5	ft
Depth of Basin Floor (H_{FLOOR}) =	3.27	ft
Length of Basin Floor (L_{FLOOR}) =	703.5	ft
Width of Basin Floor (W_{FLOOR}) =	363.5	ft
Area of Basin Floor (A_{FLOOR}) =	255,699	ft^2
Volume of Basin Floor (V_{FLOOR}) =	300,251	ft^3
Depth of Main Basin (H_{MAIN}) =	1.90	ft
Length of Main Basin (L_{MAIN}) =	718.7	ft
Width of Main Basin (W_{MAIN}) =	378.7	ft
Area of Main Basin (A_{MAIN}) =	272,148	ft^2
Volume of Main Basin (V_{MAIN}) =	501,373	ft^3
Calculated Total Basin Volume (V_{total}) =	**18.428**	acre-feet

Depth Increment = 0.50 ft

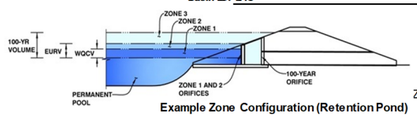
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		36.5	36.5	1,328.66		0.031		
ISV	0.33		36.5	36.5	1,328.66		0.031	438	0.010
	0.50		36.5	36.5	1,328.66		0.031	664	0.015
	1.00		71.1	53.5	3,802.00		0.087	1,522	0.035
	1.50		173.1	103.5	17,910.53		0.411	6,525	0.150
	2.00		275.1	153.5	42,219.06		0.969	21,133	0.485
	2.50		377.1	203.5	76,727.59		1.761	50,444	1.158
	3.00		479.1	253.5	121,436.12		2.788	99,560	2.286
Zone 1 (WQCV)	3.34		548.5	287.5	157,664.16		3.619	146,874	3.372
	3.50		581.1	303.5	176,344.65		4.048	173,580	3.985
	4.00		683.1	353.5	241,453.18		5.543	277,605	6.373
Floor	4.10		703.5	363.5	255,698.88		5.870	302,459	6.944
	4.50		706.7	366.7	259,123.46		5.949	405,423	9.307
Zone 2 (EURV)	4.61		707.6	367.5	260,068.81		5.970	433,979	9.963
	5.00		710.7	370.7	263,432.99		6.048	536,061	12.306
	5.50		714.7	374.7	267,774.52		6.147	668,861	15.355
Zone 3 (100-year)	6.00		718.7	378.7	272,148.04		6.248	803,841	18.454
	6.50		722.7	382.7	276,553.57		6.349	941,015	21.603
	7.00		726.7	386.7	280,991.10		6.451	1,080,399	24.803
	7.50		730.7	390.7	285,460.62		6.553	1,222,011	28.054
	8.00		734.7	394.7	289,962.15		6.657	1,365,865	31.356
	8.50		738.7	398.7	294,495.68		6.761	1,511,979	34.710
	9.00		742.7	402.7	299,061.21		6.866	1,660,366	38.117
	9.50		746.7	406.7	303,658.73		6.971	1,811,045	41.576
	10.00		750.7	410.7	308,288.26		7.077	1,964,031	45.088
	10.50		754.7	414.7	312,949.79		7.184	2,119,339	48.653
	11.00		758.7	418.7	317,643.31		7.292	2,276,986	52.272
	11.50		762.7	422.7	322,368.84		7.401	2,436,987	55.946
	12.00		766.7	426.7	327,126.37		7.510	2,599,360	59.673
	12.50		770.7	430.7	331,915.89		7.620	2,764,119	63.455
	13.00		774.7	434.7	336,737.42		7.730	2,931,281	67.293
	13.50		778.7	438.7	341,590.95		7.842	3,100,862	71.186
	14.00		782.7	442.7	346,476.47		7.954	3,272,877	75.135
	14.50		786.7	446.7	351,394.00		8.067	3,447,344	79.140
	15.00		790.7	450.7	356,343.53		8.181	3,624,277	83.202
	15.50		794.7	454.7	361,325.05		8.295	3,803,692	87.321
	16.00		798.7	458.7	366,338.58		8.410	3,985,607	91.497
	16.50		802.7	462.7	371,384.11		8.526	4,170,036	95.731
	17.00		806.7	466.7	376,461.63		8.642	4,356,996	100.023
	17.50		810.7	470.7	381,571.16		8.760	4,546,503	104.373
	18.00		814.7	474.7	386,712.69		8.878	4,738,573	108.783
	18.50		818.7	478.7	391,886.21		8.996	4,933,221	113.251
	19.00		822.7	482.7	397,091.74		9.116	5,130,465	117.779
	19.50		826.7	486.7	402,329.27		9.236	5,330,318	122.367
	20.00		830.7	490.7	407,598.79		9.357	5,532,799	127.016
	20.50		834.7	494.7	412,900.32		9.479	5,737,923	131.725
	21.00		838.7	498.7	418,233.85		9.601	5,945,705	136.495
	21.50		842.7	502.7	423,599.37		9.725	6,156,162	141.326
	22.00		846.7	506.7	428,996.90		9.848	6,369,309	146.219
	22.50		850.7	510.7	434,426.43		9.973	6,585,164	151.175
	23.00		854.7	514.7	439,887.95		10.098	6,803,741	156.192
	23.50		858.7	518.7	445,381.48		10.225	7,025,057	161.273
	24.00		862.7	522.7	450,907.01		10.351	7,249,128	166.417
	24.50		866.7	526.7	456,464.54		10.479	7,475,970	171.625
	25.00		870.7	530.7	462,054.06		10.607	7,705,598	176.896
	25.50		874.7	534.7	467,675.59		10.736	7,938,029	182.232
	26.00		878.7	538.7	473,329.12		10.866	8,173,279	187.633
	26.50		882.7	542.7	479,014.64		10.997	8,411,363	193.098
	27.00		886.7	546.7	484,732.17		11.128	8,652,299	198.629
	27.50		890.7	550.7	490,481.70		11.260	8,896,101	204.226
	28.00		894.7	554.7	496,263.22		11.393	9,142,786	209.889
	28.50		898.7	558.7	502,076.75		11.526	9,392,370	215.619
	29.00		902.7	562.7	507,922.28		11.660	9,644,868	221.416
	29.50		906.7	566.7	513,799.80		11.795	9,900,297	227.280
	30.00		910.7	570.7	519,709.33		11.931	10,158,673	233.211

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley-Oklahoma

Basin ID: 248



Example Zone Configuration (Retention Pond)

Clear Input Parameters (Including Tables)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.34	3.355	Orifice Plate	Orifice Plate
Zone 2 (EURV)	4.61	6.563	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 3 (100-year)	6.00	8.495	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Total (all zones)		18.413		

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

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

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)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	6.542E-02	ft^2
Depth at top of Zone using Orifice Plate =	3.34	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	13.40	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	9.42	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.11	2.23					
Orifice Area (sq. inches)	9.42	9.42	9.42					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangula	Not Selected		Calculated Parameters for Vertical Orifice	Zone 2 Rectangula	Not Selected	
Invert of Vertical Orifice =	3.34	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	4.28	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	4.61	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	2.50	N/A	feet
Vertical Orifice Height =	60.00	N/A	inches				
Vertical Orifice Width =	10.26		inches				

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.61	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	7.94	N/A	feet
Overflow Weir Front Edge Length =	220.00	N/A	feet	Overflow Weir Slope Length =	10.54	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	75.37	N/A	
Horiz. Length of Weir Sides =	10.00	N/A	feet	Overflow Grate Open Area w/o Debris =	1614.03	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	807.01	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	21.41	N/A	ft^2
Outlet Pipe Diameter =	72.00	N/A	inches	Outlet Orifice Centroid =	2.37	N/A	feet
Restrictor Plate Height Above Pipe Invert =	51.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.00	N/A	radians

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	7.90	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.98	feet
Spillway Crest Length =	177.00	feet	Stage at Top of Freeboard =	9.88	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	7.05	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	44.24	acre-ft

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

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	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	3.355	9.918	6.851	9.719	13.001	19.029	24.412	30.796	48.268
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.851	9.719	13.001	19.029	24.412	30.796	48.268
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.4	14.7	41.2	109.3	158.4	222.5	381.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.11	0.29	0.78	1.13	1.59	2.72
Peak Inflow Q (cfs) =	N/A	N/A	115.4	162.7	216.9	329.6	422.0	532.2	823.6
Peak Outflow Q (cfs) =	1.4	4.4	2.5	4.0	19.9	70.3	124.8	205.2	243.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	0.5	0.6	0.8	0.9	0.6
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.0	0.1	0.1	0.1
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) =	38	68	60	69	71	69	66	64	58
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	63	72	76	75	74	73	71
Maximum Ponding Depth (ft) =	3.34	4.61	4.02	4.48	4.87	5.30	5.65	6.07	7.63
Area at Maximum Ponding Depth (acres) =	3.62	5.97	5.61	5.94	6.02	6.11	6.18	6.26	6.58
Maximum Volume Stored (acre-ft) =	3.372	9.963	6.484	9.129	11.462	14.129	16.218	18.829	28.841

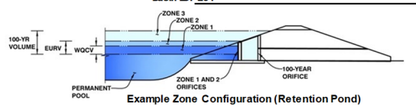
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greely - Oklaoma Basin

Basin ID: 264



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	127.40	acres
Watershed Length =	3,476	ft
Watershed Length to Centroid =	1,780	ft
Watershed Slope =	0.021	ft/ft
Watershed Imperviousness =	62.02%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	2.581	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	7.605	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	5.224	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	7.581	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	10.425	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	15.878	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	20.677	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	26.477	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 3 in.) =	28.852	acre-feet	3.00	inches
Approximate 2-yr Detention Volume =	4.851	acre-feet		
Approximate 5-yr Detention Volume =	7.239	acre-feet		
Approximate 10-yr Detention Volume =	8.859	acre-feet		
Approximate 25-yr Detention Volume =	11.070	acre-feet		
Approximate 50-yr Detention Volume =	12.472	acre-feet		
Approximate 100-yr Detention Volume =	14.866	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	2.581	acre-feet
Zone 2 Volume (EURV - Zone 1)	5.024	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	7.261	acre-feet
Total Detention Basin Volume =	14.866	acre-feet
Initial Surcharge Volume (ISV) =	337	ft^3
Initial Surcharge Depth (ISD) =	0.33	ft
Total Available Detention Depth (H_{total}) =	6.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	1,022	ft^2
Surcharge Volume Length (L_{ISV}) =	32.0	ft
Surcharge Volume Width (W_{ISV}) =	32.0	ft
Depth of Basin Floor (H_{FLOOR}) =	2.77	ft
Length of Basin Floor (L_{FLOOR}) =	597.1	ft
Width of Basin Floor (W_{FLOOR}) =	309.0	ft
Area of Basin Floor (A_{FLOOR}) =	184,471	ft^2
Volume of Basin Floor (V_{FLOOR}) =	183,950	ft^3
Depth of Main Basin (H_{MAIN}) =	2.40	ft
Length of Main Basin (L_{MAIN}) =	616.3	ft
Width of Main Basin (W_{MAIN}) =	328.2	ft
Area of Main Basin (A_{MAIN}) =	202,235	ft^2
Volume of Main Basin (V_{MAIN}) =	463,884	ft^3
Calculated Total Basin Volume (V_{total}) =	**14.892**	acre-feet

Depth Increment = 0.50 ft

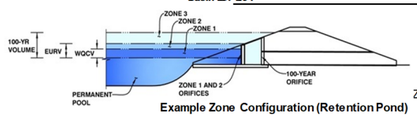
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		32.0	32.0	1,022.10		0.023		
ISV	0.33		32.0	32.0	1,022.10		0.023	337	0.008
	0.50		32.0	32.0	1,022.10		0.023	511	0.012
	1.00		66.7	49.0	3,263.88		0.075	1,196	0.027
	1.50		168.7	99.0	16,691.36		0.383	5,760	0.132
	2.00		270.7	149.0	40,318.83		0.926	19,587	0.450
	2.50		372.7	199.0	74,146.31		1.702	47,779	1.097
	3.00		474.7	249.0	118,173.79		2.713	95,434	2.191
Zone 1 (WQCV)	3.14		503.2	263.0	132,329.32		3.038	112,959	2.593
	3.50		576.7	299.0	172,401.27		3.958	167,652	3.849
Floor	3.60		597.1	309.0	184,470.76		4.235	185,493	4.258
	4.00		600.3	312.2	187,380.27		4.302	259,862	5.966
Zone 2 (EURV)	4.38		603.3	315.2	190,163.27		4.366	331,595	7.612
	4.50		604.3	316.2	191,045.95		4.386	354,467	8.137
	5.00		608.3	320.2	194,743.63		4.471	450,913	10.352
	5.50		612.3	324.2	198,473.32		4.556	549,216	12.608
Zone 3 (100-year)	6.00		616.3	328.2	202,235.00		4.643	649,392	14.908
	6.50		620.3	332.2	206,028.68		4.730	751,457	17.251
	7.00		624.3	336.2	209,854.36		4.818	855,426	19.638
	7.50		628.3	340.2	213,712.04		4.906	961,316	22.069
	8.00		632.3	344.2	217,601.72		4.995	1,069,143	24.544
	8.50		636.3	348.2	221,523.41		5.085	1,178,923	27.064
	9.00		640.3	352.2	225,477.09		5.176	1,290,672	29.630
	9.50		644.3	356.2	229,462.77		5.268	1,404,406	32.241
	10.00		648.3	360.2	233,480.45		5.360	1,520,140	34.898
	10.50		652.3	364.2	237,530.13		5.453	1,637,892	37.601
	11.00		656.3	368.2	241,611.82		5.547	1,757,676	40.351
	11.50		660.3	372.2	245,725.50		5.641	1,879,509	43.148
	12.00		664.3	376.2	249,871.18		5.736	2,003,407	45.992
	12.50		668.3	380.2	254,048.86		5.832	2,129,385	48.884
	13.00		672.3	384.2	258,258.54		5.929	2,257,461	51.824
	13.50		676.3	388.2	262,500.23		6.026	2,387,649	54.813
	14.00		680.3	392.2	266,773.91		6.124	2,519,966	57.850
	14.50		684.3	396.2	271,079.59		6.223	2,654,428	60.937
	15.00		688.3	400.2	275,417.27		6.323	2,791,051	64.074
	15.50		692.3	404.2	279,786.95		6.423	2,929,851	67.260
	16.00		696.3	408.2	284,188.64		6.524	3,070,844	70.497
	16.50		700.3	412.2	288,622.32		6.626	3,214,045	73.784
	17.00		704.3	416.2	293,088.00		6.728	3,359,471	77.123
	17.50		708.3	420.2	297,585.68		6.832	3,507,138	80.513
	18.00		712.3	424.2	302,115.36		6.936	3,657,062	83.955
	18.50		716.3	428.2	306,677.05		7.040	3,809,259	87.449
	19.00		720.3	432.2	311,270.73		7.146	3,963,745	90.995
	19.50		724.3	436.2	315,896.41		7.252	4,120,535	94.594
	20.00		728.3	440.2	320,554.09		7.359	4,279,646	98.247
	20.50		732.3	444.2	325,243.77		7.467	4,441,094	101.953
	21.00		736.3	448.2	329,965.46		7.575	4,604,895	105.714
	21.50		740.3	452.2	334,719.14		7.684	4,771,065	109.529
	22.00		744.3	456.2	339,504.82		7.794	4,939,620	113.398
	22.50		748.3	460.2	344,322.50		7.905	5,110,575	117.323
	23.00		752.3	464.2	349,172.18		8.016	5,283,948	121.303
	23.50		756.3	468.2	354,053.87		8.128	5,459,753	125.339
	24.00		760.3	472.2	358,967.55		8.241	5,638,007	129.431
	24.50		764.3	476.2	363,913.23		8.354	5,818,726	133.580
	25.00		768.3	480.2	368,890.91		8.469	6,001,925	137.785
	25.50		772.3	484.2	373,900.59		8.584	6,187,622	142.048
	26.00		776.3	488.2	378,942.28		8.699	6,375,831	146.369
	26.50		780.3	492.2	384,015.96		8.816	6,566,570	150.748
	27.00		784.3	496.2	389,121.64		8.933	6,759,853	155.185
	27.50		788.3	500.2	394,259.32		9.051	6,955,697	159.681
	28.00		792.3	504.2	399,429.00		9.170	7,154,117	164.236
	28.50		796.3	508.2	404,630.69		9.289	7,355,131	168.851
	29.00		800.3	512.2	409,864.37		9.409	7,558,753	173.525
	29.50		804.3	516.2	415,130.05		9.530	7,765,001	178.260
	30.00		808.3	520.2	420,427.73		9.652	7,973,889	183.055

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greely - Oklaoma Basin

Basin ID: 264



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.14	2.581	Orifice Plate	Orifice Plate
Zone 2 (EURV)	4.38	5.024	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 3 (100-year)	6.00	7.261	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Total (all zones)		14.866		

Clear Input Parameters (Including Tables)

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

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

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)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	5.118E-02	ft^2
Depth at top of Zone using Orifice Plate =	3.14	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	12.60	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	7.37	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.05	2.09					
Orifice Area (sq. inches)	7.37	7.37	7.37					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected		Calculated Parameters for Vertical Orifice	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	3.14	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.20	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	4.38	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.08	N/A	feet
Vertical Orifice Height =	2.00	N/A	inches				
Vertical Orifice Width =	14.59		inches				

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.38	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	7.71	N/A	feet
Overflow Weir Front Edge Length =	157.00	N/A	feet	Overflow Weir Slope Length =	10.54	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	60.90	N/A	
Horiz. Length of Weir Sides =	10.00	N/A	feet	Overflow Grate Open Area w/o Debris =	1151.83	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	575.91	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	18.91	N/A	ft^2
Outlet Pipe Diameter =	66.00	N/A	inches	Outlet Orifice Centroid =	2.26	N/A	feet
Restrictor Plate Height Above Pipe Invert =	49.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.08	N/A	radians

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	6.30	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.98	feet
Spillway Crest Length =	143.00	feet	Stage at Top of Freeboard =	8.28	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	5.05	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	25.95	acre-ft

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

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	0.85	1.12	1.40	1.87	2.30	2.79	3.00
CUHP Runoff Volume (acre-ft) =	2.581	7.605	5.224	7.581	10.425	15.878	20.677	26.477	28.852
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	5.224	7.581	10.425	15.878	20.677	26.477	28.852
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.3	13.1	36.8	97.6	141.5	198.8	220.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.10	0.29	0.77	1.11	1.56	1.73
Peak Inflow Q (cfs) =	N/A	N/A	80.4	117.3	162.7	259.3	337.8	429.8	467.5
Peak Outflow Q (cfs) =	1.0	2.4	1.9	2.3	17.5	66.3	114.9	185.8	194.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.5	0.7	0.8	0.9	0.9
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.1	0.1	0.2	0.2
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) =	38	68	57	69	72	69	66	63	62
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	60	73	77	76	75	73	73
Maximum Ponding Depth (ft) =	3.14	4.38	3.76	4.29	4.71	5.25	5.65	6.13	6.34
Area at Maximum Ponding Depth (acres) =	3.04	4.37	4.26	4.35	4.42	4.51	4.58	4.67	4.70
Maximum Volume Stored (acre-ft) =	2.593	7.612	4.895	7.177	9.062	11.475	13.248	15.513	16.450

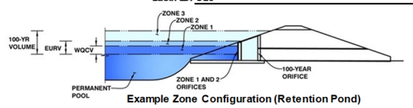
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greely - Oklahoma Basin

Basin ID: 510



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	168.30	acres
Watershed Length =	5,098	ft
Watershed Length to Centroid =	2,895	ft
Watershed Slope =	0.025	ft/ft
Watershed Imperviousness =	56.60%	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.

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	3.159	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	9.102	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	6.210	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	9.236	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	12.929	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	20.171	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	26.507	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	34.232	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	55.096	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	5.743	acre-feet		
Approximate 5-yr Detention Volume =	8.776	acre-feet		
Approximate 10-yr Detention Volume =	10.724	acre-feet		
Approximate 25-yr Detention Volume =	13.463	acre-feet		
Approximate 50-yr Detention Volume =	15.203	acre-feet		
Approximate 100-yr Detention Volume =	18.381	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	3.159	acre-feet
Zone 2 Volume (EURV - Zone 1)	5.943	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	9.280	acre-feet
Total Detention Basin Volume =	18.381	acre-feet
Initial Surcharge Volume (ISV) =	413	ft^3
Initial Surcharge Depth (ISD) =	0.33	ft
Total Available Detention Depth (H_{total}) =	6.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	1,251	ft^2
Surcharge Volume Length (L_{ISV}) =	35.4	ft
Surcharge Volume Width (W_{ISV}) =	35.4	ft
Depth of Basin Floor (H_{FLOOR}) =	3.28	ft
Length of Basin Floor (L_{FLOOR}) =	704.5	ft
Width of Basin Floor (W_{FLOOR}) =	363.4	ft
Area of Basin Floor (A_{FLOOR}) =	255,991	ft^2
Volume of Basin Floor (V_{FLOOR}) =	300,817	ft^3
Depth of Main Basin (H_{MAIN}) =	1.89	ft
Length of Main Basin (L_{MAIN}) =	719.6	ft
Width of Main Basin (W_{MAIN}) =	378.5	ft
Area of Main Basin (A_{MAIN}) =	272,366	ft^2
Volume of Main Basin (V_{MAIN}) =	499,217	ft^3
Calculated Total Basin Volume (V_{total}) =	**18.390**	acre-feet

Depth Increment = 0.50 ft

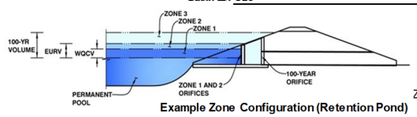
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		35.4	35.4	1,251		0.029		
ISV	0.33		35.4	35.4	1,251		0.029	413	0.009
	0.50		35.4	35.4	1,251		0.029	626	0.014
	1.00		70.1	52.4	3,669		0.084	1,440	0.033
	1.50		172.1	102.4	17,613		0.404	6,335	0.145
	2.00		274.1	152.4	41,757		0.959	20,753	0.476
	2.50		376.1	202.4	76,101		1.747	49,792	1.143
	3.00		478.1	252.4	120,646		2.770	98,554	2.262
Zone 1 (WQCV)	3.29		537.2	281.4	151,155		3.470	137,882	3.165
	3.50		580.1	302.4	175,390		4.026	172,138	3.952
	4.00		682.1	352.4	240,334		5.517	275,644	6.328
Floor	4.11		704.5	363.4	255,991		5.877	302,938	6.954
Zone 2 (EURV)	4.48		707.5	366.3	259,161		5.950	398,240	9.142
	4.50		707.6	366.5	259,332		5.953	403,425	9.261
	5.00		711.6	370.5	263,645		6.052	534,168	12.263
	5.50		715.6	374.5	267,989		6.152	667,075	15.314
Zone 3 (100-year)	6.00		719.6	378.5	272,366		6.253	802,163	18.415
	6.50		723.6	382.5	276,774		6.354	939,446	21.567
	7.00		727.6	386.5	281,214		6.456	1,078,942	24.769
	7.50		731.6	390.5	285,687		6.558	1,220,666	28.023
	8.00		735.6	394.5	290,191		6.662	1,364,634	31.328
	8.50		739.6	398.5	294,728		6.766	1,510,863	34.685
	9.00		743.6	402.5	299,296		6.871	1,659,367	38.094
	9.50		747.6	406.5	303,896		6.977	1,810,164	41.556
	10.00		751.6	410.5	308,529		7.083	1,963,269	45.070
	10.50		755.6	414.5	313,193		7.190	2,118,698	48.639
	11.00		759.6	418.5	317,890		7.298	2,276,468	52.261
	11.50		763.6	422.5	322,618		7.406	2,436,593	55.936
	12.00		767.6	426.5	327,378		7.516	2,599,091	59.667
	12.50		771.6	430.5	332,171		7.626	2,763,977	63.452
	13.00		775.6	434.5	336,995		7.736	2,931,267	67.293
	13.50		779.6	438.5	341,852		7.848	3,100,978	71.189
	14.00		783.6	442.5	346,740		7.960	3,273,124	75.141
	14.50		787.6	446.5	351,660		8.073	3,447,723	79.149
	15.00		791.6	450.5	356,613		8.187	3,624,790	83.214
	15.50		795.6	454.5	361,597		8.301	3,804,341	87.336
	16.00		799.6	458.5	366,614		8.416	3,986,393	91.515
	16.50		803.6	462.5	371,662		8.532	4,170,960	95.752
	17.00		807.6	466.5	376,743		8.649	4,358,060	100.047
	17.50		811.6	470.5	381,855		8.766	4,547,708	104.401
	18.00		815.6	474.5	386,999		8.884	4,739,920	108.814
	18.50		819.6	478.5	392,176		9.003	4,934,713	113.285
	19.00		823.6	482.5	397,384		9.123	5,132,101	117.817
	19.50		827.6	486.5	402,625		9.243	5,332,102	122.408
	20.00		831.6	490.5	407,897		9.364	5,534,731	127.060
	20.50		835.6	494.5	413,201		9.486	5,740,004	131.772
	21.00		839.6	498.5	418,538		9.608	5,947,938	136.546
	21.50		843.6	502.5	423,906		9.732	6,158,547	141.381
	22.00		847.6	506.5	429,307		9.856	6,371,849	146.278
	22.50		851.6	510.5	434,739		9.980	6,587,859	151.236
	23.00		855.6	514.5	440,203		10.106	6,806,594	156.258
	23.50		859.6	518.5	445,700		10.232	7,028,068	161.342
	24.00		863.6	522.5	451,228		10.359	7,252,299	166.490
	24.50		867.6	526.5	456,789		10.486	7,479,301	171.701
	25.00		871.6	530.5	462,381		10.615	7,709,093	176.976
	25.50		875.6	534.5	468,005		10.744	7,941,688	182.316
	26.00		879.6	538.5	473,662		10.874	8,177,103	187.720
	26.50		883.6	542.5	479,350		11.004	8,415,355	193.190
	27.00		887.6	546.5	485,071		11.136	8,656,459	198.725
	27.50		891.6	550.5	490,823		11.268	8,900,431	204.326
	28.00		895.6	554.5	496,607		11.401	9,147,287	209.993
	28.50		899.6	558.5	502,424		11.534	9,397,043	215.726
	29.00		903.6	562.5	508,272		11.668	9,649,716	221.527
	29.50		907.6	566.5	514,153		11.803	9,905,321	227.395
	30.00		911.6	570.5	520,065		11.939	10,163,874	233.330

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greely - Oklahoma Basin

Basin ID: 510



Example Zone Configuration (Retention Pond)

Clear Input Parameters (Including Tables)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.29	3.159	Orifice Plate	Orifice Plate
Zone 2 (EURV)	4.48	5.943	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 3 (100-year)	6.00	9.280	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Total (all zones)		18.381		

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

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

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)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	6.174E-02	ft^2
Depth at top of Zone using Orifice Plate =	3.29	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	13.20	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	8.89	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.10	2.19					
Orifice Area (sq. inches)	8.89	8.89	8.89					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangula	Not Selected		Calculated Parameters for Vertical Orifice	Zone 2 Rectangula	Not Selected	
Invert of Vertical Orifice =	3.29	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.22	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	4.48	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.08	N/A	feet
Vertical Orifice Height =	2.00	N/A	inches				
Vertical Orifice Width =	15.59		inches				

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.48	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	7.81	N/A	feet
Overflow Weir Front Edge Length =	250.00	N/A	feet	Overflow Weir Slope Length =	10.54	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	72.85	N/A	
Horiz. Length of Weir Sides =	10.00	N/A	feet	Overflow Grate Open Area w/o Debris =	1834.12	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	917.06	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	25.18	N/A	ft^2
Outlet Pipe Diameter =	72.00	N/A	inches	Outlet Orifice Centroid =	2.70	N/A	feet
Restrictor Plate Height Above Pipe Invert =	60.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.30	N/A	radians

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway	
Spillway Invert Stage=	6.05	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	2.17 feet
Spillway Crest Length =	40.00	feet	Stage at Top of Freeboard =	9.22 feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	6.92 acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	39.54 acre-ft

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

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	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	3.159	9.102	6.210	9.236	12.929	20.171	26.507	34.232	55.096
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.210	9.236	12.929	20.171	26.507	34.232	55.096
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.3	13.3	38.1	103.0	150.3	212.6	367.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.08	0.23	0.61	0.89	1.26	2.18
Peak Inflow Q (cfs) =	N/A	N/A	76.7	115.3	162.0	269.4	352.7	453.2	717.9
Peak Outflow Q (cfs) =	1.3	2.7	2.2	2.7	24.5	87.4	146.4	230.4	401.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.6	0.8	1.0	1.1	1.1
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.0	0.1	0.1	0.1
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) =	38	68	57	69	72	68	66	63	55
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	60	73	77	76	75	73	70
Maximum Ponding Depth (ft) =	3.29	4.48	3.90	4.41	4.79	5.26	5.58	5.99	7.09
Area at Maximum Ponding Depth (acres) =	3.47	5.95	5.20	5.94	6.01	6.10	6.17	6.25	6.47
Maximum Volume Stored (acre-ft) =	3.165	9.142	5.792	8.726	10.996	13.782	15.807	18.290	25.351

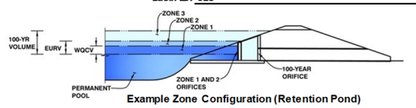
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greely - Oklahoma Basin

Basin ID: 618



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	156.60	acres
Watershed Length =	5,600	ft
Watershed Length to Centroid =	3,528	ft
Watershed Slope =	0.021	ft/ft
Watershed Imperviousness =	75.30%	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.

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	3.930	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	11.527	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	7.886	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	11.206	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	14.899	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	21.608	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	27.617	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	34.712	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	54.174	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	7.386	acre-feet		
Approximate 5-yr Detention Volume =	10.693	acre-feet		
Approximate 10-yr Detention Volume =	13.164	acre-feet		
Approximate 25-yr Detention Volume =	16.329	acre-feet		
Approximate 50-yr Detention Volume =	18.306	acre-feet		
Approximate 100-yr Detention Volume =	21.161	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	3.930	acre-feet
Zone 2 Volume (EURV - Zone 1)	7.598	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	9.634	acre-feet
Total Detention Basin Volume =	21.161	acre-feet
Initial Surcharge Volume (ISV) =	514	ft^3
Initial Surcharge Depth (ISD) =	0.33	ft
Total Available Detention Depth (H_{total}) =	6.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	1,556	ft^2
Surcharge Volume Length (L_{ISV}) =	39.4	ft
Surcharge Volume Width (W_{ISV}) =	39.4	ft
Depth of Basin Floor (H_{FLOOR}) =	3.71	ft
Length of Basin Floor (L_{FLOOR}) =	796.3	ft
Width of Basin Floor (W_{FLOOR}) =	410.4	ft
Area of Basin Floor (A_{FLOOR}) =	326,835	ft^2
Volume of Basin Floor (V_{FLOOR}) =	434,001	ft^3
Depth of Main Basin (H_{MAIN}) =	1.46	ft
Length of Main Basin (L_{MAIN}) =	808.0	ft
Width of Main Basin (W_{MAIN}) =	422.1	ft
Area of Main Basin (A_{MAIN}) =	341,067	ft^2
Volume of Main Basin (V_{MAIN}) =	487,532	ft^3
Calculated Total Basin Volume (V_{total}) =	**21.185**	acre-feet

Depth Increment = 0.50 ft

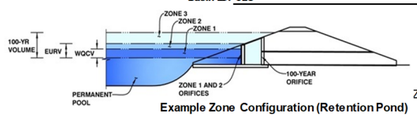
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		39.4	39.4	1,556		0.036		
ISV	0.33		39.4	39.4	1,556		0.036	514	0.012
	0.50		39.4	39.4	1,556		0.036	778	0.018
	1.00		74.1	56.4	4,184		0.096	1,763	0.040
	1.50		176.1	106.4	18,749		0.430	7,071	0.162
	2.00		278.1	156.4	43,513		0.999	22,211	0.510
	2.50		380.1	206.4	78,477		1.802	52,284	1.200
	3.00		482.1	256.4	123,641		2.838	102,388	2.351
Zone 1 (WQCV)	3.47		578.0	303.4	175,396		4.027	172,309	3.956
	3.50		584.1	306.4	179,005		4.109	177,625	4.078
	4.00		686.1	356.4	244,569		5.615	283,094	6.499
	4.50		788.1	406.4	320,334		7.354	423,895	9.731
Floor	4.54		796.3	410.4	326,835		7.503	436,838	10.028
Zone 2 (EURV)	4.74		797.9	412.0	328,769		7.547	502,398	11.533
	5.00		800.0	414.1	331,290		7.605	588,205	13.503
	5.50		804.0	418.1	336,162		7.717	755,067	17.334
Zone 3 (100-year)	6.00		808.0	422.1	341,067		7.830	924,373	21.221
	6.50		812.0	426.1	346,003		7.943	1,096,139	25.164
	7.00		816.0	430.1	350,971		8.057	1,270,381	29.164
	7.50		820.0	434.1	355,972		8.172	1,447,116	33.221
	8.00		824.0	438.1	361,004		8.288	1,626,358	37.336
	8.50		828.0	442.1	366,068		8.404	1,808,125	41.509
	9.00		832.0	446.1	371,165		8.521	1,992,432	45.740
	9.50		836.0	450.1	376,293		8.639	2,179,295	50.030
	10.00		840.0	454.1	381,454		8.757	2,368,731	54.379
	10.50		844.0	458.1	386,646		8.876	2,560,754	58.787
	11.00		848.0	462.1	391,870		8.996	2,755,382	63.255
	11.50		852.0	466.1	397,127		9.117	2,952,630	67.783
	12.00		856.0	470.1	402,415		9.238	3,152,514	72.372
	12.50		860.0	474.1	407,736		9.360	3,355,050	77.021
	13.00		864.0	478.1	413,088		9.483	3,560,255	81.732
	13.50		868.0	482.1	418,472		9.607	3,768,144	86.505
	14.00		872.0	486.1	423,889		9.731	3,978,733	91.339
	14.50		876.0	490.1	429,337		9.856	4,192,038	96.236
	15.00		880.0	494.1	434,818		9.982	4,408,075	101.195
	15.50		884.0	498.1	440,330		10.109	4,626,861	106.218
	16.00		888.0	502.1	445,874		10.236	4,848,410	111.304
	16.50		892.0	506.1	451,451		10.364	5,072,740	116.454
	17.00		896.0	510.1	457,059		10.493	5,299,866	121.668
	17.50		900.0	514.1	462,699		10.622	5,529,805	126.947
	18.00		904.0	518.1	468,372		10.752	5,762,571	132.290
	18.50		908.0	522.1	474,076		10.883	5,998,182	137.699
	19.00		912.0	526.1	479,813		11.015	6,236,653	143.174
	19.50		916.0	530.1	485,581		11.147	6,478,000	148.714
	20.00		920.0	534.1	491,381		11.281	6,722,239	154.321
	20.50		924.0	538.1	497,214		11.414	6,969,387	159.995
	21.00		928.0	542.1	503,078		11.549	7,219,458	165.736
	21.50		932.0	546.1	508,975		11.684	7,472,470	171.544
	22.00		936.0	550.1	514,903		11.821	7,728,438	177.421
	22.50		940.0	554.1	520,863		11.957	7,987,378	183.365
	23.00		944.0	558.1	526,856		12.095	8,249,307	189.378
	23.50		948.0	562.1	532,880		12.233	8,514,239	195.460
	24.00		952.0	566.1	538,936		12.372	8,782,192	201.611
	24.50		956.0	570.1	545,025		12.512	9,053,181	207.832
	25.00		960.0	574.1	551,145		12.653	9,327,222	214.124
	25.50		964.0	578.1	557,298		12.794	9,604,332	220.485
	26.00		968.0	582.1	563,482		12.936	9,884,525	226.917
	26.50		972.0	586.1	569,698		13.078	10,167,819	233.421
	27.00		976.0	590.1	575,947		13.222	10,454,229	239.996
	27.50		980.0	594.1	582,227		13.366	10,743,771	246.643
	28.00		984.0	598.1	588,540		13.511	11,036,462	253.362
	28.50		988.0	602.1	594,884		13.657	11,332,316	260.154
	29.00		992.0	606.1	601,260		13.803	11,631,351	267.019
	29.50		996.0	610.1	607,669		13.950	11,933,582	273.957
	30.00		1,000.0	614.1	614,109		14.098	12,239,025	280.969

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greely - Oklahoma Basin

Basin ID: 618



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.47	3.930	Orifice Plate	Orifice Plate
Zone 2 (EURV)	4.74	7.598	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 3 (100-year)	6.00	9.634	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Total (all zones)		21.161		

Clear Input Parameters (Including Tables)

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

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

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)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	7.576E-02	ft^2
Depth at top of Zone using Orifice Plate =	3.47	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	13.90	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	10.91	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.16	2.31					
Orifice Area (sq. inches)	10.91	10.91	10.91					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected		Calculated Parameters for Vertical Orifice	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	3.47	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.27	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	4.74	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.08	N/A	feet
Vertical Orifice Height =	2.00	N/A	inches				
Vertical Orifice Width =	19.09		inches				

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.74	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	8.07	N/A	feet
Overflow Weir Front Edge Length =	388.00	N/A	feet	Overflow Weir Slope Length =	10.54	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	121.13	N/A	
Horiz. Length of Weir Sides =	10.00	N/A	feet	Overflow Grate Open Area w/o Debris =	2846.56	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	1423.28	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	23.50	N/A	ft^2
Outlet Pipe Diameter =	78.00	N/A	inches	Outlet Orifice Centroid =	2.43	N/A	feet
Restrictor Plate Height Above Pipe Invert =	52.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.91	N/A	radians

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	5.85	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	1.89	feet
Spillway Crest Length =	50.00	feet	Stage at Top of Freeboard =	8.74	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	8.46	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	43.45	acre-ft

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

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	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	3.930	11.527	7.886	11.206	14.899	21.608	27.617	34.712	54.174
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	7.886	11.206	14.899	21.608	27.617	34.712	54.174
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.0	10.2	29.5	80.8	118.4	169.7	293.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						235.3	
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.06	0.19	0.52	0.76	1.50	1.87
Peak Inflow Q (cfs) =	N/A	N/A	95.4	134.3	176.5	272.5	347.6	437.5	676.8
Peak Outflow Q (cfs) =	1.6	3.4	2.9	3.3	22.7	80.3	135.2	214.0	356.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	0.8	1.0	1.1	0.9	1.2
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.0	0.0	0.1	0.1
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) =	38	68	57	68	72	69	67	64	59
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	60	72	76	76	75	74	71
Maximum Ponding Depth (ft) =	3.47	4.74	4.15	4.62	4.96	5.28	5.52	5.81	6.66
Area at Maximum Ponding Depth (acres) =	4.03	7.55	6.11	7.52	7.59	7.67	7.72	7.78	7.98
Maximum Volume Stored (acre-ft) =	3.956	11.533	7.378	10.554	13.123	15.642	17.411	19.659	26.358

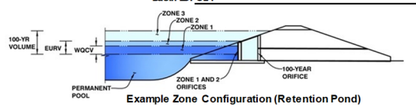
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greely - Oklahoma Basin

Basin ID: 814



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	210.60	acres
Watershed Length =	4,665	ft
Watershed Length to Centroid =	2,450	ft
Watershed Slope =	0.019	ft/ft
Watershed Imperviousness =	64.50%	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.

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	4.426	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	13.115	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	8.993	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	13.071	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	17.845	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	26.911	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	34.919	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	44.551	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	70.739	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	8.334	acre-feet		
Approximate 5-yr Detention Volume =	12.417	acre-feet		
Approximate 10-yr Detention Volume =	15.210	acre-feet		
Approximate 25-yr Detention Volume =	18.972	acre-feet		
Approximate 50-yr Detention Volume =	21.353	acre-feet		
Approximate 100-yr Detention Volume =	25.297	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	4.426	acre-feet
Zone 2 Volume (EURV - Zone 1)	8.689	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	12.181	acre-feet
Total Detention Basin Volume =	25.297	acre-feet
Initial Surcharge Volume (ISV) =	578	ft^3
Initial Surcharge Depth (ISD) =	0.33	ft
Total Available Detention Depth (H_{total}) =	6.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	

Initial Surcharge Area (A_{ISV}) =	1,753	ft^2
Surcharge Volume Length (L_{ISV}) =	41.9	ft
Surcharge Volume Width (W_{ISV}) =	41.9	ft
Depth of Basin Floor (H_{FLOOR}) =	4.78	ft
Length of Basin Floor (L_{FLOOR}) =	1,017.0	ft
Width of Basin Floor (W_{FLOOR}) =	519.9	ft
Area of Basin Floor (A_{FLOOR}) =	528,698	ft^2
Volume of Basin Floor (V_{FLOOR}) =	893,690	ft^3
Depth of Main Basin (H_{MAIN}) =	0.39	ft
Length of Main Basin (L_{MAIN}) =	1,020.1	ft
Width of Main Basin (W_{MAIN}) =	523.0	ft
Area of Main Basin (A_{MAIN}) =	533,503	ft^2
Volume of Main Basin (V_{MAIN}) =	207,128	ft^3
Calculated Total Basin Volume (V_{total}) =	**25.305**	acre-feet

Depth Increment = 0.50 ft

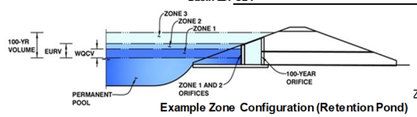
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		41.9	41.9	1,753		0.040		
ISV	0.33		41.9	41.9	1,753		0.040	578	0.013
	0.50		41.9	41.9	1,753		0.040	876	0.020
	1.00		76.5	58.9	4,506		0.103	1,970	0.045
	1.50		178.5	108.9	19,438		0.446	7,531	0.173
	2.00		280.5	158.9	44,570		1.023	23,108	0.530
	2.50		382.5	208.9	79,901		1.834	53,801	1.235
	3.00		484.5	258.9	125,433		2.880	104,710	2.404
	3.50		586.5	308.9	181,165		4.159	180,934	4.154
Zone 1 (WQCV)	3.57		600.8	315.9	189,781		4.357	193,916	4.452
	4.00		688.5	358.9	247,097		5.673	287,575	6.602
	4.50		790.5	408.9	323,229		7.420	429,731	9.865
Zone 2 (EURV)	4.90		872.1	448.9	391,478		8.987	572,455	13.142
	5.00		892.5	458.9	409,560		9.402	612,503	14.061
	5.50		994.5	508.9	506,092		11.618	840,991	19.307
Floor	5.61		1,017.0	519.9	528,698		12.137	897,900	20.613
Zone 3 (100-year)	6.00		1,020.1	523.0	533,503		12.248	1,105,029	25.368
	6.50		1,024.1	527.0	539,691		12.390	1,373,326	31.527
	7.00		1,028.1	531.0	545,912		12.532	1,644,725	37.758
	7.50		1,032.1	535.0	552,164		12.676	1,919,243	44.060
	8.00		1,036.1	539.0	558,448		12.820	2,196,895	50.434
	8.50		1,040.1	543.0	564,765		12.965	2,477,697	56.880
	9.00		1,044.1	547.0	571,113		13.111	2,761,665	63.399
	9.50		1,048.1	551.0	577,493		13.257	3,048,815	69.991
	10.00		1,052.1	555.0	583,906		13.405	3,339,164	76.657
	10.50		1,056.1	559.0	590,350		13.553	3,632,726	83.396
	11.00		1,060.1	563.0	596,827		13.701	3,929,519	90.209
	11.50		1,064.1	567.0	603,335		13.851	4,229,558	97.097
	12.00		1,068.1	571.0	609,875		14.001	4,532,859	104.060
	12.50		1,072.1	575.0	616,448		14.152	4,839,439	111.098
	13.00		1,076.1	579.0	623,052		14.303	5,149,312	118.212
	13.50		1,080.1	583.0	629,688		14.456	5,462,496	125.402
	14.00		1,084.1	587.0	636,357		14.609	5,779,006	132.668
	14.50		1,088.1	591.0	643,057		14.763	6,098,858	140.011
	15.00		1,092.1	595.0	649,790		14.917	6,422,069	147.430
	15.50		1,096.1	599.0	656,554		15.072	6,748,653	154.928
	16.00		1,100.1	603.0	663,350		15.228	7,078,628	162.503
	16.50		1,104.1	607.0	670,179		15.385	7,412,009	170.156
	17.00		1,108.1	611.0	677,039		15.543	7,748,812	177.888
	17.50		1,112.1	615.0	683,931		15.701	8,089,053	185.699
	18.00		1,116.1	619.0	690,856		15.860	8,432,749	193.589
	18.50		1,120.1	623.0	697,812		16.020	8,779,915	201.559
	19.00		1,124.1	627.0	704,801		16.180	9,130,566	209.609
	19.50		1,128.1	631.0	711,821		16.341	9,484,720	217.739
	20.00		1,132.1	635.0	718,873		16.503	9,842,393	225.950
	20.50		1,136.1	639.0	725,958		16.666	10,203,599	234.242
	21.00		1,140.1	643.0	733,074		16.829	10,568,356	242.616
	21.50		1,144.1	647.0	740,222		16.993	10,936,679	251.072
	22.00		1,148.1	651.0	747,403		17.158	11,308,584	259.609
	22.50		1,152.1	655.0	754,615		17.324	11,684,087	268.230
	23.00		1,156.1	659.0	761,860		17.490	12,063,204	276.933
	23.50		1,160.1	663.0	769,136		17.657	12,445,952	285.720
	24.00		1,164.1	667.0	776,444		17.825	12,832,346	294.590
	24.50		1,168.1	671.0	783,785		17.993	13,222,401	303.545
	25.00		1,172.1	675.0	791,157		18.162	13,616,136	312.583
	25.50		1,176.1	679.0	798,561		18.332	14,013,564	321.707
	26.00		1,180.1	683.0	805,998		18.503	14,414,702	330.916
	26.50		1,184.1	687.0	813,466		18.675	14,819,567	340.210
	27.00		1,188.1	691.0	820,967		18.847	15,228,174	349.591
	27.50		1,192.1	695.0	828,499		19.020	15,640,539	359.057
	28.00		1,196.1	699.0	836,063		19.193	16,056,678	368.611
	28.50		1,200.1	703.0	843,660		19.368	16,476,608	378.251
	29.00		1,204.1	707.0	851,288		19.543	16,900,343	387.978
	29.50		1,208.1	711.0	858,949		19.719	17,327,901	397.794
	30.00		1,212.1	715.0	866,641		19.895	17,759,297	407.697

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greely - Oklahoma Basin

Basin ID: 814



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.57	4.426	Orifice Plate	Orifice Plate
Zone 2 (EURV)	4.90	8.689	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 3 (100-year)	6.00	12.181	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Total (all zones)		25.297		

Clear Input Parameters (Including Tables)

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

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

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)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	8.458E-02	ft^2
Depth at top of Zone using Orifice Plate =	3.57	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	14.30	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	12.18	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.19	2.38					
Orifice Area (sq. inches)	12.18	12.18	12.18					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected		Calculated Parameters for Vertical Orifice	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	3.57	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.30	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	4.90	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.08	N/A	feet
Vertical Orifice Height =	2.00	N/A	inches				
Vertical Orifice Width =	21.39		inches				

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.90	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	8.23	N/A	feet
Overflow Weir Front Edge Length =	425.00	N/A	feet	Overflow Weir Slope Length =	10.54	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	103.59	N/A	
Horiz. Length of Weir Sides =	10.00	N/A	feet	Overflow Grate Open Area w/o Debris =	3118.01	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	1559.00	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	30.10	N/A	ft^2
Outlet Pipe Diameter =	90.00	N/A	inches	Outlet Orifice Centroid =	2.73	N/A	feet
Restrictor Plate Height Above Pipe Invert =	58.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.86	N/A	radians

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	6.15	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	2.45	feet
Spillway Crest Length =	50.00	feet	Stage at Top of Freeboard =	9.60	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	13.29	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	71.32	acre-ft

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

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	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	4.426	13.115	8.993	13.071	17.845	26.911	34.919	44.551	70.739
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	8.993	13.071	17.845	26.911	34.919	44.551	70.739
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.8	18.6	53.2	142.5	207.1	292.7	502.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.09	0.25	0.68	0.98	1.39	2.39
Peak Inflow Q (cfs) =	N/A	N/A	128.0	185.8	251.8	403.9	521.3	666.8	1040.9
Peak Outflow Q (cfs) =	1.8	3.9	3.3	3.8	30.3	105.6	175.2	277.6	445.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.6	0.7	0.8	0.9	0.9
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.0	0.1	0.1	0.1
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) =	38	68	57	69	71	69	66	63	57
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	60	73	77	76	75	73	70
Maximum Ponding Depth (ft) =	3.57	4.90	4.30	4.82	5.15	5.52	5.77	6.09	7.04
Area at Maximum Ponding Depth (acres) =	4.36	8.99	6.69	8.62	10.04	11.66	12.18	12.27	12.54
Maximum Volume Stored (acre-ft) =	4.452	13.142	8.455	12.349	15.519	19.423	22.559	26.471	38.259

Appendix E-3
HY-8 Culvert Sizing

Culvert Data: Structure#101

Site Data - Structure#101

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4778.22 ft
Outlet Station: 52.00 ft
Outlet Elevation: 4777.89 ft
Number of Barrels: 3

Culvert Data Summary - Structure#101

Barrel Shape: Concrete Box
Barrel Span: 12.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 21 - Culvert Summary Table: Structure#101

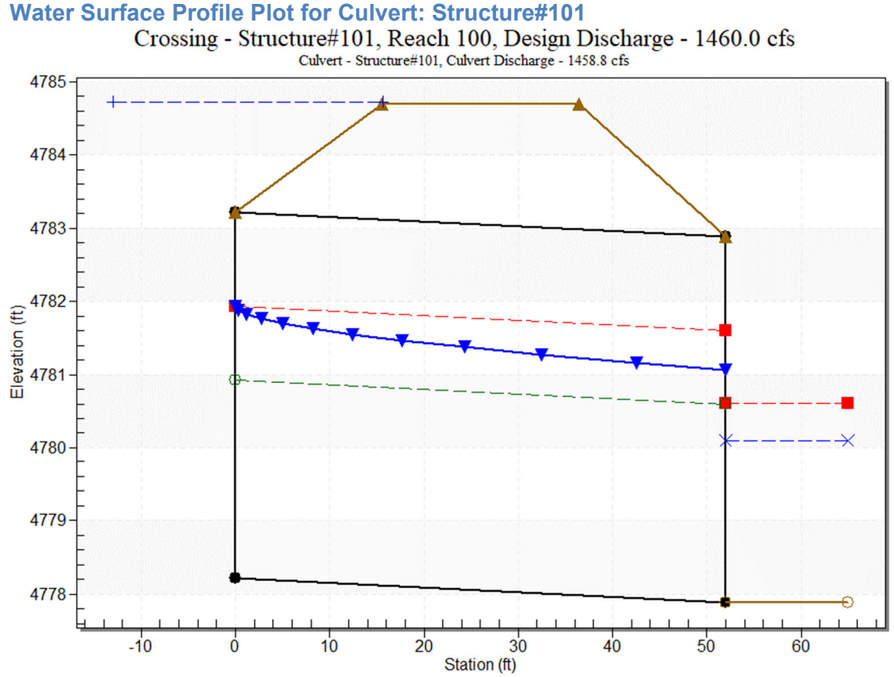
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	5.18 cfs	5.18 cfs	4778.37	0.15	0.0*	1-JS1t	0.06	0.09	0.27	0.27	0.54	2.44
100 Year	1460.00	1458.85	4784.72	6.50	5.012	5-S2n	2.71	3.71	3.17	2.20	12.78	10.02
	O_100 cfs	cfs										

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4778.22 ft,
Outlet Elevation (invert): 4777.89 ft
Culvert Length: 52.00 ft,
Culvert Slope: 0.0063

Water Surface Profile Plot for Culvert: Structure#101



Tailwater Data for Crossing: Structure#101, Option 1 and 3

Table 22 - Downstream Channel Rating Curve (Crossing: Structure#101, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
5.18	4778.16	0.27	2.44	0.38	1.18
1460.00	4780.09	2.20	10.02	3.16	1.68

Tailwater Channel Data - Structure#101, Option 1 and 3

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 30.00 (_:1)
Channel Slope: 0.0230
Channel Manning's n: 0.0240
Channel Invert Elevation: 4777.89 ft

Roadway Data for Crossing: Structure#101, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4784.70 ft
Roadway Surface: Paved
Roadway Top Width: 21.00 ft

Culvert Data: Structure#102

Site Data - Structure#102

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4782.03 ft
Outlet Station: 60.00 ft
Outlet Elevation: 4781.65 ft
Number of Barrels: 2

Culvert Data Summary - Structure#102

Barrel Shape: Concrete Box
Barrel Span: 10.00 ft
Barrel Rise: 6.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

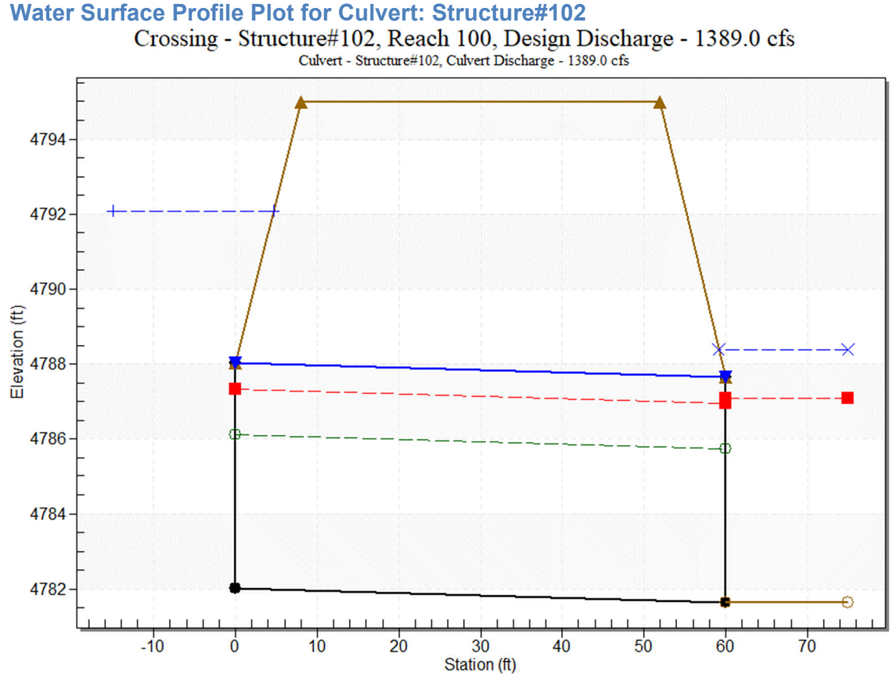
Table 19 - Culvert Summary Table: Structure#102

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	6.28 cfs	6.28 cfs	4782.55	0.25	0.516	1-S1t	0.11	0.15	0.89	0.89	0.35	1.59
100-YR	1389.00	1389.00	4792.08	10.05	9.700	4-FFf	4.09	5.31	6.00	6.73	11.57	6.13
Junction_113	cfs	cfs										

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4782.03 ft,
Outlet Elevation (invert): 4781.65 ft
Culvert Length: 60.00 ft,
Culvert Slope: 0.0063

Water Surface Profile Plot for Culvert: Structure#102



Tailwater Data for Crossing: Structure#102, Option 1 and 3

Table 20 - Downstream Channel Rating Curve (Crossing: Structure#102, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
6.28	4782.54	0.89	1.59	0.39	0.42
1389.00	4788.38	6.73	6.13	2.94	0.59

Tailwater Channel Data - Structure#102, Option 1 and 3

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 5.00 (_:1)
Channel Slope: 0.0070
Channel Manning's n: 0.0450
Channel Invert Elevation: 4781.65 ft

Roadway Data for Crossing: Structure#102, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4794.98 ft
Roadway Surface: Paved
Roadway Top Width: 44.00 ft

Culvert Data: Structure#103

Site Data - Structure#103

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4864.72 ft
Outlet Station: 295.00 ft
Outlet Elevation: 4858.55 ft
Number of Barrels: 1

Culvert Data Summary - Structure#103

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 13 - Culvert Summary Table: Structure#103

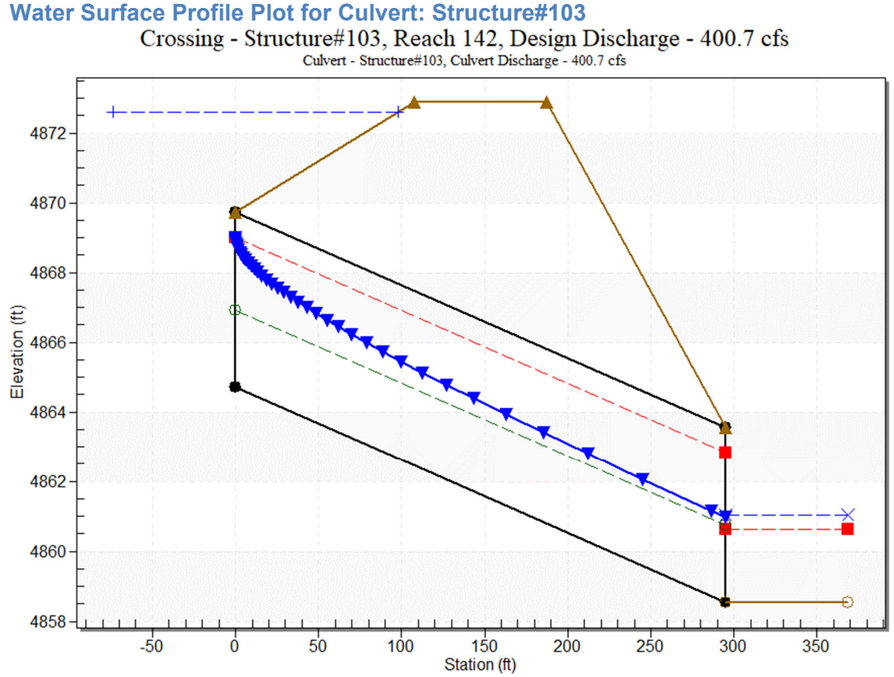
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	85.77 cfs	85.77 cfs	4867.29	2.57	0.0*	1-S2n	0.79	1.53	0.80	1.18	13.34	3.21
100 Year_L_149	400.70 cfs	400.70 cfs	4872.61	7.89	1.884	5-S2n	2.21	4.27	2.41	2.48	20.75	4.86

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4864.72 ft,
Outlet Elevation (invert): 4858.55 ft
Culvert Length: 295.06 ft,
Culvert Slope: 0.0209

Water Surface Profile Plot for Culvert: Structure#103



Tailwater Data for Crossing: Structure#103, Option 1 and 3

Table 14 - Downstream Channel Rating Curve (Crossing: Structure#103, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
85.77	4859.73	1.18	3.21	0.91	0.62
400.70	4861.03	2.48	4.86	1.91	0.69

Tailwater Channel Data - Structure#103, Option 1 and 3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 12.70 ft
Side Slope (H:V): 8.30 (_:1)
Channel Slope: 0.0123
Channel Manning's n: 0.0450
Channel Invert Elevation: 4858.55 ft

Roadway Data for Crossing: Structure#103, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4872.88 ft
Roadway Surface: Paved
Roadway Top Width: 80.00 ft

Culvert Data: Structure#104

Site Data - Structure#104

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4921.39 ft
Outlet Station: 127.00 ft
Outlet Elevation: 4919.92 ft
Number of Barrels: 1

Culvert Data Summary - Structure#104

Barrel Shape: Concrete Box
Barrel Span: 10.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

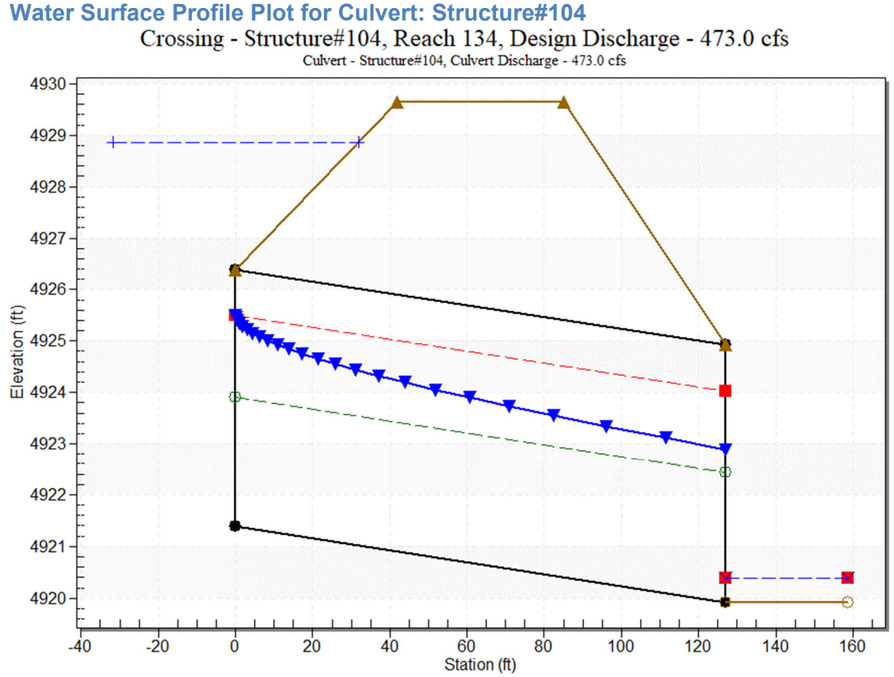
Table 11 - Culvert Summary Table: Structure#104

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	124.36 cfs	124.36 cfs	4924.24	2.85	0.387	1-S2n	1.03	1.69	1.10	0.26	11.26	2.12
100 Year, L_133	473.00 cfs	473.00 cfs	4928.86	7.47	5.543	5-S2n	2.51	4.11	2.97	0.47	15.94	3.00

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4921.39 ft,
Outlet Elevation (invert): 4919.92 ft
Culvert Length: 127.01 ft,
Culvert Slope: 0.0116

Water Surface Profile Plot for Culvert: Structure#104



Tailwater Data for Crossing: Structure#104, Option 1 and 3

Table 12 - Downstream Channel Rating Curve (Crossing: Structure#104, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
124.36	4920.18	0.26	2.12	0.74	0.92
473.00	4920.39	0.47	3.00	1.35	1.01

Tailwater Channel Data - Structure#104, Option 1 and 3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 100.00 ft
Side Slope (H:V): 500.00 (_:1)
Channel Slope: 0.0460
Channel Manning's n: 0.0450
Channel Invert Elevation: 4919.92 ft

Roadway Data for Crossing: Structure#104, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4929.64 ft
Roadway Surface: Paved
Roadway Top Width: 43.00 ft

Culvert Data: Structure#105

Site Data - Structure#105

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4844.62 ft
Outlet Station: 88.00 ft
Outlet Elevation: 4840.85 ft
Number of Barrels: 1

Culvert Data Summary - Structure#105

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting (Ke=0.9)
Inlet Depression: None

Table 17 - Culvert Summary Table: Structure#105

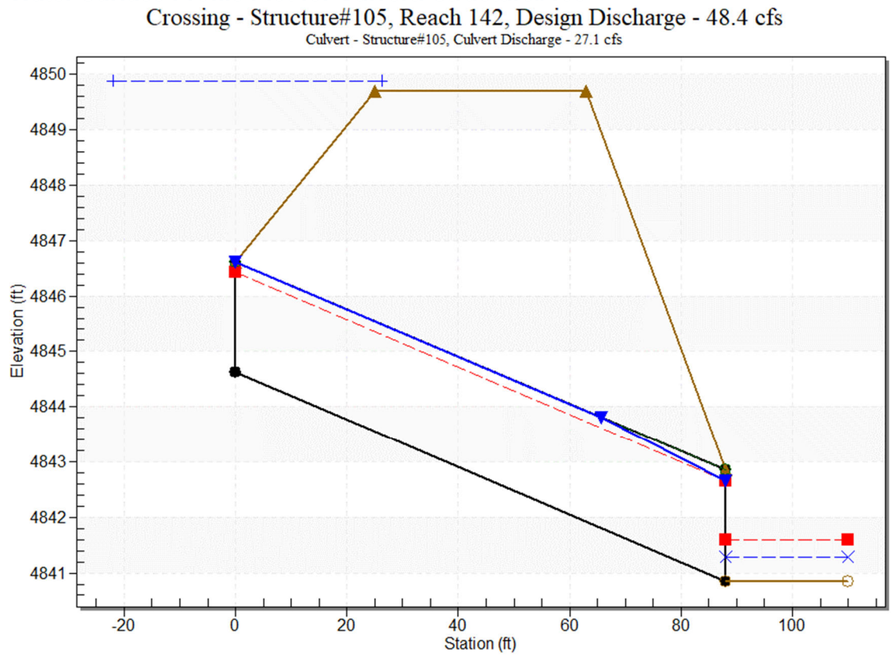
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	7.46 cfs	7.46 cfs	4846.09	1.47	0.0*	1-S2n	0.74	0.97	0.74	0.15	7.03	4.54
100 Year	48.41 cfs	27.12 cfs	4849.88	5.26	4.585	7-M2c	2.00	1.81	1.81	0.43	9.07	8.54

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4844.62 ft,
Outlet Elevation (invert): 4840.85 ft
Culvert Length: 88.08 ft,
Culvert Slope: 0.0428

Water Surface Profile Plot for Culvert: Structure#105



Tailwater Data for Crossing: Structure#105, Option 1 and 3

Table 18 - Downstream Channel Rating Curve (Crossing: Structure#105, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
7.46	4841.00	0.15	4.54	2.51	2.17
48.41	4841.28	0.43	8.54	7.32	2.54

Tailwater Channel Data - Structure#105, Option 1 and 3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 7.00 (_:1)
Channel Slope: 0.2700
Channel Manning's n: 0.0450
Channel Invert Elevation: 4840.85 ft

Roadway Data for Crossing: Structure#105, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4849.70 ft
Roadway Surface: Paved
Roadway Top Width: 38.00 ft

Culvert Data: Structure#106

Site Data - Structure#106

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4870.42 ft
Outlet Station: 100.00 ft
Outlet Elevation: 4867.47 ft
Number of Barrels: 1

Culvert Data Summary - Structure#106

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

Table 15 - Culvert Summary Table: Structure#106

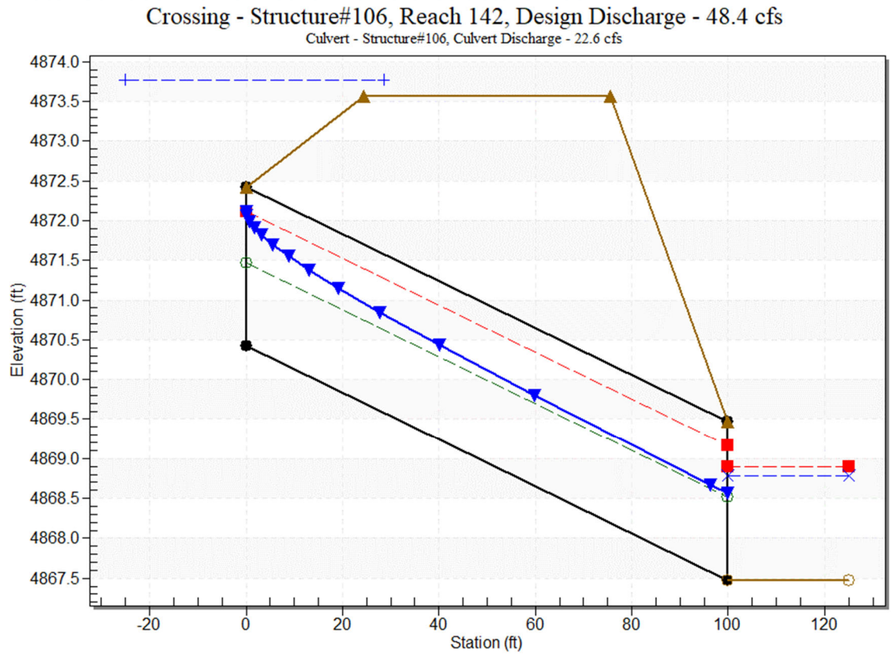
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5	1.74 cfs	1.74 cfs	4871.03	0.61	0.0*	1-S2n	0.28	0.46	0.28	0.37	6.63	2.48
100	48.41 cfs	22.55 cfs	4873.76	3.34	0.941	5-S2n	1.04	1.69	1.09	1.30	12.87	5.69

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4870.42 ft,
Outlet Elevation (invert): 4867.47 ft
Culvert Length: 100.04 ft,
Culvert Slope: 0.0295

Water Surface Profile Plot for Culvert: Structure#106



Tailwater Data for Crossing: Structure#106, Option 1 and 3

Table 16 - Downstream Channel Rating Curve (Crossing: Structure#106, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
1.74	4867.85	0.37	2.48	1.26	1.01
48.41	4868.78	1.30	5.69	4.39	1.24

Tailwater Channel Data - Structure#106, Option 1 and 3

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 5.00 (_:1)
Channel Slope: 0.0540
Channel Manning's n: 0.0450
Channel Invert Elevation: 4867.47 ft

Roadway Data for Crossing: Structure#106, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4873.57 ft
Roadway Surface: Paved
Roadway Top Width: 51.00 ft

Culvert Data: Structure#107

Site Data - Structure#107

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4970.37 ft
Outlet Station: 228.00 ft
Outlet Elevation: 4967.06 ft
Number of Barrels: 1

Culvert Data Summary - Structure#107

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

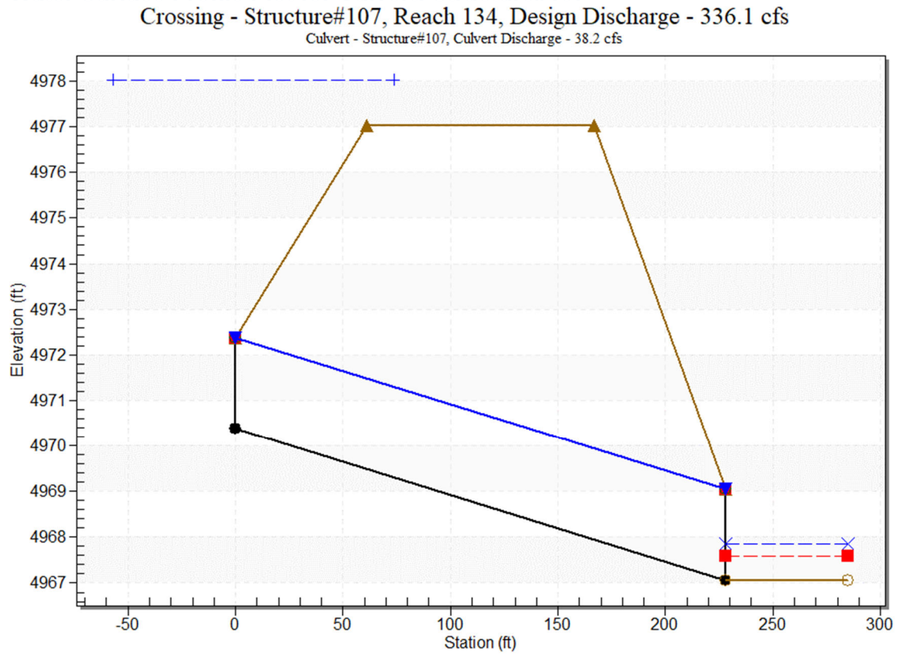
Table 9 - Culvert Summary Table: Structure#107

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	101.20 cfs	36.84 cfs	4977.39	6.84	7.018	7-M2c	2.00	1.69	1.69	0.48	13.00	1.08
100 Year	336.11 cfs	38.21 cfs	4978.02	7.29	7.648	6-FFc	2.00	2.00	2.00	0.79	12.16	1.47

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4970.37 ft,
Outlet Elevation (invert): 4967.06 ft
Culvert Length: 228.02 ft,
Culvert Slope: 0.0145

Water Surface Profile Plot for Culvert: Structure#107



Tailwater Data for Crossing: Structure#107, Option 1 and 3

Table 10 - Downstream Channel Rating Curve (Crossing: Structure#107, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
101.20	4967.54	0.48	1.08	0.18	0.36
336.11	4967.85	0.79	1.47	0.30	0.39

Tailwater Channel Data - Structure#107, Option 1 and 3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 302.00 (_:1)
Channel Slope: 0.0060
Channel Manning's n: 0.0450
Channel Invert Elevation: 4967.06 ft

Roadway Data for Crossing: Structure#107, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4977.03 ft
Roadway Surface: Paved
Roadway Top Width: 106.00 ft

Culvert Data: Structure#108

Site Data - Structure#108

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4982.36 ft
Outlet Station: 76.00 ft
Outlet Elevation: 4981.67 ft
Number of Barrels: 1

Culvert Data Summary - Structure#108

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

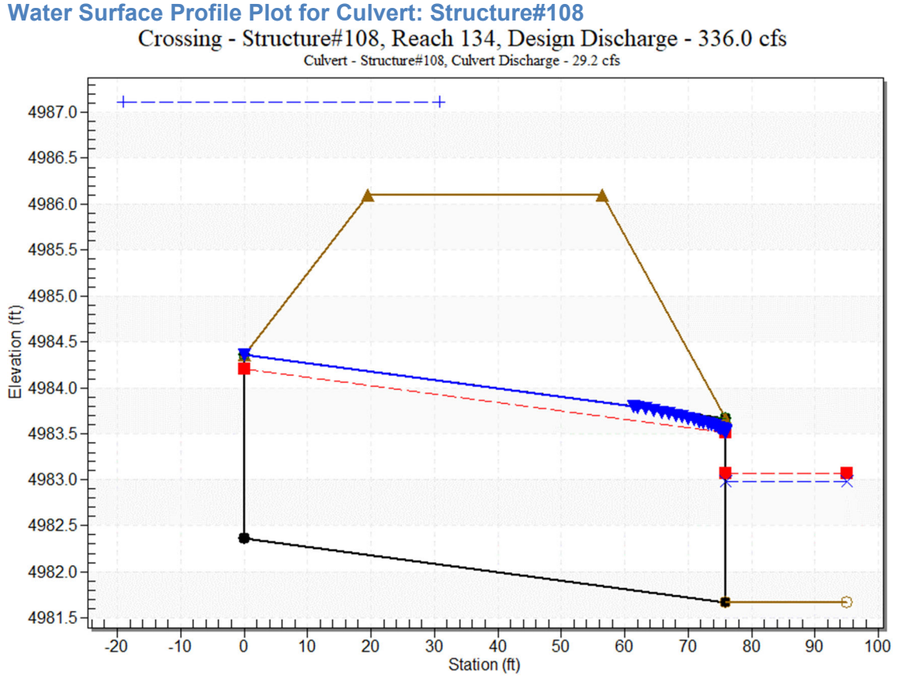
Table 7 - Culvert Summary Table: Structure#108

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5	101.00 cfs	26.47 cfs	4986.49	4.13	3.701	7-M2c	2.00	1.80	1.80	0.72	8.90	4.25
100	336.00 cfs	29.18 cfs	4987.11	4.75	4.317	7-M2c	2.00	1.85	1.85	1.31	9.62	5.91

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4982.36 ft,
Outlet Elevation (invert): 4981.67 ft
Culvert Length: 76.00 ft,
Culvert Slope: 0.0091

Water Surface Profile Plot for Culvert: Structure#108



Tailwater Data for Crossing: Structure#108, Option 1 and 3

Table 8 - Downstream Channel Rating Curve (Crossing: Structure#108, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
101.00	4982.39	0.72	4.25	1.80	1.04
336.00	4982.98	1.31	5.91	3.26	1.13

Tailwater Channel Data - Structure#108, Option 1 and 3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 20.00 ft
Side Slope (H:V): 18.00 (_:1)
Channel Slope: 0.0400
Channel Manning's n: 0.0450
Channel Invert Elevation: 4981.67 ft

Roadway Data for Crossing: Structure#108, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4986.10 ft
Roadway Surface: Paved
Roadway Top Width: 37.00 ft

Culvert Data: Structure#109

Site Data - Structure#109

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4982.18 ft
Outlet Station: 137.00 ft
Outlet Elevation: 4978.92 ft
Number of Barrels: 1

Culvert Data Summary - Structure#109

Barrel Shape: Circular
Barrel Diameter: 2.50 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

Table 5 - Culvert Summary Table: Structure#109

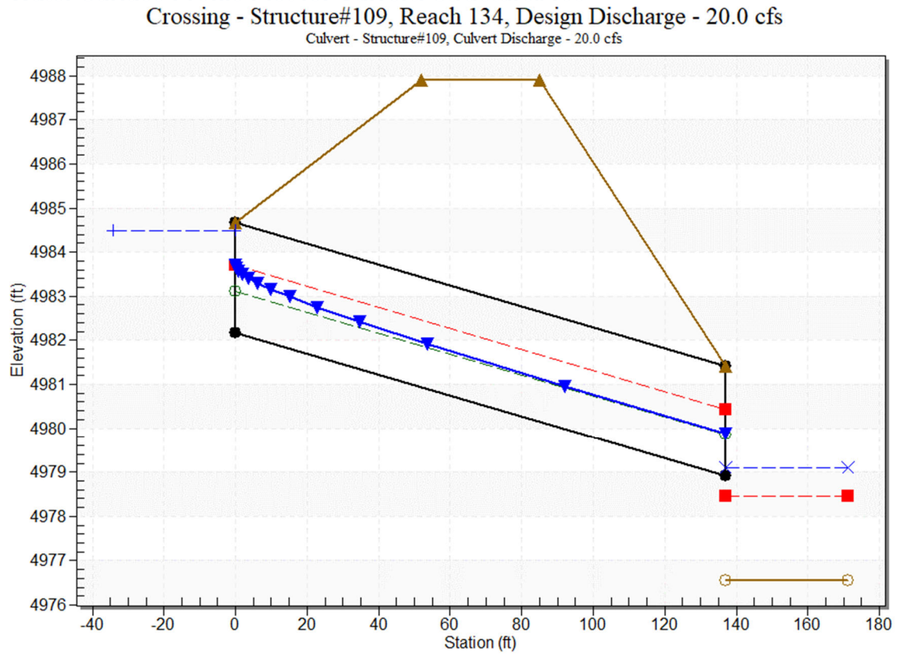
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	5.00 cfs	5.00 cfs	4983.17	1.00	0.0*	1-S2n	0.46	0.74	0.46	1.51	8.16	2.20
100 Year	20.00 cfs	20.00 cfs	4984.47	2.30	0.0*	1-S2n	0.92	1.52	0.96	2.53	11.60	3.11

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4982.18 ft,
Outlet Elevation (invert): 4978.92 ft
Culvert Length: 137.04 ft,
Culvert Slope: 0.0238

Water Surface Profile Plot for Culvert: Structure#109



Tailwater Data for Crossing: Structure#109, Option 1 and 3

Table 6 - Downstream Channel Rating Curve (Crossing: Structure#109, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
5.00	4978.06	1.51	2.20	0.97	0.45
20.00	4979.09	2.53	3.11	1.63	0.49

Tailwater Channel Data - Structure#109, Option 1 and 3

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 1.00 (_:1)
Channel Slope: 0.0103
Channel Manning's n: 0.0450
Channel Invert Elevation: 4976.56 ft

Roadway Data for Crossing: Structure#109, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4987.90 ft
Roadway Surface: Paved
Roadway Top Width: 33.00 ft

Culvert Data: Structure#201

Site Data - Structure#201

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4761.52 ft
Outlet Station: 30.46 ft
Outlet Elevation: 4760.40 ft
Number of Barrels: 3

Culvert Data Summary - Structure#201

Barrel Shape: Concrete Box
Barrel Span: 12.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 35 - Culvert Summary Table: Structure#201

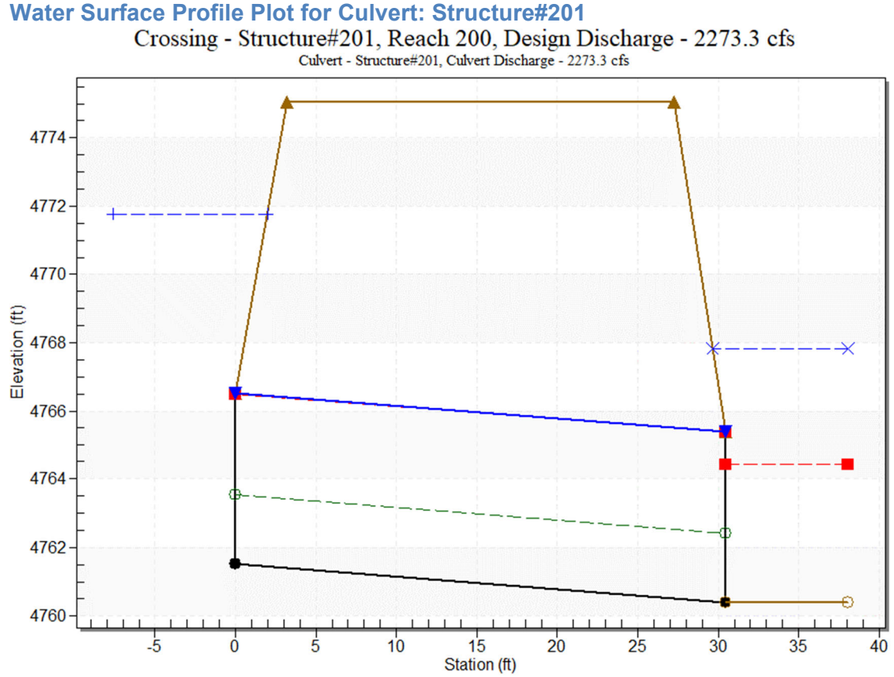
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	5.00 cfs	5.00 cfs	4761.66	0.14	0.0*	1-S2n	0.02	0.08	0.02	0.23	5.96	0.54
100 Year	2273.28	2273.28	4771.75	10.23	10.176	4-FFf	2.02	4.98	5.00	7.43	12.63	4.39
O_220	cfs	cfs										

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4761.52 ft,
Outlet Elevation (invert): 4760.40 ft
Culvert Length: 30.48 ft,
Culvert Slope: 0.0368

Water Surface Profile Plot for Culvert: Structure#201



Tailwater Data for Crossing: Structure#201, Option 1 and 3

Table 36 - Downstream Channel Rating Curve (Crossing: Structure#201, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
5.00	4760.63	0.23	0.54	0.03	0.20
2273.28	4767.83	7.43	4.39	0.93	0.34

Tailwater Channel Data - Structure#201, Option 1 and 3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 40.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0020
Channel Manning's n: 0.0450
Channel Invert Elevation: 4760.40 ft

Roadway Data for Crossing: Structure#201, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4775.04 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

Culvert Data: Structure#202

Site Data - Structure#202

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4949.72 ft
Outlet Station: 100.00 ft
Outlet Elevation: 4944.32 ft
Number of Barrels: 1

Culvert Data Summary - Structure#202

Barrel Shape: Concrete Box
Barrel Span: 6.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

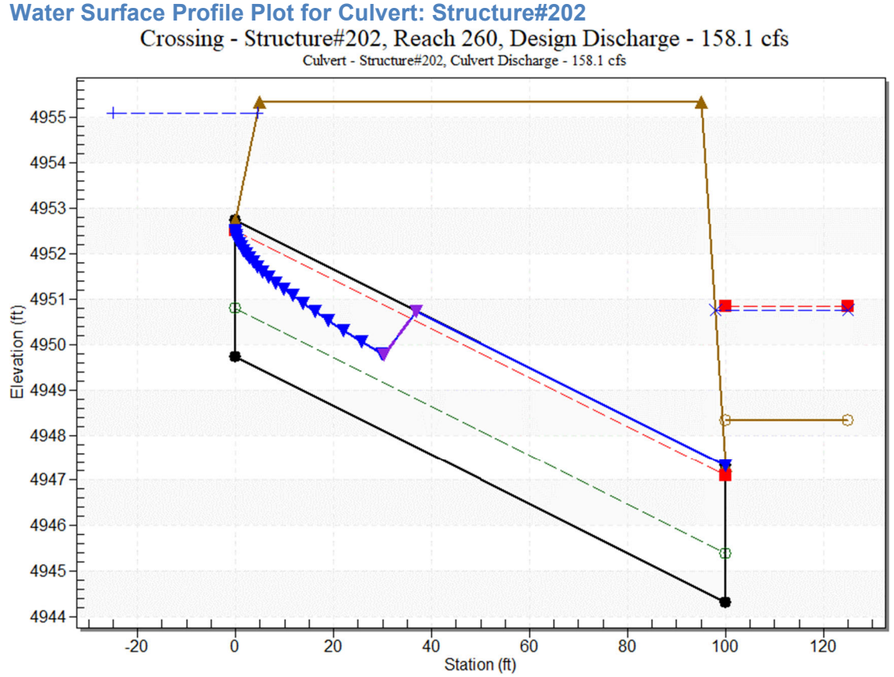
Table 3 - Culvert Summary Table: Structure#202

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5	40.39 cfs	40.39 cfs	4951.55	1.83	0.052	1-JS1f	0.44	1.12	3.00	1.31	2.24	5.11
100	158.12 cfs	158.12 cfs	4955.08	5.36	3.309	5-JS1f	1.07	2.78	3.00	2.41	8.78	7.64

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4949.72 ft,
Outlet Elevation (invert): 4944.32 ft
Culvert Length: 100.15 ft,
Culvert Slope: 0.0540

Water Surface Profile Plot for Culvert: Structure#202



Tailwater Data for Crossing: Structure#202, Option 1 and 3

Table 4 - Downstream Channel Rating Curve (Crossing: Structure#202, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
40.39	4949.63	1.31	5.11	2.68	0.99
158.12	4950.74	2.41	7.64	4.96	1.08

Tailwater Channel Data - Structure#202, Option 1 and 3

Tailwater Channel Option: Irregular Channel
Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	4962.30	0.0450
2	3.23	4962.09	0.0450
3	6.47	4961.86	0.0450
4	9.70	4961.61	0.0450
5	12.93	4961.41	0.0450
6	16.17	4961.22	0.0450
7	19.40	4960.97	0.0450
8	22.64	4960.70	0.0450

9	25.87	4960.41	0.0450
10	29.10	4960.10	0.0450
11	32.34	4959.84	0.0450
12	35.57	4959.59	0.0450
13	38.80	4959.34	0.0450
14	42.04	4959.06	0.0450
15	45.27	4958.74	0.0450
16	48.50	4958.41	0.0450
17	51.74	4958.07	0.0450
18	54.97	4957.68	0.0450
19	58.20	4957.27	0.0450
20	61.44	4956.89	0.0450
21	64.67	4956.54	0.0450
22	67.91	4956.23	0.0450
23	71.14	4955.85	0.0450
24	74.37	4955.38	0.0450
25	77.61	4954.97	0.0450
26	80.84	4954.70	0.0450
27	84.07	4954.43	0.0450
28	87.31	4954.23	0.0450
29	90.54	4954.07	0.0450
30	93.77	4953.94	0.0450
31	97.01	4953.82	0.0450
32	100.24	4953.72	0.0450
33	103.47	4953.55	0.0450
34	106.71	4953.08	0.0450
35	109.94	4952.92	0.0450
36	113.17	4953.12	0.0450
37	116.41	4951.97	0.0450
38	119.64	4950.01	0.0450
39	122.88	4948.73	0.0450
40	126.11	4948.32	0.0450
41	129.34	4949.03	0.0450
42	132.58	4951.36	0.0450
43	135.81	4953.47	0.0450
44	139.04	4955.07	0.0450
45	142.28	4956.11	0.0450
46	145.51	4956.75	0.0450
47	148.75	4956.69	0.0450
48	151.98	4955.86	0.0450
49	155.21	4954.91	0.0450
50	158.45	4954.71	0.0450
51	161.68	4954.76	0.0450
52	164.91	4954.65	0.0450
53	168.15	4954.77	0.0450
54	171.38	4955.49	0.0450
55	174.61	4956.04	0.0450
56	177.85	4956.47	0.0450
57	181.08	4957.05	0.0450
58	184.31	4957.49	0.0450
59	187.55	4957.86	0.0450
60	190.78	4958.15	0.0450
61	194.01	4958.40	0.0450
62	197.25	4958.70	0.0450
63	200.48	4958.98	0.0450
64	203.72	4959.11	0.0450
65	206.95	4959.15	0.0450
66	210.18	4959.21	0.0450
67	213.42	4959.31	0.0450
68	216.65	4959.39	0.0450
69	219.88	4959.50	0.0450
70	223.12	4959.56	0.0000

Roadway Data for Crossing: Structure#202, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4955.33 ft
Roadway Surface: Gravel
Roadway Top Width: 90.00 ft

Culvert Data: Structure#203

Site Data - Structure#203

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4979.58 ft
Outlet Station: 327.00 ft
Outlet Elevation: 4970.79 ft
Number of Barrels: 1

Culvert Data Summary - Structure#203

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

Table 1 - Culvert Summary Table: Structure#203

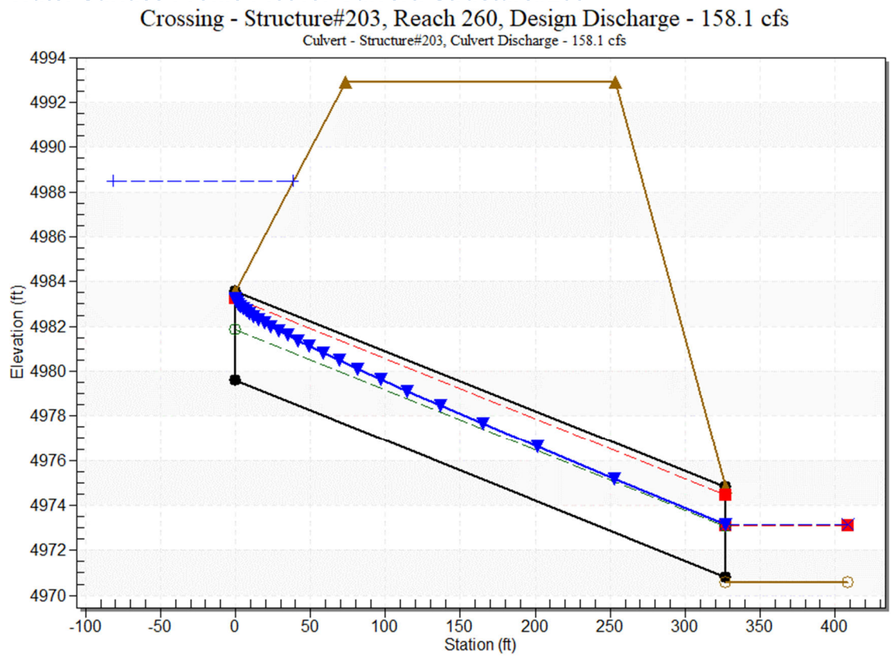
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5-year	40.39 cfs	40.39 cfs	4982.30	2.72	0.0*	1-S2n	1.07	1.90	1.07	1.52	14.86	4.35
100-year	158.12 cfs	158.12 cfs	4988.47	8.89	2.083	5-S2n	2.28	3.65	2.36	2.54	20.51	6.12

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4979.58 ft,
Outlet Elevation (invert): 4970.79 ft
Culvert Length: 327.12 ft,
Culvert Slope: 0.0269

Water Surface Profile Plot for Culvert: Structure#203



Tailwater Data for Crossing: Structure#203, Option 1 and 3

Table 2 - Downstream Channel Rating Curve (Crossing: Structure#203, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
40.39	4972.10	1.52	4.35	2.47	0.88
158.12	4973.12	2.54	6.12	4.12	0.96

Tailwater Channel Data - Structure#203, Option 1 and 3

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0260
Channel Manning's n: 0.0450
Channel Invert Elevation: 4970.58 ft

Roadway Data for Crossing: Structure#203, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4992.89 ft
Roadway Surface: Paved
Roadway Top Width: 180.00

Culvert Data: Structure#301

Site Data - Structure#301

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4786.49 ft
Outlet Station: 35.60 ft
Outlet Elevation: 4786.34 ft
Number of Barrels: 1

Culvert Data Summary - Structure#301

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 33 - Culvert Summary Table: Structure#301

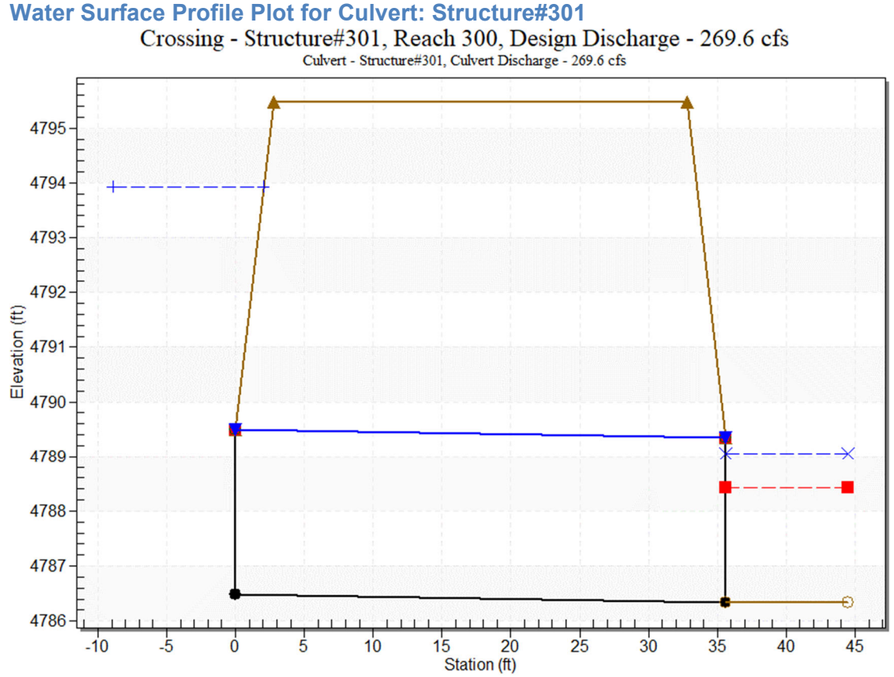
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	23.55 cfs	23.55 cfs	4787.59	1.10	0.649	1-JS1t	0.58	0.65	0.78	0.78	3.80	2.25
100 Year	269.56 cfs	269.56 cfs	4793.92	7.43	6.048	6-FFc	3.00	3.00	3.00	2.71	11.23	4.49

Junction_309

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4786.49 ft,
Outlet Elevation (invert): 4786.34 ft
Culvert Length: 35.60 ft,
Culvert Slope: 0.0042

Water Surface Profile Plot for Culvert: Structure#301



Tailwater Data for Crossing: Structure#301, Option 1 and 3

Table 34 - Downstream Channel Rating Curve (Crossing: Structure#301, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
23.55	4787.12	0.78	2.25	0.44	0.51
269.56	4789.05	2.71	4.49	1.52	0.60

Tailwater Channel Data - Structure#301, Option 1 and 3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 4.50 (_:1)
Channel Slope: 0.0090
Channel Manning's n: 0.0450
Channel Invert Elevation: 4786.34 ft

Roadway Data for Crossing: Structure#301, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4795.47 ft
Roadway Surface: Gravel
Roadway Top Width: 30.00 ft

Culvert Data: Structure#501

Site Data - Structure#501

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4824.39 ft
Outlet Station: 88.00 ft
Outlet Elevation: 4816.39 ft
Number of Barrels: 1

Culvert Data Summary - Structure#501

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 23 - Culvert Summary Table: Structure#501

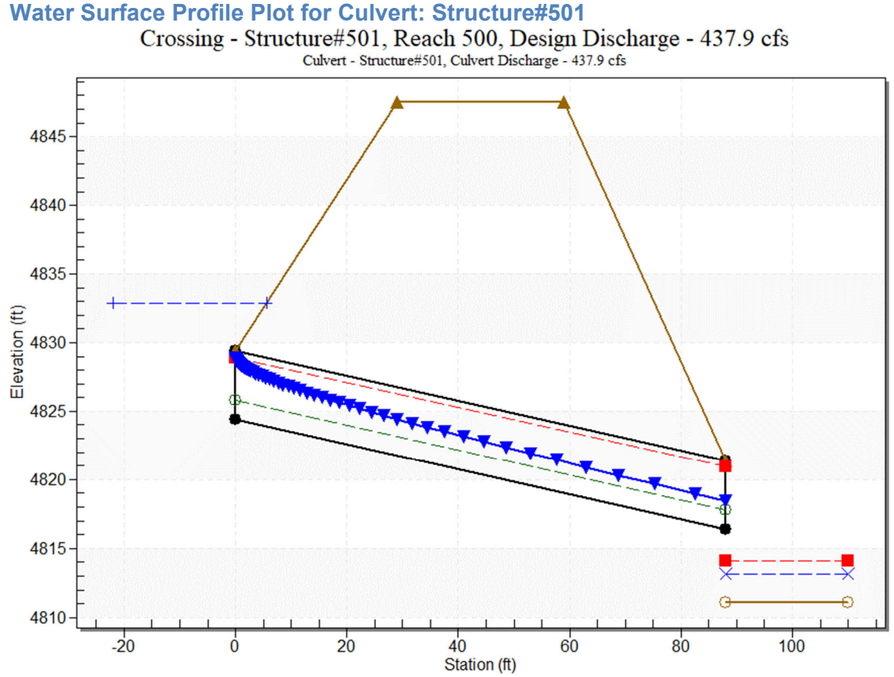
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	19.99 cfs	19.99 cfs	4825.30	0.91	0.0*	1-S2n	0.19	0.58	0.19	0.64	12.84	7.02
100 Year - L_513	437.88 cfs	437.88 cfs	4832.89	8.50	0.0*	5-S2n	1.42	4.53	2.05	2.03	26.74	15.18

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4824.39 ft,
Outlet Elevation (invert): 4816.39 ft
Culvert Length: 88.36 ft,
Culvert Slope: 0.0909

Water Surface Profile Plot for Culvert: Structure#501



Tailwater Data for Crossing: Structure#501, Option 1 and 3

Table 24 - Downstream Channel Rating Curve (Crossing: Structure#501, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
19.99	4811.74	0.64	7.02	8.36	2.19
437.88	4813.13	2.03	15.18	26.60	2.66

Tailwater Channel Data - Structure#501, Option 1 and 3

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 7.00 (_:1)
Channel Slope: 0.2100
Channel Manning's n: 0.0450
Channel Invert Elevation: 4811.10 ft

Roadway Data for Crossing: Structure#501, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4847.50 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Culvert Data: Structure#601

Site Data - Structure#601

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4827.99 ft
Outlet Station: 120.50 ft
Outlet Elevation: 4825.15 ft
Number of Barrels: 1

Culvert Data Summary - Structure#601

Barrel Shape: Concrete Box
Barrel Span: 10.00 ft
Barrel Rise: 6.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 31 - Culvert Summary Table: Structure#601

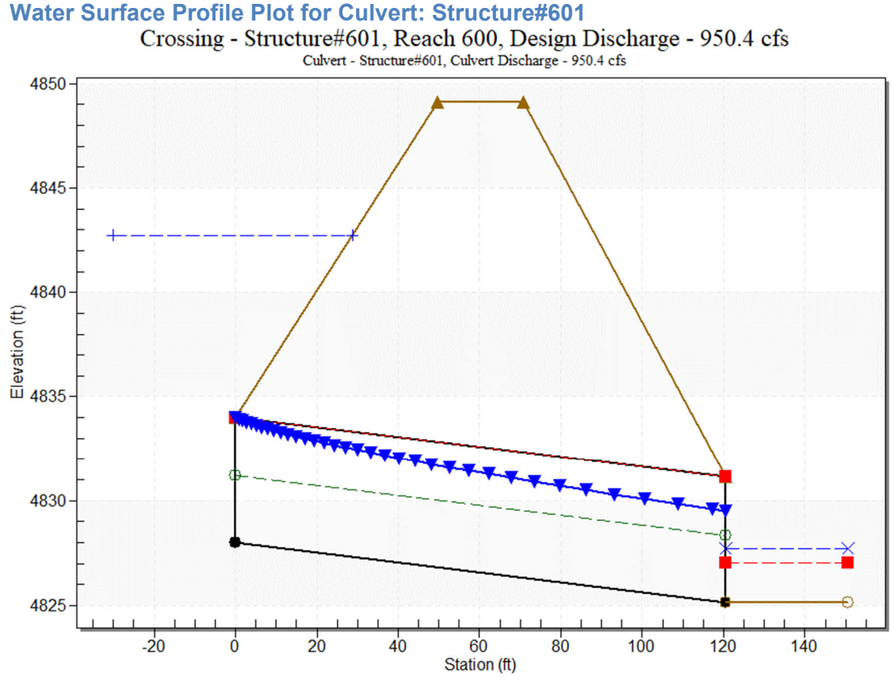
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	17.62 cfs	17.62 cfs	4828.76	0.77	0.0*	1-S2n	0.24	0.46	0.24	0.31	7.45	1.20
100 Year - Junction 609	950.35 cfs	950.35 cfs	4842.74	14.75	9.852	5-S2n	3.20	6.00	4.33	2.54	21.93	3.92

* Full Flow Headwater elevation is below inlet invert
.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4827.99 ft,
Outlet Elevation (invert): 4825.15 ft
Culvert Length: 120.53 ft,
Culvert Slope: 0.0236

Water Surface Profile Plot for Culvert: Structure#601



Tailwater Data for Crossing: Structure#601, Option 1 and 3

Table 32 - Downstream Channel Rating Curve (Crossing: Structure#601, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
17.62	4825.46	0.31	1.20	0.15	0.41
950.35	4827.69	2.54	3.92	1.19	0.55

Tailwater Channel Data - Structure#601, Option 1 and 3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 40.00 ft
Side Slope (H:V): 21.90 (_:1)
Channel Slope: 0.0075
Channel Manning's n: 0.0450
Channel Invert Elevation: 4825.15 ft

Roadway Data for Crossing: Structure#601, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4849.11 ft
Roadway Surface: Gravel
Roadway Top Width: 21.00 ft

Culvert Data: Structure#602

Site Data - Structure#602

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4832.33 ft
Outlet Station: 41.00 ft
Outlet Elevation: 4832.02 ft
Number of Barrels: 2

Culvert Data Summary - Structure#602

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

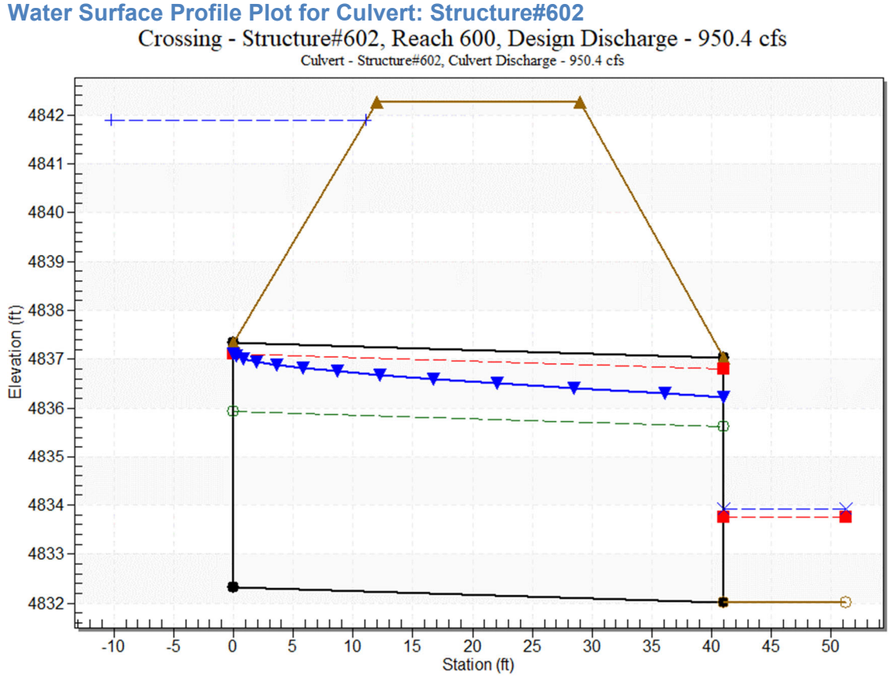
Table 27 - Culvert Summary Table: Structure#602

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	17.62 cfs	17.62 cfs	4832.90	0.57	0.026	1-S2n	0.26	0.34	0.26	0.21	4.23	1.52
100-YR, Junction_609	950.35 cfs	950.35 cfs	4841.89	9.56	8.081	5-S2n	3.60	4.79	4.21	1.91	14.11	5.53

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4832.33 ft,
Outlet Elevation (invert): 4832.02 ft
Culvert Length: 41.00 ft,
Culvert Slope: 0.0076

Water Surface Profile Plot for Culvert: Structure#602



Tailwater Data for Crossing: Structure#602, Option 1 and 3

Table 28 - Downstream Channel Rating Curve (Crossing: Structure#602, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
17.62	4832.23	0.21	1.52	0.25	0.61
950.35	4833.93	1.91	5.53	2.26	0.84

Tailwater Channel Data - Structure#602, Option 1 and 3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 52.00 ft
Side Slope (H:V): 20.00 (_:1)
Channel Slope: 0.0190
Channel Manning's n: 0.0450
Channel Invert Elevation: 4832.02 ft

Roadway Data for Crossing: Structure#602, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4842.26 ft
Roadway Surface: Paved
Roadway Top Width: 17.00 ft

Culvert Data: Structure#603

Site Data - Structure#603

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4918.96 ft
Outlet Station: 234.00 ft
Outlet Elevation: 4917.04 ft
Number of Barrels: 1

Culvert Data Summary - Structure#603

Barrel Shape: Concrete Box
Barrel Span: 12.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 25 - Culvert Summary Table: Structure#603

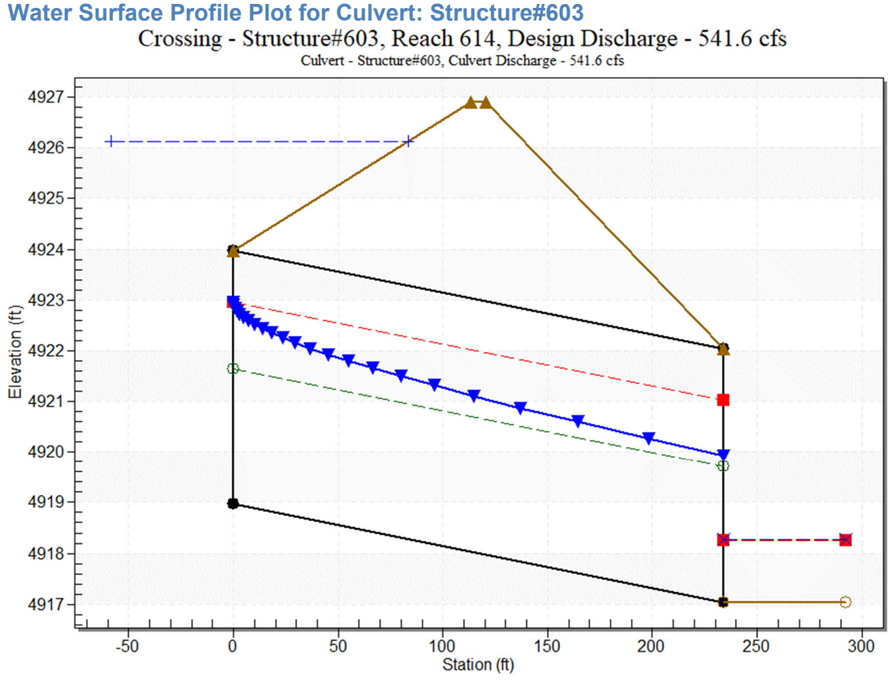
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	78.44 cfs	78.44 cfs	4920.84	1.87	0.0*	1-S2n	0.76	1.10	0.76	0.38	8.64	2.88
100-YR, L_617	541.60 cfs	541.60 cfs	4926.12	7.15	5.046	5-S2n	2.67	3.98	2.89	1.22	15.60	6.12

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4918.96 ft,
Outlet Elevation (invert): 4917.04 ft
Culvert Length: 234.01 ft,
Culvert Slope: 0.0082

Water Surface Profile Plot for Culvert: Structure#603



Tailwater Data for Crossing: Structure#603, Option 1 and 3

Table 26 - Downstream Channel Rating Curve (Crossing: Structure#603, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
78.44	4917.42	0.38	2.88	0.67	0.82
541.60	4918.26	1.22	6.12	2.12	0.99

Tailwater Channel Data - Structure#603, Option 1 and 3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 70.00 ft
Side Slope (H:V): 2.00 (_:1)
Channel Slope: 0.0278
Channel Manning's n: 0.0450
Channel Invert Elevation: 4917.04 ft

Roadway Data for Crossing: Structure#603, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4926.90 ft
Roadway Surface: Gravel
Roadway Top Width: 7.00 ft

Culvert Data: Structure#801

Site Data - Structure#801

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4960.15 ft
Outlet Station: 71.00 ft
Outlet Elevation: 4960.01 ft
Number of Barrels: 2

Culvert Data Summary - Structure#801

Barrel Shape: Concrete Box
Barrel Span: 9.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

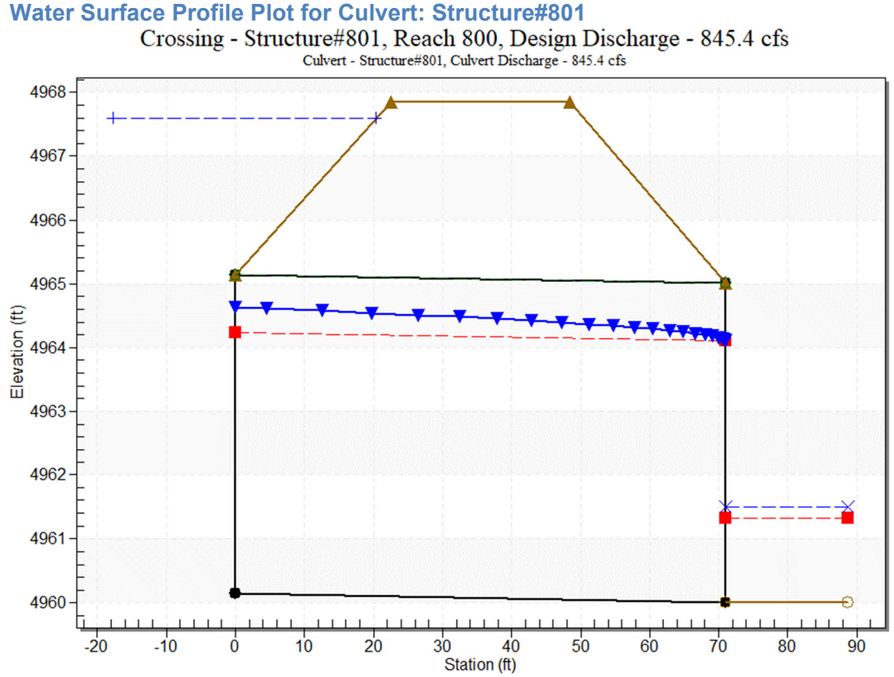
Table 29 - Culvert Summary Table: Structure#801

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	62.87 cfs	62.87 cfs	4961.39	1.24	1.243	2-M2c	0.82	0.72	0.72	0.31	4.83	2.04
100-YR, O_800	845.36 cfs	845.36 cfs	4967.59	7.44	7.041	7-M2c	5.00	4.09	4.09	1.48	11.48	5.72

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4960.15 ft,
Outlet Elevation (invert): 4960.01 ft
Culvert Length: 71.00 ft,
Culvert Slope: 0.0019

Water Surface Profile Plot for Culvert: Structure#801



Tailwater Data for Crossing: Structure#801, Option 1 and 3

Table 30 - Downstream Channel Rating Curve (Crossing: Structure#801, Option 1 and 3

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
62.87	4960.32	0.31	2.04	0.36	0.65
845.36	4961.49	1.48	5.72	1.71	0.83

Tailwater Channel Data - Structure#801, Option 1 and 3

Tailwater Channel Option: Rectangular Channel
Bottom Width: 100.00 ft
Channel Slope: 0.0185
Channel Manning's n: 0.0450
Channel Invert Elevation: 4960.01 ft

Roadway Data for Crossing: Structure#801, Option 1 and 3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4967.84 ft
Roadway Surface: Paved
Roadway Top Width: 26.00 ft

Culvert Data: Structure#101, Option 2A/2B

Site Data - Structure#101, Option 2A/2B

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4778.22 ft
Outlet Station: 52.00 ft
Outlet Elevation: 4777.89 ft
Number of Barrels: 2

Culvert Data Summary - Structure#101, Option 2A/2B

Barrel Shape: Concrete Box
Barrel Span: 12.00 ft
Barrel Rise: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 11 - Culvert Summary Table: Structure#101, Option 2A/2B

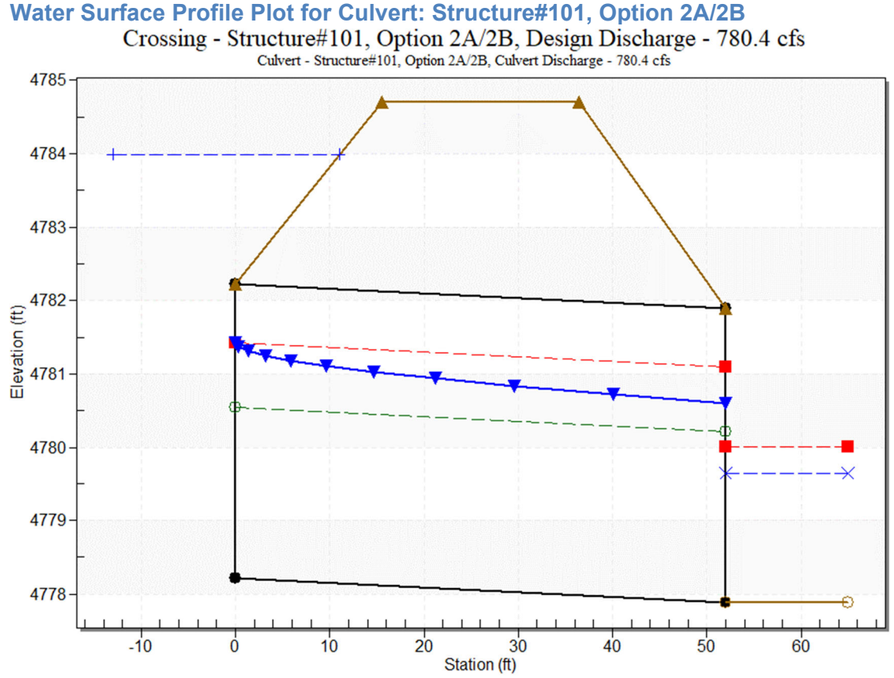
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	5.18 cfs	5.18 cfs	4778.41	0.19	0.0*	1-JS1t	0.10	0.11	0.27	0.27	0.81	2.44
100 Year	72.62 cfs	72.62 cfs	4779.34	1.12	0.400	1-S2n	0.51	0.66	0.52	0.72	5.84	4.73
100-YR, L_115	780.40 cfs	780.40 cfs	4783.98	5.76	4.940	5-S2n	2.33	3.20	2.71	1.74	12.01	8.56

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4778.22 ft,
Outlet Elevation (invert): 4777.89 ft
Culvert Length: 52.00 ft,
Culvert Slope: 0.0063

Water Surface Profile Plot for Culvert: Structure#101, Option 2A/2B



Tailwater Data for Crossing: Structure#101, Option 2A/2B

Table 12 - Downstream Channel Rating Curve (Crossing: Structure#101, Option 2A/2B)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
5.18	4778.16	0.27	2.44	0.38	1.18
72.62	4778.61	0.72	4.73	1.03	1.39
780.40	4779.63	1.74	8.56	2.50	1.62

Tailwater Channel Data - Structure#101, Option 2A/2B

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 30.00 (_:1)
Channel Slope: 0.0230
Channel Manning's n: 0.0240
Channel Invert Elevation: 4777.89 ft

Roadway Data for Crossing: Structure#101, Option 2A/2B

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4784.70 ft
Roadway Surface: Paved
Roadway Top Width: 21.00 ft

Culvert Data: Structure#101, Option 2C

Site Data - Structure#101, Option 2C

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4778.22 ft
Outlet Station: 52.00 ft
Outlet Elevation: 4777.89 ft
Number of Barrels: 2

Culvert Data Summary - Structure#101, Option 2C

Barrel Shape: Concrete Box
Barrel Span: 14.00 ft
Barrel Rise: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 27 - Culvert Summary Table: Structure#101, Option 2C

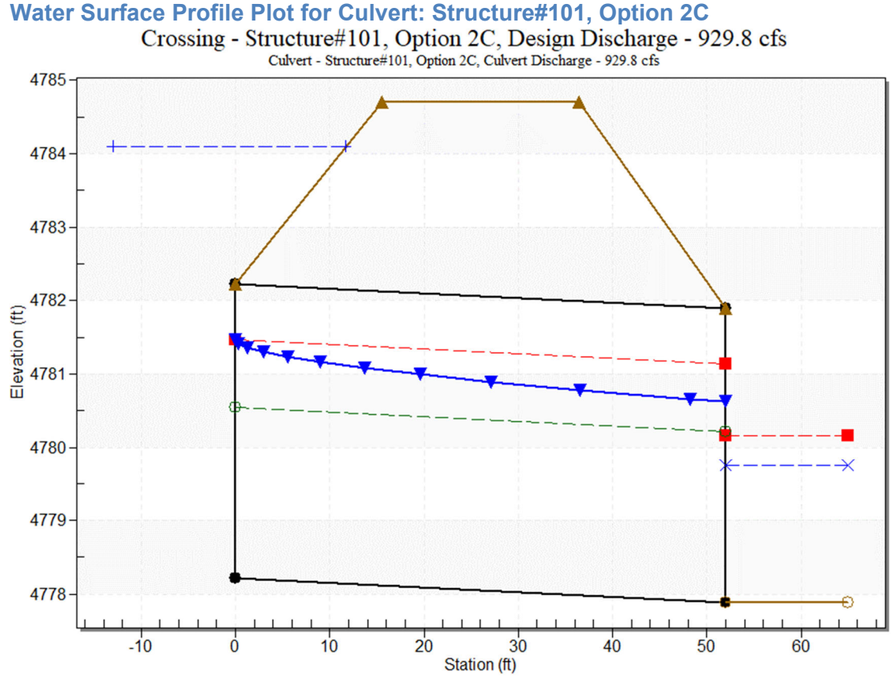
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	5.18 cfs	5.18 cfs	4778.39	0.17	0.0*	1-JS1t	0.09	0.10	0.27	0.27	0.70	2.44
100 Year	72.62 cfs	72.62 cfs	4779.23	1.01	0.396	1-S2n	0.46	0.59	0.47	0.72	5.56	4.73
100-YR, L_115	929.80 cfs	929.80 cfs	4784.10	5.88	5.028	5-S2n	2.32	3.25	2.73	1.86	12.14	8.95

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4778.22 ft,
Outlet Elevation (invert): 4777.89 ft
Culvert Length: 52.00 ft,
Culvert Slope: 0.0063

Water Surface Profile Plot for Culvert: Structure#101, Option 2C



Tailwater Data for Crossing: Structure#101, Option 2C

Table 28 - Downstream Channel Rating Curve (Crossing: Structure#101, Option 2C)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
5.18	4778.16	0.27	2.44	0.38	1.18
72.62	4778.61	0.72	4.73	1.03	1.39
929.80	4779.75	1.86	8.95	2.67	1.63

Tailwater Channel Data - Structure#101, Option 2C

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 30.00 (_:1)
Channel Slope: 0.0230
Channel Manning's n: 0.0240
Channel Invert Elevation: 4777.89 ft

Roadway Data for Crossing: Structure#101, Option 2C

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4784.70 ft
Roadway Surface: Paved
Roadway Top Width: 21.00 ft

Culvert Data: Structure#102, Option 2A/2B/2C

Site Data - Structure#102, Option 2A/2B/2C

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4782.03 ft
Outlet Station: 60.00 ft
Outlet Elevation: 4781.65 ft
Number of Barrels: 2

Culvert Data Summary - Structure#102, Option 2A/2B/2C

Barrel Shape: Concrete Box
Barrel Span: 10.00 ft
Barrel Rise: 6.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

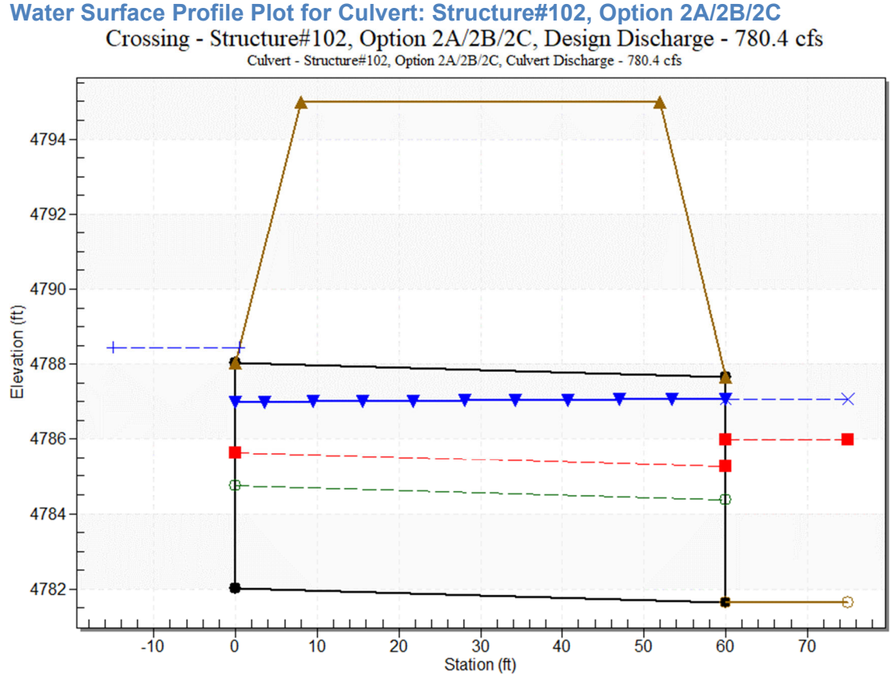
Table 9 - Culvert Summary Table: Structure#102, Option 2A/2B/2C

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	6.28 cfs	6.28 cfs	4782.55	0.25	0.516	1-S1t	0.11	0.15	0.89	0.89	0.35	1.59
100 Year	157.30 cfs	157.30 cfs	4784.82	2.12	2.791	1-S1t	0.93	1.24	2.98	2.98	2.64	3.55
100-YR, L_115	780.40 cfs	780.40 cfs	4788.43	6.13	6.396	1-S1t	2.71	3.62	5.42	5.42	7.19	5.30

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4782.03 ft,
Outlet Elevation (invert): 4781.65 ft
Culvert Length: 60.00 ft,
Culvert Slope: 0.0063

Water Surface Profile Plot for Culvert: Structure#102, Option 2A/2B/2C



Tailwater Data for Crossing: Structure#102, Option 2A/2B/2C

Table 10 - Downstream Channel Rating Curve (Crossing: Structure#102, Option 2A/2B/2C)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
6.28	4782.54	0.89	1.59	0.39	0.42
157.30	4784.63	2.98	3.55	1.30	0.51
780.40	4787.07	5.42	5.30	2.37	0.57

Tailwater Channel Data - Structure#102, Option 2A/2B/2C

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 5.00 (_:1)
Channel Slope: 0.0070
Channel Manning's n: 0.0450
Channel Invert Elevation: 4781.65 ft

Roadway Data for Crossing: Structure#102, Option 2A/2B/2C

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4794.98 ft
Roadway Surface: Paved
Roadway Top Width: 44.00 ft

Culvert Data: Structure#103, Option 2A/2C

Site Data - Structure#103, Option 2A/2C

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4864.72 ft
Outlet Station: 295.00 ft
Outlet Elevation: 4858.55 ft
Number of Barrels: 1

Culvert Data Summary - Structure#103, Option 2A/2C

Barrel Shape: Concrete Box
Barrel Span: 6.00 ft
Barrel Rise: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 7 - Culvert Summary Table: Structure#103, Option 2A/2C

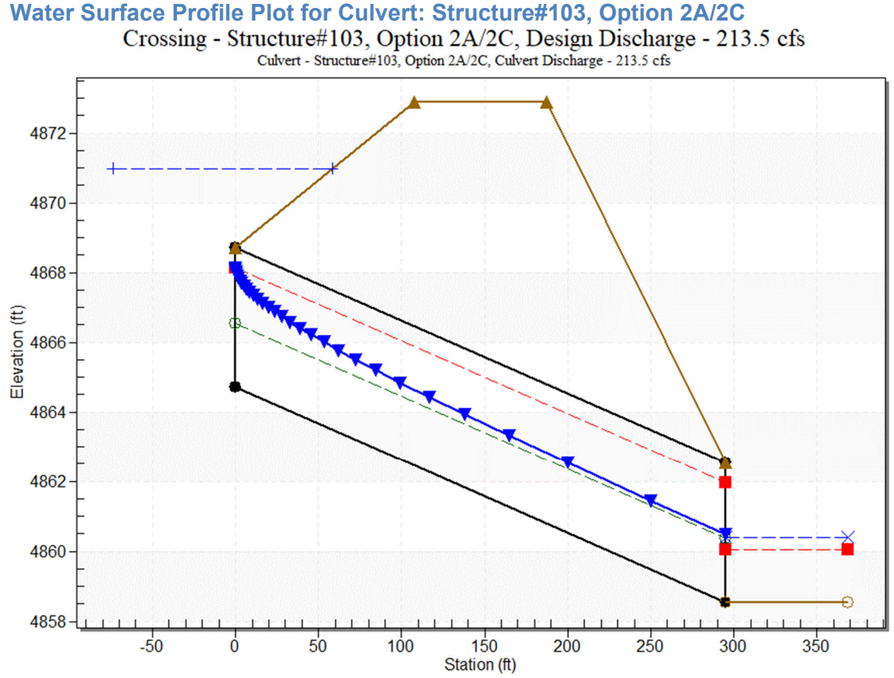
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	85.77 cfs	85.77 cfs	4867.81	3.09	0.0*	1-S2n	0.98	1.85	0.98	1.18	14.65	3.21
100 Year_L_149	213.50 cfs	213.50 cfs	4870.98	6.26	0.561	5-S2n	1.82	3.40	1.92	1.85	18.52	4.12

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4864.72 ft,
Outlet Elevation (invert): 4858.55 ft
Culvert Length: 295.06 ft,
Culvert Slope: 0.0209

Water Surface Profile Plot for Culvert: Structure#103, Option 2A/2C



Tailwater Data for Crossing: Structure#103, Option 2A/2C

Table 8 - Downstream Channel Rating Curve (Crossing: Structure#103, Option 2A/2C)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
85.77	4859.73	1.18	3.21	0.91	0.62
213.50	4860.40	1.85	4.12	1.42	0.66

Tailwater Channel Data - Structure#103, Option 2A/2C

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 12.70 ft
Side Slope (H:V): 8.30 (_:1)
Channel Slope: 0.0123
Channel Manning's n: 0.0450
Channel Invert Elevation: 4858.55 ft

Roadway Data for Crossing: Structure#103, Option 2A/2C

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4872.88 ft
Roadway Surface: Paved
Roadway Top Width: 80.00 ft

Culvert Data: Structure#104, Option 2A/2B

Site Data - Structure#104, Option 2A/2B

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4921.39 ft
Outlet Station: 127.00 ft
Outlet Elevation: 4919.92 ft
Number of Barrels: 1

Culvert Data Summary - Structure#104, Option 2A/2B

Barrel Shape: Concrete Box
Barrel Span: 6.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 5 - Culvert Summary Table: Structure#104, Option 2A/2B

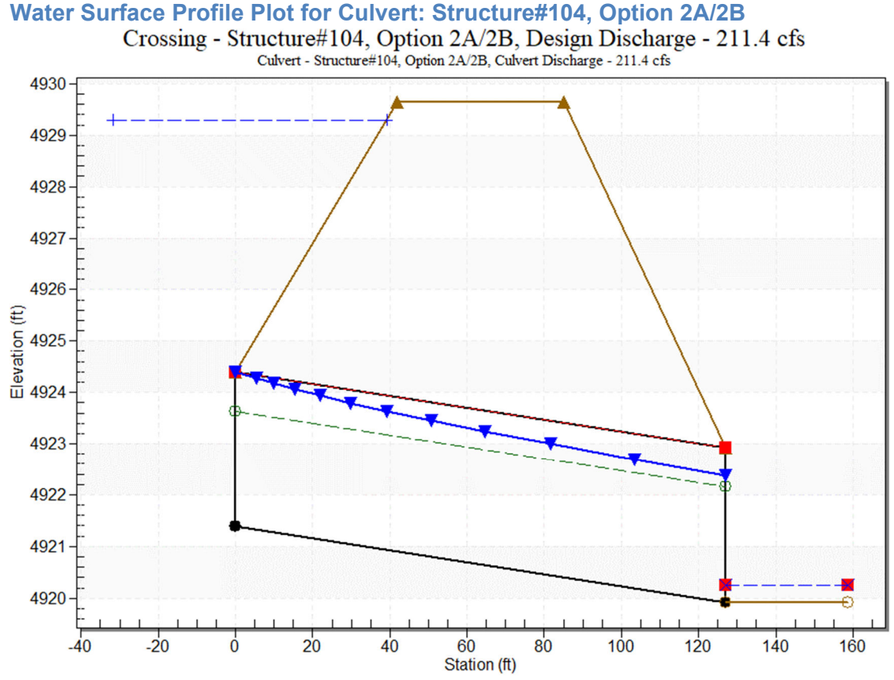
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	124.36 cfs	124.36 cfs	4925.63	4.24	2.721	5-S2n	1.54	2.37	1.66	0.26	12.48	2.12
100 Year,	211.40 cfs	211.40 cfs	4929.30	7.91	5.879	5-S2n	2.24	3.00	2.46	0.33	14.34	2.44

L_133

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4921.39 ft,
Outlet Elevation (invert): 4919.92 ft
Culvert Length: 127.01 ft,
Culvert Slope: 0.0116

Water Surface Profile Plot for Culvert: Structure#104, Option 2A/2B



Tailwater Data for Crossing: Structure#104, Option 2A/2B

Table 6 - Downstream Channel Rating Curve (Crossing: Structure#104, Option 2A/2B)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
124.36	4920.18	0.26	2.12	0.74	0.92
211.40	4920.25	0.33	2.44	0.94	0.96

Tailwater Channel Data - Structure#104, Option 2A/2B

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 100.00 ft
Side Slope (H:V): 500.00 (_:1)
Channel Slope: 0.0460
Channel Manning's n: 0.0450
Channel Invert Elevation: 4919.92 ft

Roadway Data for Crossing: Structure#104, Option 2A/2B

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4929.64 ft
Roadway Surface: Paved
Roadway Top Width: 43.00 ft

Culvert Data: Structure#201, Option 2A

Site Data - Structure#201, Option 2A

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4761.52 ft
Outlet Station: 30.46 ft
Outlet Elevation: 4760.40 ft
Number of Barrels: 2

Culvert Data Summary - Structure#201, Option 2A

Barrel Shape: Concrete Box
Barrel Span: 11.00 ft
Barrel Rise: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 25 - Culvert Summary Table: Structure#201, Option 2A

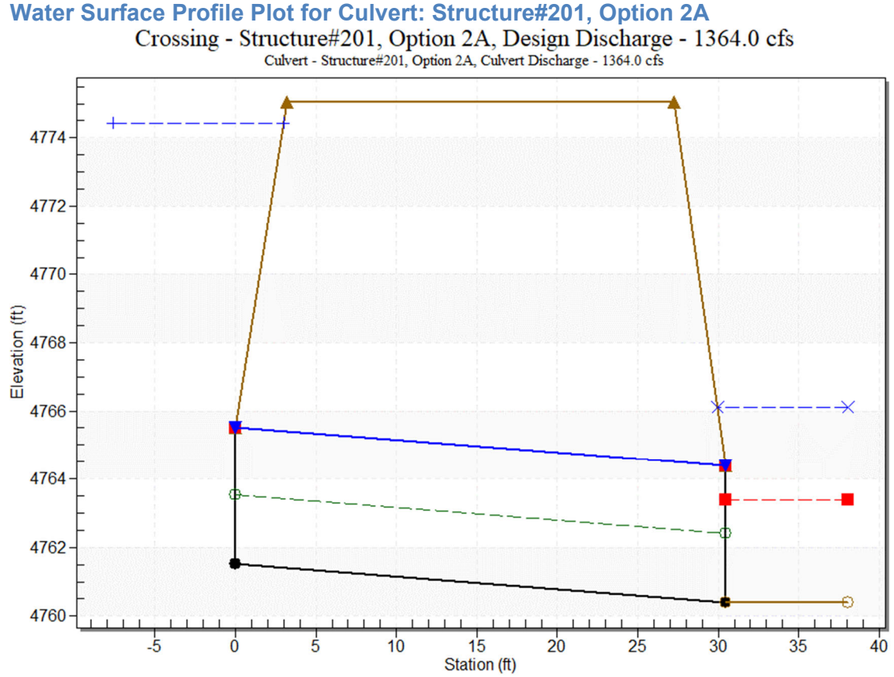
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	5.00 cfs	5.00 cfs	4761.71	0.19	0.0*	1-S2n	0.04	0.12	0.06	0.23	3.60	0.54
100-YR, O_220	1364.00 cfs	1364.00 cfs	4774.42	12.90	10.475	4-FFf	2.01	4.00	4.00	5.71	15.50	3.80

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4761.52 ft,
Outlet Elevation (invert): 4760.40 ft
Culvert Length: 30.48 ft,
Culvert Slope: 0.0368

Water Surface Profile Plot for Culvert: Structure#201, Option 2A



Tailwater Data for Crossing: Structure#201, Option 2A

Table 26 - Downstream Channel Rating Curve (Crossing: Structure#201, Option 2A)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
5.00	4760.63	0.23	0.54	0.03	0.20
1364.00	4766.11	5.71	3.80	0.71	0.33

Tailwater Channel Data - Structure#201, Option 2A

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 40.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0020
Channel Manning's n: 0.0450
Channel Invert Elevation: 4760.40 ft

Roadway Data for Crossing: Structure#201, Option 2A

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4775.04 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

Culvert Data: Structure#201, Option 2B

Site Data - Structure#201, Option 2B

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4761.52 ft
Outlet Station: 30.46 ft
Outlet Elevation: 4760.40 ft
Number of Barrels: 2

Culvert Data Summary - Structure#201, Option 2B

Barrel Shape: Concrete Box
Barrel Span: 12.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 29 - Culvert Summary Table: Structure#201, Option 2B

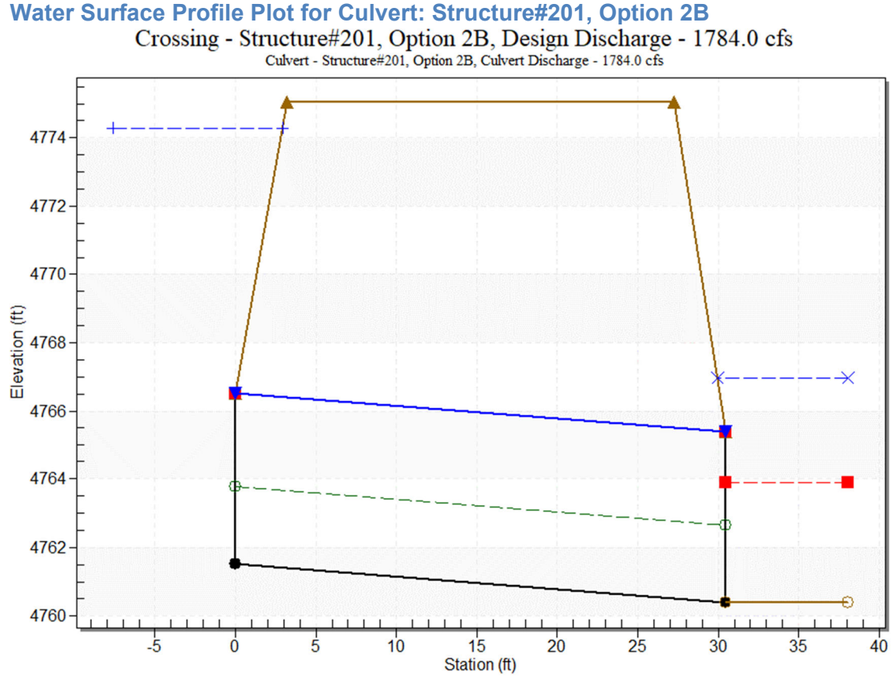
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	5.00 cfs	5.00 cfs	4761.70	0.18	0.0*	1-S2n	0.03	0.11	0.03	0.23	5.96	0.54
100 Year	1784.00	1784.00	4774.27	12.75	10.800	4-FFf	2.25	5.00	5.00	6.57	14.87	4.10
O_220	cfs	cfs										

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4761.52 ft,
Outlet Elevation (invert): 4760.40 ft
Culvert Length: 30.48 ft,
Culvert Slope: 0.0368

Water Surface Profile Plot for Culvert: Structure#201, Option 2B



Tailwater Data for Crossing: Structure#201, Option 2B

Table 30 - Downstream Channel Rating Curve (Crossing: Structure#201, Option 2B)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
5.00	4760.63	0.23	0.54	0.03	0.20
1784.00	4766.97	6.57	4.10	0.82	0.33

Tailwater Channel Data - Structure#201, Option 2B

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 40.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0020
Channel Manning's n: 0.0450
Channel Invert Elevation: 4760.40 ft

Roadway Data for Crossing: Structure#201, Option 2B

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4775.04 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

Culvert Data: Structure#201, Option 2C

Site Data - Structure#201, Option 2C

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4761.52 ft
Outlet Station: 30.46 ft
Outlet Elevation: 4760.40 ft
Number of Barrels: 2

Culvert Data Summary - Structure#201, Option 2C

Barrel Shape: Concrete Box
Barrel Span: 12.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 31 - Culvert Summary Table: Structure#201, Option 2C

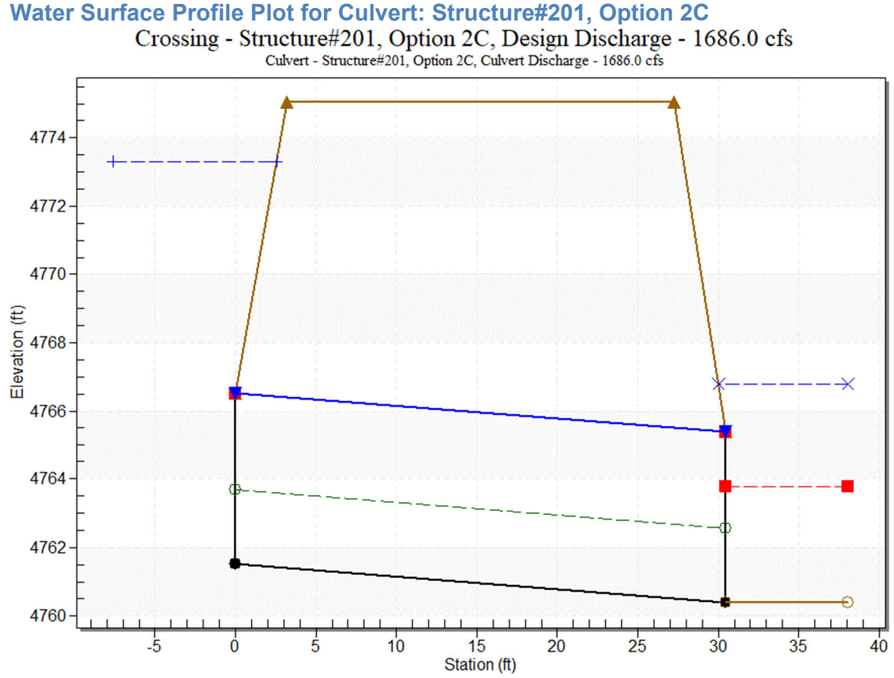
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	5.00 cfs	5.00 cfs	4761.70	0.18	0.0*	1-S2n	0.03	0.11	0.03	0.23	5.96	0.54
100 Year	1686.00	1686.00	4773.30	11.78	10.040	4-FFf	2.17	5.00	5.00	6.38	14.05	4.03
O_220	cfs	cfs										

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4761.52 ft,
Outlet Elevation (invert): 4760.40 ft
Culvert Length: 30.48 ft,
Culvert Slope: 0.0368

Water Surface Profile Plot for Culvert: Structure#201, Option 2C



Tailwater Data for Crossing: Structure#201, Option 2C

Table 32 - Downstream Channel Rating Curve (Crossing: Structure#201, Option 2C)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
5.00	4760.63	0.23	0.54	0.03	0.20
1686.00	4766.78	6.38	4.03	0.80	0.33

Tailwater Channel Data - Structure#201, Option 2C

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 40.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0020
Channel Manning's n: 0.0450
Channel Invert Elevation: 4760.40 ft

Roadway Data for Crossing: Structure#201, Option 2C

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4775.04 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

Culvert Data: Structure#202, Option 2A/2B/2C

Site Data - Structure#202, Option 2A/2B/2C

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4949.72 ft
Outlet Station: 100.00 ft
Outlet Elevation: 4944.32 ft
Number of Barrels: 1

Culvert Data Summary - Structure#202, Option 2A/2B/2C

Barrel Shape: Concrete Box
Barrel Span: 6.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

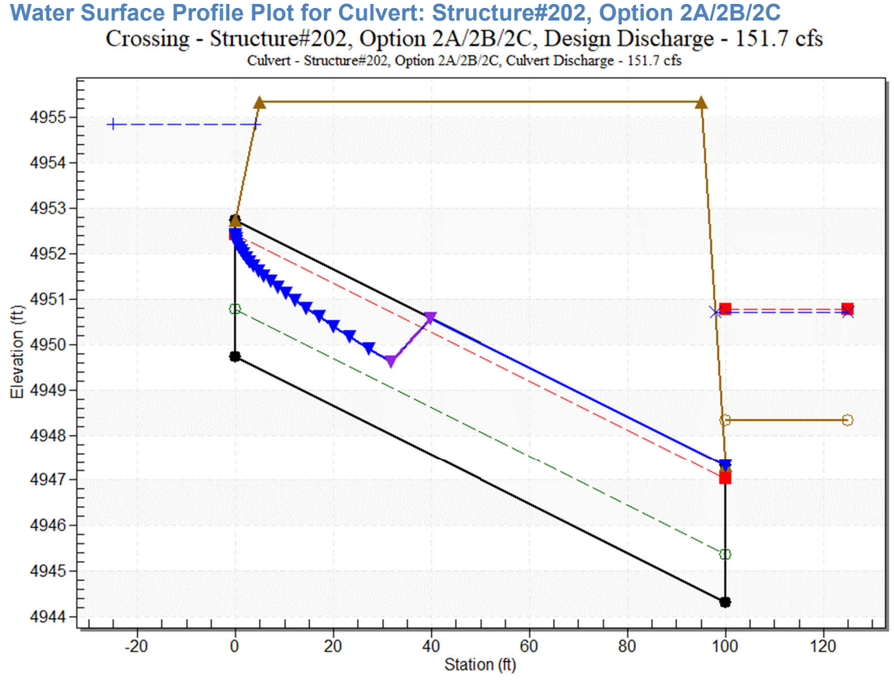
Table 3 - Culvert Summary Table: Structure#202, Option 2A/2B/2C

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5	40.39 cfs	40.39 cfs	4951.55	1.83	0.052	1-JS1f	0.44	1.12	3.00	1.31	2.24	5.11
100-YR, Junction_263	151.66 cfs	151.66 cfs	4954.84	5.12	3.080	5-JS1f	1.04	2.71	3.00	2.37	8.43	7.55

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4949.72 ft,
Outlet Elevation (invert): 4944.32 ft
Culvert Length: 100.15 ft,
Culvert Slope: 0.0540

Water Surface Profile Plot for Culvert: Structure#202, Option 2A/2B/2C



Tailwater Data for Crossing: Structure#202, Option 2A/2B/2C

Table 4 - Downstream Channel Rating Curve (Crossing: Structure#202, Option 2A/2B/2C)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
40.39	4949.63	1.31	5.11	2.68	0.99
151.66	4950.69	2.37	7.55	4.86	1.08

Tailwater Channel Data - Structure#202, Option 2A/2B/2C

Tailwater Channel Option: Irregular Channel
Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	4962.30	0.0450
2	3.23	4962.09	0.0450
3	6.47	4961.86	0.0450
4	9.70	4961.61	0.0450
5	12.93	4961.41	0.0450
6	16.17	4961.22	0.0450
7	19.40	4960.97	0.0450
8	22.64	4960.70	0.0450

9	25.87	4960.41	0.0450
10	29.10	4960.10	0.0450
11	32.34	4959.84	0.0450
12	35.57	4959.59	0.0450
13	38.80	4959.34	0.0450
14	42.04	4959.06	0.0450
15	45.27	4958.74	0.0450
16	48.50	4958.41	0.0450
17	51.74	4958.07	0.0450
18	54.97	4957.68	0.0450
19	58.20	4957.27	0.0450
20	61.44	4956.89	0.0450
21	64.67	4956.54	0.0450
22	67.91	4956.23	0.0450
23	71.14	4955.85	0.0450
24	74.37	4955.38	0.0450
25	77.61	4954.97	0.0450
26	80.84	4954.70	0.0450
27	84.07	4954.43	0.0450
28	87.31	4954.23	0.0450
29	90.54	4954.07	0.0450
30	93.77	4953.94	0.0450
31	97.01	4953.82	0.0450
32	100.24	4953.72	0.0450
33	103.47	4953.55	0.0450
34	106.71	4953.08	0.0450
35	109.94	4952.92	0.0450
36	113.17	4953.12	0.0450
37	116.41	4951.97	0.0450
38	119.64	4950.01	0.0450
39	122.88	4948.73	0.0450
40	126.11	4948.32	0.0450
41	129.34	4949.03	0.0450
42	132.58	4951.36	0.0450
43	135.81	4953.47	0.0450
44	139.04	4955.07	0.0450
45	142.28	4956.11	0.0450
46	145.51	4956.75	0.0450
47	148.75	4956.69	0.0450
48	151.98	4955.86	0.0450
49	155.21	4954.91	0.0450
50	158.45	4954.71	0.0450
51	161.68	4954.76	0.0450
52	164.91	4954.65	0.0450
53	168.15	4954.77	0.0450
54	171.38	4955.49	0.0450
55	174.61	4956.04	0.0450
56	177.85	4956.47	0.0450
57	181.08	4957.05	0.0450
58	184.31	4957.49	0.0450
59	187.55	4957.86	0.0450
60	190.78	4958.15	0.0450
61	194.01	4958.40	0.0450
62	197.25	4958.70	0.0450
63	200.48	4958.98	0.0450
64	203.72	4959.11	0.0450
65	206.95	4959.15	0.0450
66	210.18	4959.21	0.0450
67	213.42	4959.31	0.0450
68	216.65	4959.39	0.0450
69	219.88	4959.50	0.0450
70	223.12	4959.56	0.0000

Roadway Data for Crossing: Structure#202, Option 2A/2B/2C

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4955.33 ft
Roadway Surface: Gravel
Roadway Top Width: 90.00 ft

Culvert Data: Structure#202, Option 2C

Site Data - Structure#202, Option 2C

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4949.72 ft
Outlet Station: 100.00 ft
Outlet Elevation: 4944.32 ft
Number of Barrels: 2

Culvert Data Summary - Structure#202, Option 2C

Barrel Shape: Concrete Box
Barrel Span: 7.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 33 - Culvert Summary Table: Structure#202, Option 2C

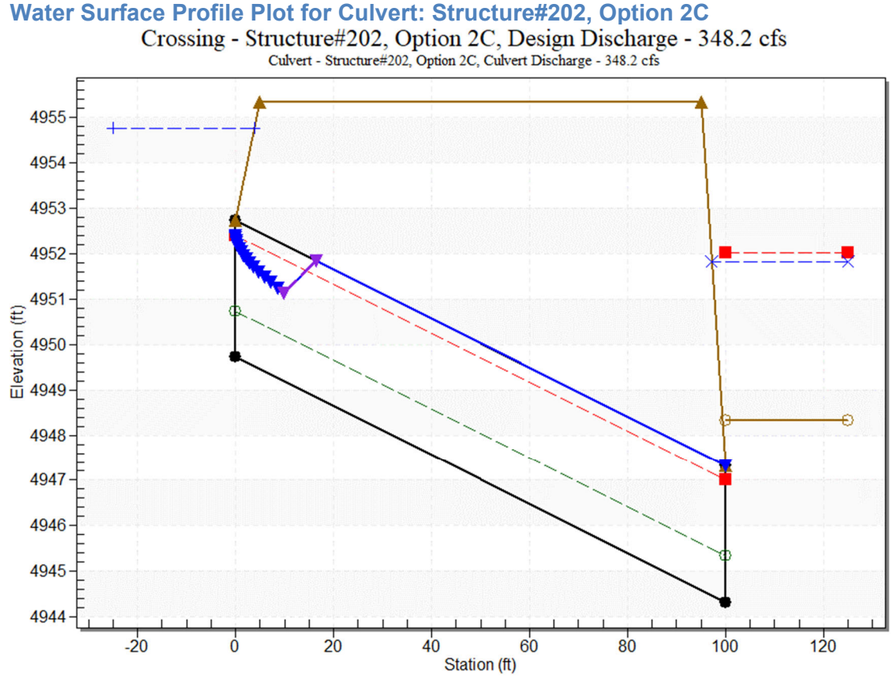
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5	40.39 cfs	40.39 cfs	4950.76	1.04	0.0*	1-JS1f	0.26	0.64	3.00	1.31	0.96	5.11
100-YR, Junction_263	348.25 cfs	348.25 cfs	4954.75	5.03	4.098	5-JS1f	1.01	2.68	3.00	3.48	8.29	9.51

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4949.72 ft,
Outlet Elevation (invert): 4944.32 ft
Culvert Length: 100.15 ft,
Culvert Slope: 0.0540

Water Surface Profile Plot for Culvert: Structure#202, Option 2C



Tailwater Data for Crossing: Structure#202, Option 2C

Table 34 - Downstream Channel Rating Curve (Crossing: Structure#202, Option 2C)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
40.39	4949.63	1.31	5.11	2.68	0.99
348.25	4951.81	3.48	9.51	7.15	1.13

Tailwater Channel Data - Structure#202, Option 2C

Tailwater Channel Option: Irregular Channel
Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	4962.30	0.0450
2	3.23	4962.09	0.0450
3	6.47	4961.86	0.0450
4	9.70	4961.61	0.0450
5	12.93	4961.41	0.0450
6	16.17	4961.22	0.0450
7	19.40	4960.97	0.0450
8	22.64	4960.70	0.0450

9	25.87	4960.41	0.0450
10	29.10	4960.10	0.0450
11	32.34	4959.84	0.0450
12	35.57	4959.59	0.0450
13	38.80	4959.34	0.0450
14	42.04	4959.06	0.0450
15	45.27	4958.74	0.0450
16	48.50	4958.41	0.0450
17	51.74	4958.07	0.0450
18	54.97	4957.68	0.0450
19	58.20	4957.27	0.0450
20	61.44	4956.89	0.0450
21	64.67	4956.54	0.0450
22	67.91	4956.23	0.0450
23	71.14	4955.85	0.0450
24	74.37	4955.38	0.0450
25	77.61	4954.97	0.0450
26	80.84	4954.70	0.0450
27	84.07	4954.43	0.0450
28	87.31	4954.23	0.0450
29	90.54	4954.07	0.0450
30	93.77	4953.94	0.0450
31	97.01	4953.82	0.0450
32	100.24	4953.72	0.0450
33	103.47	4953.55	0.0450
34	106.71	4953.08	0.0450
35	109.94	4952.92	0.0450
36	113.17	4953.12	0.0450
37	116.41	4951.97	0.0450
38	119.64	4950.01	0.0450
39	122.88	4948.73	0.0450
40	126.11	4948.32	0.0450
41	129.34	4949.03	0.0450
42	132.58	4951.36	0.0450
43	135.81	4953.47	0.0450
44	139.04	4955.07	0.0450
45	142.28	4956.11	0.0450
46	145.51	4956.75	0.0450
47	148.75	4956.69	0.0450
48	151.98	4955.86	0.0450
49	155.21	4954.91	0.0450
50	158.45	4954.71	0.0450
51	161.68	4954.76	0.0450
52	164.91	4954.65	0.0450
53	168.15	4954.77	0.0450
54	171.38	4955.49	0.0450
55	174.61	4956.04	0.0450
56	177.85	4956.47	0.0450
57	181.08	4957.05	0.0450
58	184.31	4957.49	0.0450
59	187.55	4957.86	0.0450
60	190.78	4958.15	0.0450
61	194.01	4958.40	0.0450
62	197.25	4958.70	0.0450
63	200.48	4958.98	0.0450
64	203.72	4959.11	0.0450
65	206.95	4959.15	0.0450
66	210.18	4959.21	0.0450
67	213.42	4959.31	0.0450
68	216.65	4959.39	0.0450
69	219.88	4959.50	0.0450
70	223.12	4959.56	0.0000

Roadway Data for Crossing: Structure#202, Option 2C

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4955.33 ft
Roadway Surface: Gravel
Roadway Top Width: 90.00 ft

Culvert Data: Structure#203, Option 2A/2B/2C

Site Data - Structure#203, Option 2A/2B/2C

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4979.58 ft
Outlet Station: 327.00 ft
Outlet Elevation: 4970.79 ft
Number of Barrels: 1

Culvert Data Summary - Structure#203, Option 2A/2B/2C

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

Table 1 - Culvert Summary Table: Structure#203, Option 2A/2B/2C

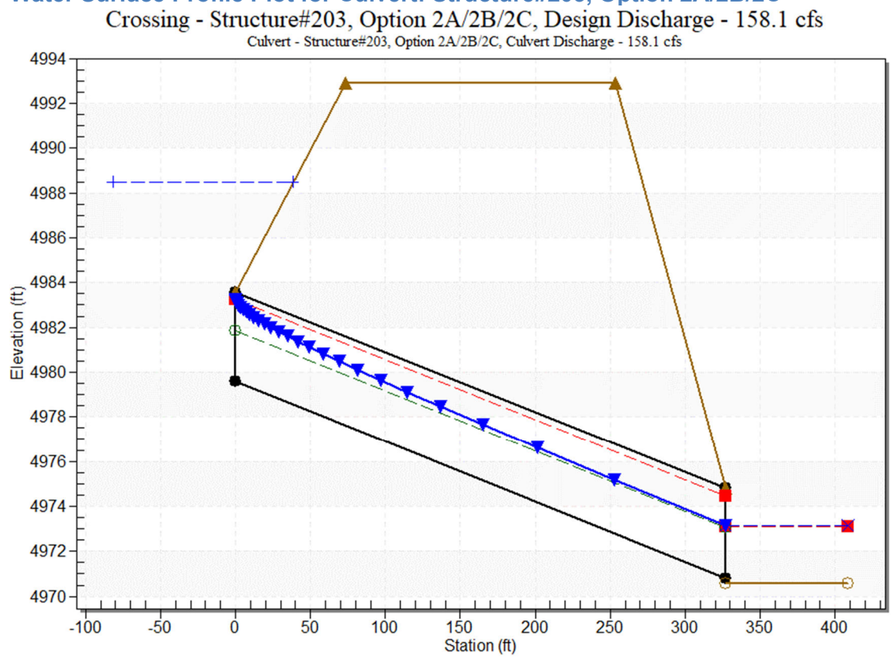
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5-year	40.39 cfs	40.39 cfs	4982.30	2.72	0.0*	1-S2n	1.07	1.90	1.07	1.52	14.86	4.35
100-year, Junction _268	158.12 cfs	158.12 cfs	4988.47	8.89	2.083	5-S2n	2.28	3.65	2.36	2.54	20.51	6.12

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4979.58 ft,
Outlet Elevation (invert): 4970.79 ft
Culvert Length: 327.12 ft,
Culvert Slope: 0.0269

Water Surface Profile Plot for Culvert: Structure#203, Option 2A/2B/2C



Tailwater Data for Crossing: Structure#203, Option 2A/2B/2C

Table 2 - Downstream Channel Rating Curve (Crossing: Structure#203, Option 2A/2B/2C)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
40.39	4972.10	1.52	4.35	2.47	0.88
158.12	4973.12	2.54	6.12	4.12	0.96

Tailwater Channel Data - Structure#203, Option 2A/2B/2C

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0260
Channel Manning's n: 0.0450
Channel Invert Elevation: 4970.58 ft

Roadway Data for Crossing: Structure#203, Option 2A/2B/2C

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4992.89 ft
Roadway Surface: Paved
Roadway Top Width: 180.00 ft

Culvert Data: Structure#301, Reach 300

Site Data - Structure#301, Reach 300

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4786.49 ft
Outlet Station: 35.60 ft
Outlet Elevation: 4786.34 ft
Number of Barrels: 1

Culvert Data Summary - Structure#301, Reach 300

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

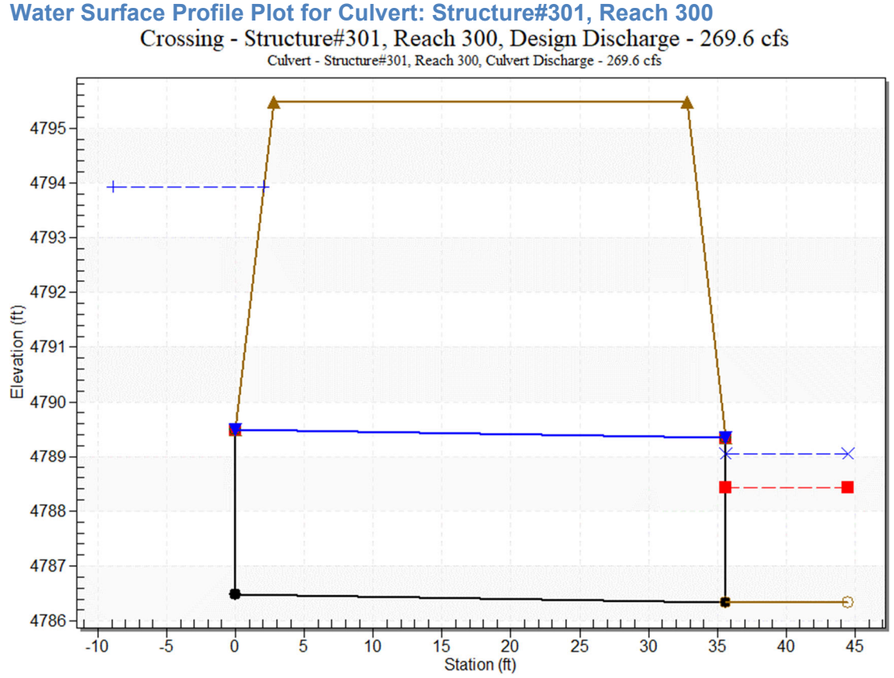
Table 23 - Culvert Summary Table: Structure#301, Reach 300

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	23.55 cfs	23.55 cfs	4787.59	1.10	0.649	1-JS1t	0.58	0.65	0.78	0.78	3.80	2.25
100 Year	269.56 cfs	269.56 cfs	4793.92	7.43	6.048	6-FFc	3.00	3.00	3.00	2.71	11.23	4.49

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4786.49 ft,
Outlet Elevation (invert): 4786.34 ft
Culvert Length: 35.60 ft,
Culvert Slope: 0.0042

Water Surface Profile Plot for Culvert: Structure#301, Reach 300



Tailwater Data for Crossing: Structure#301, Reach 300

Table 24 - Downstream Channel Rating Curve (Crossing: Structure#301, Reach 300)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
23.55	4787.12	0.78	2.25	0.44	0.51
269.56	4789.05	2.71	4.49	1.52	0.60

Tailwater Channel Data - Structure#301, Reach 300

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 4.50 (_:1)
Channel Slope: 0.0090
Channel Manning's n: 0.0450
Channel Invert Elevation: 4786.34 ft

Roadway Data for Crossing: Structure#301, Reach 300

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4795.47 ft
Roadway Surface: Gravel
Roadway Top Width: 30.00 ft

Culvert Data: Structure#501, Option 2

Site Data - Structure#501, Option 2

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4824.39 ft
Outlet Station: 88.00 ft
Outlet Elevation: 4816.39 ft
Number of Barrels: 1

Culvert Data Summary - Structure#501, Option 2

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 13 - Culvert Summary Table: Structure#501, Option 2

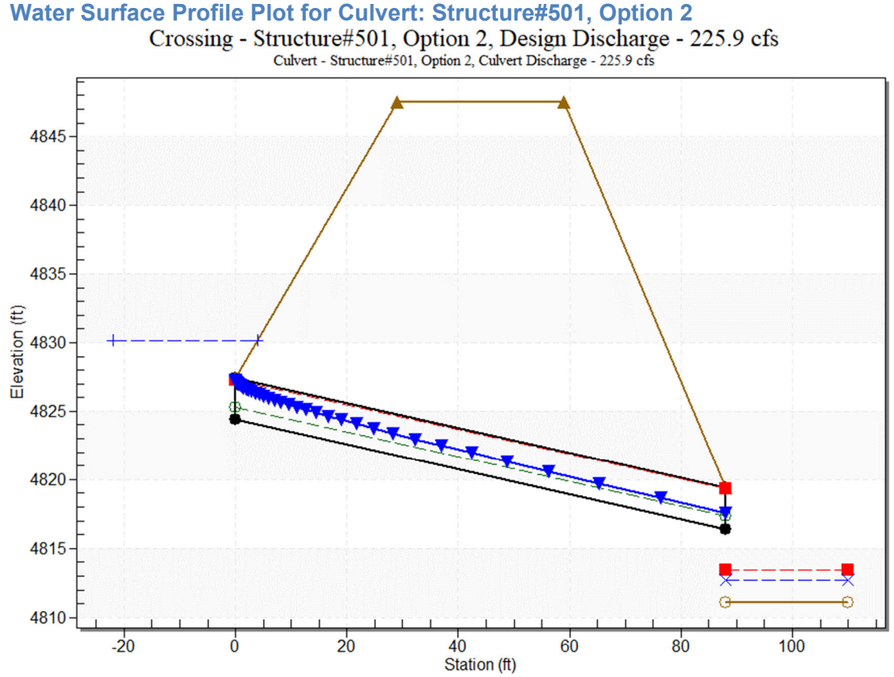
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	19.99 cfs	19.99 cfs	4825.30	0.91	0.0*	1-S2n	0.20	0.58	0.20	0.64	12.57	7.02
100 Year	174.84 cfs	174.84 cfs	4828.73	4.34	0.0*	5-S2n	0.78	2.46	0.95	1.44	23.02	12.07
100-YR, L_513	225.90 cfs	225.90 cfs	4830.16	5.77	0.0*	5-S2n	0.92	2.91	1.17	1.58	24.08	12.87

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4824.39 ft,
Outlet Elevation (invert): 4816.39 ft
Culvert Length: 88.36 ft,
Culvert Slope: 0.0909

Water Surface Profile Plot for Culvert: Structure#501, Option 2



Tailwater Data for Crossing: Structure#501, Option 2

Table 14 - Downstream Channel Rating Curve (Crossing: Structure#501, Option 2)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
19.99	4811.74	0.64	7.02	8.36	2.19
174.84	4812.54	1.44	12.07	18.85	2.51
225.90	4812.68	1.58	12.87	20.75	2.55

Tailwater Channel Data - Structure#501, Option 2

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 7.00 (_:1)
Channel Slope: 0.2100
Channel Manning's n: 0.0450
Channel Invert Elevation: 4811.10 ft

Roadway Data for Crossing: Structure#501, Option 2

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4847.50 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Culvert Data: Structure#601, Option 2

Site Data - Structure#601, Option 2

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4827.99 ft
Outlet Station: 120.50 ft
Outlet Elevation: 4825.15 ft
Number of Barrels: 1

Culvert Data Summary - Structure#601, Option 2

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 21 - Culvert Summary Table: Structure#601, Option 2

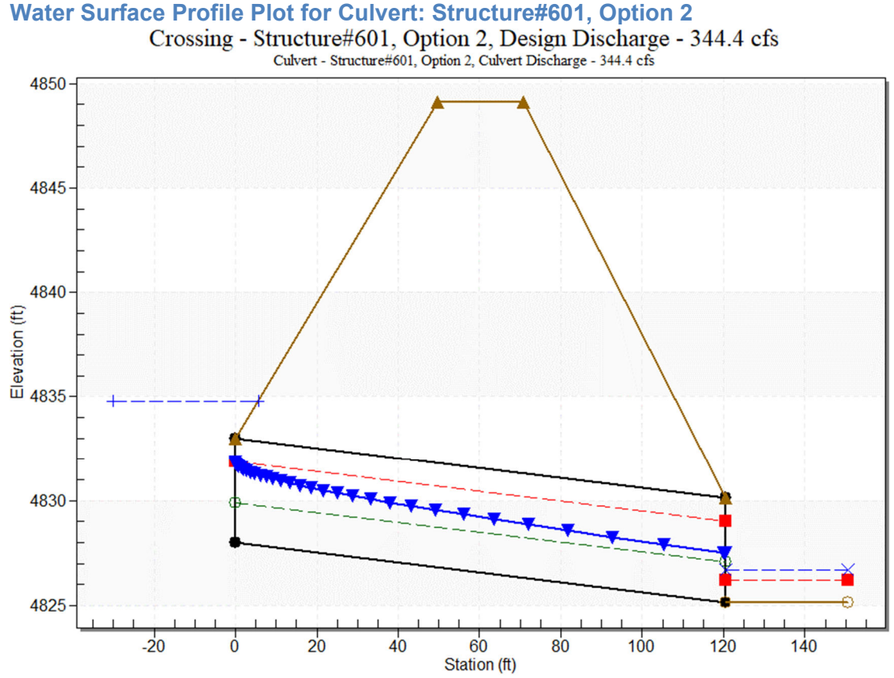
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	17.62 cfs	17.62 cfs	4828.88	0.89	0.0*	1-S2n	0.28	0.53	0.28	0.31	7.89	1.20
100 Year	145.90 cfs	145.90 cfs	4831.62	3.63	0.0*	1-S2n	1.07	2.18	1.21	1.00	15.07	2.34
100-YR, L_613	344.40 cfs	344.40 cfs	4834.80	6.81	3.643	5-S2n	1.91	3.86	2.36	1.56	18.25	2.98

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4827.99 ft,
Outlet Elevation (invert): 4825.15 ft
Culvert Length: 120.53 ft,
Culvert Slope: 0.0236

Water Surface Profile Plot for Culvert: Structure#601, Option 2



Tailwater Data for Crossing: Structure#601, Option 2

Table 22 - Downstream Channel Rating Curve (Crossing: Structure#601, Option 2)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
17.62	4825.46	0.31	1.20	0.15	0.41
145.90	4826.15	1.00	2.34	0.47	0.48
344.40	4826.71	1.56	2.98	0.73	0.51

Tailwater Channel Data - Structure#601, Option 2

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 40.00 ft
Side Slope (H:V): 21.90 (_:1)
Channel Slope: 0.0075
Channel Manning's n: 0.0450
Channel Invert Elevation: 4825.15 ft

Roadway Data for Crossing: Structure#601, Option 2

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4849.11 ft
Roadway Surface: Gravel
Roadway Top Width: 21.00 ft

Culvert Data: Structure#602, Option 2

Site Data - Structure#602, Option 2

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4832.33 ft
Outlet Station: 41.00 ft
Outlet Elevation: 4832.02 ft
Number of Barrels: 1

Culvert Data Summary - Structure#602, Option 2

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

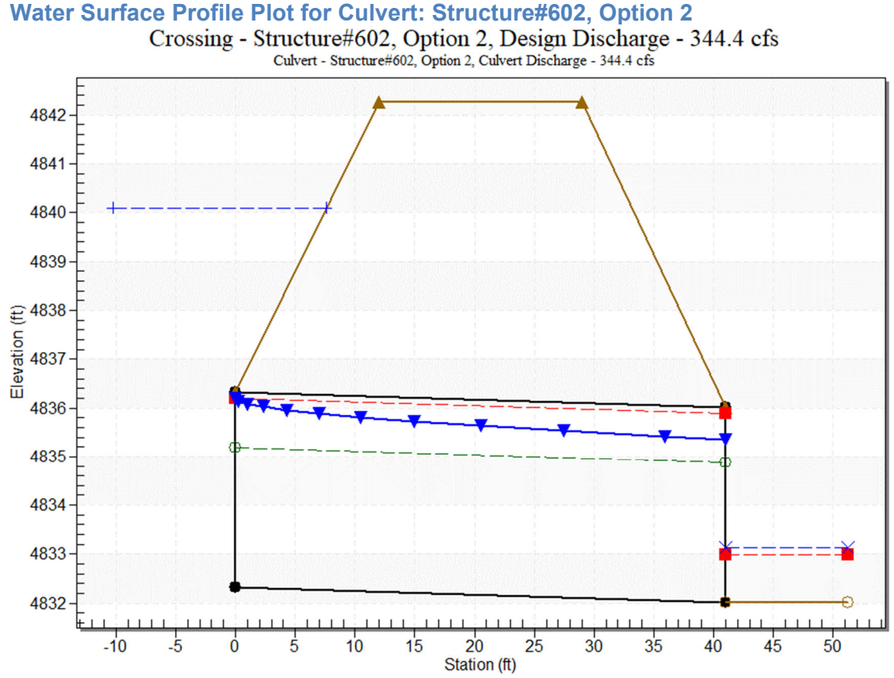
Table 17 - Culvert Summary Table: Structure#602, Option 2

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	17.62 cfs	17.62 cfs	4833.24	0.91	0.230	1-S2n	0.40	0.53	0.41	0.21	5.38	1.52
100 Year	145.90 cfs	145.90 cfs	4836.00	3.67	2.390	1-S2n	1.56	2.18	1.79	0.70	10.16	3.16
100-YR, L_613	344.40 cfs	344.40 cfs	4840.10	7.77	6.528	5-S2n	2.84	3.86	3.34	1.12	12.90	4.12

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4832.33 ft,
Outlet Elevation (invert): 4832.02 ft
Culvert Length: 41.00 ft,
Culvert Slope: 0.0076

Water Surface Profile Plot for Culvert: Structure#602, Option 2



Tailwater Data for Crossing: Structure#602, Option 2

Table 18 - Downstream Channel Rating Curve (Crossing: Structure#602, Option 2)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
17.62	4832.23	0.21	1.52	0.25	0.61
145.90	4832.72	0.70	3.16	0.83	0.73
344.40	4833.14	1.12	4.12	1.33	0.78

Tailwater Channel Data - Structure#602, Option 2

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 52.00 ft
Side Slope (H:V): 20.00 (_:1)
Channel Slope: 0.0190
Channel Manning's n: 0.0450
Channel Invert Elevation: 4832.02 ft

Roadway Data for Crossing: Structure#602, Option 2

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4842.26 ft
Roadway Surface: Paved
Roadway Top Width: 17.00 ft

Culvert Data: Structure#603, Option 2

Site Data - Structure#603, Option 2

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4918.96 ft
Outlet Station: 234.00 ft
Outlet Elevation: 4917.04 ft
Number of Barrels: 1

Culvert Data Summary - Structure#603, Option 2

Barrel Shape: Concrete Box
Barrel Span: 7.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

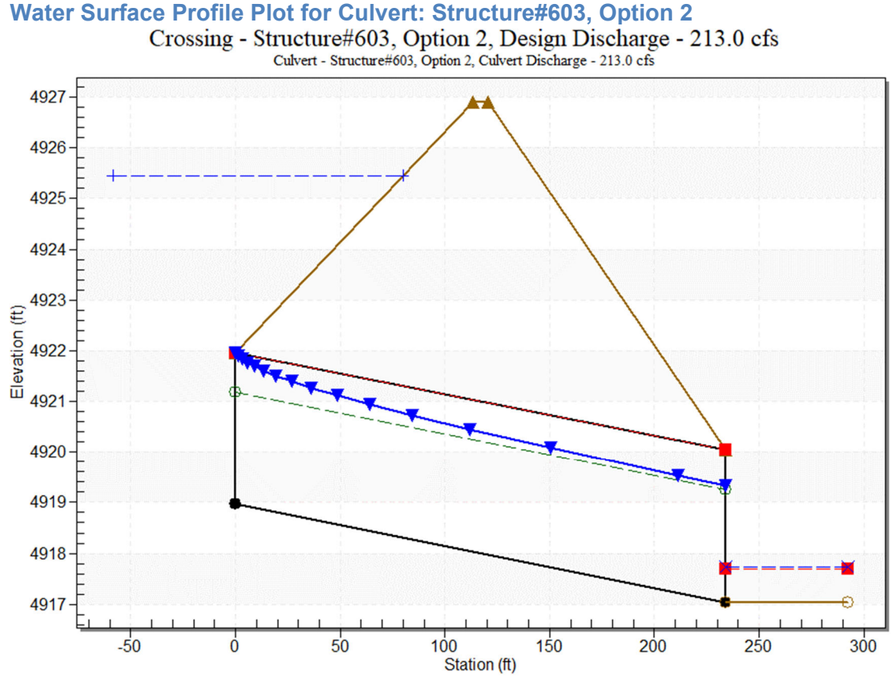
Table 15 - Culvert Summary Table: Structure#603, Option 2

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	78.44 cfs	78.44 cfs	4921.61	2.65	0.173	1-S2n	1.11	1.57	1.11	0.38	10.06	2.88
100-YR, L_613	213.03 cfs	213.03 cfs	4925.44	6.47	4.936	5-S2n	2.21	3.00	2.29	0.70	13.29	4.27

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4918.96 ft,
Outlet Elevation (invert): 4917.04 ft
Culvert Length: 234.01 ft,
Culvert Slope: 0.0082

Water Surface Profile Plot for Culvert: Structure#603, Option 2



Tailwater Data for Crossing: Structure#603, Option 2

Table 16 - Downstream Channel Rating Curve (Crossing: Structure#603, Option 2)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
78.44	4917.42	0.38	2.88	0.67	0.82
213.03	4917.74	0.70	4.27	1.21	0.91

Tailwater Channel Data - Structure#603, Option 2

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 70.00 ft
Side Slope (H:V): 2.00 (_:1)
Channel Slope: 0.0278
Channel Manning's n: 0.0450
Channel Invert Elevation: 4917.04 ft

Roadway Data for Crossing: Structure#603, Option 2

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4926.90 ft
Roadway Surface: Gravel
Roadway Top Width: 7.00 ft

Culvert Data: Structure#801, Option 2

Site Data - Structure#801, Option 2

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4960.15 ft
Outlet Station: 71.00 ft
Outlet Elevation: 4960.01 ft
Number of Barrels: 1

Culvert Data Summary - Structure#801, Option 2

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

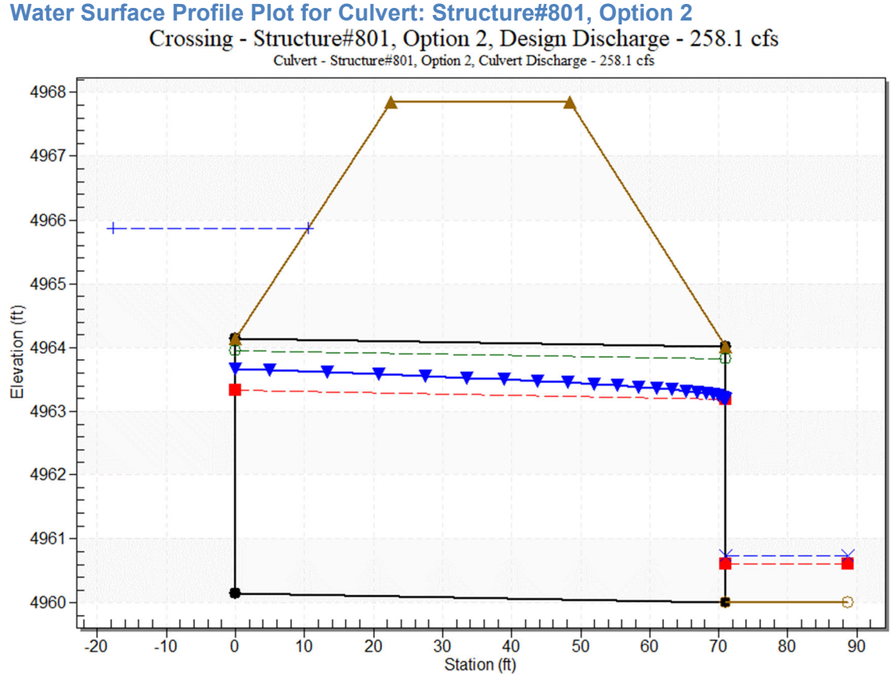
Table 19 - Culvert Summary Table: Structure#801, Option 2

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	62.87 cfs	62.87 cfs	4962.28	2.13	2.136	2-M2c	1.41	1.24	1.24	0.31	6.33	2.04
100 Year	199.58 cfs	199.58 cfs	4964.76	4.61	4.615	7-M2c	3.15	2.68	2.68	0.62	9.30	3.23
100-YR, L_813	258.10 cfs	258.10 cfs	4965.87	5.73	5.478	7-M2c	3.81	3.19	3.19	0.72	10.13	3.58

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4960.15 ft,
Outlet Elevation (invert): 4960.01 ft
Culvert Length: 71.00 ft,
Culvert Slope: 0.0019

Water Surface Profile Plot for Culvert: Structure#801, Option 2



Tailwater Data for Crossing: Structure#801, Option 2

Table 20 - Downstream Channel Rating Curve (Crossing: Structure#801, Option 2)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
62.87	4960.32	0.31	2.04	0.36	0.65
199.58	4960.63	0.62	3.23	0.71	0.72
258.10	4960.73	0.72	3.58	0.83	0.74

Tailwater Channel Data - Structure#801, Option 2

Tailwater Channel Option: Rectangular Channel
Bottom Width: 100.00 ft
Channel Slope: 0.0185
Channel Manning's n: 0.0450
Channel Invert Elevation: 4960.01 ft

Roadway Data for Crossing: Structure#801, Option 2

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4967.84 ft
Roadway Surface: Paved
Roadway Top Width: 26.00 ft

Appendix E-4
Option 1
SWMM Inputs/Outputs

```
[TITLE]
;;Project Title/Notes
City of Greeley
Storm Drainage Master Plan
Oklahoma and South Basins Baseline Hydrology
Matrix Design Group, Inc. 2022
Scenario ID = 7_Ex_100yr_0mi^2_GOS_Hydrology

[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             12:00:00
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         0:00:20
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         12.566
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 "R:\22.906.007 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221
Models\CUHP_SWMM\CUHP\7_Ex_100yr_0mi^2_GreeleyOS.txt"

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
CONSTANT         0.0
DRY_ONLY         NO

[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
109              4779       0          0          0          0
110              4794       0          0          0          0
113              4784       0          0          0          0
114              4798       0          0          0          0
115              4816.7     0          0          0          0
117              4818       0          0          0          0
118              4830       0          0          0          0
119              4834       0          0          0          0
121              4835       0          0          0          0
122              4983       0          0          0          0
126              4999       0          0          0          0
129              4835       0          0          0          0
130              4910       0          0          0          0
133              4917       0          0          0          0
134              4945       0          0          0          0
138              4970       0          0          0          0
139              4817       0          0          0          0
141              4827       0          0          0          0
142              4820       0          0          0          0
146              4849       0          0          0          0
149              4869       0          0          0          0
150              4890       0          0          0          0
154              4904       0          0          0          0
210              4770       0          0          0          0
219              4772       0          0          0          0
220              4777       0          0          0          0
221              4790.6     0          0          0          0
223              4793       0          0          0          0
224              4810       0          0          0          0
225              4840       0          0          0          0
226              4850       0          0          0          0
228              4864       0          0          0          0
231              4790.8     0          0          0          0
232              4810       0          0          0          0
235              4845       0          0          0          0
236              4847       0          0          0          0
237              4846       0          0          0          0
239              4850       0          0          0          0
240              4849       0          0          0          0
241              4862       0          0          0          0
243              4863       0          0          0          0
244              4894       0          0          0          0
245              4980       0          0          0          0
247              4981       0          0          0          0
248              4986       0          0          0          0
250              5015       0          0          0          0
252              4990       0          0          0          0
256              4851       0          0          0          0
259              4863       0          0          0          0
260              4905       0          0          0          0
263              4922       0          0          0          0
264              4960       0          0          0          0
268              4991       0          0          0          0
309              4778       0          0          0          0
310              4779       0          0          0          0
314              4839       0          0          0          0
410              4793       0          0          0          0
414              4796       0          0          0          0
418              4802       0          0          0          0
422              4800       0          0          0          0
426              4810       0          0          0          0
509              4826       0          0          0          0
510              4856       0          0          0          0
513              4880       0          0          0          0
514              4931       0          0          0          0
518              4940       0          0          0          0
609              4832       0          0          0          0
610              4858       0          0          0          0
613              4888       0          0          0          0
614              4899       0          0          0          0
617              4942       0          0          0          0
618              4950       0          0          0          0
```

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622              4981       0          0          0          0
710              4975       0          0          0          0
809              4965       0          0          0          0
810              4969       0          0          0          0
813              4967       0          0          0          0
814              4970       0          0          0          0
818              4990       0          0          0          0

[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
O_100            4778       FREE                        NO
O_210            4754       FREE                        NO
O_220            4769       FREE                        NO
O_300            4775       FREE                        NO
O_410            4779       FREE                        NO
O_414            4781       FREE                        NO
O_418            4784       FREE                        NO
O_422            4789       FREE                        NO
O_426            4793       FREE                        NO
O_500            4804       FREE                        NO
O_600            4812       FREE                        NO
O_710            4961       FREE                        NO
O_800            4960       FREE                        NO

[CONDUITS]
;;Name           From Node        To Node          Length     Roughness  InOffset   OutOffset  InitFlow   MaxFlow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- -------
---
DL_109           109              O_100            11.88      0.01       0          0          0          0
DL_110           110              109              157.65     0.01       0          0          0          0
DL_114           114              113              299.75     0.01       0          0          0          0
DL_118           118              117              163.54     0.01       0          0          0          0
DL_121           121              119              71.39      0.01       0          0          0          0
DL_122           122              121              314.61     0.01       0          0          0          0
DL_129           129              119              51.02      0.01       0          0          0          0
DL_130           130              129              235.94     0.01       0          0          0          0
DL_134           134              133              214.69     0.01       0          0          0          0
DL_142           142              139              112.30     0.01       0          0          0          0
DL_150           150              149              280.05     0.01       0          0          0          0
DL_210           210              O_210            198.34     0.01       0          0          0          0
DL_219           219              O_220            12.79      0.01       0          0          0          0
DL_220           220              219              239.57     0.01       0          0          0          0
DL_223           223              221              55.56      0.01       0          0          0          0
DL_224           224              223              150.97     0.01       0          0          0          0
DL_226           226              225              235.05     0.01       0          0          0          0
DL_231           231              221              59.69      0.01       0          0          0          0
DL_232           232              231              238.21     0.01       0          0          0          0
DL_236           236              235              18.27      0.01       0          0          0          0
DL_237           237              235              21.32      0.01       0          0          0          0
DL_240           240              237              121.37     0.01       0          0          0          0
DL_243           243              241              54.47      0.01       0          0          0          0
DL_244           244              243              238.80     0.01       0          0          0          0
DL_247           247              245              23.77      0.01       0          0          0          0
DL_248           248              247              146.80     0.01       0          0          0          0
DL_252           252              245              191.47     0.01       0          0          0          0
DL_256           256              239              29.90      0.035      0          0          0          0
DL_259           259              241              41.68      0.01       0          0          0          0
DL_260           260              259              177.64     0.01       0          0          0          0
DL_264           264              263              240.21     0.01       0          0          0          0
DL_309           309              O_300            10.54      0.01       0          0          0          0
DL_310           310              309              116.14     0.01       0          0          0          0
DL_410           410              O_410            110.50     0.01       0          0          0          0
DL_414           414              O_414            95.89      0.01       0          0          0          0
DL_418           418              O_418            213.42     0.01       0          0          0          0
DL_422           422              O_422            87.13      0.01       0          0          0          0
DL_426           426              O_426            204.94     0.01       0          0          0          0
DL_509           509              O_500            10         0.01       0          0          0          0
DL_510           510              509              125.31     0.01       0          0          0          0
DL_514           514              513              289.06     0.01       0          0          0          0
DL_518           518              513              320.57     0.01       0          0          0          0
DL_609           609              O_600            147        0.01       0          0          0          0
DL_610           610              609              118.83     0.01       0          0          0          0
DL_614           614              613              298.82     0.01       0          0          0          0
DL_618           618              617              238.73     0.01       0          0          0          0
DL_710           710              O_710            202.60     0.01       0          0          0          0
DL_809           809              O_800            15.11      0.01       0          0          0          0
DL_810           810              809              133.38     0.01       0          0          0          0
DL_814           814              813              463.70     0.01       0          0          0          0
L_114            113              109              144        0.035      0          0          0          0
L_115            115              113              3260       0.035      0          0          0          0
L_117            117              115              86         0.035      0          0          0          0
L_119            119              117              1087       0.035      0          0          0          0
L_126            126              121              5178       0.035      0          0          0          0
L_133            133              129              2743       0.035      0          0          0          0
L_138            138              133              2426       0.035      0          0          0          0
L_139            139              115              73         0.035      0          0          0          0
L_141            141              139              542        0.035      0          0          0          0
L_146            146              141              165        0.035      0          0          0          0
L_149            149              141              1479       0.035      0          0          0          0
L_154            154              149              1625       0.035      0          0          0          0
L_221            221              219              2511       0.035      0          0          0          0
L_225            225              223              1810       0.035      0          0          0          0
L_228            228              225              847        0.035      0          0          0          0
L_235            235              231              3274       0.035      0          0          0          0
L_239            239              237              288        0.035      0          0          0          0
L_241            241              239              1092       0.035      0          0          0          0
L_245            245              243              4101       0.035      0          0          0          0
L_250            250              247              2063       0.035      0          0          0          0
L_263            263              259              2459       0.035      0          0          0          0
L_268            268              263              1464       0.035      0          0          0          0
L_314            314              309              2623       0.035      0          0          0          0
L_513            513              509              3358       0.035      0          0          0          0
L_613            613              609              3459       0.035      0          0          0          0
L_617            617              613              2214       0.035      0          0          0          0
L_622            622              617              1661       0.035      0          0          0          0
L_813            813              809              190        0.035      0          0          0          0
L_818            818              813              1740       0.035      0          0          0          0

[XSECTIONS]
;;Link            Shape        Geom1            Geom2      Geom3      Geom4      Barrels    Culvert
;;--------------- ------------ ---------------- ---------- ---------- ---------- ---------- ----------
DL_109           DUMMY        0                0          0          0          1
DL_110           DUMMY        0                0          0          0          1
DL_114           DUMMY        0                0          0          0          1
DL_118           DUMMY        0                0          0          0          1
DL_121           DUMMY        0                0          0          0          1
DL_122           DUMMY        0                0          0          0          1
DL_129           DUMMY        0                0          0          0          1
DL_130           DUMMY        0                0          0          0          1
DL_134           DUMMY        0                0          0          0          1
DL_142           DUMMY        0                0          0          0          1
DL_150           DUMMY        0                0          0          0          1
DL_210           DUMMY        0                0          0          0          1
DL_219           DUMMY        0                0          0          0          1
DL_220           DUMMY        0                0          0          0          1
DL_223           DUMMY        0                0          0          0          1
DL_224           DUMMY        0                0          0          0          1
DL_226           DUMMY        0                0          0          0          1
DL_231           DUMMY        0                0          0          0          1
DL_232           DUMMY        0                0          0          0          1
DL_236           DUMMY        0                0          0          0          1
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DL_237           DUMMY        0               0          0          0          1
DL_240           DUMMY        0               0          0          0          1
DL_243           DUMMY        0               0          0          0          1
DL_244           DUMMY        0               0          0          0          1
DL_247           DUMMY        0               0          0          0          1
DL_248           DUMMY        0               0          0          0          1
DL_252           DUMMY        0               0          0          0          1
DL_256           DUMMY        0               0          0          0          1
DL_259           DUMMY        0               0          0          0          1
DL_260           DUMMY        0               0          0          0          1
DL_264           DUMMY        0               0          0          0          1
DL_309           DUMMY        0               0          0          0          1
DL_310           DUMMY        0               0          0          0          1
DL_410           DUMMY        0               0          0          0          1
DL_414           DUMMY        0               0          0          0          1
DL_418           DUMMY        0               0          0          0          1
DL_422           DUMMY        0               0          0          0          1
DL_426           DUMMY        0               0          0          0          1
DL_509           DUMMY        0               0          0          0          1
DL_510           DUMMY        0               0          0          0          1
DL_514           DUMMY        0               0          0          0          1
DL_518           DUMMY        0               0          0          0          1
DL_609           DUMMY        0               0          0          0          1
DL_610           DUMMY        0               0          0          0          1
DL_614           DUMMY        0               0          0          0          1
DL_618           DUMMY        0               0          0          0          1
DL_710           DUMMY        0               0          0          0          1
DL_809           DUMMY        0               0          0          0          1
DL_810           DUMMY        0               0          0          0          1
DL_814           DUMMY        0               0          0          0          1
L_114            TRIANGULAR   10              200        0          0          1
L_115            TRAPEZOIDAL  10              100        5          5          1
L_117            TRAPEZOIDAL  10              10         2          2          1
L_119            TRAPEZOIDAL  10              10         2          2          1
L_126            TRAPEZOIDAL  10              30         2          2          1
L_133            TRAPEZOIDAL  10              75         8          8          1
L_138            TRAPEZOIDAL  10              50         8          8          1
L_139            TRAPEZOIDAL  10              20         2          2          1
L_141            TRAPEZOIDAL  10              30         2          2          1
L_146            TRAPEZOIDAL  10              20         10         10         1
L_149            TRAPEZOIDAL  10              30         2          2          1
L_154            TRAPEZOIDAL  10              50         2          2          1
L_221            TRAPEZOIDAL  10              40         4          4          1
L_225            TRAPEZOIDAL  10              40         2          2          1
L_228            TRAPEZOIDAL  10              20         2          2          1
L_235            TRAPEZOIDAL  10              100        3          3          1
L_239            TRAPEZOIDAL  10              75         2          2          1
L_241            TRAPEZOIDAL  10              30         2          2          1
L_245            TRAPEZOIDAL  10              10         2          2          1
L_250            TRAPEZOIDAL  10              10         50         50         1
L_263            TRAPEZOIDAL  10              20         2          2          1
L_268            TRAPEZOIDAL  10              20         2          2          1
L_314            TRAPEZOIDAL  10              50         2          2          1
L_513            TRAPEZOIDAL  10              50         2          2          1
L_613            TRAPEZOIDAL  10              100        3          3          1
L_617            TRAPEZOIDAL  10              80         2          2          1
L_622            TRAPEZOIDAL  10              20         10         10         1
L_813            TRIANGULAR   10              200        0          0          1
L_818            TRAPEZOIDAL  10              20         15         15         1

[REPORT]
;;Reporting Options
INPUT      YES
CONTROLS   YES
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS 0.000 0.000 10000.000 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
109              5102.566           6684.379
110              5239.481           6606.235
113              5099.162           6645.950
114              4946.247           6388.140
115              5455.307           5936.453
117              5459.502           5892.031
118              5393.226           5742.525
119              5584.348           5675.863
121              5588.201           5604.578
122              5390.914           5359.510
126              5835.196           4448.324
129              5608.238           5630.780
130              5814.773           5516.723
133              5874.302           5074.022
134              6082.961           5023.505
138              6053.073           4613.128
139              5481.851           5918.234
141              5586.592           5875.000
142              5558.916           5836.544
146              5641.061           5888.617
149              5867.318           5620.461
150              5955.032           5354.501
154              6148.045           5356.145
210              4613.128           6728.003
219              4397.696           6681.739
220              4413.147           6442.663
221              4737.430           6129.888
223              4741.638           6074.484
224              4626.040           5977.381
225              4713.895           5639.835
226              4561.305           5461.043
228              4769.382           5447.172
231              4777.088           6085.273
232              4995.954           5991.253
235              4968.403           5326.564
236              4980.734           5313.078
237              4954.531           5310.381
239              4932.182           5235.627
240              4838.933           5273.389
241              4932.953           4990.559
243              4898.274           4948.559
244              4713.317           4797.511
245              4711.390           4094.747
247              4718.711           4072.133
248              4856.273           4020.885
250              4826.816           3603.701
252              4541.461           4006.507
256              4960.697           5231.389
259              4946.825           4951.256
260              5080.533           4834.309
263              4999.302           4427.200
264              5177.636           4266.266
268              5105.447           4097.591
309              4131.983           6508.642
310              4245.916           6486.109
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314             4240.223        5865.922
410             3935.754        6190.992
414             3846.369        6111.383
418             3782.123        5931.215
422             3685.754        6016.411
426             3600.559        5792.947
509             3353.701        5776.274
510             3478.537        5787.198
513             3854.749        5117.318
514             3795.083        4834.478
518             4172.703        5076.463
609             3219.186        5620.030
610             3325.755        5567.466
613             3512.570        4814.944
614             3482.198        4517.667
617             3867.318        4429.469
618             4100.262        4377.240
622             4099.162        4095.670
710             3302.327        4304.182
809             3213.687        3986.208
810             3339.820        4029.579
813             3240.223        3939.246
814             3658.196        3738.446
818             3491.620        3597.940
O_100           5103.352        6696.229
O_210           4629.888        6925.628
O_220           4389.665        6691.690
O_300           4125.698        6517.109
O_410           3896.648        6294.344
O_414           3805.168        6197.975
O_418           3747.207        6141.760
O_422           3607.542        6054.818
O_426           3497.905        5970.321
O_500           3351.955        5783.170
O_600           3208.799        5625.349
O_710           3202.514        4372.207
O_800           3201.117        3994.588

[VERTICES]
;;Link          X-Coord         Y-Coord
;;------------- ---------------- ----------------
DL_256          4952.219        5236.398
L_115           5434.183        5971.238
L_115           5424.406        5997.774
L_115           5404.853        6008.947
L_115           5388.094        6031.294
L_115           5371.334        6073.193
L_115           5351.781        6110.903
L_115           5348.987        6145.819
L_115           5337.814        6156.992
L_115           5336.418        6172.355
L_115           5321.054        6189.115
L_115           5316.865        6211.461
L_115           5308.485        6231.014
L_115           5295.915        6236.601
L_115           5272.172        6268.724
L_115           5272.172        6285.484
L_115           5255.412        6299.450
L_115           5249.825        6362.299
L_115           5234.462        6377.662
L_115           5228.876        6411.182
L_115           5209.323        6439.115
L_115           5189.770        6462.858
L_115           5171.613        6493.584
L_115           5160.440        6500.567
L_115           5168.820        6529.897
L_115           5164.630        6556.433
L_115           5142.284        6564.813
L_115           5119.937        6588.556
L_115           5117.144        6603.919
L_115           5103.177        6615.093
L_115           5092.004        6626.266
L_119           5538.879        5725.570
L_119           5519.613        5759.479
L_119           5472.603        5820.361
L_119           5471.062        5862.747
L_126           5736.167        4561.883
L_126           5736.167        4662.068
L_126           5766.993        4709.849
L_126           5777.782        4751.464
L_126           5756.204        4836.236
L_126           5740.791        4916.384
L_126           5723.836        4924.091
L_126           5696.093        4982.660
L_126           5688.386        5004.239
L_126           5643.688        5055.102
L_126           5642.147        5096.717
L_126           5657.560        5159.911
L_126           5646.771        5221.563
L_126           5654.477        5277.050
L_126           5635.982        5330.996
L_126           5611.321        5381.859
L_126           5592.825        5420.391
L_126           5583.577        5529.824
L_126           5571.247        5546.779
L_126           5577.412        5574.522
L_133           5846.369        5101.955
L_133           5824.022        5110.335
L_133           5787.709        5182.961
L_133           5768.156        5244.413
L_133           5743.017        5319.832
L_133           5731.844        5398.045
L_133           5717.877        5420.391
L_133           5717.877        5445.531
L_133           5673.184        5554.469
L_133           5656.425        5576.816
L_133           5631.285        5579.609
L_138           6047.486        4632.682
L_138           6081.006        4677.374
L_138           6122.905        4705.307
L_138           6142.458        4727.654
L_138           6139.665        4766.760
L_138           6108.939        4800.279
L_138           6106.145        4842.179
L_138           6047.486        4898.045
L_138           6036.313        4925.978
L_138           5991.620        4939.944
L_138           5958.101        4962.291
L_138           5932.961        5020.950
L_138           5913.408        5043.296
L_141           5536.969        5896.517
L_141           5510.552        5906.447
L_141           5489.382        5913.753
L_149           5844.058        5634.633
L_149           5828.645        5643.881
L_149           5790.883        5682.414
L_149           5767.764        5710.928
L_149           5747.727        5722.488
L_149           5732.314        5731.736
L_149           5714.588        5748.690
L_149           5693.010        5770.268
L_149           5640.606        5818.819
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L_149	5625.193	5851.187
L_149	5611.321	5862.747
L_154	6111.732	5364.525
L_154	6089.385	5384.078
L_154	6022.346	5425.978
L_154	6013.966	5448.324
L_154	5980.447	5481.844
L_154	5958.101	5509.777
L_154	5930.168	5546.089
L_154	5913.408	5576.816
L_154	5888.268	5596.369
L_221	4708.624	6187.369
L_221	4690.468	6218.095
L_221	4669.518	6261.391
L_221	4638.792	6320.051
L_221	4633.205	6341.000
L_221	4589.909	6378.710
L_221	4580.133	6398.263
L_221	4567.563	6412.229
L_221	4546.613	6454.129
L_221	4525.663	6469.492
L_221	4480.971	6549.101
L_221	4455.831	6592.397
L_221	4441.865	6606.363
L_221	4426.501	6645.470
L_221	4411.138	6656.643
L_225	4707.730	5659.101
L_225	4707.730	5677.597
L_225	4690.775	5726.919
L_225	4690.775	5773.158
L_225	4696.941	5779.323
L_225	4690.775	5799.360
L_225	4681.527	5813.232
L_225	4703.106	5891.839
L_225	4726.225	5955.032
L_225	4735.473	5992.024
L_225	4744.721	6041.346
L_228	4766.299	5472.603
L_228	4758.593	5489.558
L_228	4746.262	5515.760
L_228	4737.014	5537.338
L_228	4716.977	5555.834
L_228	4720.060	5572.788
L_228	4729.308	5595.908
L_228	4724.684	5614.404
L_235	4968.211	5371.648
L_235	4946.632	5411.722
L_235	4923.513	5428.676
L_235	4908.100	5457.961
L_235	4888.063	5491.870
L_235	4875.732	5516.531
L_235	4864.943	5550.439
L_235	4872.650	5581.265
L_235	4852.613	5632.129
L_235	4846.447	5649.083
L_235	4854.154	5672.203
L_235	4849.530	5741.561
L_235	4858.778	5766.222
L_235	4858.778	5857.159
L_235	4843.365	5889.527
L_235	4834.117	5968.133
L_235	4810.997	6009.749
L_235	4797.125	6034.410
L_235	4792.502	6060.612
L_235	4792.502	6072.942
L_239	4927.559	5257.976
L_239	4936.806	5278.013
L_239	4943.742	5292.656
L_241	4944.513	5016.762
L_241	4932.953	5034.487
L_241	4921.393	5052.982
L_241	4915.228	5095.368
L_241	4913.687	5127.736
L_241	4920.623	5157.791
L_241	4925.247	5204.031
L_241	4933.724	5217.902
L_245	4650.123	4284.256
L_245	4614.673	4375.193
L_245	4613.132	4413.725
L_245	4628.545	4441.469
L_245	4645.499	4478.460
L_245	4679.408	4535.489
L_245	4711.776	4574.021
L_245	4728.730	4592.517
L_245	4754.932	4624.884
L_245	4771.887	4641.839
L_245	4765.721	4666.500
L_245	4771.887	4735.859
L_245	4779.593	4786.722
L_245	4785.758	4817.548
L_245	4801.171	4839.126
L_245	4825.832	4851.457
L_245	4842.787	4840.667
L_245	4858.200	4859.163
L_245	4867.448	4891.531
L_245	4878.237	4905.402
L_245	4884.402	4920.815
L_250	4844.972	3642.458
L_250	4839.385	3949.721
L_250	4801.676	3974.860
L_250	4763.966	3998.603
L_250	4722.067	4029.330
L_263	4994.413	4465.258
L_263	4979.050	4480.622
L_263	4979.050	4533.694
L_263	4991.620	4554.644
L_263	4979.050	4579.784
L_263	4981.844	4648.219
L_263	4970.670	4671.962
L_263	4990.223	4697.102
L_263	4986.034	4743.191
L_263	5019.553	4787.884
L_263	5019.553	4813.024
L_263	4984.637	4838.163
L_263	4977.654	4859.113
L_263	4955.307	4874.476
L_263	4962.291	4910.789
L_263	4946.927	4928.946
L_268	5082.402	4144.029
L_268	5037.709	4199.895
L_268	5020.950	4215.258
L_268	5004.190	4258.554
L_268	4998.603	4275.314
L_268	5006.983	4297.661
L_268	4998.603	4314.420
L_268	4998.603	4360.510
L_268	4993.017	4371.683
L_268	4994.413	4395.426
L_314	4240.573	5898.045
L_314	4228.003	5942.737
L_314	4222.416	6043.296
L_314	4216.830	6061.453

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L_314            4229.399          6100.559
L_314            4232.193          6150.838
L_314            4246.159          6173.184
L_314            4232.193          6206.704
L_314            4232.193          6286.313
L_314            4219.623          6294.693
L_314            4214.036          6331.006
L_314            4202.863          6346.369
L_314            4188.897          6400.838
L_314            4184.707          6427.374
L_314            4158.170          6460.894
L_314            4152.584          6476.257
L_314            4144.204          6481.844
L_314            4145.601          6497.207
L_513            3850.010          5159.482
L_513            3820.034          5187.959
L_513            3805.046          5205.945
L_513            3797.552          5217.935
L_513            3782.564          5225.429
L_513            3775.070          5223.930
L_513            3761.581          5250.909
L_513            3746.593          5259.901
L_513            3725.609          5261.400
L_513            3704.626          5292.875
L_513            3694.135          5334.842
L_513            3685.142          5348.331
L_513            3658.163          5378.307
L_513            3619.194          5426.268
L_513            3601.209          5445.753
L_513            3574.230          5495.213
L_513            3539.758          5523.690
L_513            3500.789          5558.163
L_513            3473.811          5583.642
L_513            3464.818          5592.635
L_513            3443.835          5598.630
L_513            3412.360          5627.108
L_513            3398.871          5660.081
L_513            3388.379          5681.065
L_513            3392.876          5706.544
L_513            3386.880          5718.535
L_513            3358.403          5750.009
L_613            3499.127          4890.931
L_613            3501.920          4956.573
L_613            3485.161          4973.333
L_613            3482.367          5008.249
L_613            3462.814          5052.942
L_613            3461.418          5085.065
L_613            3437.675          5094.841
L_613            3426.501          5126.964
L_613            3388.792          5156.294
L_613            3359.462          5195.400
L_613            3349.686          5207.970
L_613            3327.339          5221.936
L_613            3316.166          5233.109
L_613            3299.406          5255.456
L_613            3285.440          5298.752
L_613            3272.870          5340.651
L_613            3261.697          5381.154
L_613            3250.524          5446.796
L_613            3251.920          5501.266
L_613            3263.094          5529.199
L_613            3260.300          5558.528
L_613            3243.541          5582.271
L_613            3228.177          5600.428
L_617            3843.575          4435.143
L_617            3803.073          4470.059
L_617            3772.346          4471.456
L_617            3734.637          4502.182
L_617            3737.430          4524.529
L_617            3709.497          4542.685
L_617            3694.134          4548.272
L_617            3663.408          4581.791
L_617            3643.855          4583.188
L_617            3618.715          4630.674
L_617            3621.508          4647.434
L_617            3613.128          4660.003
L_617            3593.575          4690.730
L_617            3587.989          4704.696
L_617            3569.832          4734.026
L_617            3568.436          4741.009
L_617            3548.883          4754.976
L_617            3526.536          4778.719
L_622            4100.559          4153.020
L_622            4069.832          4213.076
L_622            4011.173          4271.735
L_622            3993.017          4316.428
L_622            3956.704          4363.914
L_622            3917.598          4391.847
L_622            3899.441          4394.640
L_818            3470.670          3615.223
L_818            3417.598          3625.000
L_818            3399.441          3625.000
L_818            3395.251          3647.346
L_818            3384.078          3651.536
L_818            3368.715          3678.073
L_818            3344.972          3719.972
L_818            3339.385          3746.508
L_818            3317.039          3777.235
L_818            3311.453          3802.374
L_818            3298.883          3813.547
L_818            3283.520          3848.464
L_818            3251.397          3884.777
L_818            3244.413          3895.950


[BACKDROP]
FILE       "R:\22.906.007 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221
Models\CUHP_SWMM\SWMM\Backgrounds\Background_basemap.jpg"
DIMENSIONS 0.000 2873.094 10000.000 7126.906
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EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
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City of Greeley
Storm Drainage Master Plan
Oklahoma and South Basins Baseline Hydrology

WARNING 08: elevation drop exceeds length for Conduit DL_509

*************
Element Count
*************
Number of rain gages ...... 0
Number of subcatchments ... 0
Number of nodes ........... 92
Number of links ........... 79
Number of pollutants ...... 0
Number of land uses ....... 0


************
Node Summary
************

                                  Invert      Max.    Ponded    External
Name                Type           Elev.     Depth      Area    Inflow
-----------------------------------------------------------------------
109                 JUNCTION     4779.00     10.00       0.0
110                 JUNCTION     4794.00      0.00       0.0
113                 JUNCTION     4784.00     10.00       0.0
114                 JUNCTION     4798.00      0.00       0.0
115                 JUNCTION     4816.70     10.00       0.0
117                 JUNCTION     4818.00     10.00       0.0
118                 JUNCTION     4830.00      0.00       0.0
119                 JUNCTION     4834.00     10.00       0.0
121                 JUNCTION     4835.00     10.00       0.0
122                 JUNCTION     4983.00      0.00       0.0
126                 JUNCTION     4999.00     10.00       0.0
129                 JUNCTION     4835.00     10.00       0.0
130                 JUNCTION     4910.00      0.00       0.0
133                 JUNCTION     4917.00     10.00       0.0
134                 JUNCTION     4945.00      0.00       0.0
138                 JUNCTION     4970.00     10.00       0.0
139                 JUNCTION     4817.00     10.00       0.0
141                 JUNCTION     4827.00     10.00       0.0
142                 JUNCTION     4820.00      0.00       0.0
146                 JUNCTION     4849.00     10.00       0.0
149                 JUNCTION     4869.00     10.00       0.0
150                 JUNCTION     4890.00      0.00       0.0
154                 JUNCTION     4904.00     10.00       0.0
210                 JUNCTION     4770.00      0.00       0.0
219                 JUNCTION     4772.00     10.00       0.0
220                 JUNCTION     4777.00      0.00       0.0
221                 JUNCTION     4790.60     10.00       0.0
223                 JUNCTION     4793.00     10.00       0.0
224                 JUNCTION     4810.00      0.00       0.0
225                 JUNCTION     4840.00     10.00       0.0
226                 JUNCTION     4850.00      0.00       0.0
228                 JUNCTION     4864.00     10.00       0.0
231                 JUNCTION     4790.80     10.00       0.0
232                 JUNCTION     4810.00      0.00       0.0
235                 JUNCTION     4845.00     10.00       0.0
236                 JUNCTION     4847.00      0.00       0.0
237                 JUNCTION     4846.00     10.00       0.0
239                 JUNCTION     4850.00     10.00       0.0
240                 JUNCTION     4849.00      0.00       0.0
241                 JUNCTION     4862.00     10.00       0.0
243                 JUNCTION     4863.00     10.00       0.0
244                 JUNCTION     4894.00      0.00       0.0
245                 JUNCTION     4980.00     10.00       0.0
247                 JUNCTION     4981.00     10.00       0.0
248                 JUNCTION     4986.00      0.00       0.0
250                 JUNCTION     5015.00     10.00       0.0
252                 JUNCTION     4990.00      0.00       0.0
256                 JUNCTION     4851.00      0.00       0.0
259                 JUNCTION     4863.00     10.00       0.0
260                 JUNCTION     4905.00      0.00       0.0
263                 JUNCTION     4922.00     10.00       0.0
264                 JUNCTION     4960.00      0.00       0.0
268                 JUNCTION     4991.00     10.00       0.0
309                 JUNCTION     4778.00     10.00       0.0
310                 JUNCTION     4779.00      0.00       0.0
314                 JUNCTION     4839.00     10.00       0.0
410                 JUNCTION     4793.00      0.00       0.0
414                 JUNCTION     4796.00      0.00       0.0
418                 JUNCTION     4802.00      0.00       0.0
422                 JUNCTION     4800.00      0.00       0.0
426                 JUNCTION     4810.00      0.00       0.0
509                 JUNCTION     4826.00     10.00       0.0
510                 JUNCTION     4856.00      0.00       0.0
513                 JUNCTION     4880.00     10.00       0.0
514                 JUNCTION     4931.00      0.00       0.0
518                 JUNCTION     4940.00      0.00       0.0
609                 JUNCTION     4832.00     10.00       0.0
610                 JUNCTION     4858.00      0.00       0.0
613                 JUNCTION     4888.00     10.00       0.0
614                 JUNCTION     4899.00      0.00       0.0
617                 JUNCTION     4942.00     10.00       0.0
618                 JUNCTION     4950.00      0.00       0.0
622                 JUNCTION     4981.00     10.00       0.0
710                 JUNCTION     4975.00      0.00       0.0
809                 JUNCTION     4965.00     10.00       0.0
810                 JUNCTION     4969.00      0.00       0.0
813                 JUNCTION     4967.00     10.00       0.0
814                 JUNCTION     4970.00      0.00       0.0
818                 JUNCTION     4990.00     10.00       0.0
O_100               OUTFALL      4778.00      0.00       0.0
O_210               OUTFALL      4754.00      0.00       0.0
O_220               OUTFALL      4769.00      0.00       0.0
O_300               OUTFALL      4775.00      0.00       0.0
O_410               OUTFALL      4779.00      0.00       0.0
O_414               OUTFALL      4781.00      0.00       0.0
O_418               OUTFALL      4784.00      0.00       0.0
O_422               OUTFALL      4789.00      0.00       0.0
O_426               OUTFALL      4793.00      0.00       0.0
O_500               OUTFALL      4804.00      0.00       0.0
O_600               OUTFALL      4820.00      0.00       0.0
O_710               OUTFALL      4961.00      0.00       0.0
O_800               OUTFALL      4960.00      0.00       0.0


************
Link Summary
************
Name                From Node        To Node          Type            Length    %Slope Roughness
---------------------------------------------------------------------------------------------------
DL_109              109              O_100            CONDUIT           11.9    8.4475    0.0100
DL_110              110              109              CONDUIT          157.7    9.5581    0.0100
DL_114              114              113              CONDUIT          299.8    4.6757    0.0100
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DL_118	118	117	CONDUIT	163.5	7.3575	0.0100
DL_121	121	119	CONDUIT	71.4	1.4009	0.0100
DL_122	122	121	CONDUIT	314.6	53.3094	0.0100
DL_129	129	119	CONDUIT	51.0	1.9604	0.0100
DL_130	130	129	CONDUIT	235.9	33.5267	0.0100
DL_134	134	133	CONDUIT	214.7	13.1544	0.0100
DL_142	142	139	CONDUIT	112.3	2.6724	0.0100
DL_150	150	149	CONDUIT	280.1	7.5198	0.0100
DL_210	210	O_210	CONDUIT	198.3	8.0933	0.0100
DL_219	219	O_220	CONDUIT	12.8	24.1290	0.0100
DL_220	220	219	CONDUIT	239.6	2.0875	0.0100
DL_223	223	221	CONDUIT	55.6	4.3237	0.0100
DL_224	224	223	CONDUIT	151.0	11.3326	0.0100
DL_226	226	225	CONDUIT	235.1	4.2583	0.0100
DL_231	231	221	CONDUIT	59.7	0.3351	0.0100
DL_232	232	231	CONDUIT	238.2	8.0864	0.0100
DL_236	236	235	CONDUIT	18.3	11.0131	0.0100
DL_237	237	235	CONDUIT	21.3	4.6956	0.0100
DL_240	240	237	CONDUIT	121.4	2.4725	0.0100
DL_243	243	241	CONDUIT	54.5	1.8362	0.0100
DL_244	244	243	CONDUIT	238.8	13.0924	0.0100
DL_247	247	245	CONDUIT	23.8	4.2107	0.0100
DL_248	248	247	CONDUIT	146.8	3.4080	0.0100
DL_252	252	245	CONDUIT	191.5	5.2299	0.0100
DL_256	256	239	CONDUIT	29.9	3.3464	0.0100
DL_259	259	241	CONDUIT	41.7	2.3999	0.0100
DL_260	260	259	CONDUIT	177.6	24.3332	0.0100
DL_264	264	263	CONDUIT	240.2	16.0212	0.0100
DL_309	309	O_300	CONDUIT	10.5	29.6911	0.0100
DL_310	310	309	CONDUIT	116.1	0.8611	0.0100
DL_410	410	O_410	CONDUIT	110.5	12.7726	0.0100
DL_414	414	O_414	CONDUIT	95.9	15.8379	0.0100
DL_418	418	O_418	CONDUIT	213.4	8.4642	0.0100
DL_422	422	O_422	CONDUIT	87.1	12.7266	0.0100
DL_426	426	O_426	CONDUIT	204.9	8.3238	0.0100
DL_509	509	O_500	CONDUIT	10.0	220.0000	0.0100
DL_510	510	509	CONDUIT	125.3	24.6577	0.0100
DL_514	514	513	CONDUIT	289.1	17.9246	0.0100
DL_518	518	513	CONDUIT	320.6	19.0534	0.0100
DL_609	609	O_600	CONDUIT	147.0	8.1906	0.0100
DL_610	610	609	CONDUIT	118.8	22.4233	0.0100
DL_614	614	613	CONDUIT	298.8	3.6836	0.0100
DL_618	618	617	CONDUIT	238.7	3.3529	0.0100
DL_710	710	O_710	CONDUIT	202.6	6.9267	0.0100
DL_809	809	O_800	CONDUIT	15.1	35.0662	0.0100
DL_810	810	809	CONDUIT	133.4	3.0003	0.0100
DL_814	814	813	CONDUIT	463.7	0.6470	0.0100
L_114	113	109	CONDUIT	144.0	3.4743	0.0350
L_115	115	113	CONDUIT	3260.0	1.0031	0.0350
L_117	117	115	CONDUIT	86.0	1.5118	0.0350
L_119	119	117	CONDUIT	1087.0	1.4721	0.0350
L_126	126	121	CONDUIT	5178.0	3.1688	0.0350
L_133	133	129	CONDUIT	2743.0	2.9908	0.0350
L_138	138	133	CONDUIT	2426.0	2.1852	0.0350
L_139	139	115	CONDUIT	73.0	0.4110	0.0350
L_141	141	139	CONDUIT	542.0	1.8453	0.0350
L_146	146	141	CONDUIT	165.0	13.4535	0.0350
L_149	149	141	CONDUIT	1479.0	2.8409	0.0350
L_154	154	149	CONDUIT	1625.0	2.1543	0.0350
L_221	221	219	CONDUIT	2511.0	0.7408	0.0350
L_225	225	223	CONDUIT	1810.0	2.5976	0.0350
L_228	228	225	CONDUIT	847.0	2.8347	0.0350
L_235	235	231	CONDUIT	3274.0	1.6557	0.0350
L_239	239	237	CONDUIT	288.0	1.3890	0.0350
L_241	241	239	CONDUIT	1092.0	1.0990	0.0350
L_245	245	243	CONDUIT	4101.0	2.8541	0.0350
L_250	250	247	CONDUIT	2063.0	1.6483	0.0350
L_263	263	259	CONDUIT	2459.0	2.4000	0.0350
L_268	268	263	CONDUIT	1464.0	4.7184	0.0350
L_314	314	309	CONDUIT	2623.0	2.3262	0.0350
L_513	513	509	CONDUIT	3358.0	1.6083	0.0350
L_613	613	609	CONDUIT	3459.0	1.6192	0.0350
L_617	617	613	CONDUIT	2214.0	2.4398	0.0350
L_622	622	617	CONDUIT	1661.0	2.3486	0.0350
L_813	813	809	CONDUIT	190.0	1.0527	0.0350
L_818	818	813	CONDUIT	1740.0	1.3220	0.0350

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Cross Section Summary
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Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
DL_109	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_110	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_114	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_118	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_121	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_122	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_129	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_130	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_134	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_142	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_150	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_210	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_219	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_220	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_223	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_224	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_226	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_231	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_232	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_236	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_237	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_240	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_243	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_244	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_247	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_248	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_252	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_256	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_259	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_260	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_264	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_309	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_310	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_410	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_414	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_418	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_422	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_426	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_509	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_510	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_514	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_518	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_609	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_610	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_614	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_618	DUMMY	0.00	0.00	0.00	0.00	1	0.00

DL_710	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_809	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_810	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_814	DUMMY	0.00	0.00	0.00	0.00	1	0.00
L_114	TRIANGULAR	10.00	1000.00	4.98	200.00	1	23063.49
L_115	TRAPEZOIDAL	10.00	1500.00	7.43	200.00	1	24279.48
L_117	TRAPEZOIDAL	10.00	300.00	5.48	50.00	1	4869.25
L_119	TRAPEZOIDAL	10.00	300.00	5.48	50.00	1	4804.89
L_126	TRAPEZOIDAL	10.00	500.00	6.69	70.00	1	13419.02
L_133	TRAPEZOIDAL	10.00	1550.00	6.56	235.00	1	39885.90
L_138	TRAPEZOIDAL	10.00	1300.00	6.15	210.00	1	27399.52
L_139	TRAPEZOIDAL	10.00	400.00	6.18	60.00	1	3666.51
L_141	TRAPEZOIDAL	10.00	500.00	6.69	70.00	1	10240.20
L_146	TRAPEZOIDAL	10.00	1200.00	5.43	220.00	1	57731.32
L_149	TRAPEZOIDAL	10.00	500.00	6.69	70.00	1	12705.71
L_154	TRAPEZOIDAL	10.00	700.00	7.39	90.00	1	16550.33
L_221	TRAPEZOIDAL	10.00	800.00	6.53	120.00	1	10215.79
L_225	TRAPEZOIDAL	10.00	600.00	7.08	80.00	1	15141.09
L_228	TRAPEZOIDAL	10.00	400.00	6.18	60.00	1	9629.49
L_235	TRAPEZOIDAL	10.00	1300.00	7.96	160.00	1	28321.67
L_239	TRAPEZOIDAL	10.00	950.00	7.94	115.00	1	18911.69
L_241	TRAPEZOIDAL	10.00	500.00	6.69	70.00	1	7902.48
L_245	TRAPEZOIDAL	10.00	300.00	5.48	50.00	1	6690.39
L_250	TRAPEZOIDAL	10.00	5100.00	5.05	1010.00	1	81811.71
L_263	TRAPEZOIDAL	10.00	400.00	6.18	60.00	1	8860.57
L_268	TRAPEZOIDAL	10.00	400.00	6.18	60.00	1	12423.61
L_314	TRAPEZOIDAL	10.00	700.00	7.39	90.00	1	17197.82
L_513	TRAPEZOIDAL	10.00	700.00	7.39	90.00	1	14299.92
L_613	TRAPEZOIDAL	10.00	1300.00	7.96	160.00	1	28007.61
L_617	TRAPEZOIDAL	10.00	1000.00	8.02	120.00	1	26566.21
L_622	TRAPEZOIDAL	10.00	1200.00	5.43	220.00	1	24121.37
L_813	TRIANGULAR	10.00	1000.00	4.98	200.00	1	12695.23
L_818	TRAPEZOIDAL	10.00	1700.00	5.30	320.00	1	25231.25

```
**********                                                  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 ..........                                 568.337       185.201
External Outflow .........                                 573.327       186.827
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 ......                                   0.085         0.028
Continuity Error (%) .....                                  -0.893

*******************************
Highest Flow Instability Indexes
*******************************
All links are stable.

************************
Routing Time Step Summary
************************
Minimum Time Step           :    20.00 sec
Average Time Step           :    20.00 sec
Maximum Time Step           :    20.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00
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
-------------------------------------------------------------------------------------
109                  JUNCTION        0.73     3.49  4782.49    0  00:54        3.49
110                  JUNCTION        0.00     0.00  4794.00    0  00:00        0.00
113                  JUNCTION        0.73     3.49  4787.49    0  00:54        3.48
114                  JUNCTION        0.00     0.00  4798.00    0  00:00        0.00
115                  JUNCTION        0.57     4.31  4821.01    0  00:47        4.29
117                  JUNCTION        0.57     4.31  4822.31    0  00:47        4.29
118                  JUNCTION        0.00     0.00  4830.00    0  00:00        0.00
119                  JUNCTION        0.55     4.20  4838.20    0  00:45        4.20
121                  JUNCTION        0.05     0.28  4835.28    0  01:10        0.28
122                  JUNCTION        0.00     0.00  4983.00    0  00:00        0.00
126                  JUNCTION        0.04     0.30  4999.30    0  00:45        0.30
129                  JUNCTION        0.08     0.88  4835.88    0  00:45        0.88
130                  JUNCTION        0.00     0.00  4910.00    0  00:00        0.00
133                  JUNCTION        0.09     0.97  4917.97    0  00:40        0.97
134                  JUNCTION        0.00     0.00  4945.00    0  00:00        0.00
138                  JUNCTION        0.08     1.00  4971.00    0  00:35        1.00
139                  JUNCTION        0.43     3.39  4820.39    0  00:43        3.38
141                  JUNCTION        0.21     1.73  4828.73    0  00:42        1.72
142                  JUNCTION        0.00     0.00  4820.00    0  00:00        0.00
146                  JUNCTION        0.06     0.32  4849.32    0  00:55        0.32
```

```
*********************************************************
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 12:00:00
Antecedent Dry Days ......  0.0
Report Time Step .........  00:05:00
Routing Time Step ........  20.00 sec


*********************
Control Actions Taken
*********************
```

149	JUNCTION	0.15	1.43	4870.43	0	00:40	1.43
150	JUNCTION	0.00	0.00	4890.00	0	00:00	0.00
154	JUNCTION	0.08	1.00	4905.00	0	00:35	1.00
210	JUNCTION	0.00	0.00	4770.00	0	00:00	0.00
219	JUNCTION	0.59	4.49	4776.49	0	00:54	4.49
220	JUNCTION	0.00	0.00	4777.00	0	00:00	0.00
221	JUNCTION	0.58	4.51	4795.11	0	00:50	4.51
223	JUNCTION	0.12	1.04	4794.04	0	00:45	1.04
224	JUNCTION	0.00	0.00	4810.00	0	00:00	0.00
225	JUNCTION	0.12	1.04	4841.04	0	00:41	1.04
226	JUNCTION	0.00	0.00	4850.00	0	00:00	0.00
228	JUNCTION	0.12	0.99	4864.99	0	00:40	0.98
231	JUNCTION	0.23	1.91	4792.71	0	00:50	1.91
232	JUNCTION	0.00	0.00	4810.00	0	00:00	0.00
235	JUNCTION	0.22	1.93	4846.93	0	00:45	1.93
236	JUNCTION	0.00	0.00	4847.00	0	00:00	0.00
237	JUNCTION	0.25	2.30	4848.30	0	00:45	2.30
239	JUNCTION	0.42	3.81	4853.81	0	00:45	3.81
240	JUNCTION	0.00	0.00	4849.00	0	00:00	0.00
241	JUNCTION	0.41	3.81	4865.81	0	00:43	3.81
243	JUNCTION	0.34	3.30	4866.30	0	00:43	3.29
244	JUNCTION	0.00	0.00	4894.00	0	00:00	0.00
245	JUNCTION	0.33	3.33	4983.33	0	00:40	3.33
247	JUNCTION	0.09	0.89	4981.89	0	00:42	0.88
248	JUNCTION	0.00	0.00	4986.00	0	00:00	0.00
250	JUNCTION	0.08	0.93	5015.93	0	00:35	0.93
252	JUNCTION	0.00	0.00	4990.00	0	00:00	0.00
256	JUNCTION	0.00	0.00	4851.00	0	00:00	0.00
259	JUNCTION	0.19	1.74	4864.74	0	00:44	1.74
260	JUNCTION	0.00	0.00	4905.00	0	00:00	0.00
263	JUNCTION	0.19	1.75	4923.75	0	00:41	1.74
264	JUNCTION	0.00	0.00	4960.00	0	00:00	0.00
268	JUNCTION	0.09	0.90	4991.90	0	00:40	0.90
309	JUNCTION	0.07	0.66	4778.66	0	00:47	0.65
310	JUNCTION	0.00	0.00	4779.00	0	00:00	0.00
314	JUNCTION	0.06	0.67	4839.67	0	00:40	0.67
410	JUNCTION	0.00	0.00	4793.00	0	00:00	0.00
414	JUNCTION	0.00	0.00	4796.00	0	00:00	0.00
418	JUNCTION	0.00	0.00	4802.00	0	00:00	0.00
422	JUNCTION	0.00	0.00	4800.00	0	00:00	0.00
426	JUNCTION	0.00	0.00	4810.00	0	00:00	0.00
509	JUNCTION	0.15	1.33	4827.33	0	00:47	1.32
510	JUNCTION	0.00	0.00	4856.00	0	00:00	0.00
513	JUNCTION	0.14	1.36	4881.36	0	00:40	1.36
514	JUNCTION	0.00	0.00	4931.00	0	00:00	0.00
518	JUNCTION	0.00	0.00	4940.00	0	00:00	0.00
609	JUNCTION	0.13	1.26	4833.26	0	00:48	1.26
610	JUNCTION	0.00	0.00	4858.00	0	00:00	0.00
613	JUNCTION	0.12	1.30	4889.30	0	00:41	1.30
614	JUNCTION	0.00	0.00	4899.00	0	00:00	0.00
617	JUNCTION	0.15	1.50	4943.50	0	00:41	1.50
618	JUNCTION	0.00	0.00	4950.00	0	00:00	0.00
622	JUNCTION	0.14	1.52	4982.52	0	00:35	1.50
710	JUNCTION	0.00	0.00	4975.00	0	00:00	0.00
809	JUNCTION	0.43	3.28	4968.28	0	00:41	3.27
810	JUNCTION	0.00	0.00	4969.00	0	00:00	0.00
813	JUNCTION	0.43	3.28	4970.28	0	00:41	3.27
814	JUNCTION	0.00	0.00	4970.00	0	00:00	0.00
818	JUNCTION	0.15	1.51	4991.51	0	00:35	1.51
O_100	OUTFALL	0.00	0.00	4778.00	0	00:00	0.00
O_210	OUTFALL	0.00	0.00	4754.00	0	00:00	0.00
O_220	OUTFALL	0.00	0.00	4769.00	0	00:00	0.00
O_300	OUTFALL	0.00	0.00	4775.00	0	00:00	0.00
O_410	OUTFALL	0.00	0.00	4779.00	0	00:00	0.00
O_414	OUTFALL	0.00	0.00	4781.00	0	00:00	0.00
O_418	OUTFALL	0.00	0.00	4784.00	0	00:00	0.00
O_422	OUTFALL	0.00	0.00	4789.00	0	00:00	0.00
O_426	OUTFALL	0.00	0.00	4793.00	0	00:00	0.00
O_500	OUTFALL	0.00	0.00	4804.00	0	00:00	0.00
O_600	OUTFALL	0.00	0.00	4820.00	0	00:00	0.00
O_710	OUTFALL	0.00	0.00	4961.00	0	00:00	0.00
O_800	OUTFALL	0.00	0.00	4960.00	0	00:00	0.00

****
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
109	JUNCTION	0.00	1459.62	0 00:54	0	43.9	0.000
110	JUNCTION	72.62	72.62	0 01:05	3.55	3.55	0.000
113	JUNCTION	0.00	1389.09	0 00:54	0	40.4	0.000
114	JUNCTION	157.30	157.30	0 00:50	5.4	5.4	0.000
115	JUNCTION	0.00	1277.86	0 00:46	0	34.5	0.000
117	JUNCTION	0.00	820.58	0 00:47	0	22.2	0.000
118	JUNCTION	53.02	53.02	0 00:50	1.8	1.8	0.000
119	JUNCTION	0.00	769.18	0 00:45	0	20.4	0.000
121	JUNCTION	0.00	250.65	0 00:50	0	8.55	0.000
122	JUNCTION	235.38	235.38	0 00:45	7.46	7.46	0.000
126	JUNCTION	31.01	31.01	0 00:45	1.02	1.02	0.000
129	JUNCTION	0.00	522.01	0 00:45	0	11.8	0.000
130	JUNCTION	65.49	65.49	0 00:50	2.47	2.47	0.000
133	JUNCTION	0.00	474.02	0 00:39	0	9.28	0.000
134	JUNCTION	159.32	159.32	0 00:35	3.48	3.48	0.000
138	JUNCTION	336.11	336.11	0 00:35	5.75	5.75	0.000
139	JUNCTION	0.00	464.94	0 00:43	0	12.4	0.000
141	JUNCTION	0.00	443.51	0 00:42	0	11.4	0.000
142	JUNCTION	23.12	23.12	0 00:50	1.01	1.01	0.000
146	JUNCTION	48.81	48.81	0 00:55	2.28	2.28	0.000
149	JUNCTION	0.00	401.01	0 00:40	0	9.08	0.000
150	JUNCTION	99.87	99.87	0 00:45	3.26	3.26	0.000
154	JUNCTION	316.19	316.19	0 00:35	5.8	5.8	0.000
210	JUNCTION	90.08	90.08	0 00:45	2.43	2.43	0.000
219	JUNCTION	0.00	2273.28	0 00:54	0	64	0.000
220	JUNCTION	134.31	134.31	0 00:50	4.78	4.78	0.000
221	JUNCTION	0.00	2159.63	0 00:50	0	59.1	0.000
223	JUNCTION	0.00	397.28	0 00:45	0	11	0.000
224	JUNCTION	102.13	102.13	0 00:45	3.15	3.15	0.000
225	JUNCTION	0.00	297.42	0 00:41	0	7.87	0.000
226	JUNCTION	157.08	157.08	0 00:40	3.81	3.81	0.000
228	JUNCTION	142.96	142.96	0 00:40	4.05	4.05	0.000
231	JUNCTION	0.00	1771.84	0 00:50	0	48.1	0.000
232	JUNCTION	138.79	138.79	0 00:55	5.26	5.26	0.000
235	JUNCTION	0.00	1663.11	0 00:45	0	42.5	0.000
236	JUNCTION	105.63	105.63	0 00:45	3.49	3.49	0.000
237	JUNCTION	0.00	1557.59	0 00:45	0	39	0.000
239	JUNCTION	0.00	1524.53	0 00:45	0	38	0.000
240	JUNCTION	33.33	33.33	0 00:45	1.04	1.04	0.000
241	JUNCTION	0.00	1343.38	0 00:43	0	32.4	0.000
243	JUNCTION	0.00	900.77	0 00:43	0	20.4	0.000
244	JUNCTION	237.04	237.04	0 00:40	5.92	5.92	0.000
245	JUNCTION	0.00	680.47	0 00:40	0	14.4	0.000
247	JUNCTION	0.00	509.02	0 00:39	0	9.99	0.000
248	JUNCTION	372.42	372.42	0 00:35	7	7	0.000
250	JUNCTION	181.64	181.64	0 00:35	2.96	2.96	0.000

252	JUNCTION	172.98	172.98	0	00:40	4.43	4.43	0.000
256	JUNCTION	182.91	182.91	0	00:45	5.55	5.55	0.000
259	JUNCTION	0.00	444.89	0	00:45	0	12	0.000
260	JUNCTION	98.74	98.74	0	00:50	3.33	3.33	0.000
263	JUNCTION	0.00	350.78	0	00:41	0	8.68	0.000
264	JUNCTION	195.65	195.65	0	00:40	4.78	4.78	0.000
268	JUNCTION	158.12	158.12	0	00:40	3.89	3.89	0.000
309	JUNCTION	0.00	269.56	0	00:49	0	7.72	0.000
310	JUNCTION	110.61	110.61	0	00:50	3.8	3.8	0.000
314	JUNCTION	168.04	168.04	0	00:40	3.88	3.88	0.000
410	JUNCTION	19.09	19.09	0	00:45	0.65	0.65	0.000
414	JUNCTION	19.85	19.85	0	00:45	0.579	0.579	0.000
418	JUNCTION	53.79	53.79	0	00:50	1.97	1.97	0.000
422	JUNCTION	2.89	2.89	0	00:40	0.0781	0.0781	0.000
426	JUNCTION	52.54	52.54	0	00:50	1.97	1.97	0.000
509	JUNCTION	0.00	609.28	0	00:48	0	17.8	0.000
510	JUNCTION	174.84	174.84	0	00:50	6.55	6.55	0.000
513	JUNCTION	0.00	456.02	0	00:40	0	11.1	0.000
514	JUNCTION	229.26	229.26	0	00:40	6	6	0.000
518	JUNCTION	226.75	226.75	0	00:40	5.15	5.15	0.000
609	JUNCTION	0.00	950.35	0	00:49	0	23.7	0.000
610	JUNCTION	145.90	145.90	0	00:50	5.68	5.68	0.000
613	JUNCTION	0.00	846.72	0	00:41	0	17.8	0.000
614	JUNCTION	321.94	321.94	0	00:35	6.49	6.49	0.000
617	JUNCTION	0.00	550.30	0	00:38	0	11.2	0.000
618	JUNCTION	216.70	216.70	0	00:35	3.84	3.84	0.000
622	JUNCTION	359.48	359.48	0	00:35	7.38	7.38	-0.000
710	JUNCTION	163.49	163.49	0	00:35	3.16	3.16	0.000
809	JUNCTION	0.00	845.36	0	00:41	0	18.9	0.000
810	JUNCTION	199.58	199.58	0	00:35	4.62	4.62	0.000
813	JUNCTION	0.00	648.06	0	00:41	0	14.3	0.000
814	JUNCTION	350.41	350.41	0	00:40	7.74	7.74	0.000
818	JUNCTION	312.24	312.24	0	00:35	6.5	6.5	-0.000
O_100	OUTFALL	0.00	1459.62	0	00:54	0	43.9	0.000
O_210	OUTFALL	0.00	90.08	0	00:45	0	2.43	0.000
O_220	OUTFALL	0.00	2273.28	0	00:54	0	64	0.000
O_300	OUTFALL	0.00	269.56	0	00:49	0	7.72	0.000
O_410	OUTFALL	0.00	19.09	0	00:45	0	0.65	0.000
O_414	OUTFALL	0.00	19.85	0	00:45	0	0.579	0.000
O_418	OUTFALL	0.00	53.79	0	00:50	0	1.97	0.000
O_422	OUTFALL	0.00	2.89	0	00:40	0	0.0781	0.000
O_426	OUTFALL	0.00	52.54	0	00:50	0	1.97	0.000
O_500	OUTFALL	0.00	609.28	0	00:48	0	17.8	0.000
O_600	OUTFALL	0.00	950.35	0	00:49	0	23.7	0.000
O_710	OUTFALL	0.00	163.49	0	00:35	0	3.16	0.000
O_800	OUTFALL	0.00	845.36	0	00:41	0	18.9	0.000

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
O_100	98.56	137.90	1459.62	43.921
O_210	31.02	24.23	90.08	2.428
O_220	98.52	201.07	2273.28	64.011
O_300	62.45	38.25	269.56	7.720
O_410	35.37	5.69	19.09	0.650
O_414	30.79	5.82	19.85	0.579
O_418	38.80	15.68	53.79	1.966
O_422	27.41	0.88	2.89	0.078
O_426	40.23	15.16	52.54	1.970
O_500	88.06	62.51	609.28	17.787
O_600	99.26	73.75	950.35	23.654
O_710	23.56	41.47	163.49	3.157
O_800	42.50	137.56	845.36	18.891
System	55.12	759.96	845.36	186.813

****
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
DL_109	DUMMY	1459.62	0 00:54			
DL_110	DUMMY	72.62	0 01:05			
DL_114	DUMMY	157.30	0 00:50			
DL_118	DUMMY	53.02	0 00:50			
DL_121	DUMMY	250.65	0 00:50			
DL_122	DUMMY	235.38	0 00:45			
DL_129	DUMMY	522.01	0 00:45			
DL_130	DUMMY	65.49	0 00:50			
DL_134	DUMMY	159.32	0 00:35			
DL_142	DUMMY	23.12	0 00:50			
DL_150	DUMMY	99.87	0 00:45			
DL_210	DUMMY	90.08	0 00:45			
DL_219	DUMMY	2273.28	0 00:54			
DL_220	DUMMY	134.31	0 00:50			
DL_223	DUMMY	397.28	0 00:45			
DL_224	DUMMY	102.13	0 00:45			
DL_226	DUMMY	157.08	0 00:40			
DL_231	DUMMY	1771.84	0 00:50			
DL_232	DUMMY	138.79	0 00:55			
DL_236	DUMMY	105.63	0 00:45			
DL_237	DUMMY	1557.59	0 00:45			
DL_240	DUMMY	33.33	0 00:45			
DL_243	DUMMY	900.77	0 00:43			
DL_244	DUMMY	237.04	0 00:40			
DL_247	DUMMY	509.02	0 00:39			
DL_248	DUMMY	372.42	0 00:35			
DL_252	DUMMY	172.98	0 00:40			
DL_256	DUMMY	182.91	0 00:45			
DL_259	DUMMY	444.89	0 00:45			
DL_260	DUMMY	98.74	0 00:50			
DL_264	DUMMY	195.65	0 00:40			
DL_309	DUMMY	269.56	0 00:49			
DL_310	DUMMY	110.61	0 00:50			
DL_410	DUMMY	19.09	0 00:45			
DL_414	DUMMY	19.85	0 00:45			
DL_418	DUMMY	53.79	0 00:50			
DL_422	DUMMY	2.89	0 00:40			
DL_426	DUMMY	52.54	0 00:50			
DL_509	DUMMY	609.28	0 00:48			
DL_510	DUMMY	174.84	0 00:50			

DL_514	DUMMY	229.26	0	00:40			
DL_518	DUMMY	226.75	0	00:40			
DL_609	DUMMY	950.35	0	00:49			
DL_610	DUMMY	145.90	0	00:50			
DL_614	DUMMY	321.94	0	00:35			
DL_618	DUMMY	216.70	0	00:35			
DL_710	DUMMY	163.49	0	00:35			
DL_809	DUMMY	845.36	0	00:41			
DL_810	DUMMY	199.58	0	00:35			
DL_814	DUMMY	350.41	0	00:40			
L_114	CONDUIT	1389.05	0	00:54	11.43	0.06	0.35
L_115	CONDUIT	1233.31	0	00:54	6.17	0.05	0.19
L_117	CONDUIT	820.56	0	00:47	10.23	0.17	0.43
L_119	CONDUIT	767.91	0	00:47	9.97	0.16	0.42
L_126	CONDUIT	27.69	0	01:10	3.37	0.00	0.03
L_133	CONDUIT	457.65	0	00:45	6.49	0.01	0.09
L_138	CONDUIT	316.28	0	00:40	5.79	0.01	0.10
L_139	CONDUIT	464.94	0	00:43	5.12	0.13	0.34
L_141	CONDUIT	443.30	0	00:43	7.67	0.04	0.17
L_146	CONDUIT	48.80	0	00:55	6.64	0.00	0.03
L_149	CONDUIT	399.89	0	00:42	8.53	0.03	0.14
L_154	CONDUIT	306.65	0	00:39	6.04	0.02	0.10
L_221	CONDUIT	2139.31	0	00:54	8.30	0.21	0.45
L_225	CONDUIT	295.21	0	00:45	6.78	0.02	0.10
L_228	CONDUIT	142.74	0	00:45	6.61	0.01	0.10
L_235	CONDUIT	1634.24	0	00:50	8.17	0.06	0.19
L_239	CONDUIT	1524.30	0	00:45	8.33	0.08	0.23
L_241	CONDUIT	1341.72	0	00:45	9.38	0.17	0.38
L_245	CONDUIT	668.69	0	00:43	12.41	0.10	0.33
L_250	CONDUIT	162.58	0	00:42	3.61	0.00	0.09
L_263	CONDUIT	346.98	0	00:44	8.56	0.04	0.17
L_268	CONDUIT	156.99	0	00:42	8.06	0.01	0.09
L_314	CONDUIT	161.26	0	00:47	4.86	0.01	0.07
L_513	CONDUIT	437.88	0	00:47	6.34	0.03	0.13
L_613	CONDUIT	806.19	0	00:48	6.29	0.03	0.13
L_617	CONDUIT	541.61	0	00:42	6.62	0.02	0.10
L_622	CONDUIT	352.48	0	00:41	6.80	0.01	0.15
L_813	CONDUIT	647.92	0	00:41	6.04	0.05	0.33
L_818	CONDUIT	305.14	0	00:43	4.90	0.01	0.15

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Fri Sep 30 10:24:29 2022
Analysis ended on: Fri Sep 30 10:24:29 2022
Total elapsed time: < 1 sec

Appendix E-5
Alternatives Results Summary

			Reach 134										Reach 150										Reach 118									
			Node 133		Link 138		Detention D_134						Node 149		Link 154		Detention D_150						Node 117		Link 119								
			Detention				Channel Improvements						Detention				Channel Improvements						Detention				Channel Improvements					
			Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}	Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}	Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}
Option 1	Do Nothing	Alternative 1																														
		Alternative 2																														
		Alternative 3																														
		Alternative 4							316	5.8	1.0								307	6.0	1.0								768	10.0	4.2	
Option 2A	w/ Detention	Alternative 1																														
		Alternative 2																									89	5	470	5.0	1.00	114
		Alternative 3	16.2	5.2	469	211	86	5	312	5.0	0.70	108	12.9	3.9	400	214	79	5	304	5.0	0.7	101										
		Alternative 4																														
Option 2B	w/ Detention	Alternative 1																														
		Alternative 2															81	5	304	5.0	0.7	103					89	5	470	5.0	1.0	114
		Alternative 3	16.2	5.2	469	211	86	5	312	5.0	0.7	108																				
		Alternative 4																														
Option 2C	w/ Detention	Alternative 1																														
		Alternative 2					86	5	312	5.0	0.7	108															150	5	755	5.0	1.0	175
		Alternative 3											12.9	3.9	400	214	79	5	304	5.0	0.7	101										
		Alternative 4																														
Option 3	w/out Detention	Alternative 1																														
		Alternative 2					86	5	312	5.0	0.7	108					81	5	304	5.0	0.7	103					150	5	755	5.0	1.0	175
		Alternative 3																														
		Alternative 4																														
Option 4	w/ LID	Alternative 1																														
		Alternative 2																									89	5	462	5.0	1	114
		Alternative 3	5.4	1.1	376	210	86	5	305	4.2	0.8	108	4	0.8	369	249	79	5	302	5.0	0.7	101										
		Alternative 4																														

			Reach 142										Reach 100									
			Node 139		Link 149								Node O_100		Link 115							
			Detention				Channel Improvements						Detention				Channel Improvements					
			Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}	Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}
Option 1	Do Nothing	Alternative 1																				
		Alternative 2																				
		Alternative 3																				
		Alternative 4							400	8.5	1.4								1233	6.2	1.9	
Option 2A	w/ Detention	Alternative 1																				
		Alternative 2					69	5	214	5.0	0.6	90					114	5	780	5.0	1.3	142
		Alternative 3																				
		Alternative 4																				
Option 2B	w/ Detention	Alternative 1																				
		Alternative 2					133	5	396	5.0	0.6	154					123	5	834	5.0	1.3	151
		Alternative 3																				
		Alternative 4																				
Option 2C	w/ Detention	Alternative 1																				
		Alternative 2					69	5	214	5.0	0.6	90					137	5	930	5.0	1.3	165
		Alternative 3																				
		Alternative 4																				
Option 3	w/out Detention	Alternative 1																				
		Alternative 2					133	5	396	5.0	0.6	154					185	5	1196	5.0	1.3	213
		Alternative 3																				
		Alternative 4																				
Option 4	w/ LID	Alternative 1																				
		Alternative 2					80	5	249	5.0	0.6	101					118	5	806	5.0	1.3	146
		Alternative 3																				
		Alternative 4																				

Alternative 1 - Detention
Alternative 2 - Channel Improvements
Alternative 3 - Detention & Channel Improvements
Alternative 4 - Do Nothing

Vol. - Volume, acre-ft
Q_{in} - Inflow, cfs
Q_{out} - Outflow, cfs
W_{bot} - Bottom width, ft
W_{top} - Top width, ft (including 1.5' freeboard)
Side S - Channel side slopes, H:V
V_{100} - Average channel velocity, ft/sec
Q_{100} - Maximum flow in channel, ft/sec
Depth - 100-yr flow depth, ft
Area - acres

			Reach 260										Reach 244										Reach 241									
			Node			Link	263	Detention	D_268				Node			Link	245	Detention	D_248				Node			Link	241					
			Detention					Channel Improvements					Detention					Channel Improvements					Detention					Channel Improvements					
			Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}	Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}	Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}
Option 1	Do Nothing	Alternative 1																														
		Alternative 2																														
		Alternative 3																														
		Alternative 4							347	8.6	1.7								669	12.4	3.3								1342	9.4	3.8	
Option 2A	w/ Detention	Alternative 1																														
		Alternative 2																									100	5	632	4.9	1.2	127
		Alternative 3	16.0	5.4	348	152	40	5	151	5.0	0.7	62	18.8	7.1	509	194	110	5	304	4.9	0.6	131										
		Alternative 4																														
Option 2B	w/ Detention	Alternative 1																														
		Alternative 2															225	5	615	5.0	0.6	246					150	5	928	4.9	1.2	177
		Alternative 3	16.0	5.4	348	152	40	5	151	5.0	0.7	62																				
		Alternative 4																														
Option 2C	w/ Detention	Alternative 1																														
		Alternative 2					100	5	338	5.0	0.7	122															125	5	817	5.0	1.2	152
		Alternative 3											18.8	7.1	509	194	105	5	304	5.0	0.6	126										
		Alternative 4																														
Option 3	w/out Detention	Alternative 1																														
		Alternative 2					100	5	338	5.0	0.7	122					230	5	614	5.0	0.5	250					210	5	1263	4.9	1.2	237
		Alternative 3																														
		Alternative 4																														
Option 4	w/ LID	Alternative 1																														
		Alternative 2																									100	5	562	4.7	1.1	126
		Alternative 3	6.6	1.1	302	137	40	5	136	4.8	0.7	62	10.3	1.8	509	266	110	5	261	4.6	0.5	130										
		Alternative 4															`															

			Reach 232										Reach 224										Reach 200									
			Node			Link	235						Node			Link	225						Node			Link	221					
			Detention					Channel Improvements					Detention					Channel Improvements					Detention					Channel Improvements					
			Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}	Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}	Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}
Option 1	Do Nothing	Alternative 1																														
		Alternative 2																														
		Alternative 3																														
		Alternative 4							1634	8.2	1.9								295	6.8	1.0								2139	8.3	4.5	
Option 2A	w/ Detention	Alternative 1																														
		Alternative 2					190	5	864	5.0	0.9	214					90	5	293	5.0	0.6	111					140	5	1253	5.0	1.7	172
		Alternative 3																														
		Alternative 4																														
Option 2B	w/ Detention	Alternative 1																														
		Alternative 2					270	5	1195	5.0	0.9	294					90	5	293	5.0	0.6	111					200	5	1657	5.0	1.6	231
		Alternative 3																														
		Alternative 4																														
Option 2C	w/ Detention	Alternative 1																														
		Alternative 2					245	5	1100	5.0	0.9	269					90	5	293	5.0	0.6	111					190	5	1562	4.9	1.6	221
		Alternative 3																														
		Alternative 4																														
Option 3	w/out Detention	Alternative 1																														
		Alternative 2					350	5	1510	5.0	0.9	374					90	5	293	5.0	0.6	111					250	5	1961	4.9	1.6	281
		Alternative 3																														
		Alternative 4																														
Option 4	w/ LID	Alternative 1																														
		Alternative 2					190	5	770	4.8	0.8	213					90	5	265	4.8	0.6	111					140	5	1113	4.9	1.5	170
		Alternative 3																														
		Alternative 4																														

Alternative 1 - Detention
Alternative 2 - Channel Improvements
Alternative 3 - Detention & Channel Improvements
Alternative 4 - Do Nothing

Vol. - Volume, acre-ft
Q_{in} - Inflow, cfs
Q_{out} - Outflow, cfs
W_{bot} - Bottom width, ft
W_{top} - Top width, ft (including 1.5' freeboard)
Side S - Channel side slopes, H:V
V_{100} - Average channel velocity, ft/sec
Q_{100} - Maximum flow in channel, ft/sec
Depth - 100-yr flow depth, ft
Area - acres

			Reach 500									
			Node O_500 Link 513 Detention D_510									
			Detention				Channel Improvements					
			Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}
Option 1	Do Nothing	Alternative 1										
		Alternative 2										
		Alternative 3										
		Alternative 4							438	6.3	1.3	
Option 2	w/ Detention	Alternative 1	18.4	6	456	230			228	4.9	0.9	
		Alternative 2										
		Alternative 3										
		Alternative 4										
Option 3	w/out Detention	Alternative 1										
		Alternative 2					92	5	428	5.0	0.9	116
		Alternative 3										
		Alternative 4										
Option 4	w/ LID	Alternative 1	7.5	1.3	382	210			208	4.7	0.9	69
		Alternative 2										
		Alternative 3										
		Alternative 4										

Alternative 1 - Detention
Alternative 2 - Channel Improvements
Alternative 3 - Detention & Channel Improvements
Alternative 4 - Do Nothing

Vol. - Volume, acre-ft
Q_{in} - Inflow, cfs
Q_{out} - Outflow, cfs
W_{bot} - Bottom width, ft
W_{top} - Top width, ft (including 1.5' freeboard)
Side S - Channel side slopes, H:V
V_{100} - Average channel velocity, ft/sec
Q_{100} - Maximum flow in channel, ft/sec
Depth - 100-yr flow depth, ft
Area - acres

			Reach 618										Reach 614										Reach 600									
			Node 617 Link 622 Detention D_618										Node 613 Link 617 Detention										Node O_600 Link 613									
			Detention				Channel Improvements						Detention				Channel Improvements						Detention				Channel Improvements					
			Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}	Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}	Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}
Option 1	Do Nothing	Alternative 1																														
		Alternative 2																														
		Alternative 3																														
		Alternative 4							352	6.8	1.5								542	6.6	1.0								806	6.3	1.3	
Option 2	w/ Detention	Alternative 1																														
		Alternative 2																														
		Alternative 3	21.2	8	544	214	101	5	351	5.0	0.7	123																				
		Alternative 4																	213	4.6	0.6								344	4.5	0.8	
Option 3	w/out Detention	Alternative 1																														
		Alternative 2					101	5	351	5.0	0.7	123					163	5	528	5.0	0.6	184					178	5	765	5.0	0.9	202
		Alternative 3																														
		Alternative 4																														
Option 4	w/ LID	Alternative 1																														
		Alternative 2																														
		Alternative 3	6.8	1.3	415	234	101	5	350	5.0	0.7	123																				
		Alternative 4																	233	4.7	0.6	97							365	4.6	0.8	120

Alternative 1 - Detention
Alternative 2 - Channel Improvements
Alternative 3 - Detention & Channel Improvements
Alternative 4 - Do Nothing

Vol. - Volume, acre-ft
Q_{in} - Inflow, cfs
Q_{out} - Outflow, cfs
W_{bot} - Bottom width, ft
W_{top} - Top width, ft (including 1.5' freeboard)
Side S - Channel side slopes, H:V
V_{100} - Average channel velocity, ft/sec
Q_{100} - Maximum flow in channel, ft/sec
Depth - 100-yr flow depth, ft
Area - acres

			Reach 800									
			Node O_800 Link 813 Detention D_814									
			Detention				Channel Improvements					
			Vol.	Area	Q_{in}	Q_{out}	W_{bot}	Side S	Q_{100}	V_{100}	Depth	W_{top}
Option 1	Do Nothing	Alternative 1										
		Alternative 2										
		Alternative 3										
		Alternative 4							648	6.0	3.3	
Option 2	w/ Detention	Alternative 1	25.4	12	646	258			258	4.8	2.3	
		Alternative 2										
		Alternative 3										
		Alternative 4										
Option 3	w/out Detention	Alternative 1										
		Alternative 2										
		Alternative 3					93	5	648	5.0	1.3	121
		Alternative 4										
Option 4	w/ LID	Alternative 1	2.4	0.6	327	282			282	4.9	2.4	63
		Alternative 2										
		Alternative 3										
		Alternative 4										

Alternative 1 - Detention
Alternative 2 - Channel Improvements
Alternative 3 - Detention & Channel Improvements
Alternative 4 - Do Nothing

Vol. - Volume, acre-ft
Q_{in} - Inflow, cfs
Q_{out} - Outflow, cfs
W_{bot} - Bottom width, ft
W_{top} - Top width, ft (including 1.5' freeboard)
Side S - Channel side slopes, H:V
V_{100} - Average channel velocity, ft/sec
Q_{100} - Maximum flow in channel, ft/sec
Depth - 100-yr flow depth, ft
Area - acres

Appendix E-6
MHFD Cost Estimate Workbooks

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	**Greeley - Comprehensive Drainage Plan Oklahoma & South Basins Concept Design**		
DRAINAGEWAY :	**1**		
REACH :	**1**		
JURISDICTION :	**Greeley**		
REACH ID:	**CD-Reach1**	**Ben Liu**	**DATE :** **10/6/2023**

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	**Box Height (ft)**	**No. of Barrels**	**Length (ft)**				
12	4	3	52	L.F.	$4,587.55	$238,552.00	Structure 101, Reach 100
6	5	1	296	L.F.	$1,095.56	$324,287.00	Structure 103, Reach 142
6	5	1	127	L.F.	$1,095.56	$139,137.00	Structure 104, Reach 134
Channel Improvements							
Excavation, Mid Range			20612	C.Y.	$40.00	$824,480.00	
Detention/Water Quality Facilities							
Detention (Complete-in-Place)							
Detention Facility 1 (Complete-in-Place)			5	AC-FT	$76,152.00	$380,760.00	Flood Control Detention 134
Detention Facility 2 (Complete-in-Place)			4	AC-FT	$76,152.00	$304,608.00	Flood Control Detention 150
Removals							
Removal of culvert pipe (48"<D<84")			526	L.F.	$84.00	$44,184.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			29	ACRE	$1,670.00	$47,929.00	Channels + 2 detetion ponds
Land Acquisition							
Easement/ROW Acquisition			28.70	ACRE	$11,228.00	$322,244.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$701,976.00
Hydraulic Structures				$0.00
Channel Improvements				$824,480.00
Detention/Water Quality Facilities				$685,368.00
Removals				$44,184.00
Landscaping and Maintenance Improvements				$47,929.00
Special Items (User Defined)				$0.00
Subtotal Capital Improvement Costs				**$2,303,937.00**
Additional Capital Improvement Costs				
Dewatering		L.S.		$0.00
Mobilization	5%			$115,197.00
Traffic Control		L.S.		$0.00
Utility Coordination/Relocation		L.S.		$0.00

Stormwater Management/Erosion Control	5%			$115,197.00	
Subtotal Additional Capital Improvement Costs				**$230,394.00**	
Land Acquisition Costs					
ROW/Easements				$322,244.00	
Subtotal Land Acquisition Costs				**$322,244.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering	15%			$380,150.00	
Legal/Administrative	5%			$126,717.00	
Contract Admin/Construction Management	10%			$253,433.00	
Contingency	25%			$633,583.00	
Subtotal Other Costs				**$1,393,883.00**	
Total Capital Improvement Costs				**$4,250,458.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, e	474	L.F.	$2.00	$948.00	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	7450	L.F.	$3.00	$22,350.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, st	1.9	ACRE	$2,505.00	$4,760.00	
Total Annual Operation and Maintenance Cost				**$28,058.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$1,402,900.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	**Greeley - Comprehensive Drainage Plan Oklahoma & South Basins**			
DRAINAGEWAY :	**2**			
REACH :	**2**			
JURISDICTION :	**Greeley**			
REACH ID:	**Option 4-Reach2**	**Sabastian Ortega**	**DATE :**	**6/20/2023**

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	**Box Height (ft)**	**No. of Barrels**	**Length (ft)**				
8	6	2	30	L.F.	$2,643.81	$80,557.00	Structure 201, Reach 200
4	3	2	145	L.F.	$1,355.84	$196,597.00	Structure 202, Reach 260
4	3	2	327	L.F.	$1,355.84	$443,361.00	Structure 203, Reach 260
Channel Improvements							
Excavation, Mid Range			7703	C.Y.	$40.00	$308,120.00	
Detention/Water Quality Facilities							
Detention (Complete-in-Place)							
Detention Facility 1 (Complete-in-Place)			7	AC-FT	$76,152.00	$533,064.00	
Detention Facility 2 (Complete-in-Place)			10	AC-FT	$76,152.00	$761,520.00	
Removals							
Removal of culvert pipe (48"<D<84")			422	L.F.	$84.00	$35,448.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			30	ACRE	$1,670.00	$50,100.00	
Land Acquisition							
Easement/ROW Acquisition			29.90	ACRE	$11,228.00	$335,717.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains			$0.00	
Concrete Box Culverts			$720,515.00	
Hydraulic Structures			$0.00	
Channel Improvements			$308,120.00	
Detention/Water Quality Facilities			$1,294,584.00	
Removals			$35,448.00	
Landscaping and Maintenance Improvements			$50,100.00	
Special Items (User Defined)			$0.00	
Subtotal Capital Improvement Costs			**$2,408,767.00**	
Additional Capital Improvement Costs				
Dewatering		L.S.	$0.00	
Mobilization	5%		$120,438.00	
Traffic Control		L.S.	$0.00	
Utility Coordination/Relocation		L.S.	$0.00	
Stormwater Management/Erosion Control	5%		$120,438.00	
Subtotal Additional Capital Improvement Costs			**$240,876.00**	
Land Acquisition Costs				

ROW/Easements				$335,717.00	
Subtotal Land Acquisition Costs				**$335,717.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering	15%			$397,446.00	
Legal/Administrative	5%			$132,482.00	
Contract Admin/Construction Management	10%			$264,964.00	
Contingency	25%			$662,411.00	
Subtotal Other Costs				**$1,457,303.00**	
Total Capital Improvement Costs				**$4,442,663.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, et	95	L.F.	$2.00	$190.00	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	11313	L.F.	$3.00	$33,939.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, str	2.9	ACRE	$2,505.00	$7,265.00	
Total Annual Operation and Maintenance Cost				**$41,394.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$2,069,700.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	**Greeley - Comprehensive Drainage Plan Oklahoma & South Basins**			
DRAINAGEWAY :	**3**			
REACH :	**3**			
JURISDICTION :	**Greeley**			
REACH ID:	**Option 4-Reach3**	**Sabastian Ortega**	**DATE :**	**6/20/2023**

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft)	**Box Height (ft)**	**No. of Barrels**	**Length (ft)**			
8	4	1	327	L.F.	$1,183.69	$387,066.00	Structure 301, Reach 300

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$387,066.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$0.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$0.00
Subtotal Capital Improvement Costs				**$387,066.00**
Additional Capital Improvement Costs				
Dewatering		L.S.		$0.00
Mobilization	5%			$19,353.00
Traffic Control		L.S.		$0.00
Utility Coordination/Relocation		L.S.		$0.00
Stormwater Management/Erosion Control	5%			$19,353.00
Subtotal Additional Capital Improvement Costs				**$38,706.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$63,866.00
Legal/Administrative	5%			$21,289.00
Contract Admin/Construction Management	10%			$42,577.00
Contingency	25%			$106,443.00
Subtotal Other Costs				**$234,175.00**
Total Capital Improvement Costs				**$659,947.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, et	88	L.F.	$2.00	$176.00
Total Annual Operation and Maintenance Cost				**$176.00**

Effective Interest Rate	0.00%	
Total Operation and Maintenance Costs Over 50 Years	**$8,800.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	**Greeley - Comprehensive Drainage Plan Oklahoma & South Basins**			
DRAINAGEWAY :	**5**			
REACH :	**5**			
JURISDICTION :	**Greeley**			
REACH ID:	**Option 4-Reach5**	**Sabastian Ortega**	**DATE :**	**6/20/2023**

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	**Box Height (ft)**	**No. of Barrels**	**Length (ft)**				
8	5	2	88	L.F.	$2,505.59	$220,492.00	Structure 501, Reach 500
Detention/Water Quality Facilities							
Detention (Complete-in-Place)							
Detention Facility 1 (Complete-in-Place)			8	AC-FT	$76,152.00	$609,216.00	
Removals							
Removal of culvert pipe (48"<D<84")			88	L.F.	$84.00	$7,392.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,670.00	$1,670.00	
Land Acquisition							
Easement/ROW Acquisition			1.30	ACRE	$11,228.00	$14,596.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains			$0.00	
Concrete Box Culverts			$220,492.00	
Hydraulic Structures			$0.00	
Channel Improvements			$0.00	
Detention/Water Quality Facilities			$609,216.00	
Removals			$7,392.00	
Landscaping and Maintenance Improvements			$1,670.00	
Special Items (User Defined)			$0.00	
Subtotal Capital Improvement Costs			**$838,770.00**	
Additional Capital Improvement Costs				
Dewatering		L.S.	$0.00	
Mobilization	5%		$41,939.00	
Traffic Control		L.S.	$0.00	
Utility Coordination/Relocation		L.S.	$0.00	
Stormwater Management/Erosion Control	5%		$41,939.00	
Subtotal Additional Capital Improvement Costs			**$83,878.00**	
Land Acquisition Costs				
ROW/Easements			$14,596.00	
Subtotal Land Acquisition Costs			**$14,596.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$138,397.00	
Legal/Administrative	5%		$46,132.00	

Contract Admin/Construction Management	10%			$92,265.00	
Contingency	25%			$230,662.00	
Subtotal Other Costs				**$507,456.00**	
Total Capital Improvement Costs				**$1,444,700.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, et	88	L.F.	$2.00	$176.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, str	1	ACRE	$2,505.00	$2,505.00	
Total Annual Operation and Maintenance Cost				**$2,681.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$134,050.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	**Greeley - Comprehensive Drainage Plan Oklahoma & South Basins**			
DRAINAGEWAY :	**6**			
REACH :	**6**			
JURISDICTION :	**Greeley**			
REACH ID:	**Option 4-Reach6**	**Sabastian Ortega**	**DATE :**	**6/20/2023**

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	**Box Height (ft)**	**No. of Barrels**	**Length (ft)**				
8	4	2	126	L.F.	$2,367.38	$298,289.00	Structure 601, Reach 600
8	6	1	41	L.F.	$1,321.90	$54,198.00	Structure 602, Reach 600
6	5	1	234	L.F.	$1,095.56	$256,362.00	Structure 603, Reach 614
Channel Improvements							
Excavation, Mid Range			4000	C.Y.	$40.00	$160,000.00	
Detention/Water Quality Facilities							
Detention (Complete-in-Place)							
Detention Facility 1 (Complete-in-Place)			7	AC-FT	$76,152.00	$533,064.00	
Removals							
Removal of culvert pipe (48"<D<84")			396	L.F.	$84.00	$33,264.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			7	ACRE	$1,670.00	$11,690.00	
Land Acquisition							
Easement/ROW Acquisition			6.90	ACRE	$11,228.00	$77,473.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains			$0.00	
Concrete Box Culverts			$608,849.00	
Hydraulic Structures			$0.00	
Channel Improvements			$160,000.00	
Detention/Water Quality Facilities			$533,064.00	
Removals			$33,264.00	
Landscaping and Maintenance Improvements			$11,690.00	
Special Items (User Defined)			$0.00	
Subtotal Capital Improvement Costs			**$1,346,867.00**	
Additional Capital Improvement Costs				
Dewatering		L.S.	$0.00	
Mobilization	5%		$67,343.00	
Traffic Control		L.S.	$0.00	
Utility Coordination/Relocation		L.S.	$0.00	
Stormwater Management/Erosion Control	5%		$67,343.00	
Subtotal Additional Capital Improvement Costs			**$134,686.00**	
Land Acquisition Costs				
ROW/Easements			$77,473.00	

Subtotal Land Acquisition Costs			**$77,473.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$222,233.00	
Legal/Administrative	5%		$74,078.00	
Contract Admin/Construction Management	10%		$148,155.00	
Contingency	25%		$370,388.00	
Subtotal Other Costs			**$814,854.00**	
Total Capital Improvement Costs			**$2,373,880.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, et	241	L.F.	$2.00	$482.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	1991	L.F.	$3.00	$5,973.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, str	1.3	ACRE	$2,505.00	$3,257.00
Total Annual Operation and Maintenance Cost				**$9,712.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$485,600.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	**Greeley - Comprehensive Drainage Plan Oklahoma & South Basins**			
DRAINAGEWAY :	**8**			
REACH :	**8**			
JURISDICTION :	**Greeley**			
REACH ID:	**Option 4-Reach8**	**Sabastian Ortega**	**DATE :**	**6/20/2023**

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Concrete Box Culverts							
Box Culvert Pipe							
Individual Box Span (ft)	**Box Height (ft)**	**No. of Barrels**	**Length (ft)**				
9	5	1	71	L.F.	$1,382.22	$98,138.00	Structure 801, Reach 800
Detention/Water Quality Facilities							
Detention (Complete-in-Place)							
Detention Facility 1 (Complete-in-Place)			2	AC-FT	$76,152.00	$152,304.00	
Removals							
Removal of culvert pipe (48"<D<84")			71	L.F.	$84.00	$5,964.00	
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			1	ACRE	$1,670.00	$1,670.00	
Land Acquisition							
Easement/ROW Acquisition			0.60	ACRE	$11,228.00	$6,737.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains			$0.00	
Concrete Box Culverts			$98,138.00	
Hydraulic Structures			$0.00	
Channel Improvements			$0.00	
Detention/Water Quality Facilities			$152,304.00	
Removals			$5,964.00	
Landscaping and Maintenance Improvements			$1,670.00	
Special Items (User Defined)			$0.00	
Subtotal Capital Improvement Costs			**$258,076.00**	
Additional Capital Improvement Costs				
Dewatering		L.S.	$0.00	
Mobilization	5%		$12,904.00	
Traffic Control		L.S.	$0.00	
Utility Coordination/Relocation		L.S.	$0.00	
Stormwater Management/Erosion Control	5%		$12,904.00	
Subtotal Additional Capital Improvement Costs			**$25,808.00**	
Land Acquisition Costs				
ROW/Easements			$6,737.00	
Subtotal Land Acquisition Costs			**$6,737.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$42,583.00	
Legal/Administrative	5%		$14,194.00	

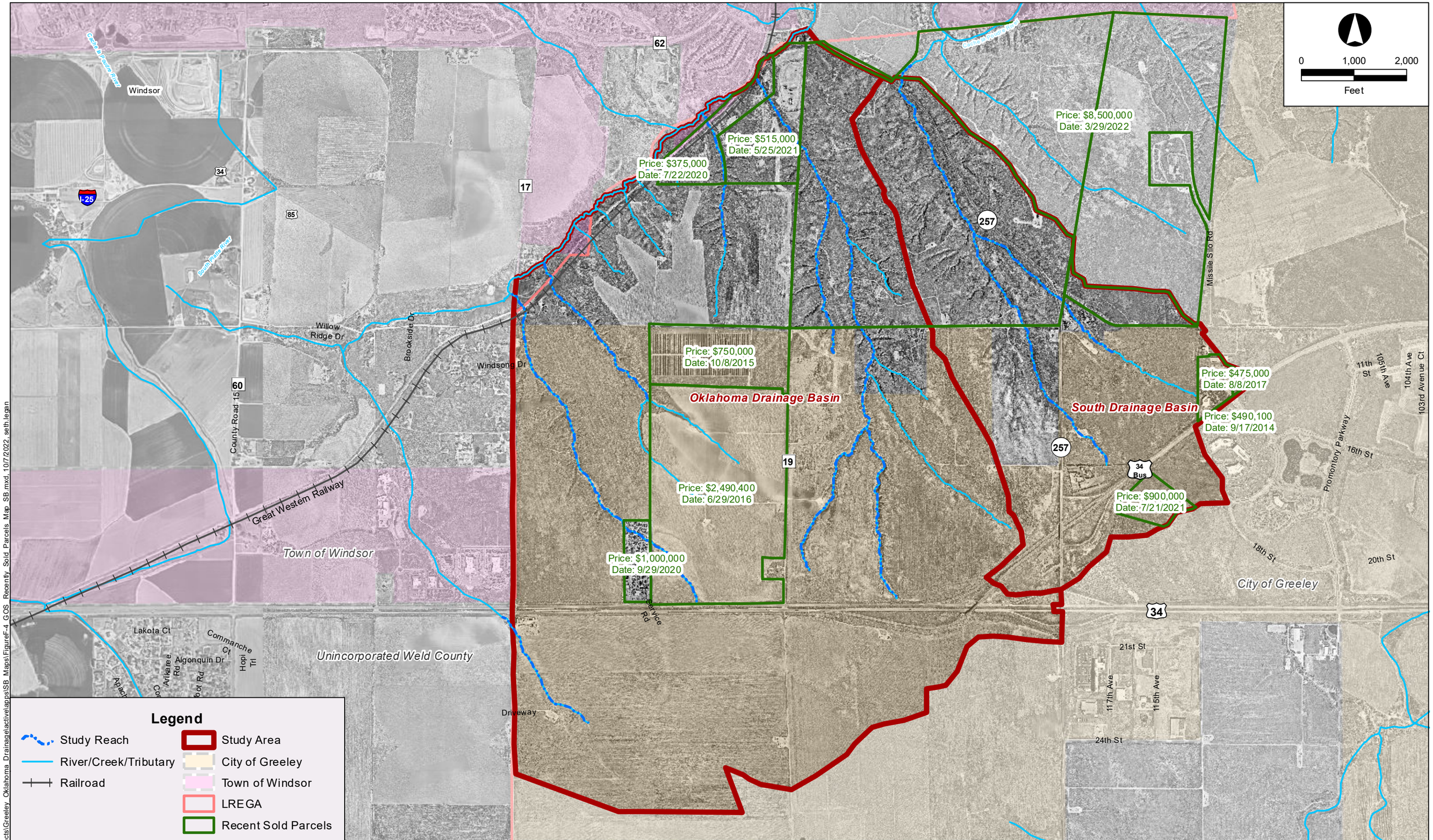
Contract Admin/Construction Management	10%		$28,388.00	
Contingency	25%		$70,971.00	
Subtotal Other Costs			**$156,136.00**	
Total Capital Improvement Costs			**$446,757.00**	

Master Plan Operation and Maintenance Cost Summary					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, et	71	L.F.	$2.00	$142.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, str	0.6	ACRE	$2,505.00	$1,503.00	
Total Annual Operation and Maintenance Cost				**$1,645.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$82,250.00**	

Appendix E-7
Watershed Development Area Data

Developed area per drainageway used to estimate LID costs.

Drainageway	Developed Acres
100	367
200	588
300	33
500	180
600	259
800	275



No.	DATE	DESCRIPTION	APPR.

Matrix Excellence by Design

designed by:
drawn by: SB
checked by: BL
project no.: 22.906.007
date: 10/07/2022

Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA & SOUTH BASINS

Recently Sold Parcels Map

FIGURE
E-4

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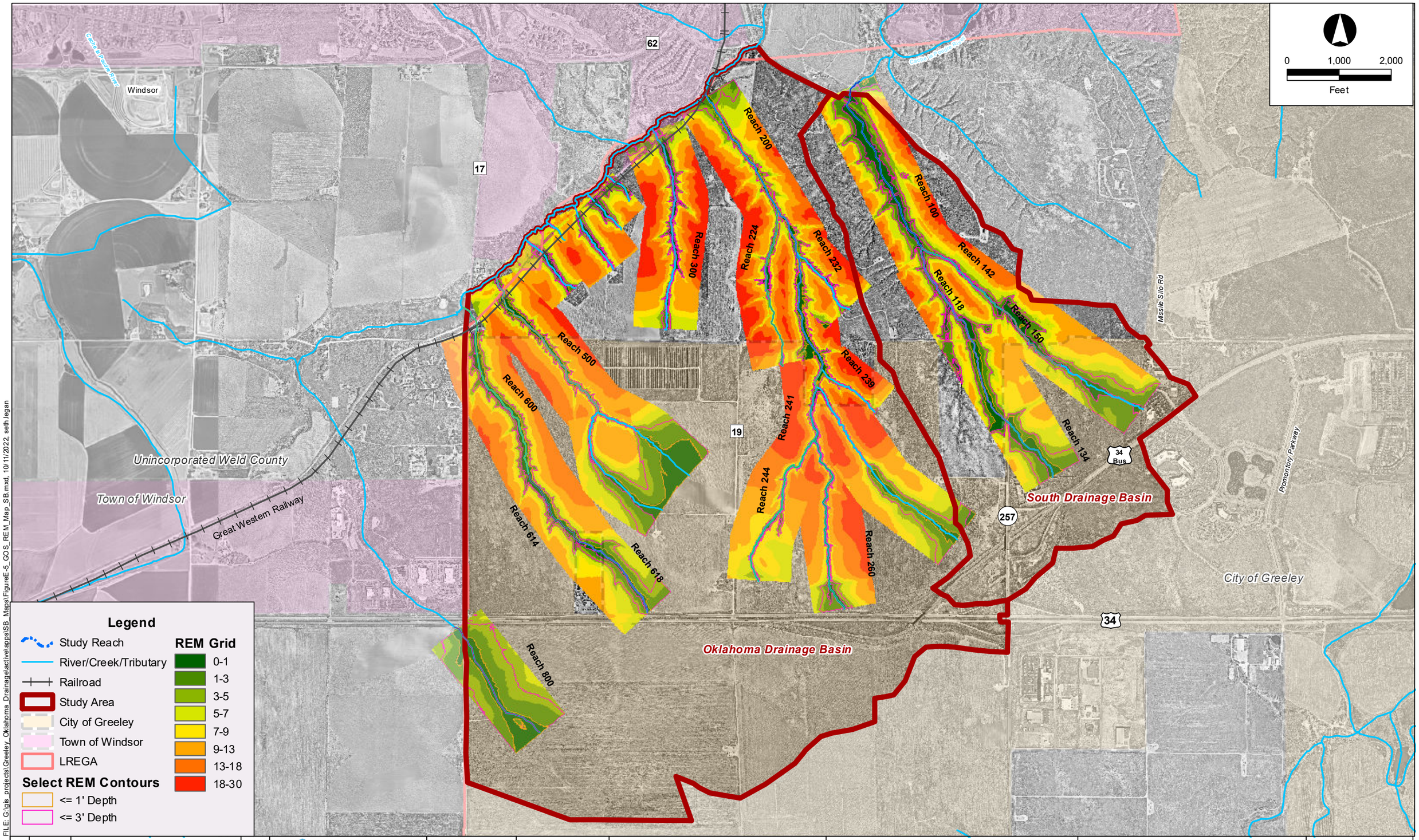
Appendix E-8
REM Analysis



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No.	DATE	DESCRIPTION	APPR.

Matrix Excellence by Design

designed by: _____
drawn by: SL
checked by: BL
project no.: 22.906.007
date: 10/10/2022

Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA & SOUTH BASINS

RELATIVE ELEVATION MODEL MAP

FIGURE
E-5

Appendix F – Conceptual Design Information

Appendix F-1
Master Plan CUHP

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)	Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Level 0, 1, or 2
110	110	Greeley	0.110952822	0.505587917	0.975436018	0.02684766	4.820737181	0.35	0.1	3	0.0018	0.5	1
114	114	Greeley	0.174764598	0.345576119	0.913906857	0.0312403	3.752357186	0.4	0.1	3	0.0018	0.5	1
118	118	Greeley	0.058968648	0.278247514	0.474007872	0.04819382	2	0.4	0.1	3	0.0018	0.5	1
122	122	Greeley	0.19157863	0.486210776	1.183828113	0.02698517	39.27255494	0.35	0.1	3	0.0018	0.5	1
126	126	Greeley	0.031919042	0.13284572	0.285771932	0.01270918	21.18917229	0.4	0.1	4.5	0.0018	0.6	1
130	130	Greeley	0.072980302	0.317818741	0.607243259	0.03762747	14.31068495	0.35	0.1	3	0.0018	0.5	1
134	134	Greeley	0.083580917	0.217491068	0.592687856	0.02822271	53.91451166	0.35	0.1	3	0.0018	0.5	1
138	138	Greeley	0.129930011	0.176257294	0.482923871	0.01687139	69.34394877	0.35	0.1	3	0.0018	0.5	1
142	142	Greeley	0.030890369	0.233000544	0.50033805	0.03406558	11.91409337	0.4	0.1	3	0.0018	0.5	1
146	146	Greeley	0.061905013	0.463464432	0.83104885	0.03315856	28.65373826	0.35	0.1	3	0.0018	0.5	1
150	150	Greeley	0.093223072	0.272214295	0.641151666	0.03963757	20.08833335	0.35	0.1	3	0.0018	0.5	1
154	154	Greeley	0.139304475	0.23114776	0.514968392	0.0265195	52.97871048	0.35	0.1	3	0.0018	0.5	1
210	210	Greeley	0.076267928	0.154691854	0.505717302	0.04202201	4.601847262	0.35	0.1	3	0.0018	0.5	1
220	220	Greeley	0.156293653	0.409625328	0.799572182	0.03412727	2.189946933	0.4	0.1	3	0.0018	0.5	1
224	224	Greeley	0.099813642	0.238523822	0.641844735	0.04081524	2.795231977	0.35	0.1	3	0.0018	0.5	1
226	226	Greeley	0.09545433	0.306856848	0.592639995	0.03424751	44.60872727	0.35	0.1	3	0.0018	0.5	1
228	228	Greeley	0.103307894	0.358631542	0.663823168	0.02629643	40.88558129	0.35	0.1	3	0.0018	0.5	1
232	232	Greeley	0.165677697	0.431660241	0.94545034	0.03350421	3.622125398	0.35	0.1	3	0.0018	0.5	1
236	236	Greeley	0.093673395	0.354821675	0.753050383	0.03634251	31.47408377	0.35	0.1	3	0.0018	0.5	1
240	240	Greeley	0.034144278	0.160191302	0.394562467	0.05120151	2.196775283	0.4	0.1	3	0.0018	0.5	1
244	244	Greeley	0.141199827	0.480467858	0.830113943	0.03791815	53.8547025	0.35	0.1	3	0.0018	0.5	1
248	248	Greeley	0.151033244	0.283568341	0.543127416	0.01647859	75.46271738	0.35	0.1	3	0.0018	0.5	1
250	250	Greeley	0.06810435	0.119714714	0.3390754	0.02230576	66.05611389	0.35	0.1	3	0.0018	0.5	1
252	252	Greeley	0.098477447	0.392582841	0.739289007	0.02068143	68.6237571	0.35	0.1	3	0.0018	0.5	1
256	256	Greeley	0.146337052	0.553542124	0.954109554	0.03158611	43.82339629	0.35	0.1	4.5	0.0018	0.6	1
260	260	Greeley	0.100939614	0.320599877	0.669813609	0.04996541	9.84813284	0.35	0.1	3	0.0018	0.5	1
264	264	Greeley	0.107453202	0.330585985	0.853876791	0.0238855	66.33033078	0.35	0.1	3	0.0018	0.5	1
268	268	Greeley	0.091510502	0.286780307	0.636923534	0.01820713	56.98002868	0.35	0.1	3	0.0018	0.5	1
310	310	Greeley	0.137553973	0.388804948	0.759984312	0.03827878	2.431648745	0.4	0.1	4.5	0.0018	0.6	1
314	314	Greeley	0.108267578	0.245402263	0.52621195	0.03778565	34.99117854	0.35	0.1	4.5	0.0018	0.6	1
410	410	Greeley	0.020917903	0.189336755	0.311130118	0.07286034	4.838477626	0.4	0.1	3	0.0018	0.5	1
414	414	Greeley	0.018875883	0.142500288	0.262753364	0.08689954	2.943664473	0.4	0.1	3	0.0018	0.5	1
418	418	Greeley	0.061909836	0.276378079	0.605327709	0.04701707	3.67986231	0.35	0.1	3	0.0018	0.5	1
422	422	Greeley	0.006473634	0.101765905	0.195760122	0.09749497	4.017800086	0.4	0.1	5	0.0007	1	1
426	426	Greeley	0.067956922	0.320305456	0.634797112	0.04560671	4.667130809	0.35	0.1	4.5	0.0018	0.6	1
510	510	Greeley	0.192891198	0.483088431	0.919804256	0.0330221	14.91855212	0.35	0.1	3	0.0018	0.5	1
514	514	Greeley	0.1383943	0.456719265	0.927453009	0.02533254	60.8784184	0.35	0.1	3	0.0018	0.5	1
518	518	Greeley	0.124522156	0.298231902	0.642157799	0.02418529	51.84052788	0.35	0.1	3	0.0018	0.5	1
610	610	Greeley	0.165567195	0.451763756	0.970572743	0.0318034	16.8183793	0.35	0.1	3	0.0018	0.5	1
614	614	Greeley	0.156737366	0.330011646	0.606783893	0.03554558	52.38284884	0.35	0.1	3	0.0018	0.5	1
618	618	Greeley	0.084019173	0.184845517	0.446457134	0.02554086	76.87799799	0.35	0.1	3	0.0018	0.5	1
622	622	Greeley	0.1606888	0.335653493	0.672843987	0.01869943	74.46635266	0.35	0.1	3	0.0018	0.5	1
710	710	Greeley	0.067835484	0.192091911	0.420748645	0.01749048	77.18189111	0.35	0.1	3	0.0018	0.5	1
810	810	Greeley	0.099777947	0.338774989	0.677094687	0.02319473	76.72843683	0.35	0.1	3	0.0018	0.5	1
814	814	Greeley	0.172775323	0.312127197	0.833805187	0.01579485	68.61234094	0.35	0.1	3	0.0018	0.5	1
818	818	Greeley	0.156178631	0.361078569	0.56921566	0.02261656	60.02650419	0.35	0.1	4.5	0.0018	0.6	1

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
110		0.147	0.164	71.2	10.49	37.0	7.42	17.5	47	257,766	1.84	473,338	65.0	73	473,245	1.02
114		0.151	0.206	45.3	8.67	23.5	6.13	14.4	116	406,013	1.78	721,528	50.0	157	721,151	1.41
118		0.156	0.131	43.8	5.91	22.8	4.18	9.9	40	136,996	1.76	240,856	50.0	53	240,835	1.41
122		0.094	0.218	37.1	7.71	19.3	5.45	12.8	155	445,075	2.23	994,334	45.0	232	993,705	1.89
126		0.112	0.078	40.0	3.88	20.8	2.74	6.5	24	74,154	1.83	135,547	45.0	31	135,166	1.51
130		0.121	0.116	48.7	5.84	25.3	4.13	9.7	45	169,548	1.94	329,048	50.0	65	328,917	1.40
134		0.087	0.182	19.8	4.27	10.3	3.01	7.1	127	194,175	2.41	467,672	35.0	158	464,232	2.95
138		0.081	0.245	12.6	3.88	6.6	2.74	6.5	309	301,853	2.59	783,054	35.0	337	768,468	4.05
142		0.125	0.080	58.4	5.10	30.4	3.60	8.5	16	71,765	1.87	134,112	50.0	23	133,907	1.17
146		0.102	0.109	63.3	6.79	32.9	4.80	11.3	29	143,818	2.11	303,229	55.0	48	303,224	1.21
150		0.112	0.126	39.3	5.30	20.4	3.75	8.8	71	216,576	2.01	434,934	45.0	100	434,158	1.67
154		0.088	0.227	15.6	4.22	8.1	2.98	7.0	268	323,632	2.40	775,838	35.0	314	773,687	3.52
210		0.148	0.140	31.3	4.85	16.3	3.43	8.1	73	177,186	1.83	324,965	45.0	90	324,052	1.85
220		0.156	0.202	47.5	8.89	24.7	6.28	14.8	99	363,101	1.76	639,124	50.0	134	638,747	1.34
224		0.154	0.163	38.6	6.35	20.1	4.49	10.6	77	231,887	1.82	420,951	45.0	102	421,133	1.60
226		0.092	0.175	24.4	4.78	12.7	3.38	8.0	117	221,759	2.30	509,470	40.0	155	508,247	2.55
228		0.094	0.172	30.7	5.55	16.0	3.92	9.3	101	240,005	2.25	540,783	45.0	141	540,071	2.13
232		0.151	0.202	51.6	9.50	26.8	6.71	15.8	96	384,902	1.82	702,016	55.0	139	701,742	1.31
236		0.100	0.139	39.6	5.73	20.6	4.05	9.5	71	217,622	2.14	466,071	45.0	104	465,681	1.74
240		0.156	0.102	38.8	4.54	20.2	3.21	7.6	26	79,324	1.76	139,630	45.0	33	139,293	1.53
244		0.087	0.230	25.1	5.93	13.1	4.19	9.9	169	328,035	2.41	789,839	40.0	235	788,745	2.60
248		0.079	0.269	15.0	4.59	7.8	3.25	7.7	303	350,880	2.67	936,288	35.0	372	934,635	3.85
250		0.082	0.180	11.4	3.08	5.9	2.18	5.1	179	158,220	2.55	404,169	35.0	181	394,372	4.16
252		0.081	0.216	24.7	5.59	12.8	3.95	9.3	120	228,783	2.59	591,507	40.0	172	590,560	2.73
256		0.093	0.208	35.2	7.12	18.3	5.03	11.9	125	339,970	2.17	738,960	45.0	180	737,894	1.92
260		0.131	0.142	42.3	6.11	22.0	4.32	10.2	72	234,503	1.89	442,967	50.0	99	443,000	1.53
264		0.082	0.222	23.2	5.44	12.0	3.84	9.1	139	249,635	2.56	638,512	40.0	195	638,136	2.83
268		0.086	0.194	24.0	5.07	12.5	3.59	8.5	115	212,597	2.45	519,866	40.0	157	518,851	2.68
310		0.155	0.190	46.6	8.32	24.2	5.88	13.9	89	319,565	1.59	507,766	50.0	111	507,556	1.26
314		0.097	0.157	23.9	4.38	12.4	3.10	7.3	136	251,527	2.05	516,373	40.0	166	514,876	2.39
410		0.147	0.078	42.8	4.05	22.3	2.86	6.8	15	48,596	1.79	86,935	45.0	19	86,728	1.43
414		0.153	0.077	34.7	3.55	18.0	2.51	5.9	16	43,852	1.77	77,546	45.0	20	77,272	1.64
418		0.151	0.129	48.3	6.30	25.1	4.45	10.5	38	143,829	1.82	262,413	50.0	54	262,486	1.36
422		0.152	0.047	40.3	2.96	21.0	2.09	4.9	5	15,040	0.70	10,486	40.0	3	10,403	0.70
426		0.148	0.133	51.1	6.71	26.6	4.74	11.2	40	157,878	1.66	262,320	50.0	53	262,391	1.21
510		0.120	0.176	49.0	8.13	25.5	5.75	13.6	118	448,125	1.95	872,868	50.0	175	872,345	1.41
514		0.084	0.240	26.2	6.35	13.6	4.48	10.6	158	321,518	2.49	801,281	40.0	228	799,650	2.57
518		0.088	0.213	21.4	5.01	11.1	3.54	8.3	174	289,290	2.38	689,564	40.0	225	686,541	2.83
610		0.117	0.165	51.1	7.99	26.6	5.65	13.3	97	384,646	1.97	757,751	50.0	146	757,266	1.37
614		0.088	0.238	17.8	4.76	9.3	3.36	7.9	263	364,132	2.39	870,328	35.0	319	866,011	3.18
618		0.078	0.208	12.9	3.55	6.7	2.51	5.9	196	195,193	2.69	524,214	35.0	217	512,807	4.03
622		0.079	0.276	17.1	5.12	8.9	3.62	8.5	282	373,312	2.66	991,623	35.0	359	984,692	3.49
710		0.078	0.189	15.3	3.72	8.0	2.63	6.2	133	157,595	2.69	423,823	35.0	163	421,595	3.76
810		0.078	0.224	19.9	4.93	10.4	3.49	8.2	150	231,804	2.68	622,114	40.0	199	617,486	3.12
814		0.081	0.278	19.4	5.64	10.1	3.99	9.4	267	401,392	2.59	1,037,724	40.0	350	1,033,411	3.16
818		0.085	0.252	18.3	5.04	9.5	3.56	8.4	255	362,834	2.40	870,121	35.0	310	865,139	3.10

Appendix F-2
Master Plan Detention

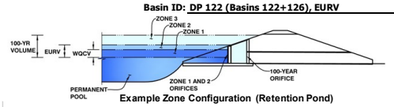
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 122 (Basins 122+126), EURV



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	143.04	acres
Watershed Length =	6,251	ft
Watershed Length to Centroid =	2,567	ft
Watershed Slope =	0.025	ft/ft
Watershed Imperviousness =	36.36%	percent
Percentage Hydrologic Soil Group A =	36.8%	percent
Percentage Hydrologic Soil Group B =	55.2%	percent
Percentage Hydrologic Soil Groups C/D =	8.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	2.027	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	5.394	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	2.864	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	4.183	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	5.948	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	11.597	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	16.409	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	22.961	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	39.704	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	2.712	acre-feet		
Approximate 5-yr Detention Volume =	3.961	acre-feet		
Approximate 10-yr Detention Volume =	5.619	acre-feet		
Approximate 25-yr Detention Volume =	7.642	acre-feet		
Approximate 50-yr Detention Volume =	9.010	acre-feet		
Approximate 100-yr Detention Volume =	11.395	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	2.027	acre-feet
Zone 2 Volume (EURV - Zone 1)	3.367	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	6.001	acre-feet
Total Detention Basin Volume =	11.395	acre-feet
Initial Surcharge Volume (ISV) =	265	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.008	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	

Initial Surcharge Area (A_{ISV}) =	530	ft^2
Surcharge Volume Length (L_{ISV}) =	23.0	ft
Surcharge Volume Width (W_{ISV}) =	23.0	ft
Depth of Basin Floor (H_{FLOOR}) =	4.78	ft
Length of Basin Floor (L_{FLOOR}) =	639.6	ft
Width of Basin Floor (W_{FLOOR}) =	321.8	ft
Area of Basin Floor (A_{FLOOR}) =	205,812	ft^2
Volume of Basin Floor (V_{FLOOR}) =	345,408	ft^3
Depth of Main Basin (H_{MAIN}) =	0.72	ft
Length of Main Basin (L_{MAIN}) =	645.4	ft
Width of Main Basin (W_{MAIN}) =	327.5	ft
Area of Main Basin (A_{MAIN}) =	211,383	ft^2
Volume of Main Basin (V_{MAIN}) =	150,186	ft^3
Calculated Total Basin Volume (V_{total}) =	**11.389**	acre-feet

Depth Increment = 0.25 ft

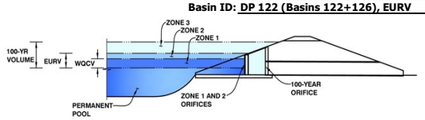
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		23.0	23.0	530		0.012		
ISV	0.50		23.0	23.0	530		0.012	265	0.006
	0.75		23.0	23.0	530		0.012	397	0.009
	1.00		23.0	23.0	530		0.012	530	0.012
	1.25		55.3	38.6	2,135		0.049	842	0.019
	1.50		87.5	54.3	4,749		0.109	1,681	0.039
	1.75		119.8	69.9	8,370		0.192	3,300	0.076
	2.00		152.0	85.5	13,000		0.298	5,951	0.137
	2.25		184.3	101.1	18,637		0.428	9,884	0.227
	2.50		216.5	116.8	25,281		0.580	15,353	0.352
	2.75		248.8	132.4	32,934		0.756	22,609	0.519
	3.00		281.0	148.0	41,595		0.955	31,904	0.732
	3.25		313.3	163.6	51,263		1.177	43,490	0.998
	3.50		345.5	179.3	61,939		1.422	57,619	1.323
	3.75		377.8	194.9	73,623		1.690	74,544	1.711
	4.00		410.0	210.5	86,315		1.982	94,515	2.170
	4.25		442.3	226.1	100,014		2.296	117,785	2.704
Zone 1 (WQCV)	4.37		457.7	233.6	106,948		2.455	130,200	2.989
	4.50		474.5	241.8	114,721		2.634	144,606	3.320
	4.75		506.8	257.4	130,437		2.994	175,230	4.023
	5.00		539.0	273.0	147,159		3.378	209,908	4.819
	5.25		571.3	288.6	164,890		3.785	248,893	5.714
	5.50		603.5	304.3	183,629		4.216	292,437	6.713
	5.75		635.8	319.9	203,375		4.669	340,792	7.823
Zone 2 (EURV)	5.80		639.8	321.9	205,966		4.728	351,047	8.059
	6.00		641.4	323.5	207,508		4.764	392,394	9.008
	6.25		643.4	325.5	209,441		4.808	444,513	10.205
Floor	6.50		645.4	327.5	211,383		4.853	497,116	11.412
	6.75		647.4	329.5	213,333		4.897	550,205	12.631
	7.00		649.4	331.5	215,291		4.942	603,783	13.861
	7.25		651.4	333.5	217,257		4.988	657,851	15.102
Zone 3 (100-year)	7.34		652.1	334.2	217,967		5.004	677,437	15.552
	7.50		653.4	335.5	219,231		5.033	712,412	16.355
	7.75		655.4	337.5	221,213		5.078	767,467	17.619
	8.00		657.4	339.5	223,202		5.124	823,019	18.894
	8.25		659.4	341.5	225,200		5.170	879,069	20.181
	8.50		661.4	343.5	227,206		5.216	935,620	21.479
	8.75		663.4	345.5	229,220		5.262	992,673	22.789
	9.00		665.4	347.5	231,242		5.309	1,050,231	24.110
	9.25		667.4	349.5	233,272		5.355	1,108,295	25.443
	9.50		669.4	351.5	235,309		5.402	1,166,867	26.788
	9.75		671.4	353.5	237,355		5.449	1,225,950	28.144
	10.00		673.4	355.5	239,409		5.496	1,285,545	29.512
	10.25		675.4	357.5	241,471		5.543	1,345,655	30.892
	10.50		677.4	359.5	243,541		5.591	1,406,281	32.284
	10.75		679.4	361.5	245,619		5.639	1,467,426	33.687
	11.00		681.4	363.5	247,704		5.687	1,529,091	35.103
	11.25		683.4	365.5	249,798		5.735	1,591,279	36.531
	11.50		685.4	367.5	251,900		5.783	1,653,991	37.970
	11.75		687.4	369.5	254,010		5.831	1,717,230	39.422
	12.00		689.4	371.5	256,128		5.880	1,780,997	40.886
	12.25		691.4	373.5	258,254		5.929	1,845,294	42.362
	12.50		693.4	375.5	260,388		5.978	1,910,124	43.850
	12.75		695.4	377.5	262,529		6.027	1,975,489	45.351
	13.00		697.4	379.5	264,679		6.076	2,041,390	46.864
	13.25		699.4	381.5	266,837		6.126	2,107,829	48.389
	13.50		701.4	383.5	269,003		6.175	2,174,809	49.927
	13.75		703.4	385.5	271,177		6.225	2,242,331	51.477
	14.00		705.4	387.5	273,359		6.275	2,310,398	53.039
	14.25		707.4	389.5	275,548		6.326	2,379,011	54.615
	14.50		709.4	391.5	277,746		6.376	2,448,173	56.202
	14.75		711.4	393.5	279,952		6.427	2,517,885	57.803
	15.00		713.4	395.5	282,166		6.478	2,588,150	59.416
	15.25		715.4	397.5	284,388		6.529	2,658,969	61.042
	15.50		717.4	399.5	286,618		6.580	2,730,344	62.680
	15.75		719.4	401.5	288,855		6.631	2,802,278	64.331
	16.00		721.4	403.5	291,101		6.683	2,874,773	65.996
	16.25		723.4	405.5	293,355		6.735	2,947,829	67.673
	16.50		725.4	407.5	295,617		6.786	3,021,451	69.363
	16.75		727.4	409.5	297,887		6.839	3,095,639	71.066
	17.00		729.4	411.5	300,165		6.891	3,170,395	72.782
	17.25		731.4	413.5	302,451		6.943	3,245,722	74.512
	17.50		733.4	415.5	304,744		6.996	3,321,621	76.254

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 122 (Basins 122+126), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.93	2.027	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.17	3.367	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	6.001	Not Utilized	Zone 3 Not Utilized
Total (all zones)		11.395		

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 Diameter =	N/A	inches	Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.93	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	15.70	inches
Orifice Plate: Orifice Area per Row =	5.17	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	3.590E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.31	2.62					
Orifice Area (sq. inches)	5.17	5.17	5.17					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.93	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.93	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	70.77	N/A	
Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	2.60		inches

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.16	N/A	ft^2
Outlet Orifice Centroid =	0.13	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	0.78	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.18	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	1000.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	2.00	feet

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.18	feet
Stage at Top of Freeboard =	7.36	feet
Basin Area at Top of Freeboard =	5.01	acres
Basin Volume at Top of Freeboard =	15.60	acre-ft

Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	2.027	5.394	2.864	4.183	5.948	11.597	16.409	22.961	39.704
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.864	4.183	5.948	11.597	16.409	22.961	39.704
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.6	1.2	5.8	52.5	88.4	137.3	255.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.04	0.37	0.62	0.96	1.79
Peak Inflow Q (cfs) =	N/A	N/A	24.6	36.7	52.8	119.3	170.0	234.9	399.3
Peak Outflow Q (cfs) =	0.8	2.1	1.9	2.0	2.8	87.4	160.8	258.9	413.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.7	0.5	1.7	1.8	1.9	1.6
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.10	0.10	0.1	0.1	0.1	0.1	0.1	0.1
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) =	38	56	45	51	60	55	51	47	39
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	47	54	64	62	60	58	54
Maximum Ponding Depth (ft) =	3.93	5.17	4.18	4.66	5.18	5.27	5.32	5.37	5.45
Area at Maximum Ponding Depth (acres) =	1.90	3.65	2.19	2.86	3.67	3.82	3.90	3.99	4.11
Maximum Volume Stored (acre-ft) =	2.034	5.416	2.524	3.759	5.453	5.790	5.983	6.180	6.464

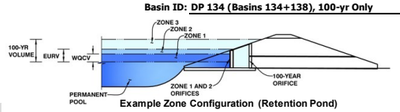
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 134 (Basins 134+138), 100-yr Only



Example Zone Configuration (Retention Pond)

Watershed Information

Flood Control Only

Flood Control Only	**No BMP**	
Watershed Area =	136.65	acres
Watershed Length =	3,476	ft
Watershed Length to Centroid =	1,780	ft
Watershed Slope =	0.021	ft/ft
Watershed Imperviousness =	63.30%	percent
Percentage Hydrologic Soil Group A =	38.5%	percent
Percentage Hydrologic Soil Group B =	39.0%	percent
Percentage Hydrologic Soil Groups C/D =	22.5%	percent
Target WQCV Drain Time =	N/A	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.693 acre-feet	1.693	acre-feet
Excess Urban Runoff Volume (EURV) =	9.653 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	5.494 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	7.678 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	10.140 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	15.763 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	20.653 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	26.847 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	43.260 acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	5.132 acre-feet		
Approximate 5-yr Detention Volume =	7.236 acre-feet		
Approximate 10-yr Detention Volume =	9.456 acre-feet		
Approximate 25-yr Detention Volume =	12.392 acre-feet		
Approximate 50-yr Detention Volume =	14.396 acre-feet		
Approximate 100-yr Detention Volume =	17.041 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (100-year)	17.041	acre-feet
Select Zone 2 Storage Volume (Optional)		acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	17.041	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	15.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.010	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	0	ft^2
Surcharge Volume Length (L_{ISV}) =	0.0	ft
Surcharge Volume Width (W_{ISV}) =	0.0	ft
Depth of Basin Floor (H_{FLOOR}) =	0.00	ft
Length of Basin Floor (L_{FLOOR}) =	222.7	ft
Width of Basin Floor (W_{FLOOR}) =	111.4	ft
Area of Basin Floor (A_{FLOOR}) =	24,808	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{MAIN}) =	15.00	ft
Length of Main Basin (L_{MAIN}) =	342.7	ft
Width of Main Basin (W_{MAIN}) =	231.4	ft
Area of Main Basin (A_{MAIN}) =	79,302	ft^2
Volume of Main Basin (V_{MAIN}) =	742,323	ft^3
Calculated Total Basin Volume (V_{total}) =	**17.041**	acre-feet

Depth Increment = 0.25 ft

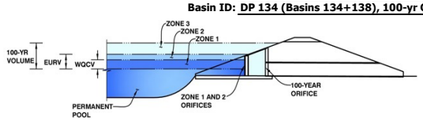
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		222.7	111.4	24,808		0.570		
	0.25		224.7	113.4	25,480		0.585	6,286	0.144
	0.50		226.7	115.4	26,160		0.601	12,741	0.292
	0.75		228.7	117.4	26,849		0.616	19,367	0.445
	1.00		230.7	119.4	27,545		0.632	26,166	0.601
	1.25		232.7	121.4	28,249		0.649	33,140	0.761
	1.50		234.7	123.4	28,961		0.665	40,291	0.925
	1.75		236.7	125.4	29,682		0.681	47,621	1.093
	2.00		238.7	127.4	30,410		0.698	55,132	1.266
	2.25		240.7	129.4	31,146		0.715	62,827	1.442
	2.50		242.7	131.4	31,890		0.732	70,706	1.623
	2.75		244.7	133.4	32,643		0.749	78,773	1.808
	3.00		246.7	135.4	33,403		0.767	87,028	1.998
	3.25		248.7	137.4	34,171		0.784	95,475	2.192
	3.50		250.7	139.4	34,947		0.802	104,114	2.390
	3.75		252.7	141.4	35,731		0.820	112,949	2.593
	4.00		254.7	143.4	36,524		0.838	121,981	2.800
	4.25		256.7	145.4	37,324		0.857	131,211	3.012
	4.50		258.7	147.4	38,132		0.875	140,643	3.229
	4.75		260.7	149.4	38,948		0.894	150,278	3.450
	5.00		262.7	151.4	39,773		0.913	160,118	3.676
	5.25		264.7	153.4	40,605		0.932	170,165	3.906
	5.50		266.7	155.4	41,445		0.951	180,421	4.142
	5.75		268.7	157.4	42,293		0.971	190,888	4.382
	6.00		270.7	159.4	43,150		0.991	201,569	4.627
	6.25		272.7	161.4	44,014		1.010	212,464	4.878
	6.50		274.7	163.4	44,886		1.030	223,576	5.133
	6.75		276.7	165.4	45,766		1.051	234,908	5.393
	7.00		278.7	167.4	46,655		1.071	246,460	5.658
	7.25		280.7	169.4	47,551		1.092	258,236	5.928
	7.50		282.7	171.4	48,455		1.112	270,236	6.204
	7.75		284.7	173.4	49,367		1.133	282,464	6.484
	8.00		286.7	175.4	50,288		1.154	294,920	6.770
	8.25		288.7	177.4	51,216		1.176	307,608	7.062
	8.50		290.7	179.4	52,152		1.197	320,529	7.358
	8.75		292.7	181.4	53,096		1.219	333,685	7.660
	9.00		294.7	183.4	54,048		1.241	347,078	7.968
	9.25		296.7	185.4	55,009		1.263	360,710	8.281
	9.50		298.7	187.4	55,977		1.285	374,583	8.599
	9.75		300.7	189.4	56,953		1.307	388,699	8.923
Zone 1 (100-year)	10.00		302.7	191.4	57,937		1.330	403,060	9.253
	10.25		304.7	193.4	58,930		1.353	417,668	9.588
	10.50		306.7	195.4	59,930		1.376	432,526	9.929
	10.75		308.7	197.4	60,938		1.399	447,634	10.276
	11.00		310.7	199.4	61,954		1.422	462,995	10.629
	11.25		312.7	201.4	62,979		1.446	478,612	10.987
	11.50		314.7	203.4	64,011		1.469	494,485	11.352
	11.75		316.7	205.4	65,051		1.493	510,618	11.722
	12.00		318.7	207.4	66,099		1.517	527,012	12.099
	12.25		320.7	209.4	67,156		1.542	543,668	12.481
	12.50		322.7	211.4	68,220		1.566	560,590	12.869
	12.75		324.7	213.4	69,292		1.591	577,779	13.264
	13.00		326.7	215.4	70,372		1.616	595,237	13.665
	13.25		328.7	217.4	71,461		1.641	612,966	14.072
	13.50		330.7	219.4	72,557		1.666	630,968	14.485
	13.75		332.7	221.4	73,661		1.691	649,245	14.905
	14.00		334.7	223.4	74,773		1.717	667,799	15.331
	14.25		336.7	225.4	75,893		1.742	686,632	15.763
	14.50		338.7	227.4	77,022		1.768	705,746	16.202
	14.75		340.7	229.4	78,158		1.794	725,144	16.647
	15.00		342.7	231.4	79,302		1.821	744,826	17.099
	15.25		344.7	233.4	80,454		1.847	764,795	17.557
	15.50		346.7	235.4	81,615		1.874	785,054	18.022
	15.75		348.7	237.4	82,783		1.900	805,603	18.494
	16.00		350.7	239.4	83,959		1.927	826,446	18.973
	16.25		352.7	241.4	85,143		1.955	847,584	19.458
	16.50		354.7	243.4	86,336		1.982	869,018	19.950
	16.75		356.7	245.4	87,536		2.010	890,752	20.449
	17.00		358.7	247.4	88,744		2.037	912,787	20.955
	17.25		360.7	249.4	89,960		2.065	935,125	21.468
	17.50		362.7	251.4	91,185		2.093	957,768	21.987

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 134 (Basins 134+138), 100-yr Only



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (100-year)	14.97	17.041	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 2				Select Zone 2 Outlet Type
Zone 3				Select Zone 3 Outlet Type
Total (all zones)		17.041		

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 Diameter =	N/A	inches	Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	sq. inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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 Rectangular	Not Selected	
Invert of Vertical Orifice =	0.00		ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	6.50		ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	48.00		inches
Vertical Orifice Width =	60.00		inches

Calculated Parameters for Vertical Orifice

	Zone 1 Rectangular	Not Selected	
Vertical Orifice Area =	20.00		ft^2
Vertical Orifice Centroid =	2.00		feet

Size Vertical Orifice to drain (EURV - WQCV) Only

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	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =	Select Grate Type	Select Grate Type	
Debris Clogging % =			%

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

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

Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	1.693	9.653	5.494	7.678	10.140	15.763	20.653	26.847	43.260
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	5.494	7.678	10.140	15.763	20.653	26.847	43.260
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.8	1.7	9.2	71.1	117.8	180.1	329.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.07	0.52	0.86	1.32	2.41
Peak Inflow Q (cfs) =	N/A	N/A	85.2	119.7	157.4	261.6	346.5	362.2	715.3
Peak Outflow Q (cfs) =	52.0	265.6	54.6	80.2	109.6	178.7	217.5	209.4	341.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	48.0	11.9	2.5	1.8	1.2	1.0
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	Vertical Orifice
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) =	6	2	4	3	3	3	3	3	2
Time to Drain 99% of Inflow Volume (hours) =	**14**	4	7	6	5	4	4	7	3
Maximum Ponding Depth (ft) =	2.60	10.30	2.41	2.99	3.55	5.44	7.10	6.73	14.55
Area at Maximum Ponding Depth (acres) =	0.74	1.36	0.73	0.77	0.81	0.95	1.08	1.05	1.77
Maximum Volume Stored (acre-ft) =	1.697	9.656	1.558	1.983	2.422	4.085	5.765	5.361	16.273

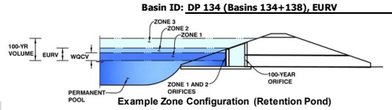
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 134 (Basins 134+138), EURV



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	136.65	acres
Watershed Length =	3,476	ft
Watershed Length to Centroid =	1,780	ft
Watershed Slope =	0.021	ft/ft
Watershed Imperviousness =	63.30%	percent
Percentage Hydrologic Soil Group A =	38.5%	percent
Percentage Hydrologic Soil Group B =	39.0%	percent
Percentage Hydrologic Soil Groups C/D =	22.5%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.693 acre-feet	1.693	acre-feet
Excess Urban Runoff Volume (EURV) =	9.653 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	5.494 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	7.678 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	10.140 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	15.763 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	20.653 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	26.847 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	43.260 acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	5.132 acre-feet		
Approximate 5-yr Detention Volume =	7.236 acre-feet		
Approximate 10-yr Detention Volume =	9.456 acre-feet		
Approximate 25-yr Detention Volume =	12.392 acre-feet		
Approximate 50-yr Detention Volume =	14.396 acre-feet		
Approximate 100-yr Detention Volume =	17.041 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	1.693	acre-feet
Zone 2 Volume (EURV - Zone 1)	7.960	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	7.388	acre-feet
Total Detention Basin Volume =	17.041	acre-feet
Initial Surcharge Volume (ISV) =	221	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.006	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	

Initial Surcharge Area (A_{ISV}) =	442	ft^2
Surcharge Volume Length (L_{ISV}) =	21.0	ft
Surcharge Volume Width (W_{ISV}) =	21.0	ft
Depth of Basin Floor (H_{FLOOR}) =	4.07	ft
Length of Basin Floor (L_{FLOOR}) =	715.6	ft
Width of Basin Floor (W_{FLOOR}) =	360.2	ft
Area of Basin Floor (A_{FLOOR}) =	257,778	ft^2
Volume of Basin Floor (V_{FLOOR}) =	364,808	ft^3
Depth of Main Basin (H_{MAIN}) =	1.43	ft
Length of Main Basin (L_{MAIN}) =	727.1	ft
Width of Main Basin (W_{MAIN}) =	371.6	ft
Area of Main Basin (A_{MAIN}) =	270,217	ft^2
Volume of Main Basin (V_{MAIN}) =	377,481	ft^3
Calculated Total Basin Volume (V_{total}) =	**17.051**	acre-feet

Depth Increment = 0.25 ft

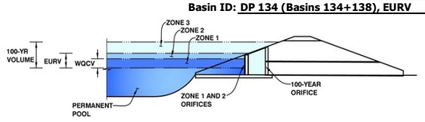
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		21.0	21.0	442		0.010		
ISV	0.50		21.0	21.0	442		0.010	221	0.005
	0.75		21.0	21.0	442		0.010	332	0.008
	1.00		21.0	21.0	442		0.010	442	0.010
	1.25		63.7	41.9	2,667		0.061	794	0.018
	1.50		106.4	62.7	6,670		0.153	1,924	0.044
	1.75		149.0	83.5	12,450		0.286	4,277	0.098
	2.00		191.7	104.4	20,008		0.459	8,297	0.190
	2.25		234.4	125.2	29,343		0.674	14,429	0.331
	2.50		277.0	146.0	40,457		0.929	23,117	0.531
	2.75		319.7	166.9	53,348		1.225	34,806	0.799
	3.00		362.4	187.7	68,017		1.561	49,939	1.146
	3.25		405.0	208.5	84,464		1.939	68,962	1.583
Zone 1 (WQCV)	3.31		415.3	213.5	88,676		2.036	74,156	1.702
	3.50		447.7	229.4	102,689		2.357	92,320	2.119
	3.75		490.4	250.2	122,691		2.817	120,455	2.765
	4.00		533.0	271.0	144,471		3.317	153,813	3.531
	4.25		575.7	291.9	168,029		3.857	192,839	4.427
	4.50		618.4	312.7	193,365		4.439	237,976	5.463
	4.75		661.0	333.5	220,479		5.061	289,669	6.650
	5.00		703.7	354.4	249,370		5.725	348,363	7.997
Floor	5.07		715.6	360.2	257,778		5.918	366,113	8.405
	5.25		717.1	361.6	259,329		5.953	412,652	9.473
Zone 2 (EURV)	5.29		717.4	362.0	259,675		5.961	423,033	9.711
	5.50		719.1	363.6	261,491		6.003	477,755	10.968
	5.75		721.1	365.6	263,660		6.053	543,398	12.475
	6.00		723.1	367.6	265,838		6.103	609,586	13.994
	6.25		725.1	369.6	268,023		6.153	676,318	15.526
Zone 3 (100-year)	6.50		727.1	371.6	270,217		6.203	743,598	17.071
	6.75		729.1	373.6	272,418		6.254	811,427	18.628
	7.00		731.1	375.6	274,628		6.305	879,808	20.198
	7.25		733.1	377.6	276,845		6.355	948,741	21.780
	7.50		735.1	379.6	279,070		6.407	1,018,231	23.375
	7.75		737.1	381.6	281,304		6.458	1,088,277	24.983
	8.00		739.1	383.6	283,545		6.509	1,158,883	26.604
	8.25		741.1	385.6	285,795		6.561	1,230,051	28.238
	8.50		743.1	387.6	288,052		6.613	1,301,781	29.885
	8.75		745.1	389.6	290,318		6.665	1,374,077	31.544
	9.00		747.1	391.6	292,591		6.717	1,446,941	33.217
	9.25		749.1	393.6	294,873		6.769	1,520,374	34.903
	9.50		751.1	395.6	297,162		6.822	1,594,378	36.602
	9.75		753.1	397.6	299,460		6.875	1,668,955	38.314
	10.00		755.1	399.6	301,765		6.928	1,744,108	40.039
	10.25		757.1	401.6	304,079		6.981	1,819,839	41.778
	10.50		759.1	403.6	306,400		7.034	1,896,148	43.530
	10.75		761.1	405.6	308,729		7.087	1,973,039	45.295
	11.00		763.1	407.6	311,067		7.141	2,050,514	47.073
	11.25		765.1	409.6	313,412		7.195	2,128,573	48.865
	11.50		767.1	411.6	315,766		7.249	2,207,221	50.671
	11.75		769.1	413.6	318,127		7.303	2,286,457	52.490
	12.00		771.1	415.6	320,497		7.358	2,366,285	54.322
	12.25		773.1	417.6	322,874		7.412	2,446,706	56.169
	12.50		775.1	419.6	325,260		7.467	2,527,723	58.029
	12.75		777.1	421.6	327,653		7.522	2,609,337	59.902
	13.00		779.1	423.6	330,055		7.577	2,691,550	61.789
	13.25		781.1	425.6	332,464		7.632	2,774,365	63.691
	13.50		783.1	427.6	334,882		7.688	2,857,783	65.606
	13.75		785.1	429.6	337,307		7.744	2,941,806	67.535
	14.00		787.1	431.6	339,740		7.799	3,026,437	69.477
	14.25		789.1	433.6	342,182		7.855	3,111,677	71.434
	14.50		791.1	435.6	344,631		7.912	3,197,528	73.405
	14.75		793.1	437.6	347,089		7.968	3,283,993	75.390
	15.00		795.1	439.6	349,554		8.025	3,371,073	77.389
	15.25		797.1	441.6	352,028		8.081	3,458,771	79.402
	15.50		799.1	443.6	354,509		8.138	3,547,088	81.430
	15.75		801.1	445.6	356,999		8.196	3,636,026	83.472
	16.00		803.1	447.6	359,496		8.253	3,725,588	85.528
	16.25		805.1	449.6	362,002		8.310	3,815,775	87.598
	16.50		807.1	451.6	364,515		8.368	3,906,589	89.683
	16.75		809.1	453.6	367,037		8.426	3,998,033	91.782
	17.00		811.1	455.6	369,566		8.484	4,090,108	93.896
	17.25		813.1	457.6	372,103		8.542	4,182,817	96.024
	17.50		815.1	459.6	374,649		8.601	4,276,161	98.167

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 134 (Basins 134+138), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.31	1.693	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.29	7.960	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	7.388	Not Utilized	Zone 3 Not Utilized
Total (all zones)		17.041		

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 Diameter =	N/A	inches

Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.31	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	13.20	inches
Orifice Plate: Orifice Area per Row =	4.55	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	3.160E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.10	2.21					
Orifice Area (sq. inches)	4.55	4.55	4.55					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.31	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.31	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	29.87	N/A	
Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	4.75		inches

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.37	N/A	ft^2
Outlet Orifice Centroid =	0.23	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.08	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.30	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	1000.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.28	feet
Stage at Top of Freeboard =	6.58	feet
Basin Area at Top of Freeboard =	6.22	acres
Basin Volume at Top of Freeboard =	17.57	acre-ft

Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	1.693	9.653	5.494	7.678	10.140	15.763	20.653	26.847	43.260
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	5.494	7.678	10.140	15.763	20.653	26.847	43.260
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.8	1.7	9.2	71.1	117.8	180.1	329.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.07	0.52	0.86	1.32	2.41
Peak Inflow Q (cfs) =	N/A	N/A	85.2	119.7	157.4	261.6	346.5	448.4	715.3
Peak Outflow Q (cfs) =	0.7	4.9	4.6	4.8	4.9	114.6	232.9	380.0	664.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.9	0.5	1.6	2.0	2.1	2.0
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.36	0.34	0.4	0.4	0.4	0.4	0.4	0.4
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) =	38	54	48	51	55	52	48	44	34
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	52	57	62	61	60	58	53
Maximum Ponding Depth (ft) =	3.31	5.29	4.34	4.80	5.22	5.41	5.48	5.55	5.66
Area at Maximum Ponding Depth (acres) =	2.04	5.96	4.06	5.16	5.95	5.99	6.00	6.01	6.03
Maximum Volume Stored (acre-ft) =	1.702	9.711	4.783	6.854	9.295	10.428	10.788	11.208	11.931

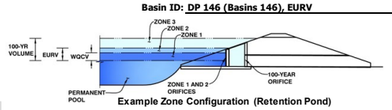
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 146 (Basins 146), EURV



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB		Note: L / W Ratio > 8
Watershed Area =	36.92	acres	L / W Ratio = 11.97
Watershed Length =	4,388	ft	
Watershed Length to Centroid =	2,447	ft	
Watershed Slope =	0.033	ft/ft	
Watershed Imperviousness =	28.65%	percent	
Percentage Hydrologic Soil Group A =	16.6%	percent	
Percentage Hydrologic Soil Group B =	35.9%	percent	
Percentage Hydrologic Soil Groups C/D =	47.5%	percent	
Target WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	User Input		

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

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.292	acre-feet	0.292	acre-feet
Excess Urban Runoff Volume (EURV) =	1.016	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	0.566	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	0.871	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	1.475	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	3.036	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	4.323	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	6.026	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	10.408	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	0.553	acre-feet		
Approximate 5-yr Detention Volume =	0.897	acre-feet		
Approximate 10-yr Detention Volume =	1.227	acre-feet		
Approximate 25-yr Detention Volume =	1.663	acre-feet		
Approximate 50-yr Detention Volume =	1.935	acre-feet		
Approximate 100-yr Detention Volume =	2.546	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	0.292	acre-feet
Zone 2 Volume (EURV - Zone 1)	0.724	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	1.530	acre-feet
Total Detention Basin Volume =	2.546	acre-feet
Initial Surcharge Volume (ISV) =	38	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.010	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	

Initial Surcharge Area (A_{ISV}) =	76	ft^2
Surcharge Volume Length (L_{ISV}) =	8.7	ft
Surcharge Volume Width (W_{ISV}) =	8.7	ft
Depth of Basin Floor (H_{FLOOR}) =	1.93	ft
Length of Basin Floor (L_{FLOOR}) =	209.5	ft
Width of Basin Floor (W_{FLOOR}) =	105.2	ft
Area of Basin Floor (A_{FLOOR}) =	22,042	ft^2
Volume of Basin Floor (V_{FLOOR}) =	15,064	ft^3
Depth of Main Basin (H_{MAIN}) =	3.57	ft
Length of Main Basin (L_{MAIN}) =	238.0	ft
Width of Main Basin (W_{MAIN}) =	133.8	ft
Area of Main Basin (A_{MAIN}) =	31,846	ft^2
Volume of Main Basin (V_{MAIN}) =	95,655	ft^3
Calculated Total Basin Volume (V_{total}) =	**2.544**	acre-feet

Depth Increment = 0.25 ft

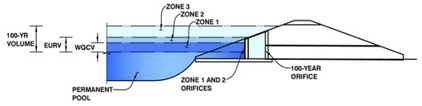
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		8.7	8.7	76		0.002		
ISV	0.50		8.7	8.7	76		0.002	38	0.001
	0.75		8.7	8.7	76		0.002	57	0.001
	1.00		8.7	8.7	76		0.002	76	0.002
	1.25		34.7	21.2	738		0.017	165	0.004
	1.50		60.7	33.7	2,049		0.047	499	0.011
	1.75		86.7	46.2	4,010		0.092	1,243	0.029
	2.00		112.7	58.7	6,622		0.152	2,559	0.059
	2.25		138.7	71.2	9,883		0.227	4,608	0.106
	2.50		164.7	83.7	13,794		0.317	7,554	0.173
	2.75		190.7	96.2	18,356		0.421	11,560	0.265
Zone 1 (WQCV)	2.82		198.0	99.7	19,749		0.453	12,893	0.296
Floor	2.93		209.5	105.2	22,042		0.506	15,190	0.349
	3.00		210.0	105.8	22,219		0.510	16,739	0.384
	3.25		212.0	107.8	22,854		0.525	22,373	0.514
	3.50		214.0	109.8	23,498		0.539	28,167	0.647
	3.75		216.0	111.8	24,150		0.554	34,123	0.783
	4.00		218.0	113.8	24,809		0.570	40,243	0.924
Zone 2 (EURV)	4.17		219.4	115.2	25,262		0.580	44,499	1.022
	4.25		220.0	115.8	25,477		0.585	46,528	1.068
	4.50		222.0	117.8	26,153		0.600	52,982	1.216
	4.75		224.0	119.8	26,836		0.616	59,605	1.368
	5.00		226.0	121.8	27,528		0.632	66,401	1.524
	5.25		228.0	123.8	28,227		0.648	73,370	1.684
	5.50		230.0	125.8	28,935		0.664	80,515	1.848
	5.75		232.0	127.8	29,651		0.681	87,838	2.016
	6.00		234.0	129.8	30,374		0.697	95,341	2.189
	6.25		236.0	131.8	31,106		0.714	103,026	2.365
Zone 3 (100-year)	6.50		238.0	133.8	31,846		0.731	110,895	2.546
	6.75		240.0	135.8	32,593		0.748	118,949	2.731
	7.00		242.0	137.8	33,349		0.766	127,192	2.920
	7.25		244.0	139.8	34,112		0.783	135,625	3.114
	7.50		246.0	141.8	34,884		0.801	144,249	3.312
	7.75		248.0	143.8	35,664		0.819	153,067	3.514
	8.00		250.0	145.8	36,451		0.837	162,081	3.721
	8.25		252.0	147.8	37,247		0.855	171,294	3.932
	8.50		254.0	149.8	38,051		0.874	180,706	4.148
	8.75		256.0	151.8	38,862		0.892	190,320	4.369
	9.00		258.0	153.8	39,682		0.911	200,137	4.595
	9.25		260.0	155.8	40,509		0.930	210,161	4.825
	9.50		262.0	157.8	41,345		0.949	220,393	5.060
	9.75		264.0	159.8	42,189		0.969	230,834	5.299
	10.00		266.0	161.8	43,040		0.988	241,488	5.544
	10.25		268.0	163.8	43,900		1.008	252,355	5.793
	10.50		270.0	165.8	44,768		1.028	263,438	6.048
	10.75		272.0	167.8	45,643		1.048	274,740	6.307
	11.00		274.0	169.8	46,527		1.068	286,261	6.572
	11.25		276.0	171.8	47,418		1.089	298,004	6.841
	11.50		278.0	173.8	48,318		1.109	309,971	7.116
	11.75		280.0	175.8	49,226		1.130	322,163	7.396
	12.00		282.0	177.8	50,141		1.151	334,584	7.681
	12.25		284.0	179.8	51,065		1.172	347,235	7.971
	12.50		286.0	181.8	51,997		1.194	360,117	8.267
	12.75		288.0	183.8	52,936		1.215	373,234	8.568
	13.00		290.0	185.8	53,884		1.237	386,586	8.875
	13.25		292.0	187.8	54,839		1.259	400,176	9.187
	13.50		294.0	189.8	55,803		1.281	414,006	9.504
	13.75		296.0	191.8	56,775		1.303	428,078	9.827
	14.00		298.0	193.8	57,754		1.326	442,394	10.156
	14.25		300.0	195.8	58,742		1.349	456,956	10.490
	14.50		302.0	197.8	59,738		1.371	471,766	10.830
	14.75		304.0	199.8	60,741		1.394	486,826	11.176
	15.00		306.0	201.8	61,753		1.418	502,137	11.527
	15.25		308.0	203.8	62,772		1.441	517,703	11.885
	15.50		310.0	205.8	63,800		1.465	533,524	12.248
	15.75		312.0	207.8	64,836		1.488	549,603	12.617
	16.00		314.0	209.8	65,879		1.512	565,943	12.992
	16.25		316.0	211.8	66,931		1.537	582,544	13.373
	16.50		318.0	213.8	67,991		1.561	599,409	13.761
	16.75		320.0	215.8	69,058		1.585	616,540	14.154
	17.00		322.0	217.8	70,134		1.610	633,938	14.553
	17.25		324.0	219.8	71,217		1.635	651,607	14.959
	17.50		326.0	221.8	72,309		1.660	669,548	15.371

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 146 (Basins 146), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	2.82	0.292	Orifice Plate	Orifice Plate
Zone 2 (EURV)	4.17	0.724	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	1.530	Not Utilized	Zone 3 Not Utilized
Total (all zones)		2.546		

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 Diameter =	N/A	inches	Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.82	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	11.30	inches
Orifice Plate: Orifice Area per Row =	0.82	sq. inches (diameter = 1 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	5.694E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.94	1.88					
Orifice Area (sq. inches)	0.82	0.82	0.82					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.82	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	2.82	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	326.29	N/A	
Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	0.92		inches

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.03	N/A	ft^2
Outlet Orifice Centroid =	0.05	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	0.46	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.18	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	1000.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.05	feet
Stage at Top of Freeboard =	5.23	feet
Basin Area at Top of Freeboard =	0.65	acres
Basin Volume at Top of Freeboard =	1.66	acre-ft

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	0.292	1.016	0.566	0.871	1.475	3.036	4.323	6.026	10.408
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.566	0.871	1.475	3.036	4.323	6.026	10.408
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.3	3.2	13.1	20.3	30.4	55.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.09	0.36	0.55	0.82	1.49
Peak Inflow Q (cfs) =	N/A	N/A	3.3	5.1	9.0	20.9	29.6	41.3	70.6
Peak Outflow Q (cfs) =	0.1	0.4	0.4	0.4	4.9	26.4	32.0	61.0	73.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.4	1.5	2.0	1.6	2.0	1.3
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.02	0.02	0.0	0.0	0.0	0.0	0.0	0.0
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	57	48	55	60	52	47	41	27
Time to Drain 99% of Inflow Volume (hours) =	**40**	61	51	59	65	62	60	57	51
Maximum Ponding Depth (ft) =	2.82	4.17	3.15	3.68	4.19	4.22	4.23	4.25	4.26
Area at Maximum Ponding Depth (acres) =	0.45	0.58	0.52	0.55	0.58	0.58	0.58	0.58	0.59
Maximum Volume Stored (acre-ft) =	0.296	1.022	0.461	0.745	1.033	1.051	1.051	1.068	1.074

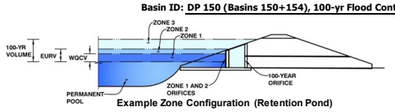
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 150 (Basins 150+154), 100-yr Flood Control Only



Example Zone Configuration (Retention Pond)

Watershed Information — Flood Control Only

Flood Control Only	=	**No BMP**
Watershed Area =	148.82	acres
Watershed Length =	3,715	ft
Watershed Length to Centroid =	2,085	ft
Watershed Slope =	0.032	ft/ft
Watershed Imperviousness =	39.79%	percent
Percentage Hydrologic Soil Group A =	69.7%	percent
Percentage Hydrologic Soil Group B =	16.6%	percent
Percentage Hydrologic Soil Groups C/D =	13.7%	percent
Target WQCV Drain Time =	N/A	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.334	acre-feet	1.334	acre-feet
Excess Urban Runoff Volume (EURV) =	6.250	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	3.293	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	4.710	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	6.261	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	11.187	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	15.825	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	22.502	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	39.531	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	3.042	acre-feet		
Approximate 5-yr Detention Volume =	4.371	acre-feet		
Approximate 10-yr Detention Volume =	5.826	acre-feet		
Approximate 25-yr Detention Volume =	8.127	acre-feet		
Approximate 50-yr Detention Volume =	9.797	acre-feet		
Approximate 100-yr Detention Volume =	12.322	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (100-year)	12.322	acre-feet
Select Zone 2 Storage Volume (Optional)		acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	12.322	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	15.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.010	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	0	ft^2
Surcharge Volume Length (L_{ISV}) =	0.0	ft
Surcharge Volume Width (W_{ISV}) =	0.0	ft
Depth of Basin Floor (H_{FLOOR}) =	0.00	ft
Length of Basin Floor (L_{FLOOR}) =	175.3	ft
Width of Basin Floor (W_{FLOOR}) =	87.6	ft
Area of Basin Floor (A_{FLOOR}) =	15,359	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{MAIN}) =	15.00	ft
Length of Main Basin (L_{MAIN}) =	295.3	ft
Width of Main Basin (W_{MAIN}) =	207.6	ft
Area of Main Basin (A_{MAIN}) =	61,306	ft^2
Volume of Main Basin (V_{MAIN}) =	536,750	ft^3
Calculated Total Basin Volume (V_{total}) =	**12.322**	acre-feet

Depth Increment = 0.25 ft

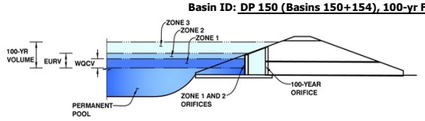
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		175.3	87.6	15,359		0.353		
	0.25		177.3	89.6	15,888		0.365	3,906	0.090
	0.50		179.3	91.6	16,426		0.377	7,945	0.182
	0.75		181.3	93.6	16,972		0.390	12,120	0.278
	1.00		183.3	95.6	17,526		0.402	16,432	0.377
	1.25		185.3	97.6	18,088		0.415	20,883	0.479
	1.50		187.3	99.6	18,657		0.428	25,476	0.585
	1.75		189.3	101.6	19,235		0.442	30,212	0.694
	2.00		191.3	103.6	19,821		0.455	35,094	0.806
	2.25		193.3	105.6	20,415		0.469	40,124	0.921
	2.50		195.3	107.6	21,017		0.482	45,302	1.040
	2.75		197.3	109.6	21,626		0.496	50,633	1.162
	3.00		199.3	111.6	22,244		0.511	56,116	1.288
	3.25		201.3	113.6	22,870		0.525	61,755	1.418
	3.50		203.3	115.6	23,504		0.540	67,552	1.551
	3.75		205.3	117.6	24,146		0.554	73,508	1.688
	4.00		207.3	119.6	24,795		0.569	79,625	1.828
	4.25		209.3	121.6	25,453		0.584	85,906	1.972
	4.50		211.3	123.6	26,119		0.600	92,353	2.120
	4.75		213.3	125.6	26,793		0.615	98,966	2.272
	5.00		215.3	127.6	27,475		0.631	105,750	2.428
	5.25		217.3	129.6	28,164		0.647	112,704	2.587
	5.50		219.3	131.6	28,862		0.663	119,832	2.751
	5.75		221.3	133.6	29,568		0.679	127,136	2.919
	6.00		223.3	135.6	30,282		0.695	134,617	3.090
	6.25		225.3	137.6	31,003		0.712	142,278	3.266
	6.50		227.3	139.6	31,733		0.728	150,119	3.446
	6.75		229.3	141.6	32,471		0.745	158,145	3.631
	7.00		231.3	143.6	33,217		0.763	166,356	3.819
	7.25		233.3	145.6	33,971		0.780	174,754	4.012
	7.50		235.3	147.6	34,732		0.797	183,342	4.209
	7.75		237.3	149.6	35,502		0.815	192,121	4.410
	8.00		239.3	151.6	36,280		0.833	201,093	4.616
	8.25		241.3	153.6	37,066		0.851	210,261	4.827
	8.50		243.3	155.6	37,860		0.869	219,627	5.042
	8.75		245.3	157.6	38,661		0.888	229,192	5.262
	9.00		247.3	159.6	39,471		0.906	238,958	5.486
	9.25		249.3	161.6	40,289		0.925	248,928	5.715
	9.50		251.3	163.6	41,115		0.944	259,103	5.948
	9.75		253.3	165.6	41,949		0.963	269,486	6.187
	10.00		255.3	167.6	42,790		0.982	280,078	6.430
	10.25		257.3	169.6	43,640		1.002	290,882	6.678
	10.50		259.3	171.6	44,498		1.022	301,899	6.931
	10.75		261.3	173.6	45,364		1.041	313,132	7.189
	11.00		263.3	175.6	46,237		1.061	324,582	7.451
	11.25		265.3	177.6	47,119		1.082	336,251	7.719
	11.50		267.3	179.6	48,009		1.102	348,142	7.992
	11.75		269.3	181.6	48,907		1.123	360,256	8.270
	12.00		271.3	183.6	49,813		1.144	372,596	8.554
	12.25		273.3	185.6	50,726		1.165	385,163	8.842
	12.50		275.3	187.6	51,648		1.186	397,960	9.136
	12.75		277.3	189.6	52,578		1.207	410,988	9.435
	13.00		279.3	191.6	53,516		1.229	424,250	9.739
	13.25		281.3	193.6	54,462		1.250	437,747	10.049
	13.50		283.3	195.6	55,415		1.272	451,481	10.365
	13.75		285.3	197.6	56,377		1.294	465,455	10.685
	14.00		287.3	199.6	57,347		1.317	479,670	11.012
	14.25		289.3	201.6	58,325		1.339	494,129	11.344
	14.50		291.3	203.6	59,311		1.362	508,833	11.681
	14.75		293.3	205.6	60,304		1.384	523,785	12.024
Zone 1 (100-year)	14.97		295.0	207.4	61,186		1.405	537,149	12.331
	15.00		295.3	207.6	61,306		1.407	538,986	12.373
	15.25		297.3	209.6	62,316		1.431	554,439	12.728
	15.50		299.3	211.6	63,334		1.454	570,145	13.089
	15.75		301.3	213.6	64,360		1.477	586,106	13.455
	16.00		303.3	215.6	65,393		1.501	602,325	13.827
	16.25		305.3	217.6	66,435		1.525	618,804	14.206
	16.50		307.3	219.6	67,485		1.549	635,544	14.590
	16.75		309.3	221.6	68,543		1.574	652,547	14.980
	17.00		311.3	223.6	69,608		1.598	669,816	15.377
	17.25		313.3	225.6	70,682		1.623	687,352	15.779
	17.50		315.3	227.6	71,764		1.647	705,157	16.188

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 150 (Basins 150+154), 100-yr Flood Control Only



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (100-year)	14.97	12.322	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 2				Select Zone 2 Outlet Type
Zone 3				Select Zone 3 Outlet Type
Total (all zones)		12.322		

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 Diameter =	N/A	inches	Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	sq. inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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 Rectangular	Not Selected	
Invert of Vertical Orifice =	0.00		ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	14.97		ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	56.00		inches
Vertical Orifice Width =	60.00		inches

Calculated Parameters for Vertical Orifice

	Zone 1 Rectangular	Not Selected	
Vertical Orifice Area =	23.33		ft^2
Vertical Orifice Centroid =	2.33		feet

Size Vertical Orifice to drain (EURV - WQCV) Only

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	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =	Select Grate Type	Select Grate Type	
Debris Clogging % =			%

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

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

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	1.334	6.250	3.293	4.710	6.261	11.187	15.825	22.502	39.531
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.293	4.710	6.261	11.187	15.825	22.599	39.531
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.4	1.3	2.3	50.2	96.6	164.7	328.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.02	0.34	0.65	1.11	2.21
Peak Inflow Q (cfs) =	N/A	N/A	39.3	57.2	77.2	162.2	233.0	360.9	565.6
Peak Outflow Q (cfs) =	62.2	284.8	29.8	44.7	62.0	139.0	193.6	249.2	368.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	34.5	27.2	2.8	2.0	1.5	1.1
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	Vertical Orifice 1
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) =	3	1	3	3	3	3	2	3	2
Time to Drain 99% of Inflow Volume (hours) =	**8**	3	6	5	4	4	3	4	3
Maximum Ponding Depth (ft) =	3.09	9.82	1.78	2.22	2.66	4.15	5.30	7.25	13.09
Area at Maximum Ponding Depth (acres) =	0.52	0.97	0.44	0.47	0.49	0.58	0.65	0.78	1.24
Maximum Volume Stored (acre-ft) =	1.334	6.254	0.702	0.902	1.113	1.914	2.620	4.012	9.838

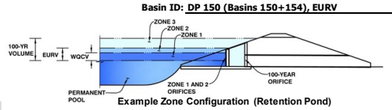
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 150 (Basins 150+154), EURV



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	148.82	acres
Watershed Length =	3,715	ft
Watershed Length to Centroid =	2,085	ft
Watershed Slope =	0.032	ft/ft
Watershed Imperviousness =	39.79%	percent
Percentage Hydrologic Soil Group A =	69.7%	percent
Percentage Hydrologic Soil Group B =	16.6%	percent
Percentage Hydrologic Soil Groups C/D =	13.7%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.334 acre-feet	1.334	acre-feet
Excess Urban Runoff Volume (EURV) =	6.250 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	3.293 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	4.710 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	6.261 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	11.187 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	15.825 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	22.502 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	39.531 acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	3.042 acre-feet		
Approximate 5-yr Detention Volume =	4.371 acre-feet		
Approximate 10-yr Detention Volume =	5.826 acre-feet		
Approximate 25-yr Detention Volume =	8.127 acre-feet		
Approximate 50-yr Detention Volume =	9.797 acre-feet		
Approximate 100-yr Detention Volume =	12.322 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	1.334	acre-feet
Zone 2 Volume (EURV - Zone 1)	4.916	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	6.073	acre-feet
Total Detention Basin Volume =	12.322	acre-feet
Initial Surcharge Volume (ISV) =	174	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.007	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	

Initial Surcharge Area (A_{ISV}) =	349	ft^2
Surcharge Volume Length (L_{ISV}) =	18.7	ft
Surcharge Volume Width (W_{ISV}) =	18.7	ft
Depth of Basin Floor (H_{FLOOR}) =	3.95	ft
Length of Basin Floor (L_{FLOOR}) =	598.8	ft
Width of Basin Floor (W_{FLOOR}) =	300.8	ft
Area of Basin Floor (A_{FLOOR}) =	180,115	ft^2
Volume of Basin Floor (V_{FLOOR}) =	248,045	ft^3
Depth of Main Basin (H_{MAIN}) =	1.55	ft
Length of Main Basin (L_{MAIN}) =	611.2	ft
Width of Main Basin (W_{MAIN}) =	313.2	ft
Area of Main Basin (A_{MAIN}) =	191,424	ft^2
Volume of Main Basin (V_{MAIN}) =	287,899	ft^3
Calculated Total Basin Volume (V_{total}) =	**12.312**	acre-feet

Depth Increment = 0.25 ft

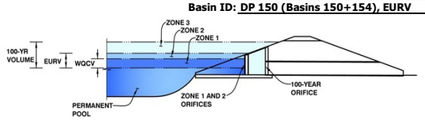
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		18.7	18.7	349		0.008		
ISV	0.50		18.7	18.7	349		0.008	174	0.004
	0.75		18.7	18.7	349		0.008	261	0.006
	1.00		18.7	18.7	349		0.008	349	0.008
	1.25		55.4	36.5	2,023		0.046	618	0.014
	1.50		92.1	54.4	5,009		0.115	1,470	0.034
	1.75		128.8	72.2	9,306		0.214	3,232	0.074
	2.00		165.5	90.1	14,914		0.342	6,232	0.143
	2.25		202.2	108.0	21,834		0.501	10,798	0.248
	2.50		239.0	125.8	30,065		0.690	17,258	0.396
	2.75		275.7	143.7	39,606		0.909	25,940	0.595
	3.00		312.4	161.5	50,460		1.158	37,171	0.853
	3.25		349.1	179.4	62,624		1.438	51,279	1.177
	3.50		385.8	197.2	76,100		1.747	68,592	1.575
	3.75		422.5	215.1	90,886		2.086	89,438	2.053
Zone 1 (WQCV)	3.95		451.9	229.4	103,660		2.380	108,878	2.500
	4.00		459.2	233.0	106,984		2.456	114,144	2.620
	4.25		496.0	250.8	124,394		2.856	143,039	3.284
	4.50		532.7	268.7	143,114		3.285	176,450	4.051
	4.75		569.4	286.5	163,146		3.745	214,706	4.929
	5.00		599.2	301.2	180,475		4.143	258,033	5.924
	5.25		601.2	303.2	182,280		4.185	303,377	6.965
	5.50		603.2	305.2	184,093		4.226	349,173	8.016
	5.75		605.2	307.2	185,914		4.268	395,424	9.078
	6.00		607.2	309.2	187,742		4.310	442,131	10.150
Zone 2 (EURV)	6.12		608.1	310.2	188,623		4.330	464,713	10.668
	6.25		609.2	311.2	189,579		4.352	489,296	11.233
Floor	6.50		611.2	313.2	191,424		4.394	536,921	12.326
	6.75		613.2	315.2	193,277		4.437	585,009	13.430
	7.00		615.2	317.2	195,137		4.480	633,560	14.545
	7.25		617.2	319.2	197,006		4.523	682,578	15.670
	7.50		619.2	321.2	198,883		4.566	732,064	16.806
Zone 3 (100-year)	7.65		620.4	322.4	200,013		4.592	761,981	17.493
	7.75		621.2	323.2	200,768		4.609	782,020	17.953
	8.00		623.2	325.2	202,660		4.652	832,448	19.110
	8.25		625.2	327.2	204,561		4.696	883,351	20.279
	8.50		627.2	329.2	206,470		4.740	934,730	21.458
	8.75		629.2	331.2	208,387		4.784	986,587	22.649
	9.00		631.2	333.2	210,311		4.828	1,038,924	23.850
	9.25		633.2	335.2	212,244		4.872	1,091,743	25.063
	9.50		635.2	337.2	214,185		4.917	1,145,046	26.287
	9.75		637.2	339.2	216,134		4.962	1,198,836	27.521
	10.00		639.2	341.2	218,090		5.007	1,253,114	28.768
	10.25		641.2	343.2	220,055		5.052	1,307,882	30.025
	10.50		643.2	345.2	222,028		5.097	1,363,142	31.293
	10.75		645.2	347.2	224,009		5.143	1,418,897	32.573
	11.00		647.2	349.2	225,997		5.188	1,475,147	33.865
	11.25		649.2	351.2	227,994		5.234	1,531,896	35.167
	11.50		651.2	353.2	229,999		5.280	1,589,145	36.482
	11.75		653.2	355.2	232,012		5.326	1,646,896	37.808
	12.00		655.2	357.2	234,032		5.373	1,705,151	39.145
	12.25		657.2	359.2	236,061		5.419	1,763,913	40.494
	12.50		659.2	361.2	238,098		5.466	1,823,183	41.855
	12.75		661.2	363.2	240,143		5.513	1,882,962	43.227
	13.00		663.2	365.2	242,195		5.560	1,943,254	44.611
	13.25		665.2	367.2	244,256		5.607	2,004,061	46.007
	13.50		667.2	369.2	246,325		5.655	2,065,383	47.415
	13.75		669.2	371.2	248,402		5.703	2,127,224	48.834
	14.00		671.2	373.2	250,486		5.750	2,189,585	50.266
	14.25		673.2	375.2	252,579		5.798	2,252,468	51.710
	14.50		675.2	377.2	254,680		5.847	2,315,875	53.165
	14.75		677.2	379.2	256,789		5.895	2,379,808	54.633
	15.00		679.2	381.2	258,905		5.944	2,444,270	56.113
	15.25		681.2	383.2	261,030		5.992	2,509,262	57.605
	15.50		683.2	385.2	263,163		6.041	2,574,786	59.109
	15.75		685.2	387.2	265,304		6.091	2,640,844	60.625
	16.00		687.2	389.2	267,452		6.140	2,707,438	62.154
	16.25		689.2	391.2	269,609		6.189	2,774,570	63.695
	16.50		691.2	393.2	271,774		6.239	2,842,243	65.249
	16.75		693.2	395.2	273,947		6.289	2,910,458	66.815
	17.00		695.2	397.2	276,127		6.339	2,979,217	68.393
	17.25		697.2	399.2	278,316		6.389	3,048,522	69.984
	17.50		699.2	401.2	280,513		6.440	3,118,376	71.588

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 150 (Basins 150+154), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.36	1.334	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.08	4.916	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	6.073		Select Zone 3 Outlet Type
Total (all zones)		12.322		

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 Diameter =	N/A	inches

Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.36	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	13.40	inches
Orifice Plate: Orifice Area per Row =	3.57	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	2.479E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.12	2.24					
Orifice Area (sq. inches)	3.57	3.57	3.57					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.36		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00		feet
Overflow Weir Grate Slope =	0.00		H:V
Horiz. Length of Weir Sides =	4.00		feet
Overflow Grate Type =	Type C Grate	Select Grate Type	
Debris Clogging % =	50%		%

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.36		feet
Overflow Weir Slope Length =	4.00		feet
Grate Open Area / 100-yr Orifice Area =	47.64		
Overflow Grate Open Area w/o Debris =	11.14		ft^2
Overflow Grate Open Area w/ Debris =	5.57		ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50		ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00		inches
Restrictor Plate Height Above Pipe Invert =	3.42		inches

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.23		ft^2
Outlet Orifice Centroid =	0.17		feet
Half-Central Angle of Restrictor Plate on Pipe =	0.90	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.09	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	1000.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.22	feet
Stage at Top of Freeboard =	6.31	feet
Basin Area at Top of Freeboard =	4.36	acres
Basin Volume at Top of Freeboard =	11.49	acre-ft

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	1.334	6.250	3.293	4.710	6.261	11.187	15.825	22.502	39.531
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.293	4.710	6.261	11.187	15.825	22.502	39.531
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.4	1.3	2.3	50.2	96.6	164.7	328.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.02	0.34	0.65	1.11	2.21
Peak Inflow Q (cfs) =	N/A	N/A	39.3	57.2	77.2	162.2	233.0	326.9	565.6
Peak Outflow Q (cfs) =	0.5	3.1	2.9	3.0	3.0	87.6	199.7	331.7	560.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.3	1.3	1.7	2.1	2.0	1.7
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.21	0.20	0.2	0.2	0.2	0.2	0.2	0.2
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) =	38	54	47	51	55	52	48	42	29
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	50	55	61	61	59	56	50
Maximum Ponding Depth (ft) =	3.36	5.08	4.09	4.54	4.95	5.18	5.25	5.32	5.42
Area at Maximum Ponding Depth (acres) =	1.57	4.16	2.60	3.36	4.11	4.17	4.18	4.19	4.21
Maximum Volume Stored (acre-ft) =	1.343	6.256	2.848	4.184	5.675	6.672	6.965	7.216	7.636

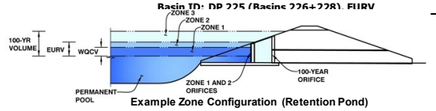
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 225 (Basins 226+228), EURV



Example Zone Configuration (Retention Pond)

Extended Detention Basin (EDB)

	EDB	
Selected BMP Type =		
Watershed Area =	127.21	acres
Watershed Length =	4,352	ft
Watershed Length to Centroid =	1,894	ft
Watershed Slope =	0.027	ft/ft
Watershed Imperviousness =	42.67%	percent
Percentage Hydrologic Soil Group A =	21.4%	percent
Percentage Hydrologic Soil Group B =	27.7%	percent
Percentage Hydrologic Soil Groups C/D =	50.9%	percent
Target WQCV Drain Time =		
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.189	acre-feet	1.189	acre-feet
Excess Urban Runoff Volume (EURV) =	5.449	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	3.309	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	4.731	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	6.987	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	12.333	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	16.803	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	22.632	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	37.926	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	3.039	acre-feet		
Approximate 5-yr Detention Volume =	4.627	acre-feet		
Approximate 10-yr Detention Volume =	6.024	acre-feet		
Approximate 25-yr Detention Volume =	7.912	acre-feet		
Approximate 50-yr Detention Volume =	9.161	acre-feet		
Approximate 100-yr Detention Volume =	11.449	acre-feet		

Zone 1 Volume (WQCV)	1.189	acre-feet
Zone 2 Volume (EURV - Zone 1)	4.260	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	6.000	acre-feet
Total Detention Basin Volume =	11.449	acre-feet
Initial Surcharge Volume (ISV) =	155	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.008	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	

Initial Surcharge Area (A_{ISV}) =	311	ft^2
Surcharge Volume Length (L_{ISV}) =	17.6	ft
Surcharge Volume Width (W_{ISV}) =	17.6	ft
Depth of Basin Floor (H_{FLOOR}) =	5.39	ft
Length of Basin Floor (L_{FLOOR}) =	712.9	ft
Width of Basin Floor (W_{FLOOR}) =	354.5	ft
Area of Basin Floor (A_{FLOOR}) =	252,739	ft^2
Volume of Basin Floor (V_{FLOOR}) =	470,569	ft^3
Depth of Main Basin (H_{MAIN}) =	0.11	ft
Length of Main Basin (L_{MAIN}) =	713.8	ft
Width of Main Basin (W_{MAIN}) =	355.4	ft
Area of Main Basin (A_{MAIN}) =	253,679	ft^2
Volume of Main Basin (V_{MAIN}) =	27,853	ft^3
Calculated Total Basin Volume (V_{total}) =	**11.449**	acre-feet

Depth Increment = 0.25 ft

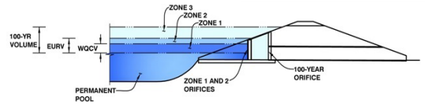
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		17.6	17.6	311		0.007		
ISV	0.50		17.6	17.6	311		0.007	155	0.004
	0.75		17.6	17.6	311		0.007	233	0.005
	1.00		17.6	17.6	311		0.007	311	0.007
	1.25		49.9	33.3	1,659		0.038	536	0.012
	1.50		82.1	48.9	4,014		0.092	1,224	0.028
	1.75		114.4	64.5	7,378		0.169	2,627	0.060
	2.00		146.6	80.1	11,749		0.270	4,997	0.115
	2.25		178.9	95.8	17,128		0.393	8,586	0.197
	2.50		211.1	111.4	23,515		0.540	13,645	0.313
	2.75		243.4	127.0	30,910		0.710	20,427	0.469
	3.00		275.6	142.6	39,312		0.902	29,184	0.670
	3.25		307.9	158.3	48,723		1.119	40,167	0.922
	3.50		340.1	173.9	59,141		1.358	53,629	1.231
	3.75		372.4	189.5	70,567		1.620	69,822	1.603
Zone 1 (WQCV)	3.84		384.0	195.1	74,927		1.720	76,368	1.753
	4.00		404.6	205.1	83,001		1.905	88,997	2.043
	4.25		436.9	220.8	96,442		2.214	111,406	2.558
	4.50		469.1	236.4	110,892		2.546	137,302	3.152
	4.75		501.4	252.0	126,349		2.901	166,936	3.832
	5.00		533.6	267.6	142,814		3.279	200,560	4.604
	5.25		565.9	283.3	160,287		3.680	238,427	5.474
	5.50		598.1	298.9	178,768		4.104	280,788	6.446
	5.75		630.4	314.5	198,256		4.551	327,895	7.527
Zone 2 (EURV)	5.90		649.7	323.9	210,433		4.831	358,542	8.231
	6.00		662.6	330.1	218,752		5.022	380,000	8.724
	6.25		694.9	345.8	240,256		5.516	437,355	10.040
Floor	6.50		713.8	355.4	253,679		5.824	499,714	11.472
	6.75		715.8	357.4	255,822		5.873	563,401	12.934
	7.00		717.8	359.4	257,972		5.922	627,625	14.408
	7.25		719.8	361.4	260,130		5.972	692,388	15.895
Zone 3 (100-year)	7.46		721.5	363.1	261,950		6.014	747,206	17.153
	7.50		721.8	363.4	262,297		6.022	757,691	17.394
	7.75		723.8	365.4	264,471		6.071	823,537	18.906
	8.00		725.8	367.4	266,654		6.122	889,927	20.430
	8.25		727.8	369.4	268,844		6.172	956,864	21.967
	8.50		729.8	371.4	271,042		6.222	1,024,350	23.516
	8.75		731.8	373.4	273,249		6.273	1,092,386	25.078
	9.00		733.8	375.4	275,463		6.324	1,160,975	26.652
	9.25		735.8	377.4	277,686		6.375	1,230,118	28.240
	9.50		737.8	379.4	279,916		6.426	1,299,818	29.840
	9.75		739.8	381.4	282,154		6.477	1,370,077	31.453
	10.00		741.8	383.4	284,401		6.529	1,440,896	33.078
	10.25		743.8	385.4	286,655		6.581	1,512,278	34.717
	10.50		745.8	387.4	288,918		6.633	1,584,225	36.369
	10.75		747.8	389.4	291,188		6.685	1,656,738	38.033
	11.00		749.8	391.4	293,466		6.737	1,729,819	39.711
	11.25		751.8	393.4	295,753		6.790	1,803,471	41.402
	11.50		753.8	395.4	298,047		6.842	1,877,696	43.106
	11.75		755.8	397.4	300,350		6.895	1,952,496	44.823
	12.00		757.8	399.4	302,660		6.948	2,027,872	46.554
	12.25		759.8	401.4	304,978		7.001	2,103,826	48.297
	12.50		761.8	403.4	307,305		7.055	2,180,362	50.054
	12.75		763.8	405.4	309,639		7.108	2,257,479	51.825
	13.00		765.8	407.4	311,982		7.162	2,335,182	53.608
	13.25		767.8	409.4	314,332		7.216	2,413,471	55.406
	13.50		769.8	411.4	316,690		7.270	2,492,348	57.216
	13.75		771.8	413.4	319,057		7.325	2,571,817	59.041
	14.00		773.8	415.4	321,431		7.379	2,651,878	60.879
	14.25		775.8	417.4	323,814		7.434	2,732,533	62.730
	14.50		777.8	419.4	326,204		7.489	2,813,785	64.596
	14.75		779.8	421.4	328,602		7.544	2,895,636	66.475

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 225 (Basins 226+228), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.47	1.189	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.25	4.260	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	6.000	Not Utilized	Zone 3 Not Utilized
	Total (all zones)	11.449		

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

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

Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

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)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	2.188E-02	ft^2
Depth at top of Zone using Orifice Plate =	3.47	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	13.90	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	3.15	sq. inches (diameter = 2 inches)	Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.16	2.31					
Orifice Area (sq. inches)	3.15	3.15	3.15					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected		Calculated Parameters for Vertical Orifice	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 2 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.47	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.47	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	57.52	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

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

	Zone 2 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.19	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.15	N/A	feet
Restrictor Plate Height Above Pipe Invert =	3.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	0.84	N/A	radians

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	5.26	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.21	feet
Spillway Crest Length =	1000.00	feet	Stage at Top of Freeboard =	6.47	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	5.82	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	11.30	acre-ft

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

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	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	1.189	5.449	3.309	4.731	6.987	12.333	16.803	22.632	37.926
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.309	4.731	6.987	12.333	16.803	22.632	37.926
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.9	1.7	18.5	75.6	116.2	169.0	302.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.15	0.59	0.91	1.33	2.38
Peak Inflow Q (cfs) =	N/A	N/A	40.0	57.7	89.2	171.2	233.6	309.5	508.4
Peak Outflow Q (cfs) =	0.5	2.6	2.4	2.5	23.6	136.6	197.0	305.5	516.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.5	1.3	1.8	1.7	1.8	1.7
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.17	0.17	0.2	0.2	0.2	0.2	0.2	0.2
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) =	38	55	48	53	56	50	45	40	28
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	52	58	63	60	58	55	50
Maximum Ponding Depth (ft) =	3.47	5.25	4.40	4.90	5.30	5.39	5.42	5.48	5.57
Area at Maximum Ponding Depth (acres) =	1.33	3.68	2.40	3.11	3.75	3.90	3.97	4.05	4.21
Maximum Volume Stored (acre-ft) =	1.191	5.474	2.880	4.253	5.622	5.966	6.123	6.324	6.695

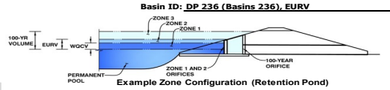
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 236 (Basins 236), EURV



Example Zone Configuration (Retention Pond)

Watershed Information

	EDB	
Extended Detention Basin (EDB)		
Watershed Area =	59.95	acres
Watershed Length =	3,976	ft
Watershed Length to Centroid =	1,873	ft
Watershed Slope =	0.036	ft/ft
Watershed Imperviousness =	31.47%	percent
Percentage Hydrologic Soil Group A =	34.2%	percent
Percentage Hydrologic Soil Group B =	64.6%	percent
Percentage Hydrologic Soil Groups C/D =	1.2%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

		acre-feet	Optional User Overrides
Water Quality Capture Volume (WQCV) =	0.468	acre-feet	0.468 acre-feet
Excess Urban Runoff Volume (EURV) =	1.930	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	0.973	acre-feet	0.85 inches
5-yr Runoff Volume (P1 = 1.12 in.) =	1.450	acre-feet	1.12 inches
10-yr Runoff Volume (P1 = 1.4 in.) =	2.147	acre-feet	1.40 inches
25-yr Runoff Volume (P1 = 1.87 in.) =	4.493	acre-feet	1.87 inches
50-yr Runoff Volume (P1 = 2.3 in.) =	6.494	acre-feet	2.30 inches
100-yr Runoff Volume (P1 = 2.79 in.) =	9.250	acre-feet	2.79 inches
500-yr Runoff Volume (P1 = 4.16 in.) =	16.225	acre-feet	4.16 inches
Approximate 2-yr Detention Volume =	0.952	acre-feet	
Approximate 5-yr Detention Volume =	1.392	acre-feet	
Approximate 10-yr Detention Volume =	2.060	acre-feet	
Approximate 25-yr Detention Volume =	2.842	acre-feet	
Approximate 50-yr Detention Volume =	3.358	acre-feet	
Approximate 100-yr Detention Volume =	4.314	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	0.468	acre-feet
Zone 2 Volume (EURV - Zone 1)	1.462	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	2.385	acre-feet
Total Detention Basin Volume =	4.314	acre-feet
Initial Surcharge Volume (ISV) =	61	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.010	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio (R_{LW}) =	2	

Initial Surcharge Area (A_{ISV}) =	122	ft^2
Surcharge Volume Length (L_{ISV}) =	11.1	ft
Surcharge Volume Width (W_{ISV}) =	11.1	ft
Depth of Basin Floor (H_{FLOOR}) =	2.88	ft
Length of Basin Floor (L_{FLOOR}) =	310.6	ft
Width of Basin Floor (W_{FLOOR}) =	155.1	ft
Area of Basin Floor (A_{FLOOR}) =	48,158	ft^2
Volume of Basin Floor (V_{FLOOR}) =	48,679	ft^3
Depth of Main Basin (H_{MAIN}) =	2.62	ft
Length of Main Basin (L_{MAIN}) =	331.5	ft
Width of Main Basin (W_{MAIN}) =	176.0	ft
Area of Main Basin (A_{MAIN}) =	58,358	ft^2
Volume of Main Basin (V_{MAIN}) =	139,322	ft^3
Calculated Total Basin Volume (V_{total}) =	**4.319**	acre-feet

Depth Increment = 0.25 ft

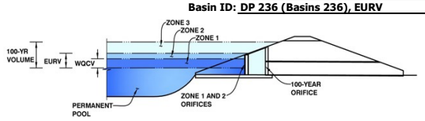
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		11.1	11.1	122		0.003		
ISV	0.50		11.1	11.1	122		0.003	61	0.001
	0.75		11.1	11.1	122		0.003	92	0.002
	1.00		11.1	11.1	122		0.003	122	0.003
	1.25		37.1	23.6	873		0.020	233	0.005
	1.50		63.1	36.1	2,274		0.052	613	0.014
	1.75		89.1	48.6	4,325		0.099	1,424	0.033
	2.00		115.1	61.1	7,026		0.161	2,830	0.065
	2.25		141.1	73.6	10,376		0.238	4,991	0.115
	2.50		167.1	86.1	14,377		0.330	8,072	0.185
	2.75		193.1	98.6	19,028		0.437	12,234	0.281
	3.00		219.1	111.1	24,329		0.559	17,640	0.405
Zone 1 (WQCV)	3.11		230.5	116.6	26,867		0.617	20,455	0.470
	3.25		245.1	123.6	30,279		0.695	24,452	0.561
	3.50		271.1	136.1	36,880		0.847	32,834	0.754
	3.75		297.1	148.6	44,131		1.013	42,947	0.986
Floor	3.88		310.6	155.1	48,158		1.106	48,944	1.124
	4.00		311.5	156.0	48,606		1.116	54,750	1.257
	4.25		313.5	158.0	49,545		1.137	67,018	1.539
	4.50		315.5	160.0	50,493		1.159	79,523	1.826
Zone 2 (EURV)	4.59		316.3	160.7	50,835		1.167	84,083	1.930
	4.75		317.5	162.0	51,448		1.181	92,265	2.118
	5.00		319.5	164.0	52,411		1.203	105,247	2.416
	5.25		321.5	166.0	53,382		1.225	118,471	2.720
	5.50		323.5	168.0	54,361		1.248	131,939	3.029
	5.75		325.5	170.0	55,348		1.271	145,653	3.344
	6.00		327.5	172.0	56,343		1.293	159,614	3.664
	6.25		329.5	174.0	57,346		1.316	173,825	3.990
Zone 3 (100-year)	6.50		331.5	176.0	58,358		1.340	188,288	4.322
	6.75		333.5	178.0	59,377		1.363	203,004	4.660
	7.00		335.5	180.0	60,404		1.387	217,977	5.004
	7.25		337.5	182.0	61,439		1.410	233,207	5.354
	7.50		339.5	184.0	62,482		1.434	248,697	5.709
	7.75		341.5	186.0	63,533		1.459	264,448	6.071
	8.00		343.5	188.0	64,592		1.483	280,464	6.439
	8.25		345.5	190.0	65,659		1.507	296,745	6.812
	8.50		347.5	192.0	66,734		1.532	313,294	7.192
	8.75		349.5	194.0	67,818		1.557	330,113	7.578
	9.00		351.5	196.0	68,909		1.582	347,204	7.971
	9.25		353.5	198.0	70,008		1.607	364,568	8.369
	9.50		355.5	200.0	71,115		1.633	382,208	8.774
	9.75		357.5	202.0	72,230		1.658	400,126	9.186
	10.00		359.5	204.0	73,353		1.684	418,324	9.603
	10.25		361.5	206.0	74,484		1.710	436,804	10.028
	10.50		363.5	208.0	75,623		1.736	455,567	10.458
	10.75		365.5	210.0	76,771		1.762	474,616	10.896
	11.00		367.5	212.0	77,926		1.789	493,953	11.340
	11.25		369.5	214.0	79,089		1.816	513,579	11.790
	11.50		371.5	216.0	80,260		1.843	533,498	12.247
	11.75		373.5	218.0	81,439		1.870	553,710	12.711
	12.00		375.5	220.0	82,626		1.897	574,218	13.182
	12.25		377.5	222.0	83,821		1.924	595,024	13.660
	12.50		379.5	224.0	85,024		1.952	616,129	14.144
	12.75		381.5	226.0	86,235		1.980	637,537	14.636
	13.00		383.5	228.0	87,455		2.008	659,248	15.134
	13.25		385.5	230.0	88,682		2.036	681,265	15.640
	13.50		387.5	232.0	89,917		2.064	703,589	16.152
	13.75		389.5	234.0	91,160		2.093	726,224	16.672
	14.00		391.5	236.0	92,411		2.121	749,170	17.199
	14.25		393.5	238.0	93,670		2.150	772,430	17.733
	14.50		395.5	240.0	94,937		2.179	796,006	18.274
	14.75		397.5	242.0	96,212		2.209	819,899	18.822
	15.00		399.5	244.0	97,496		2.238	844,112	19.378
	15.25		401.5	246.0	98,787		2.268	868,648	19.941
	15.50		403.5	248.0	100,086		2.298	893,506	20.512
	15.75		405.5	250.0	101,393		2.328	918,691	21.090
	16.00		407.5	252.0	102,708		2.358	944,204	21.676
	16.25		409.5	254.0	104,031		2.388	970,046	22.269
	16.50		411.5	256.0	105,362		2.419	996,220	22.870
	16.75		413.5	258.0	106,701		2.450	1,022,728	23.479
	17.00		415.5	260.0	108,048		2.480	1,049,571	24.095
	17.25		417.5	262.0	109,404		2.512	1,076,753	24.719
	17.50		419.5	264.0	110,767		2.543	1,104,274	25.351
	17.75		421.5	266.0	112,138		2.574	1,132,137	25.990
	18.00		423.5	268.0	113,517		2.606	1,160,343	26.638
	18.25		425.5	270.0	114,904		2.638	1,188,896	27.293
	18.50		427.5	272.0	116,299		2.670	1,217,796	27.957
	18.75		429.5	274.0	117,702		2.702	1,247,046	28.628
	19.00		431.5	276.0	119,113		2.734	1,276,648	29.308
	19.25		433.5	278.0	120,533		2.767	1,306,603	29.995
	19.50		435.5	280.0	121,960		2.800	1,336,915	30.691
	19.75		437.5	282.0	123,395		2.833	1,367,584	31.395
	20.00		439.5	284.0	124,838		2.866	1,398,613	32.108
	20.25		441.5	286.0	126,289		2.899	1,430,004	32.828
	20.50		443.5	288.0	127,748		2.933	1,461,758	33.557
	20.75		445.5	290.0	129,215		2.966	1,493,878	34.295
	21.00		447.5	292.0	130,690		3.000	1,526,366	35.041
	21.25		449.5	294.0	132,174		3.034	1,559,224	35.795
	21.50		451.5	296.0	133,665		3.069	1,592,454	36.558
	21.75		453.5	298.0	135,164		3.103	1,626,057	37.329
	22.00		455.5	300.0	136,671		3.138	1,660,036	38.109
	22.25		457.5	302.0	138,186		3.172	1,694,393	38.898
	22.50		459.5	304.0	139,709		3.207	1,729,130	39.695
	22.75		461.5	306.0	141,240		3.242	1,764,248	40.502
	23.00		463.5	308.0	142,779		3.278	1,799,751	41.317
	23.25		465.5	310.0	144,326		3.313	1,835,639	42.140
	23.50		467.5	312.0	145,882		3.349	1,871,915	42.973
	23.75		469.5	314.0	147,445		3.385	1,908,580	43.815
	24.00		471.5	316.0	149,016		3.421	1,945,638	44.666

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 236 (Basins 236), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.11	0.468	Orifice Plate	Orifice Plate
Zone 2 (EURV)	4.59	1.462	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	2.385	Not Utilized	Zone 3 Not Utilized
Total (all zones)		4.314		

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

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

Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

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)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	8.889E-03	ft^2
Depth at top of Zone using Orifice Plate =	3.11	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	12.40	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.28	sq. inches (diameter = 1-1/4 inches)	Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.04	2.07					
Orifice Area (sq. inches)	1.28	1.28	1.28					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected		Calculated Parameters for Vertical Orifice		
				Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A feet
Vertical Orifice Diameter =	N/A	N/A	inches			

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 2 Weir	Not Selected		Calculated Parameters for Overflow Weir		
				Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.11	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.11	N/A feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	164.76	N/A
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	11.14	N/A ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	5.57	N/A ft^2
Debris Clogging % =	50%	N/A	%			

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

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

	Zone 2 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate		
				Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.07	N/A ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.07	N/A feet
Restrictor Plate Height Above Pipe Invert =	1.46		inches	Half-Central Angle of Restrictor Plate on Pipe =	0.58	N/A radians

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	4.60	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.09	feet
Spillway Crest Length =	1000.00	feet	Stage at Top of Freeboard =	6.69	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.36	acres
Freeboard above Max Water Surface =	2.00	feet	Basin Volume at Top of Freeboard =	4.57	acre-ft

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

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	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	0.468	1.930	0.973	1.450	2.147	4.493	6.494	9.250	16.225
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.973	1.450	2.147	4.493	6.494	9.250	16.225
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.3	0.5	2.8	24.0	40.1	61.6	113.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.05	0.40	0.67	1.03	1.90
Peak Inflow Q (cfs) =	N/A	N/A	8.2	12.4	18.6	45.5	66.1	92.8	159.5
Peak Outflow Q (cfs) =	0.2	0.9	0.8	0.8	1.2	41.3	62.5	125.4	201.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.5	0.4	1.7	1.6	2.0	1.8
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.06	0.05	0.1	0.1	0.1	0.1	0.1	0.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	55	46	51	58	51	46	40	26
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	49	55	64	61	58	55	49
Maximum Ponding Depth (ft) =	3.11	4.59	3.58	4.01	4.60	4.66	4.67	4.72	4.76
Area at Maximum Ponding Depth (acres) =	0.62	1.17	0.90	1.12	1.17	1.17	1.17	1.18	1.18
Maximum Volume Stored (acre-ft) =	0.470	1.930	0.824	1.268	1.942	2.000	2.024	2.071	2.130

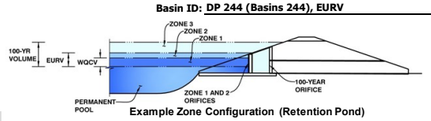
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 244 (Basins 244), EURV



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	=	**EDB**
Watershed Area	=	90.37 acres
Watershed Length	=	4,383 ft
Watershed Length to Centroid	=	2,537 ft
Watershed Slope	=	0.038 ft/ft
Watershed Imperviousness	=	53.85% percent
Percentage Hydrologic Soil Group A	=	22.5% percent
Percentage Hydrologic Soil Group B	=	62.5% percent
Percentage Hydrologic Soil Groups C/D	=	15.0% percent
Target WQCV Drain Time	=	40.0 hours
Location for 1-hr Rainfall Depths	=	User Input

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

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV)	=	0.981 acre-feet	0.981	acre-feet
Excess Urban Runoff Volume (EURV)	=	5.255 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.)	=	3.052 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.)	=	4.302 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.)	=	5.927 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.)	=	9.688 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.)	=	12.917 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.)	=	17.032 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.)	=	27.921 acre-feet	4.16	inches
Approximate 2-yr Detention Volume	=	2.810 acre-feet		
Approximate 5-yr Detention Volume	=	4.020 acre-feet		
Approximate 10-yr Detention Volume	=	5.436 acre-feet		
Approximate 25-yr Detention Volume	=	7.066 acre-feet		
Approximate 50-yr Detention Volume	=	8.166 acre-feet		
Approximate 100-yr Detention Volume	=	9.830 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	0.981	acre-feet
Zone 2 Volume (EURV - Zone 1)	4.274	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	4.575	acre-feet
Total Detention Basin Volume =	9.830	acre-feet
Initial Surcharge Volume (ISV) =	128	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.008	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	

Initial Surcharge Area (A_{ISV}) =	256	ft^2
Surcharge Volume Length (L_{ISV}) =	16.0	ft
Surcharge Volume Width (W_{ISV}) =	16.0	ft
Depth of Basin Floor (H_{FLOOR}) =	4.13	ft
Length of Basin Floor (L_{FLOOR}) =	548.8	ft
Width of Basin Floor (W_{FLOOR}) =	274.1	ft
Area of Basin Floor (A_{FLOOR}) =	150,442	ft^2
Volume of Basin Floor (V_{FLOOR}) =	216,011	ft^3
Depth of Main Basin (H_{MAIN}) =	1.37	ft
Length of Main Basin (L_{MAIN}) =	559.7	ft
Width of Main Basin (W_{MAIN}) =	285.1	ft
Area of Main Basin (A_{MAIN}) =	159,581	ft^2
Volume of Main Basin (V_{MAIN}) =	212,335	ft^3
Calculated Total Basin Volume (V_{total}) =	**9.839**	acre-feet

Depth Increment = 0.25 ft

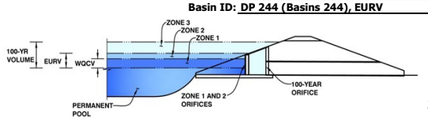
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		16.0	16.0	256		0.006		
ISV	0.50		16.0	16.0	256		0.006	128	0.003
	0.75		16.0	16.0	256		0.006	192	0.004
	1.00		16.0	16.0	256		0.006	256	0.006
	1.25		48.3	31.6	1,527		0.035	458	0.011
	1.50		80.5	47.3	3,805		0.087	1,104	0.025
	1.75		112.8	62.9	7,091		0.163	2,445	0.056
	2.00		145.0	78.5	11,385		0.261	4,733	0.109
	2.25		177.3	94.1	16,687		0.383	8,221	0.189
	2.50		209.5	109.8	22,997		0.528	13,161	0.302
	2.75		241.8	125.4	30,314		0.696	19,804	0.455
	3.00		274.0	141.0	38,639		0.887	28,402	0.652
	3.25		306.3	156.6	47,972		1.101	39,207	0.900
	3.50		338.5	172.3	58,313		1.339	52,472	1.205
Zone 1 (WQCV)	3.68		361.7	183.5	66,382		1.524	63,687	1.462
	3.75		370.8	187.9	69,662		1.599	68,448	1.571
	4.00		403.0	203.5	82,018		1.883	87,387	2.006
	4.25		435.3	219.1	95,382		2.190	109,541	2.515
	4.50		467.5	234.8	109,754		2.520	135,162	3.103
	4.75		499.8	250.4	125,134		2.873	164,502	3.776
	5.00		532.0	266.0	141,522		3.249	197,813	4.541
	5.25		549.7	275.1	151,233		3.472	234,888	5.392
	5.50		551.7	277.1	152,886		3.510	272,903	6.265
	5.75		553.7	279.1	154,548		3.548	311,332	7.147
Zone 2 (EURV)	5.86		554.6	280.0	155,282		3.565	328,372	7.538
	6.00		555.7	281.1	156,218		3.586	350,177	8.039
	6.25		557.7	283.1	157,895		3.625	389,441	8.940
Floor	6.50		559.7	285.1	159,581		3.663	429,126	9.851
	6.75		561.7	287.1	161,275		3.702	469,232	10.772
	7.00		563.7	289.1	162,976		3.741	509,764	11.703
Zone 3 (100-year)	7.09		564.5	289.8	163,591		3.756	524,459	12.040
	7.25		565.7	291.1	164,686		3.781	550,721	12.643
	7.50		567.7	293.1	166,404		3.820	592,107	13.593
	7.75		569.7	295.1	168,129		3.860	633,924	14.553
	8.00		571.7	297.1	169,863		3.900	676,173	15.523
	8.25		573.7	299.1	171,605		3.940	718,856	16.503
	8.50		575.7	301.1	173,354		3.980	761,976	17.493
	8.75		577.7	303.1	175,112		4.020	805,534	18.493
	9.00		579.7	305.1	176,878		4.061	849,533	19.503
	9.25		581.7	307.1	178,652		4.101	893,974	20.523
	9.50		583.7	309.1	180,433		4.142	938,859	21.553
	9.75		585.7	311.1	182,223		4.183	984,191	22.594
	10.00		587.7	313.1	184,021		4.225	1,029,971	23.645
	10.25		589.7	315.1	185,826		4.266	1,076,202	24.706
	10.50		591.7	317.1	187,640		4.308	1,122,885	25.778
	10.75		593.7	319.1	189,462		4.349	1,170,022	26.860
	11.00		595.7	321.1	191,291		4.391	1,217,616	27.953
	11.25		597.7	323.1	193,129		4.434	1,265,669	29.056
	11.50		599.7	325.1	194,975		4.476	1,314,181	30.169
	11.75		601.7	327.1	196,828		4.519	1,363,157	31.294
	12.00		603.7	329.1	198,690		4.561	1,412,596	32.429
	12.25		605.7	331.1	200,560		4.604	1,462,502	33.574
	12.50		607.7	333.1	202,437		4.647	1,512,877	34.731
	12.75		609.7	335.1	204,323		4.691	1,563,722	35.898
	13.00		611.7	337.1	206,217		4.734	1,615,039	37.076
	13.25		613.7	339.1	208,118		4.778	1,666,831	38.265
	13.50		615.7	341.1	210,028		4.822	1,719,099	39.465
	13.75		617.7	343.1	211,946		4.866	1,771,845	40.676
	14.00		619.7	345.1	213,871		4.910	1,825,072	41.898
	14.25		621.7	347.1	215,805		4.954	1,878,782	43.131
	14.50		623.7	349.1	217,747		4.999	1,932,975	44.375
	14.75		625.7	351.1	219,696		5.044	1,987,656	45.630
	15.00		627.7	353.1	221,654		5.088	2,042,824	46.897

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 244 (Basins 244), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.33	0.981	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.22	4.274	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	4.575	Not Utilized	Zone 3 Not Utilized
Total (all zones)		9.830		

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 Diameter	=	N/A	inches

Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area	=	N/A ft^2
Underdrain Orifice Centroid	=	N/A feet

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

Centroid of Lowest Orifice	=	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate	=	3.33	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing	=	13.30	inches
Orifice Plate: Orifice Area per Row	=	2.64	sq. inches (diameter = 1-13/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row	=	1.833E-02 ft^2
Elliptical Half-Width	=	N/A feet
Elliptical Slot Centroid	=	N/A feet
Elliptical Slot Area	=	N/A ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.11	2.22					
Orifice Area (sq. inches)	2.64	2.64	2.64					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho	=	3.33	N/A ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length	=	4.00	N/A feet
Overflow Weir Grate Slope	=	0.00	N/A H:V
Horiz. Length of Weir Sides	=	4.00	N/A feet
Overflow Grate Type	=	Type C Grate	N/A
Debris Clogging %	=	50%	N/A %

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t	=	3.33	N/A feet
Overflow Weir Slope Length	=	4.00	N/A feet
Grate Open Area / 100-yr Orifice Area	=	57.52	N/A
Overflow Grate Open Area w/o Debris	=	11.14	N/A ft^2
Overflow Grate Open Area w/ Debris	=	5.57	N/A ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe	=	2.50	N/A ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter	=	18.00	N/A inches
Restrictor Plate Height Above Pipe Invert	=	3.00	inches

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area	=	0.19	N/A ft^2
Outlet Orifice Centroid	=	0.15	N/A feet
Half-Central Angle of Restrictor Plate on Pipe	=	0.84	N/A radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage	=	5.23	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length	=	1000.00	feet
Spillway End Slopes	=	4.00	H:V
Freeboard above Max Water Surface	=	1.00	feet

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

Spillway Design Flow Depth	=	0.17 feet
Stage at Top of Freeboard	=	6.40 feet
Basin Area at Top of Freeboard	=	3.65 acres
Basin Volume at Top of Freeboard	=	9.49 acre-ft

Routed Hydrograph Results

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

Design Storm Return Period	=	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in)	=	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft)	=	0.981	5.255	3.052	4.302	5.927	9.688	12.917	17.032	27.921
Inflow Hydrograph Volume (acre-ft)	=	N/A	N/A	3.052	4.302	5.927	9.688	12.917	17.032	27.921
CUHP Predevelopment Peak Q (cfs)	=	N/A	N/A	0.5	0.9	8.3	41.9	66.4	99.6	180.7
OPTIONAL Override Predevelopment Peak Q (cfs)	=	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	=	N/A	N/A	0.01	0.01	0.09	0.46	0.73	1.10	2.00
Peak Inflow Q (cfs)	=	N/A	N/A	36.1	51.0	71.4	128.4	171.7	224.9	363.0
Peak Outflow Q (cfs)	=	0.4	2.6	2.4	2.5	5.9	80.1	134.8	206.1	427.4
Ratio Peak Outflow to Predevelopment Q	=	N/A	N/A	N/A	2.7	0.7	1.9	2.0	2.1	2.4
Structure Controlling Flow	=	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps)	=	N/A	0.18	0.17	0.2	0.2	0.2	0.2	0.2	0.2
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)	=	38	54	48	52	56	51	47	43	31
Time to Drain 99% of Inflow Volume (hours)	=	**40**	60	52	57	63	61	59	57	52
Maximum Ponding Depth (ft)	=	3.33	5.22	4.31	4.77	5.24	5.32	5.35	5.40	5.50
Area at Maximum Ponding Depth (acres)	=	1.17	3.47	2.25	2.90	3.47	3.48	3.49	3.49	3.51
Maximum Volume Stored (acre-ft)	=	0.991	5.288	2.626	3.834	5.358	5.601	5.740	5.880	6.265

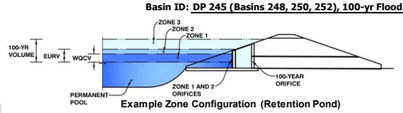
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 245 (Basins 248, 250, 252), 100-yr Flood Control only



Example Zone Configuration (Retention Pond)

Watershed Information — Flood Control Only

Flood Control Only	No BMP	
Watershed Area =	203.27	acres
Watershed Length =	3,613	ft
Watershed Length to Centroid =	1,652	ft
Watershed Slope =	0.019	ft/ft
Watershed Imperviousness =	71.33%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	61.0%	percent
Percentage Hydrologic Soil Groups C/D =	39.0%	percent
Target WQCV Drain Time =	N/A	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	2.857 acre-feet	2.857	acre-feet
Excess Urban Runoff Volume (EURV) =	15.232 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	9.666 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	13.530 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	18.103 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	26.856 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	34.525 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	43.759 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	68.877 acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	8.977 acre-feet		
Approximate 5-yr Detention Volume =	12.707 acre-feet		
Approximate 10-yr Detention Volume =	16.524 acre-feet		
Approximate 25-yr Detention Volume =	20.661 acre-feet		
Approximate 50-yr Detention Volume =	23.379 acre-feet		
Approximate 100-yr Detention Volume =	27.136 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (100-year)	27.136	acre-feet
Select Zone 2 Storage Volume (Optional)		acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	27.136	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	15.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.010	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	0	ft^2
Surcharge Volume Length (L_{ISV}) =	0.0	ft
Surcharge Volume Width (W_{ISV}) =	0.0	ft
Depth of Basin Floor (H_{FLOOR}) =	0.00	ft
Length of Basin Floor (L_{FLOOR}) =	305.6	ft
Width of Basin Floor (W_{FLOOR}) =	152.8	ft
Area of Basin Floor (A_{FLOOR}) =	46,690	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{MAIN}) =	15.00	ft
Length of Main Basin (L_{MAIN}) =	425.6	ft
Width of Main Basin (W_{MAIN}) =	272.8	ft
Area of Main Basin (A_{MAIN}) =	116,094	ft^2
Volume of Main Basin (V_{MAIN}) =	1,182,038	ft^3
Calculated Total Basin Volume (V_{total}) =	**27.136**	acre-feet

Depth Increment = 0.25 ft

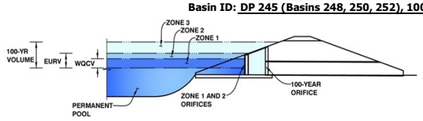
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		305.6	152.8	46,690		1.072		
	0.25		307.6	154.8	47,611		1.093	11,787	0.271
	0.50		309.6	156.8	48,539		1.114	23,806	0.547
	0.75		311.6	158.8	49,476		1.136	36,058	0.828
	1.00		313.6	160.8	50,421		1.158	48,545	1.114
	1.25		315.6	162.8	51,374		1.179	61,269	1.407
	1.50		317.6	164.8	52,334		1.201	74,232	1.704
	1.75		319.6	166.8	53,303		1.224	87,437	2.007
	2.00		321.6	168.8	54,280		1.246	100,884	2.316
	2.25		323.6	170.8	55,264		1.269	114,577	2.630
	2.50		325.6	172.8	56,257		1.291	128,517	2.950
	2.75		327.6	174.8	57,258		1.314	142,706	3.276
	3.00		329.6	176.8	58,267		1.338	157,147	3.608
	3.25		331.6	178.8	59,283		1.361	171,840	3.945
	3.50		333.6	180.8	60,308		1.384	186,789	4.288
	3.75		335.6	182.8	61,341		1.408	201,995	4.637
	4.00		337.6	184.8	62,382		1.432	217,460	4.992
	4.25		339.6	186.8	63,430		1.456	233,187	5.353
	4.50		341.6	188.8	64,487		1.480	249,176	5.720
	4.75		343.6	190.8	65,552		1.505	265,431	6.093
	5.00		345.6	192.8	66,625		1.529	281,953	6.473
	5.25		347.6	194.8	67,705		1.554	298,744	6.858
	5.50		349.6	196.8	68,794		1.579	315,806	7.250
	5.75		351.6	198.8	69,891		1.604	333,142	7.648
	6.00		353.6	200.8	70,996		1.630	350,752	8.052
	6.25		355.6	202.8	72,108		1.655	368,640	8.463
	6.50		357.6	204.8	73,229		1.681	386,807	8.880
	6.75		359.6	206.8	74,358		1.707	405,255	9.303
	7.00		361.6	208.8	75,495		1.733	423,987	9.733
	7.25		363.6	210.8	76,639		1.759	443,003	10.170
	7.50		365.6	212.8	77,792		1.786	462,307	10.613
	7.75		367.6	214.8	78,953		1.813	481,900	11.063
	8.00		369.6	216.8	80,122		1.839	501,784	11.519
	8.25		371.6	218.8	81,298		1.866	521,962	11.983
	8.50		373.6	220.8	82,483		1.894	542,434	12.453
	8.75		375.6	222.8	83,676		1.921	563,204	12.929
	9.00		377.6	224.8	84,877		1.948	584,273	13.413
	9.25		379.6	226.8	86,085		1.976	605,643	13.904
	9.50		381.6	228.8	87,302		2.004	627,316	14.401
	9.75		383.6	230.8	88,527		2.032	649,294	14.906
	10.00		385.6	232.8	89,760		2.061	671,580	15.417
	10.25		387.6	234.8	91,000		2.089	694,175	15.936
	10.50		389.6	236.8	92,249		2.118	717,081	16.462
	10.75		391.6	238.8	93,506		2.147	740,300	16.995
	11.00		393.6	240.8	94,770		2.176	763,834	17.535
	11.25		395.6	242.8	96,043		2.205	787,686	18.083
	11.50		397.6	244.8	97,324		2.234	811,857	18.638
	11.75		399.6	246.8	98,613		2.264	836,348	19.200
	12.00		401.6	248.8	99,909		2.294	861,164	19.770
	12.25		403.6	250.8	101,214		2.324	886,304	20.347
	12.50		405.6	252.8	102,527		2.354	911,771	20.931
	12.75		407.6	254.8	103,848		2.384	937,568	21.524
	13.00		409.6	256.8	105,176		2.415	963,696	22.123
	13.25		411.6	258.8	106,513		2.445	990,157	22.731
	13.50		413.6	260.8	107,858		2.476	1,016,953	23.346
	13.75		415.6	262.8	109,211		2.507	1,044,086	23.969
	14.00		417.6	264.8	110,571		2.538	1,071,559	24.600
	14.25		419.6	266.8	111,940		2.570	1,099,373	25.238
	14.50		421.6	268.8	113,317		2.601	1,127,530	25.885
	14.75		423.6	270.8	114,702		2.633	1,156,032	26.539
Zone 1 (100-year)	14.98		425.4	272.6	115,983		2.663	1,182,560	27.148
	15.00		425.6	272.8	116,094		2.665	1,184,881	27.201
	15.25		427.6	274.8	117,495		2.697	1,214,080	27.871
	15.50		429.6	276.8	118,904		2.730	1,243,629	28.550
	15.75		431.6	278.8	120,321		2.762	1,273,532	29.236
	16.00		433.6	280.8	121,745		2.795	1,303,790	29.931
	16.25		435.6	282.8	123,178		2.828	1,334,406	30.634
	16.50		437.6	284.8	124,619		2.861	1,365,380	31.345
	16.75		439.6	286.8	126,068		2.894	1,396,716	32.064
	17.00		441.6	288.8	127,524		2.928	1,428,415	32.792

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 245 (Basins 248, 250, 252), 100-yr Flood Control only



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (100-year)	14.98	27.136	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 2				Select Zone 2 Outlet Type
Zone 3				Select Zone 3 Outlet Type
Total (all zones)		27.136		

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 Diameter =	N/A	inches

Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	sq. inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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 Rectangular	Not Selected
Invert of Vertical Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	14.98	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	60.00	inches
Vertical Orifice Width =	60.00	inches

Calculated Parameters for Vertical Orifice

	Zone 1 Rectangular	Not Selected	
Vertical Orifice Area =	25.00		ft^2
Vertical Orifice Centroid =	2.50		feet

Size Vertical Orifice to drain (EURV - WQCV) Only

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	
Overflow Weir Front Edge Height, Ho =	0.00		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =	Select Grate Type	Select Grate Type	
Debris Clogging % =			%

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

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

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	2.857	15.232	9.666	13.530	18.103	26.856	34.525	43.759	68.877
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	9.666	13.530	18.103	26.856	34.525	31.974	68.877
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	2.1	11.6	50.4	158.6	234.8	332.2	584.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.06	0.25	0.78	1.16	1.63	2.88
Peak Inflow Q (cfs) =	N/A	N/A	173.4	241.1	322.4	498.4	641.1	508.0	1259.2
Peak Outflow Q (cfs) =	46.7	315.6	81.8	122.9	172.7	258.6	305.1	264.8	457.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	10.6	3.4	1.6	1.3	0.8	0.8
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	Vertical Orifice 1
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) =	12	4	6	5	4	4	3	6	3
Time to Drain 99% of Inflow Volume (hours) =	**30**	8	12	10	8	7	6	9	5
Maximum Ponding Depth (ft) =	2.43	9.91	3.14	3.93	4.74	7.12	8.93	7.34	16.94
Area at Maximum Ponding Depth (acres) =	1.29	2.05	1.35	1.42	1.50	1.74	1.94	1.77	2.92
Maximum Volume Stored (acre-ft) =	2.860	15.232	3.782	4.878	6.063	9.925	13.258	10.311	32.616

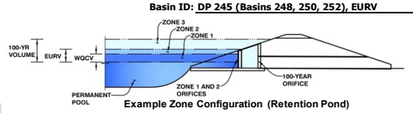
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 245 (Basins 248, 250, 252), EURV



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	203.27	acres
Watershed Length =	3,613	ft
Watershed Length to Centroid =	1,652	ft
Watershed Slope =	0.019	ft/ft
Watershed Imperviousness =	71.33%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	61.0%	percent
Percentage Hydrologic Soil Groups C/D =	39.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	2.857 acre-feet	2.857	acre-feet
Excess Urban Runoff Volume (EURV) =	15.232 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	9.666 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	13.530 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	18.103 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	26.856 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	34.525 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	43.759 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	68.877 acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	8.977 acre-feet		
Approximate 5-yr Detention Volume =	12.707 acre-feet		
Approximate 10-yr Detention Volume =	16.524 acre-feet		
Approximate 25-yr Detention Volume =	20.661 acre-feet		
Approximate 50-yr Detention Volume =	23.379 acre-feet		
Approximate 100-yr Detention Volume =	27.136 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	2.857	acre-feet
Zone 2 Volume (EURV - Zone 1)	12.375	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	11.904	acre-feet
Total Detention Basin Volume =	27.136	acre-feet
Initial Surcharge Volume (ISV) =	373	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	747	ft^2
Surcharge Volume Length (L_{ISV}) =	27.3	ft
Surcharge Volume Width (W_{ISV}) =	27.3	ft
Depth of Basin Floor (H_{FLOOR}) =	4.61	ft
Length of Basin Floor (L_{FLOOR}) =	967.8	ft
Width of Basin Floor (W_{FLOOR}) =	488.3	ft
Area of Basin Floor (A_{FLOOR}) =	472,585	ft^2
Volume of Basin Floor (V_{FLOOR}) =	756,220	ft^3
Depth of Main Basin (H_{MAIN}) =	0.89	ft
Length of Main Basin (L_{MAIN}) =	974.9	ft
Width of Main Basin (W_{MAIN}) =	495.4	ft
Area of Main Basin (A_{MAIN}) =	483,003	ft^2
Volume of Main Basin (V_{MAIN}) =	425,228	ft^3
Calculated Total Basin Volume (V_{total}) =	**27.139**	acre-feet

Depth Increment = 0.25 ft

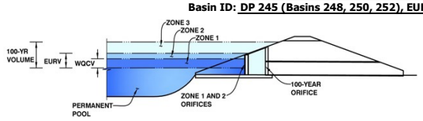
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		27.3	27.3	747		0.017		
ISV	0.50		27.3	27.3	747		0.017	373	0.009
	0.75		27.3	27.3	747		0.017	560	0.013
	1.00		27.3	27.3	747		0.017	747	0.017
	1.25		78.3	52.3	4,098		0.094	1,299	0.030
	1.50		129.3	77.3	10,000		0.230	3,008	0.069
	1.75		180.3	102.3	18,452		0.424	6,512	0.149
	2.00		231.3	127.3	29,454		0.676	12,447	0.286
	2.25		282.3	152.3	43,006		0.987	21,451	0.492
	2.50		333.3	177.3	59,107		1.357	34,162	0.784
	2.75		384.3	202.3	77,759		1.785	51,217	1.176
	3.00		435.3	227.3	98,961		2.272	73,254	1.682
	3.25		486.3	252.3	122,713		2.817	100,910	2.317
	3.50		537.3	277.3	149,014		3.421	134,823	3.095
	3.75		588.3	302.3	177,866		4.083	175,630	4.032
	4.00		639.3	327.3	209,268		4.804	223,969	5.142
	4.25		690.3	352.3	243,220		5.584	280,476	6.439
	4.50		741.3	377.3	279,721		6.422	345,791	7.938
Zone 1 (WQCV)	4.75		792.3	402.3	318,773		7.318	420,550	9.654
	5.00		843.3	427.3	360,375		8.273	505,390	11.602
	5.25		894.3	452.3	404,527		9.287	600,950	13.796
	5.50		945.3	477.3	451,229		10.359	707,866	16.250
	5.75		968.9	489.4	474,217		10.887	824,947	18.938
	6.00		970.9	491.4	477,138		10.954	943,867	21.668
	6.25		972.9	493.4	480,067		11.021	1,063,517	24.415
Floor	6.50		974.9	495.4	483,003		11.088	1,183,901	27.179
	6.75		976.9	497.4	485,948		11.156	1,305,019	29.959
	7.00		978.9	499.4	488,901		11.224	1,426,875	32.757
	7.25		980.9	501.4	491,861		11.292	1,549,470	35.571
	7.50		982.9	503.4	494,830		11.360	1,672,806	38.402
	7.75		984.9	505.4	497,807		11.428	1,796,886	41.251
	8.00		986.9	507.4	500,791		11.497	1,921,710	44.116
Zone 2 (EURV)	8.14		988.0	508.6	502,466		11.535	1,991,938	45.729
	8.25		988.9	509.4	503,784		11.565	2,047,282	46.999
	8.50		990.9	511.4	506,785		11.634	2,173,603	49.899
	8.75		992.9	513.4	509,793		11.703	2,300,675	52.816
	9.00		994.9	515.4	512,810		11.772	2,428,500	55.751
	9.25		996.9	517.4	515,835		11.842	2,557,081	58.702
	9.50		998.9	519.4	518,867		11.912	2,686,418	61.672
	9.75		1,000.9	521.4	521,908		11.981	2,816,515	64.658
	10.00		1,002.9	523.4	524,957		12.051	2,947,373	67.662
	10.25		1,004.9	525.4	528,013		12.122	3,078,994	70.684
	10.50		1,006.9	527.4	531,078		12.192	3,211,380	73.723
Zone 3 (100-year)	10.70		1,008.5	529.0	533,535		12.248	3,317,841	76.167
	10.75		1,008.9	529.4	534,151		12.262	3,344,534	76.780
	11.00		1,010.9	531.4	537,231		12.333	3,478,456	79.854
	11.25		1,012.9	533.4	540,320		12.404	3,613,150	82.947
	11.50		1,014.9	535.4	543,417		12.475	3,748,617	86.056
	11.75		1,016.9	537.4	546,521		12.546	3,884,859	89.184
	12.00		1,018.9	539.4	549,634		12.618	4,021,878	92.330
	12.25		1,020.9	541.4	552,755		12.689	4,159,676	95.493
	12.50		1,022.9	543.4	555,883		12.761	4,298,256	98.674
	12.75		1,024.9	545.4	559,020		12.833	4,437,619	101.874
	13.00		1,026.9	547.4	562,164		12.906	4,577,766	105.091
	13.25		1,028.9	549.4	565,317		12.978	4,718,701	108.326
	13.50		1,030.9	551.4	568,478		13.050	4,860,426	111.580
	13.75		1,032.9	553.4	571,646		13.123	5,002,941	114.852
	14.00		1,034.9	555.4	574,823		13.196	5,146,250	118.142
	14.25		1,036.9	557.4	578,008		13.269	5,290,353	121.450
	14.50		1,038.9	559.4	581,200		13.343	5,435,254	124.776
	14.75		1,040.9	561.4	584,401		13.416	5,580,954	128.121
	15.00		1,042.9	563.4	587,610		13.490	5,727,455	131.484
	15.25		1,044.9	565.4	590,826		13.564	5,874,760	134.866
	15.50		1,046.9	567.4	594,051		13.638	6,022,869	138.266
	15.75		1,048.9	569.4	597,284		13.712	6,171,786	141.685
	16.00		1,050.9	571.4	600,524		13.786	6,321,512	145.122
	16.25		1,052.9	573.4	603,773		13.861	6,472,049	148.578
	16.50		1,054.9	575.4	607,030		13.935	6,623,399	152.052
	16.75		1,056.9	577.4	610,294		14.010	6,775,564	155.546
	17.00		1,058.9	579.4	613,567		14.086	6,928,547	159.058

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 245 (Basins 248, 250, 252), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.43	2.857	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.40	12.375	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	11.904	Not Utilized	Zone 3 Not Utilized
Total (all zones)		27.136		

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 Diameter =	N/A	inches	Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.43	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	13.70	inches
Orifice Plate: Orifice Area per Row =	7.58	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	5.264E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.14	2.29					
Orifice Area (sq. inches)	7.58	7.58	7.58					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.43	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.43	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	17.52	N/A	
Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	7.00		inches

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.64	N/A	ft^2
Outlet Orifice Centroid =	0.34	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.35	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.41	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	1000.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.41	feet
Stage at Top of Freeboard =	6.82	feet
Basin Area at Top of Freeboard =	11.17	acres
Basin Volume at Top of Freeboard =	30.74	acre-ft

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	2.857	15.232	9.666	13.530	18.103	26.856	34.525	43.759	68.877
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	9.666	13.530	18.103	26.856	34.525	43.759	68.877
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	2.1	11.6	50.4	158.6	234.8	332.2	584.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.06	0.25	0.78	1.16	1.63	2.88
Peak Inflow Q (cfs) =	N/A	N/A	173.4	241.1	322.4	498.4	641.1	810.7	1259.2
Peak Outflow Q (cfs) =	1.1	8.4	8.0	8.2	38.3	209.6	374.8	593.1	1087.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.7	0.8	1.3	1.6	1.8	1.9
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.62	0.59	0.6	0.6	0.6	0.6	0.6	0.6
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) =	38	54	49	53	55	51	47	44	35
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	53	58	62	60	59	57	52
Maximum Ponding Depth (ft) =	3.43	5.40	4.59	5.08	5.46	5.57	5.66	5.75	5.92
Area at Maximum Ponding Depth (acres) =	3.25	9.92	6.70	8.55	10.14	10.67	10.86	10.88	10.93
Maximum Volume Stored (acre-ft) =	2.862	15.236	8.463	12.191	15.738	16.986	17.851	18.829	20.683

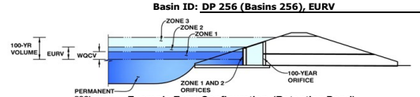
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 256 (Basins 256), EURV



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	**EDB**	
Watershed Area =	93.66	acres
Watershed Length =	5,038	ft
Watershed Length to Centroid =	2,923	ft
Watershed Slope =	0.032	ft/ft
Watershed Imperviousness =	43.82%	percent
Percentage Hydrologic Soil Group A =	20.0%	percent
Percentage Hydrologic Soil Group B =	80.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.889	acre-feet	0.889	acre-feet
Excess Urban Runoff Volume (EURV) =	4.385	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	2.474	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	3.534	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	5.037	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	8.893	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	12.163	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	16.441	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	27.609	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	2.263	acre-feet		
Approximate 5-yr Detention Volume =	3.250	acre-feet		
Approximate 10-yr Detention Volume =	4.637	acre-feet		
Approximate 25-yr Detention Volume =	6.114	acre-feet		
Approximate 50-yr Detention Volume =	7.095	acre-feet		
Approximate 100-yr Detention Volume =	8.730	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	0.889	acre-feet
Zone 2 Volume (EURV - Zone 1)	3.496	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	4.345	acre-feet
Total Detention Basin Volume =	8.730	acre-feet
Initial Surcharge Volume (ISV) =	116	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.009	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	232	ft^2
Surcharge Volume Length (L_{ISV}) =	15.2	ft
Surcharge Volume Width (W_{ISV}) =	15.2	ft
Depth of Basin Floor (H_{FLOOR}) =	4.80	ft
Length of Basin Floor (L_{FLOOR}) =	567.8	ft
Width of Basin Floor (W_{FLOOR}) =	281.9	ft
Area of Basin Floor (A_{FLOOR}) =	160,062	ft^2
Volume of Basin Floor (V_{FLOOR}) =	266,228	ft^3
Depth of Main Basin (H_{MAIN}) =	0.70	ft
Length of Main Basin (L_{MAIN}) =	573.4	ft
Width of Main Basin (W_{MAIN}) =	287.5	ft
Area of Main Basin (A_{MAIN}) =	164,851	ft^2
Volume of Main Basin (V_{MAIN}) =	113,715	ft^3
Calculated Total Basin Volume (V_{total}) =	**8.728**	acre-feet

Depth Increment = 0.25 ft

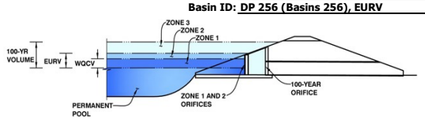
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		15.2	15.2	232		0.005		
ISV	0.50		15.2	15.2	232		0.005	116	0.003
	0.75		15.2	15.2	232		0.005	174	0.004
	1.00		15.2	15.2	232		0.005	232	0.005
	1.25		44.0	29.1	1,282		0.029	405	0.009
	1.50		72.8	43.0	3,132		0.072	940	0.022
	1.75		101.6	56.9	5,781		0.133	2,038	0.047
	2.00		130.4	70.8	9,229		0.212	3,897	0.089
	2.25		159.1	84.7	13,476		0.309	6,719	0.154
	2.50		187.9	98.6	18,523		0.425	10,702	0.246
	2.75		216.7	112.5	24,370		0.559	16,047	0.368
	3.00		245.5	126.4	31,016		0.712	22,953	0.527
	3.25		274.2	140.2	38,461		0.883	31,621	0.726
Zone 1 (WQCV)	3.43		295.0	150.2	44,316		1.017	39,065	0.897
	3.50		303.0	154.1	46,705		1.072	42,250	0.970
	3.75		331.8	168.0	55,749		1.280	55,041	1.264
	4.00		360.6	181.9	65,592		1.506	70,192	1.611
	4.25		389.4	195.8	76,235		1.750	87,903	2.018
	4.50		418.1	209.7	87,677		2.013	108,376	2.488
	4.75		446.9	223.6	99,918		2.294	131,808	3.026
	5.00		475.7	237.5	112,959		2.593	158,402	3.636
	5.25		504.5	251.4	126,799		2.911	188,355	4.324
Zone 2 (EURV)	5.28		507.9	253.0	128,514		2.950	192,184	4.412
	5.50		533.2	265.2	141,439		3.247	221,868	5.093
	5.75		562.0	279.1	156,878		3.601	259,141	5.949
Floor	5.80		567.8	281.9	160,062		3.675	267,064	6.131
	6.00		569.4	283.5	161,424		3.706	299,213	6.869
	6.25		571.4	285.5	163,133		3.745	339,782	7.800
Zone 3 (100-year)	6.50		573.4	287.5	164,851		3.784	380,780	8.742
	6.75		575.4	289.5	166,577		3.824	422,208	9.693
	7.00		577.4	291.5	168,311		3.864	464,069	10.654
	7.25		579.4	293.5	170,053		3.904	506,364	11.625
	7.50		581.4	295.5	171,802		3.944	549,096	12.606
	7.75		583.4	297.5	173,560		3.984	592,266	13.597
	8.00		585.4	299.5	175,326		4.025	635,877	14.598
	8.25		587.4	301.5	177,100		4.066	679,930	15.609
	8.50		589.4	303.5	178,881		4.107	724,427	16.631
	8.75		591.4	305.5	180,671		4.148	769,371	17.662
	9.00		593.4	307.5	182,469		4.189	814,764	18.704
	9.25		595.4	309.5	184,275		4.230	860,606	19.757
	9.50		597.4	311.5	186,089		4.272	906,902	20.820
	9.75		599.4	313.5	187,910		4.314	953,651	21.893
	10.00		601.4	315.5	189,740		4.356	1,000,857	22.977
	10.25		603.4	317.5	191,578		4.398	1,048,522	24.071
	10.50		605.4	319.5	193,424		4.440	1,096,647	25.176
	10.75		607.4	321.5	195,277		4.483	1,145,234	26.291
	11.00		609.4	323.5	197,139		4.526	1,194,286	27.417
	11.25		611.4	325.5	199,009		4.569	1,243,805	28.554
	11.50		613.4	327.5	200,887		4.612	1,293,791	29.701
	11.75		615.4	329.5	202,772		4.655	1,344,249	30.860
	12.00		617.4	331.5	204,666		4.698	1,395,178	32.029
	12.25		619.4	333.5	206,568		4.742	1,446,582	33.209
	12.50		621.4	335.5	208,478		4.786	1,498,463	34.400
	12.75		623.4	337.5	210,396		4.830	1,550,822	35.602
	13.00		625.4	339.5	212,321		4.874	1,603,661	36.815
	13.25		627.4	341.5	214,255		4.919	1,656,983	38.039
	13.50		629.4	343.5	216,197		4.963	1,710,790	39.274
	13.75		631.4	345.5	218,147		5.008	1,765,082	40.521
	14.00		633.4	347.5	220,104		5.053	1,819,864	41.778
	14.25		635.4	349.5	222,070		5.098	1,875,135	43.047
	14.50		637.4	351.5	224,044		5.143	1,930,899	44.327
	14.75		639.4	353.5	226,026		5.189	1,987,158	45.619
	15.00		641.4	355.5	228,015		5.235	2,043,913	46.922
	15.25		643.4	357.5	230,013		5.280	2,101,166	48.236
	15.50		645.4	359.5	232,019		5.326	2,158,920	49.562
	15.75		647.4	361.5	234,033		5.373	2,217,177	50.899
	16.00		649.4	363.5	236,055		5.419	2,275,937	52.248
	16.25		651.4	365.5	238,084		5.466	2,335,204	53.609
	16.50		653.4	367.5	240,122		5.512	2,394,980	54.981
	16.75		655.4	369.5	242,168		5.559	2,455,266	56.365
	17.00		657.4	371.5	244,222		5.607	2,516,065	57.761
	17.25		659.4	373.5	246,283		5.654	2,577,378	59.168
	17.50		661.4	375.5	248,353		5.701	2,639,207	60.588
	17.75		663.4	377.5	250,431		5.749	2,701,555	62.019

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 256 (Basins 256), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.43	0.889	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.28	3.496	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	4.345	Not Utilized	Zone 3 Not Utilized
Total (all zones)		8.730		

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 Diameter =	N/A	inches	Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.43	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	13.70	inches
Orifice Plate: Orifice Area per Row =	2.37	sq. inches (diameter = 1-3/4 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.646E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.14	2.29					
Orifice Area (sq. inches)	2.37	2.37	2.37					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.43	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.43	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	71.57	N/A	
Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	2.58		inches

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.16	N/A	ft^2
Outlet Orifice Centroid =	0.13	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	0.78	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.30	ft (relative to basin bottom at Stage = 0 ft)	
Spillway Crest Length =	1000.00	feet	Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate
Spillway End Slopes =	4.00	H:V	
Freeboard above Max Water Surface =	1.00	feet	

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.15	feet
Stage at Top of Freeboard =	6.45	feet
Basin Area at Top of Freeboard =	3.78	acres
Basin Volume at Top of Freeboard =	8.55	acre-ft

Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
One-Hour Rainfall Depth (in) =	0.889	4.385	2.474	3.534	5.037	8.893	12.163	16.441	27.609
CUHP Runoff Volume (acre-ft) =	N/A	N/A	2.474	3.534	5.037	8.893	12.163	16.441	27.609
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.4	0.8	7.0	37.6	60.0	90.6	165.3
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A							
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A	0.00	0.01	0.08	0.40	0.64	0.97	1.76
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	22.9	33.0	48.1	96.4	131.9	177.5	292.6
Peak Inflow Q (cfs) =	0.4	2.1	1.9	2.0	5.5	68.8	121.8	197.8	316.5
Peak Outflow Q (cfs) =	N/A	N/A	N/A	2.4	0.8	1.8	2.0	2.2	1.9
Ratio Peak Outflow to Predevelopment Q =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Structure Controlling Flow =	N/A	0.14	0.14	0.1	0.1	0.1	0.1	0.1	0.1
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) =	38	55	48	52	57	51	47	42	30
Time to Drain 97% of Inflow Volume (hours) =	**40**	60	51	57	64	61	59	56	51
Time to Drain 99% of Inflow Volume (hours) =	3.43	5.28	4.31	4.79	5.31	5.38	5.42	5.46	5.52
Maximum Ponding Depth (ft) =	1.02	2.95	1.80	2.34	2.99	3.07	3.12	3.19	3.27
Area at Maximum Ponding Depth (acres) =	0.897	4.412	2.107	3.119	4.501	4.683	4.807	4.965	5.159
Maximum Volume Stored (acre-ft) =									

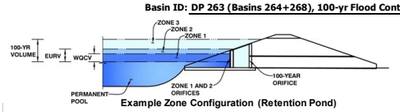
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 263 (Basins 264+268), 100-yr Flood Control Only



Example Zone Configuration (Retention Pond)

Watershed Information — Flood Control Only

	No BMP	
Flood Control Only		
Watershed Area =	127.34	acres
Watershed Length =	3,476	ft
Watershed Length to Centroid =	1,780	ft
Watershed Slope =	0.021	ft/ft
Watershed Imperviousness =	62.03%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	96.7%	percent
Percentage Hydrologic Soil Groups C/D =	3.3%	percent
Target WQCV Drain Time =	N/A	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.548 acre-feet	1.548	acre-feet
Excess Urban Runoff Volume (EURV) =	8.559 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	0.000 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	0.000 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	0.000 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	0.000 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	0.000 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	0.000 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	0.000 acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	4.739 acre-feet		
Approximate 5-yr Detention Volume =	6.682 acre-feet		
Approximate 10-yr Detention Volume =	9.148 acre-feet		
Approximate 25-yr Detention Volume =	11.540 acre-feet		
Approximate 50-yr Detention Volume =	13.141 acre-feet		
Approximate 100-yr Detention Volume =	15.481 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (100-year)	15.481	acre-feet
Select Zone 2 Storage Volume (Optional)		acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	15.481	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	15.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.010	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	0	ft^2
Surcharge Volume Length (L_{ISV}) =	0.0	ft
Surcharge Volume Width (W_{ISV}) =	0.0	ft
Depth of Basin Floor (H_{FLOOR}) =	0.00	ft
Length of Basin Floor (L_{FLOOR}) =	207.9	ft
Width of Basin Floor (W_{FLOOR}) =	103.9	ft
Area of Basin Floor (A_{FLOOR}) =	21,608	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{MAIN}) =	15.00	ft
Length of Main Basin (L_{MAIN}) =	327.9	ft
Width of Main Basin (W_{MAIN}) =	223.9	ft
Area of Main Basin (A_{MAIN}) =	73,427	ft^2
Volume of Main Basin (V_{MAIN}) =	674,335	ft^3
Calculated Total Basin Volume (V_{total}) =	**15.481**	acre-feet

Depth Increment = 0.25 ft

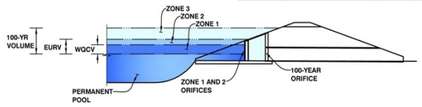
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		207.9	103.9	21,608		0.496		
	0.25		209.9	105.9	22,236		0.510	5,480	0.126
	0.50		211.9	107.9	22,871		0.525	11,118	0.255
	0.75		213.9	109.9	23,515		0.540	16,917	0.388
	1.00		215.9	111.9	24,166		0.555	22,876	0.525
	1.25		217.9	113.9	24,826		0.570	29,000	0.666
	1.50		219.9	115.9	25,494		0.585	35,290	0.810
	1.75		221.9	117.9	26,169		0.601	41,748	0.958
	2.00		223.9	119.9	26,853		0.616	48,376	1.111
	2.25		225.9	121.9	27,545		0.632	55,175	1.267
	2.50		227.9	123.9	28,244		0.648	62,149	1.427
	2.75		229.9	125.9	28,952		0.665	69,298	1.591
	3.00		231.9	127.9	29,668		0.681	76,625	1.759
	3.25		233.9	129.9	30,391		0.698	84,133	1.931
	3.50		235.9	131.9	31,123		0.714	91,822	2.108
	3.75		237.9	133.9	31,863		0.731	99,695	2.289
	4.00		239.9	135.9	32,610		0.749	107,754	2.474
	4.25		241.9	137.9	33,366		0.766	116,000	2.663
	4.50		243.9	139.9	34,130		0.784	124,437	2.857
	4.75		245.9	141.9	34,901		0.801	133,066	3.055
	5.00		247.9	143.9	35,681		0.819	141,889	3.257
	5.25		249.9	145.9	36,469		0.837	150,907	3.464
	5.50		251.9	147.9	37,264		0.855	160,123	3.676
	5.75		253.9	149.9	38,068		0.874	169,540	3.892
	6.00		255.9	151.9	38,879		0.893	179,158	4.113
	6.25		257.9	153.9	39,699		0.911	188,980	4.338
	6.50		259.9	155.9	40,527		0.930	199,008	4.569
	6.75		261.9	157.9	41,362		0.950	209,244	4.804
	7.00		263.9	159.9	42,206		0.969	219,690	5.043
	7.25		265.9	161.9	43,058		0.988	230,348	5.288
	7.50		267.9	163.9	43,917		1.008	241,220	5.538
	7.75		269.9	165.9	44,785		1.028	252,307	5.792
	8.00		271.9	167.9	45,661		1.048	263,613	6.052
	8.25		273.9	169.9	46,544		1.069	275,138	6.316
	8.50		275.9	171.9	47,436		1.089	286,886	6.586
	8.75		277.9	173.9	48,336		1.110	298,857	6.861
	9.00		279.9	175.9	49,243		1.130	311,054	7.141
	9.25		281.9	177.9	50,159		1.151	323,479	7.426
	9.50		283.9	179.9	51,083		1.173	336,134	7.717
	9.75		285.9	181.9	52,014		1.194	349,021	8.012
	10.00		287.9	183.9	52,954		1.216	362,142	8.314
	10.25		289.9	185.9	53,902		1.237	375,499	8.620
	10.50		291.9	187.9	54,857		1.259	389,094	8.932
	10.75		293.9	189.9	55,821		1.281	402,928	9.250
	11.00		295.9	191.9	56,793		1.304	417,005	9.573
	11.25		297.9	193.9	57,772		1.326	431,325	9.902
	11.50		299.9	195.9	58,760		1.349	445,892	10.236
	11.75		301.9	197.9	59,755		1.372	460,706	10.576
	12.00		303.9	199.9	60,759		1.395	475,770	10.922
	12.25		305.9	201.9	61,771		1.418	491,086	11.274
	12.50		307.9	203.9	62,790		1.441	506,656	11.631
	12.75		309.9	205.9	63,818		1.465	522,482	11.995
	13.00		311.9	207.9	64,854		1.489	538,566	12.364
	13.25		313.9	209.9	65,897		1.513	554,909	12.739
	13.50		315.9	211.9	66,949		1.537	571,515	13.120
	13.75		317.9	213.9	68,009		1.561	588,385	13.507
	14.00		319.9	215.9	69,076		1.586	605,520	13.901
	14.25		321.9	217.9	70,152		1.610	622,924	14.300
	14.50		323.9	219.9	71,236		1.635	640,597	14.706
	14.75		325.9	221.9	72,327		1.660	658,542	15.118
Zone 1 (100-year)	14.97		327.6	223.7	73,295		1.683	674,560	15.486
	15.00		327.9	223.9	73,427		1.686	676,761	15.536
	15.25		329.9	225.9	74,535		1.711	695,256	15.961
	15.50		331.9	227.9	75,650		1.737	714,029	16.392
	15.75		333.9	229.9	76,774		1.762	733,082	16.829
	16.00		335.9	231.9	77,906		1.788	752,417	17.273
	16.25		337.9	233.9	79,045		1.815	772,035	17.723
	16.50		339.9	235.9	80,193		1.841	791,940	18.180
	16.75		341.9	237.9	81,349		1.868	812,133	18.644
	17.00		343.9	239.9	82,512		1.894	832,615	19.114
	17.25		345.9	241.9	83,684		1.921	853,389	19.591
	17.50		347.9	243.9	84,863		1.948	874,458	20.075

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 263 (Basins 264+268), 100-yr Flood Control Only



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (100-year)	14.97	15.481	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 2				Select Zone 2 Outlet Type
Zone 3				Select Zone 3 Outlet Type
Total (all zones)		15.481		

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 Diameter = N/A inches

Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area = N/A ft^2

Underdrain Orifice Centroid = N/A feet

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

Centroid of Lowest Orifice = N/A ft (relative to basin bottom at Stage = 0 ft)

Depth at top of Zone using Orifice Plate = N/A ft (relative to basin bottom at Stage = 0 ft)

Orifice Plate: Orifice Vertical Spacing = N/A inches

Orifice Plate: Orifice Area per Row = N/A sq. inches

Calculated Parameters for Plate

WQ Orifice Area per Row = N/A ft^2

Elliptical Half-Width = N/A feet

Elliptical Slot Centroid = N/A feet

Elliptical Slot Area = N/A ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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 Rectangular	Not Selected	
Invert of Vertical Orifice =	0.00		ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	14.97		ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	25.00		inches
Vertical Orifice Width =	60.00		inches

Calculated Parameters for Vertical Orifice

	Zone 1 Rectangular	Not Selected	
Vertical Orifice Area =	10.42		ft^2
Vertical Orifice Centroid =	1.04		feet

Size Vertical Orifice to drain (EURV - WQCV) Only

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	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =	Select Grate Type	Select Grate Type	
Debris Clogging % =			%

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage= ft (relative to basin bottom at Stage = 0 ft)

Spillway Crest Length = feet

Spillway End Slopes = H:V

Freeboard above Max Water Surface = feet

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

Spillway Design Flow Depth= feet

Stage at Top of Freeboard = feet

Basin Area at Top of Freeboard = acres

Basin Volume at Top of Freeboard = acre-ft

Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	1.548	8.559	0.000	0.000	0.000	0.000	0.000	0.000	0.000
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	5.137	7.186	9.863	15.284	19.941	28.308	41.170
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Peak Inflow Q (cfs) =	N/A	N/A	78.0	109.6	152.1	249.4	327.8	299.3	664.4
Peak Outflow Q (cfs) =	58.0	148.3	54.8	70.5	88.7	125.8	146.4	137.2	208.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
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	Vertical Orifice 1
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) =	4	2	3	3	3	3	3	3	3
Time to Drain 99% of Inflow Volume (hours) =	**10**	3	5	5	4	4	3	6	4
Maximum Ponding Depth (ft) =	2.69	10.21	2.23	3.02	4.17	7.33	9.56	8.52	18.33
Area at Maximum Ponding Depth (acres) =	0.66	1.23	0.63	0.68	0.76	0.99	1.18	1.09	2.04
Maximum Volume Stored (acre-ft) =	1.551	8.571	1.254	1.766	2.602	5.367	7.775	6.597	21.730

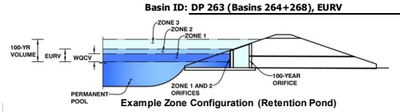
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 263 (Basins 264+268), EURV



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	**EDB**	
Watershed Area =	127.34	acres
Watershed Length =	3,476	ft
Watershed Length to Centroid =	1,780	ft
Watershed Slope =	0.021	ft/ft
Watershed Imperviousness =	62.03%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	96.7%	percent
Percentage Hydrologic Soil Groups C/D =	3.3%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.548 acre-feet	1.548	acre-feet
Excess Urban Runoff Volume (EURV) =	8.559 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	5.137 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	7.186 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	9.863 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	15.284 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	19.941 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	25.699 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	41.170 acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	4.739 acre-feet		
Approximate 5-yr Detention Volume =	6.682 acre-feet		
Approximate 10-yr Detention Volume =	9.148 acre-feet		
Approximate 25-yr Detention Volume =	11.540 acre-feet		
Approximate 50-yr Detention Volume =	13.141 acre-feet		
Approximate 100-yr Detention Volume =	15.481 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	1.548	acre-feet
Zone 2 Volume (EURV - Zone 1)	7.011	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	6.922	acre-feet
Total Detention Basin Volume =	15.481	acre-feet
Initial Surcharge Volume (ISV) =	202	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.006	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	405	ft^2
Surcharge Volume Length (L_{ISV}) =	20.1	ft
Surcharge Volume Width (W_{ISV}) =	20.1	ft
Depth of Basin Floor (H_{FLOOR}) =	3.70	ft
Length of Basin Floor (L_{FLOOR}) =	651.6	ft
Width of Basin Floor (W_{FLOOR}) =	328.4	ft
Area of Basin Floor (A_{FLOOR}) =	214,010	ft^2
Volume of Basin Floor (V_{FLOOR}) =	275,921	ft^3
Depth of Main Basin (H_{MAIN}) =	1.80	ft
Length of Main Basin (L_{MAIN}) =	666.0	ft
Width of Main Basin (W_{MAIN}) =	342.8	ft
Area of Main Basin (A_{MAIN}) =	228,330	ft^2
Volume of Main Basin (V_{MAIN}) =	398,037	ft^3
Calculated Total Basin Volume (V_{total}) =	**15.481**	acre-feet

Depth Increment = 0.25 ft

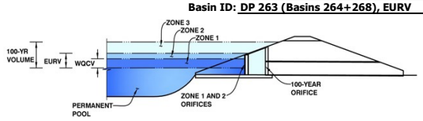
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		20.1	20.1	405		0.009		
ISV	0.50		20.1	20.1	405		0.009	202	0.005
	0.75		20.1	20.1	405		0.009	303	0.007
	1.00		20.1	20.1	405		0.009	405	0.009
	1.25		62.8	40.9	2,571		0.059	739	0.017
	1.50		105.4	61.8	6,515		0.150	1,838	0.042
	1.75		148.1	82.6	12,236		0.281	4,145	0.095
	2.00		190.8	103.4	19,736		0.453	8,104	0.186
	2.25		233.4	124.3	29,013		0.666	14,161	0.325
	2.50		276.1	145.1	40,068		0.920	22,759	0.522
	2.75		318.8	165.9	52,901		1.214	34,343	0.788
	3.00		361.4	186.8	67,512		1.550	49,358	1.133
Zone 1 (WQCV)	3.25		404.1	207.6	83,900		1.926	68,247	1.567
	3.50		446.8	228.4	102,066		2.343	91,456	2.100
	3.75		489.4	249.3	122,010		2.801	119,428	2.742
	4.00		532.1	270.1	143,732		3.300	152,609	3.503
	4.25		574.8	290.9	167,231		3.839	191,442	4.395
	4.50		617.4	311.8	192,508		4.419	236,373	5.426
Floor	4.70		651.6	328.4	214,010		4.913	277,006	6.359
	4.75		652.0	328.8	214,402		4.922	287,716	6.605
	5.00		654.0	330.8	216,368		4.967	341,562	7.841
Zone 2 (EURV)	5.15		655.2	332.0	217,551		4.994	374,106	8.588
	5.25		656.0	332.8	218,342		5.012	395,901	9.089
	5.50		658.0	334.8	220,323		5.058	450,734	10.347
	5.75		660.0	336.8	222,313		5.104	506,063	11.618
	6.00		662.0	338.8	224,311		5.149	561,891	12.899
	6.25		664.0	340.8	226,316		5.196	618,219	14.192
Zone 3 (100-year)	6.50		666.0	342.8	228,330		5.242	675,050	15.497
	6.75		668.0	344.8	230,352		5.288	732,385	16.813
	7.00		670.0	346.8	232,381		5.335	790,226	18.141
	7.25		672.0	348.8	234,419		5.382	848,576	19.481
	7.50		674.0	350.8	236,465		5.428	907,436	20.832
	7.75		676.0	352.8	238,518		5.476	966,809	22.195
	8.00		678.0	354.8	240,580		5.523	1,026,696	23.570
	8.25		680.0	356.8	242,650		5.570	1,087,100	24.956
	8.50		682.0	358.8	244,727		5.618	1,148,022	26.355
	8.75		684.0	360.8	246,813		5.666	1,209,464	27.765
	9.00		686.0	362.8	248,907		5.714	1,271,429	29.188
	9.25		688.0	364.8	251,008		5.762	1,333,918	30.623
	9.50		690.0	366.8	253,118		5.811	1,396,933	32.069
	9.75		692.0	368.8	255,236		5.859	1,460,477	33.528
	10.00		694.0	370.8	257,361		5.908	1,524,552	34.999
	10.25		696.0	372.8	259,495		5.957	1,589,159	36.482
	10.50		698.0	374.8	261,637		6.006	1,654,300	37.978
	10.75		700.0	376.8	263,786		6.056	1,719,978	39.485
	11.00		702.0	378.8	265,944		6.105	1,786,194	41.005
	11.25		704.0	380.8	268,109		6.155	1,852,950	42.538
	11.50		706.0	382.8	270,283		6.205	1,920,249	44.083
	11.75		708.0	384.8	272,465		6.255	1,988,092	45.640
	12.00		710.0	386.8	274,654		6.305	2,056,482	47.210
	12.25		712.0	388.8	276,852		6.356	2,125,420	48.793
	12.50		714.0	390.8	279,058		6.406	2,194,909	50.388
	12.75		716.0	392.8	281,271		6.457	2,264,950	51.996
	13.00		718.0	394.8	283,493		6.508	2,335,545	53.617
	13.25		720.0	396.8	285,723		6.559	2,406,697	55.250
	13.50		722.0	398.8	287,960		6.611	2,478,407	56.896
	13.75		724.0	400.8	290,206		6.662	2,550,678	58.556
	14.00		726.0	402.8	292,460		6.714	2,623,511	60.228
	14.25		728.0	404.8	294,721		6.766	2,696,909	61.913
	14.50		730.0	406.8	296,991		6.818	2,770,872	63.610
	14.75		732.0	408.8	299,269		6.870	2,845,405	65.322
	15.00		734.0	410.8	301,554		6.923	2,920,507	67.046
	15.25		736.0	412.8	303,848		6.975	2,996,183	68.783
	15.50		738.0	414.8	306,150		7.028	3,072,432	70.533
	15.75		740.0	416.8	308,459		7.081	3,149,258	72.297
	16.00		742.0	418.8	310,777		7.134	3,226,662	74.074
	16.25		744.0	420.8	313,103		7.188	3,304,647	75.864
	16.50		746.0	422.8	315,436		7.241	3,383,214	77.668
	16.75		748.0	424.8	317,778		7.295	3,462,366	79.485
	17.00		750.0	426.8	320,128		7.349	3,542,104	81.316
	17.25		752.0	428.8	322,485		7.403	3,622,431	83.160
	17.50		754.0	430.8	324,851		7.458	3,703,347	85.017

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 263 (Basins 264+268), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.25	1.548	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.15	7.011	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	6.922	Not Utilized	Zone 3 Not Utilized
Total (all zones)		15.481		

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 Diameter =	N/A	inches	Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.25	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	13.00	inches
Orifice Plate: Orifice Area per Row =	4.19	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	2.910E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.08	2.17					
Orifice Area (sq. inches)	4.19	4.19	4.19					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.25	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.25	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	32.23	N/A	
Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	4.50		inches

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.35	N/A	ft^2
Outlet Orifice Centroid =	0.22	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.05	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.16	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	1000.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.26	feet
Stage at Top of Freeboard =	6.42	feet
Basin Area at Top of Freeboard =	5.23	acres
Basin Volume at Top of Freeboard =	15.08	acre-ft

Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	1.548	8.559	5.137	7.186	9.863	15.284	19.941	25.699	41.170
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	5.137	7.186	9.863	15.284	19.941	25.699	41.170
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.1	2.8	24.0	85.4	128.3	184.2	325.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.19	0.67	1.01	1.45	2.55
Peak Inflow Q (cfs) =	N/A	N/A	78.0	109.6	152.1	249.4	327.8	418.8	664.4
Peak Outflow Q (cfs) =	0.6	4.5	4.3	4.4	18.4	138.1	236.1	366.8	686.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.6	0.8	1.6	1.8	2.0	2.1
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.33	0.32	0.3	0.3	0.3	0.3	0.3	0.3
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) =	38	53	48	52	55	50	47	43	32
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	53	57	62	60	58	56	52
Maximum Ponding Depth (ft) =	3.25	5.15	4.27	4.72	5.19	5.29	5.34	5.40	5.53
Area at Maximum Ponding Depth (acres) =	1.93	4.99	3.88	4.92	5.00	5.02	5.03	5.04	5.06
Maximum Volume Stored (acre-ft) =	1.567	8.588	4.472	6.457	8.738	9.239	9.540	9.843	10.499

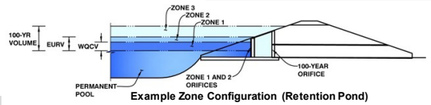
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: Basin 514+518 (DP 510) 100-yr Flood Control Only



Example Zone Configuration (Retention Pond)

Watershed Information

	Flood Control Only	
	No BMP	
Watershed Area =	168.27	acres
Watershed Length =	4,897	ft
Watershed Length to Centroid =	2,411	ft
Watershed Slope =	0.025	ft/ft
Watershed Imperviousness =	56.60%	percent
Percentage Hydrologic Soil Group A =	16.7%	percent
Percentage Hydrologic Soil Group B =	65.4%	percent
Percentage Hydrologic Soil Groups C/D =	17.9%	percent
Target WQCV Drain Time =	N/A	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.895 acre-feet	1.895	acre-feet
Excess Urban Runoff Volume (EURV) =	10.253 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	6.081 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	8.538 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	11.775 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	18.872 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	24.947 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	32.613 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	53.041 acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	5.582 acre-feet		
Approximate 5-yr Detention Volume =	7.980 acre-feet		
Approximate 10-yr Detention Volume =	10.733 acre-feet		
Approximate 25-yr Detention Volume =	13.822 acre-feet		
Approximate 50-yr Detention Volume =	15.898 acre-feet		
Approximate 100-yr Detention Volume =	19.016 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (100-year)	19.016	acre-feet
Select Zone 2 Storage Volume (Optional)		acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	19.016	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	15.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.010	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	

Initial Surcharge Area (A_{ISV}) =	0	ft^2
Surcharge Volume Length (L_{ISV}) =	0.0	ft
Surcharge Volume Width (W_{ISV}) =	0.0	ft
Depth of Basin Floor (H_{FLOOR}) =	0.00	ft
Length of Basin Floor (L_{FLOOR}) =	240.6	ft
Width of Basin Floor (W_{FLOOR}) =	120.3	ft
Area of Basin Floor (A_{FLOOR}) =	28,943	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{MAIN}) =	15.00	ft
Length of Main Basin (L_{MAIN}) =	360.6	ft
Width of Main Basin (W_{MAIN}) =	240.3	ft
Area of Main Basin (A_{MAIN}) =	86,650	ft^2
Volume of Main Basin (V_{MAIN}) =	828,357	ft^3
Calculated Total Basin Volume (V_{total}) =	**19.016**	acre-feet

Depth Increment = 0.25 ft

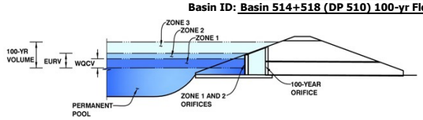
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		240.6	120.3	28,943		0.664		
	0.25		242.6	122.3	29,669		0.681	7,326	0.168
	0.50		244.6	124.3	30,402		0.698	14,835	0.341
	0.75		246.6	126.3	31,144		0.715	22,528	0.517
	1.00		248.6	128.3	31,894		0.732	30,408	0.698
	1.25		250.6	130.3	32,652		0.750	38,476	0.883
	1.50		252.6	132.3	33,417		0.767	46,734	1.073
	1.75		254.6	134.3	34,191		0.785	55,185	1.267
	2.00		256.6	136.3	34,973		0.803	63,830	1.465
	2.25		258.6	138.3	35,763		0.821	72,672	1.668
	2.50		260.6	140.3	36,561		0.839	81,713	1.876
	2.75		262.6	142.3	37,366		0.858	90,953	2.088
	3.00		264.6	144.3	38,180		0.876	100,396	2.305
	3.25		266.6	146.3	39,002		0.895	110,044	2.526
	3.50		268.6	148.3	39,832		0.914	119,898	2.752
	3.75		270.6	150.3	40,670		0.934	129,961	2.983
	4.00		272.6	152.3	41,515		0.953	140,234	3.219
	4.25		274.6	154.3	42,369		0.973	150,719	3.460
	4.50		276.6	156.3	43,231		0.992	161,419	3.706
	4.75		278.6	158.3	44,101		1.012	172,335	3.956
	5.00		280.6	160.3	44,978		1.033	183,470	4.212
	5.25		282.6	162.3	45,864		1.053	194,825	4.473
	5.50		284.6	164.3	46,758		1.073	206,402	4.738
	5.75		286.6	166.3	47,660		1.094	218,205	5.009
	6.00		288.6	168.3	48,570		1.115	230,233	5.285
	6.25		290.6	170.3	49,487		1.136	242,490	5.567
	6.50		292.6	172.3	50,413		1.157	254,977	5.853
	6.75		294.6	174.3	51,347		1.179	267,697	6.145
	7.00		296.6	176.3	52,289		1.200	280,652	6.443
	7.25		298.6	178.3	53,238		1.222	293,842	6.746
	7.50		300.6	180.3	54,196		1.244	307,271	7.054
	7.75		302.6	182.3	55,162		1.266	320,941	7.368
	8.00		304.6	184.3	56,136		1.289	334,853	7.687
	8.25		306.6	186.3	57,118		1.311	349,010	8.012
	8.50		308.6	188.3	58,107		1.334	363,413	8.343
	8.75		310.6	190.3	59,105		1.357	378,064	8.679
	9.00		312.6	192.3	60,111		1.380	392,966	9.021
	9.25		314.6	194.3	61,125		1.403	408,120	9.369
	9.50		316.6	196.3	62,147		1.427	423,529	9.723
	9.75		318.6	198.3	63,176		1.450	439,194	10.083
	10.00		320.6	200.3	64,214		1.474	455,118	10.448
	10.25		322.6	202.3	65,260		1.498	471,302	10.820
	10.50		324.6	204.3	66,314		1.522	487,748	11.197
	10.75		326.6	206.3	67,375		1.547	504,459	11.581
	11.00		328.6	208.3	68,445		1.571	521,437	11.971
	11.25		330.6	210.3	69,523		1.596	538,683	12.366
	11.50		332.6	212.3	70,609		1.621	556,199	12.769
	11.75		334.6	214.3	71,703		1.646	573,988	13.177
	12.00		336.6	216.3	72,804		1.671	592,051	13.592
	12.25		338.6	218.3	73,914		1.697	610,390	14.013
	12.50		340.6	220.3	75,032		1.722	629,009	14.440
	12.75		342.6	222.3	76,158		1.748	647,907	14.874
	13.00		344.6	224.3	77,291		1.774	667,088	15.314
	13.25		346.6	226.3	78,433		1.801	686,553	15.761
	13.50		348.6	228.3	79,583		1.827	706,305	16.215
	13.75		350.6	230.3	80,741		1.854	726,346	16.675
	14.00		352.6	232.3	81,907		1.880	746,676	17.141
	14.25		354.6	234.3	83,080		1.907	767,300	17.615
	14.50		356.6	236.3	84,262		1.934	788,217	18.095
	14.75		358.6	238.3	85,452		1.962	809,431	18.582
Zone 1 (100-year)	14.98		360.4	240.1	86,554		1.987	829,212	19.036
	15.00		360.6	240.3	86,650		1.989	830,944	19.076

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: Basin 514+518 (DP 510) 100-yr Flood Control Only



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (100-year)	14.98	19.016	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 2				Select Zone 2 Outlet Type
Zone 3				Select Zone 3 Outlet Type
Total (all zones)		19.016		

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 Diameter =	N/A	inches	

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	sq. inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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 Rectangular	Not Selected
Invert of Vertical Orifice =	0.00	
Depth at top of Zone using Vertical Orifice =	14.98	
Vertical Orifice Height =	42.00	
Vertical Orifice Width =	60.00	

ft (relative to basin bottom at Stage = 0 ft)
ft (relative to basin bottom at Stage = 0 ft)
inches
inches

Calculated Parameters for Vertical Orifice

	Zone 1 Rectangular	Not Selected	
Vertical Orifice Area =	17.50		ft^2
Vertical Orifice Centroid =	1.75		feet

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	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =	Select Grate Type	Select Grate Type	
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

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

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	1.895	10.253	6.081	8.538	11.775	18.872	24.947	32.613	53.041
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.081	8.538	11.775	18.872	24.947	24.913	53.041
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.1	2.0	20.3	89.3	138.8	205.2	368.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.12	0.53	0.82	1.22	2.19
Peak Inflow Q (cfs) =	N/A	N/A	79.6	111.7	156.4	272.8	361.7	380.9	752.9
Peak Outflow Q (cfs) =	52.4	231.7	52.1	76.9	111.7	173.6	210.1	208.4	325.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	38.3	5.5	1.9	1.5	1.0	0.9
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	Vertical Orifice 1
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) =	7	2	4	4	3	3	3	3	3
Time to Drain 99% of Inflow Volume (hours) =	**16**	5	8	7	6	4	4	7	4
Maximum Ponding Depth (ft) =	2.53	9.87	2.30	2.85	3.51	6.00	7.97	7.87	16.68
Area at Maximum Ponding Depth (acres) =	0.84	1.46	0.82	0.87	0.91	1.11	1.29	1.28	2.18
Maximum Volume Stored (acre-ft) =	1.901	10.257	1.709	2.174	2.752	5.274	7.636	7.508	22.554

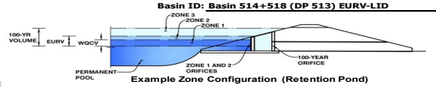
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: Basin 514+518 (DP 513) EURV-LID



Example Zone Configuration (Retention Pond)

Watershed Information

	EDB	
Extended Detention Basin (EDB)		
Watershed Area =	168.27	acres
Watershed Length =	4,897	ft
Watershed Length to Centroid =	2,411	ft
Watershed Slope =	0.025	ft/ft
Watershed Imperviousness =	56.60%	percent
Percentage Hydrologic Soil Group A =	16.7%	percent
Percentage Hydrologic Soil Group B =	65.4%	percent
Percentage Hydrologic Soil Groups C/D =	17.9%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.895 acre-feet	1.895	acre-feet
Excess Urban Runoff Volume (EURV) =	10.253 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	6.081 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	8.538 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	11.775 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	18.872 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	24.947 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	32.613 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	53.041 acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	5.582 acre-feet		
Approximate 5-yr Detention Volume =	7.980 acre-feet		
Approximate 10-yr Detention Volume =	10.733 acre-feet		
Approximate 25-yr Detention Volume =	13.822 acre-feet		
Approximate 50-yr Detention Volume =	15.898 acre-feet		
Approximate 100-yr Detention Volume =	19.016 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	1.895	acre-feet
Zone 2 Volume (EURV - Zone 1)	8.358	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	8.764	acre-feet
Total Detention Basin Volume =	19.016	acre-feet
Initial Surcharge Volume (ISV) =	248	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.006	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	

Initial Surcharge Area (A_{ISV}) =	495	ft^2
Surcharge Volume Length (L_{ISV}) =	22.3	ft
Surcharge Volume Width (W_{ISV}) =	22.3	ft
Depth of Basin Floor (H_{FLOOR}) =	4.66	ft
Length of Basin Floor (L_{FLOOR}) =	817.6	ft
Width of Basin Floor (W_{FLOOR}) =	410.6	ft
Area of Basin Floor (A_{FLOOR}) =	335,681	ft^2
Volume of Basin Floor (V_{FLOOR}) =	542,223	ft^3
Depth of Main Basin (H_{MAIN}) =	0.84	ft
Length of Main Basin (L_{MAIN}) =	824.3	ft
Width of Main Basin (W_{MAIN}) =	417.3	ft
Area of Main Basin (A_{MAIN}) =	343,979	ft^2
Volume of Main Basin (V_{MAIN}) =	285,450	ft^3
Calculated Total Basin Volume (V_{total}) =	**19.012**	acre-feet

Depth Increment = 0.25 ft

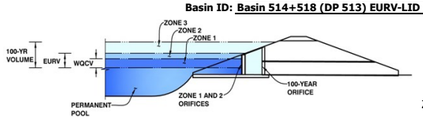
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		22.3	22.3	495		0.011		
ISV	0.50		22.3	22.3	495		0.011	248	0.006
	0.75		22.3	22.3	495		0.011	371	0.009
	1.00		22.3	22.3	495		0.011	495	0.011
	1.25		64.9	43.1	2,797		0.064	870	0.020
	1.50		107.6	63.9	6,877		0.158	2,042	0.047
	1.75		150.3	84.8	12,735		0.292	4,457	0.102
	2.00		192.9	105.6	20,370		0.468	8,558	0.196
	2.25		235.6	126.4	29,783		0.684	14,790	0.340
	2.50		278.3	147.3	40,974		0.941	23,598	0.542
	2.75		320.9	168.1	53,943		1.238	35,425	0.813
	3.00		363.6	188.9	68,690		1.577	50,717	1.164
	3.25		406.3	209.8	85,214		1.956	69,918	1.605
Zone 1 (WQCV)	3.40		431.9	222.3	95,982		2.203	83,500	1.917
	3.50		448.9	230.6	103,516		2.376	93,472	2.146
	3.75		491.6	251.4	123,596		2.837	121,824	2.797
	4.00		534.3	272.3	145,453		3.339	155,418	3.568
	4.25		576.9	293.1	169,089		3.882	194,699	4.470
	4.50		619.6	313.9	194,502		4.465	240,111	5.512
	4.75		662.3	334.8	221,693		5.089	292,098	6.706
	5.00		704.9	355.6	250,662		5.754	351,106	8.060
	5.25		747.6	376.4	281,408		6.460	417,577	9.586
Zone 2 (EURV)	5.36		766.4	385.6	295,500		6.784	449,304	10.315
	5.50		790.3	397.3	313,933		7.207	491,958	11.294
Floor	5.66		817.6	410.6	335,681		7.706	543,917	12.487
	5.75		818.3	411.3	336,566		7.726	574,168	13.181
	6.00		820.3	413.3	339,029		7.783	658,618	15.120
	6.25		822.3	415.3	341,500		7.840	743,684	17.073
Zone 3 (100-year)	6.50		824.3	417.3	343,979		7.897	829,368	19.040
	6.75		826.3	419.3	346,467		7.954	915,674	21.021
	7.00		828.3	421.3	348,962		8.011	1,002,602	23.017
	7.25		830.3	423.3	351,465		8.069	1,090,155	25.027
	7.50		832.3	425.3	353,976		8.126	1,178,335	27.051
	7.75		834.3	427.3	356,495		8.184	1,267,144	29.090
	8.00		836.3	429.3	359,022		8.242	1,356,584	31.143
	8.25		838.3	431.3	361,558		8.300	1,446,656	33.211
	8.50		840.3	433.3	364,101		8.359	1,537,363	35.293
	8.75		842.3	435.3	366,652		8.417	1,628,707	37.390
	9.00		844.3	437.3	369,211		8.476	1,720,690	39.502
	9.25		846.3	439.3	371,778		8.535	1,813,313	41.628
	9.50		848.3	441.3	374,354		8.594	1,906,580	43.769
	9.75		850.3	443.3	376,937		8.653	2,000,491	45.925
	10.00		852.3	445.3	379,528		8.713	2,095,049	48.096
	10.25		854.3	447.3	382,127		8.772	2,190,255	50.281
	10.50		856.3	449.3	384,734		8.832	2,286,113	52.482
	10.75		858.3	451.3	387,349		8.892	2,382,623	54.698
	11.00		860.3	453.3	389,973		8.953	2,479,788	56.928
	11.25		862.3	455.3	392,604		9.013	2,577,610	59.174
	11.50		864.3	457.3	395,243		9.074	2,676,091	61.435
	11.75		866.3	459.3	397,890		9.134	2,775,232	63.711
	12.00		868.3	461.3	400,545		9.195	2,875,037	66.002
	12.25		870.3	463.3	403,209		9.256	2,975,506	68.308
	12.50		872.3	465.3	405,880		9.318	3,076,642	70.630
	12.75		874.3	467.3	408,559		9.379	3,178,446	72.967
	13.00		876.3	469.3	411,246		9.441	3,280,922	75.320
	13.25		878.3	471.3	413,941		9.503	3,384,070	77.688
	13.50		880.3	473.3	416,644		9.565	3,487,893	80.071
	13.75		882.3	475.3	419,356		9.627	3,592,393	82.470
	14.00		884.3	477.3	422,075		9.690	3,697,571	84.885
	14.25		886.3	479.3	424,802		9.752	3,803,431	87.315
	14.50		888.3	481.3	427,537		9.815	3,909,973	89.761
	14.75		890.3	483.3	430,280		9.878	4,017,200	92.222
	15.00		892.3	485.3	433,031		9.941	4,125,114	94.700
	15.25		894.3	487.3	435,791		10.004	4,233,716	97.193
	15.50		896.3	489.3	438,558		10.068	4,343,010	99.702
	15.75		898.3	491.3	441,333		10.132	4,452,996	102.227
	16.00		900.3	493.3	444,116		10.196	4,563,677	104.768
	16.25		902.3	495.3	446,907		10.260	4,675,055	107.324
	16.50		904.3	497.3	449,707		10.324	4,787,131	109.897
	16.75		906.3	499.3	452,514		10.388	4,899,909	112.486
	17.00		908.3	501.3	455,329		10.453	5,013,389	115.092
	17.25		910.3	503.3	458,152		10.518	5,127,574	117.713
	17.50		912.3	505.3	460,983		10.583	5,242,466	120.350
	17.75		914.3	507.3	463,822		10.648	5,358,066	123.004
	18.00		916.3	509.3	466,670		10.713	5,474,378	125.674
	18.25		918.3	511.3	469,525		10.779	5,591,402	128.361
	18.50		920.3	513.3	472,388		10.845	5,709,141	131.064
	18.75		922.3	515.3	475,259		10.910	5,827,596	133.783
	19.00		924.3	517.3	478,138		10.977	5,946,771	136.519
	19.25		926.3	519.3	481,026		11.043	6,066,666	139.271
	19.50		928.3	521.3	483,921		11.109	6,187,284	142.041
	19.75		930.3	523.3	486,824		11.176	6,308,627	144.826
	20.00		932.3	525.3	489,735		11.243	6,430,697	147.628
	20.25		934.3	527.3	492,654		11.310	6,553,495	150.448
	20.50		936.3	529.3	495,581		11.377	6,677,025	153.283
	20.75		938.3	531.3	498,517		11.444	6,801,287	156.136
	21.00		940.3	533.3	501,460		11.512	6,926,284	159.006
	21.25		942.3	535.3	504,411		11.580	7,052,017	161.892
	21.50		944.3	537.3	507,370		11.648	7,178,490	164.795
	21.75		946.3	539.3	510,337		11.716	7,305,703	167.716
	22.00		948.3	541.3	513,313		11.784	7,433,659	170.653
	22.25		950.3	543.3	516,296		11.853	7,562,360	173.608
	22.50		952.3	545.3	519,287		11.921	7,691,808	176.580
	22.75		954.3	547.3	522,286		11.990	7,822,004	179.569
	23.00		956.3	549.3	525,293		12.059	7,952,951	182.575
	23.25		958.3	551.3	528,308		12.128	8,084,651	185.598
	23.50		960.3	553.3	531,332		12.198	8,217,106	188.639
	23.75		962.3	555.3	534,363		12.267	8,350,318	191.697
	24.00		964.3	557.3	537,402		12.337	8,484,288	194.772

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: Basin 514+518 (DP 513) EURV-LID



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.40	1.895	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.36	8.358	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	8.764	Not Utilized	Zone 3 Not Utilized
Total (all zones)		19.016		

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

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

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)

		Calculated Parameters for Plate	
Centroid of Lowest Orifice =	0.00 ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	3.514E-02 ft^2
Depth at top of Zone using Orifice Plate =	3.40 ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A feet
Orifice Plate: Orifice Vertical Spacing =	12.40 inches	Elliptical Slot Centroid =	N/A feet
Orifice Plate: Orifice Area per Row =	5.06 sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A ft^2

Size Plate to match WQCV Drain Time

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.13	2.27					
Orifice Area (sq. inches)	5.06	5.06	5.06					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected		Calculated Parameters for Vertical Orifice	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

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

	Zone 2 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.40	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.40	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	27.80	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 2 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.40	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.25	N/A	feet
Restrictor Plate Height Above Pipe Invert =	5.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.11	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway	
Spillway Invert Stage=	5.37	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.29 feet
Spillway Crest Length =	1000.00	feet	Stage at Top of Freeboard =	6.66 feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	7.93 acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	20.31 acre-ft

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

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	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	1.895	10.253	6.081	8.538	11.775	18.872	24.947	32.613	53.041
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.081	8.538	11.775	18.872	24.947	32.613	53.041
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.1	2.0	20.3	89.3	138.8	205.2	368.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.12	0.53	0.82	1.22	2.19
Peak Inflow Q (cfs) =	N/A	N/A	79.6	111.7	156.4	272.8	361.7	470.6	752.9
Peak Outflow Q (cfs) =	0.7	5.3	5.0	5.2	16.3	146.0	256.2	388.5	755.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.6	0.8	1.6	1.8	1.9	2.1
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.38	0.37	0.4	0.4	0.4	0.4	0.4	0.4
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) =	38	54	49	52	56	51	47	43	32
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	53	57	63	61	59	57	52
Maximum Ponding Depth (ft) =	3.40	5.36	4.45	4.93	5.39	5.50	5.56	5.62	5.77
Area at Maximum Ponding Depth (acres) =	2.20	6.78	4.32	5.54	6.87	7.18	7.39	7.58	7.73
Maximum Volume Stored (acre-ft) =	1.917	10.315	5.249	7.609	10.519	11.222	11.732	12.181	13.258

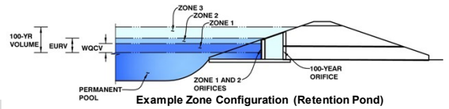
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 614 (Basins 614), EURV



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	=	**EDB**
Watershed Area =	100.31	acres
Watershed Length =	3,204	ft
Watershed Length to Centroid =	1,742	ft
Watershed Slope =	0.036	ft/ft
Watershed Imperviousness =	52.38%	percent
Percentage Hydrologic Soil Group A =	43.8%	percent
Percentage Hydrologic Soil Group B =	54.4%	percent
Percentage Hydrologic Soil Groups C/D =	1.8%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.068	acre-feet	1.068	acre-feet
Excess Urban Runoff Volume (EURV) =	5.845	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	3.178	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	4.503	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	5.945	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	9.935	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	13.374	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	17.935	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	29.726	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	2.955	acre-feet		
Approximate 5-yr Detention Volume =	4.159	acre-feet		
Approximate 10-yr Detention Volume =	5.666	acre-feet		
Approximate 25-yr Detention Volume =	7.556	acre-feet		
Approximate 50-yr Detention Volume =	8.865	acre-feet		
Approximate 100-yr Detention Volume =	10.706	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	1.068	acre-feet
Zone 2 Volume (EURV - Zone 1)	4.777	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	4.861	acre-feet
Total Detention Basin Volume =	10.706	acre-feet
Initial Surcharge Volume (ISV) =	140	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.008	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	279	ft^2
Surcharge Volume Length (L_{ISV}) =	16.7	ft
Surcharge Volume Width (W_{ISV}) =	16.7	ft
Depth of Basin Floor (H_{FLOOR}) =	4.60	ft
Length of Basin Floor (L_{FLOOR}) =	610.1	ft
Width of Basin Floor (W_{FLOOR}) =	304.2	ft
Area of Basin Floor (A_{FLOOR}) =	185,599	ft^2
Volume of Basin Floor (V_{FLOOR}) =	296,050	ft^3
Depth of Main Basin (H_{MAIN}) =	0.90	ft
Length of Main Basin (L_{MAIN}) =	617.3	ft
Width of Main Basin (W_{MAIN}) =	311.4	ft
Area of Main Basin (A_{MAIN}) =	192,234	ft^2
Volume of Main Basin (V_{MAIN}) =	170,016	ft^3
Calculated Total Basin Volume (V_{total}) =	**10.706**	acre-feet

Depth Increment = 0.25 ft

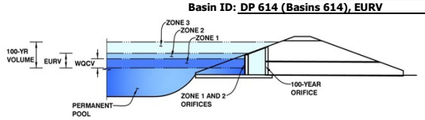
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		16.7	16.7	279		0.006		
ISV	0.50		16.7	16.7	279		0.006	140	0.003
	0.75		16.7	16.7	279		0.006	209	0.005
	1.00		16.7	16.7	279		0.006	279	0.006
	1.25		49.0	32.3	1,583		0.036	491	0.011
	1.50		81.2	48.0	3,894		0.089	1,155	0.027
	1.75		113.5	63.6	7,214		0.166	2,522	0.058
	2.00		145.7	79.2	11,541		0.265	4,845	0.111
	2.25		178.0	94.8	16,876		0.387	8,377	0.192
	2.50		210.2	110.5	23,219		0.533	13,368	0.307
	2.75		242.5	126.1	30,570		0.702	20,070	0.461
	3.00		274.7	141.7	38,928		0.894	28,736	0.660
	3.25		307.0	157.3	48,294		1.109	39,618	0.910
	3.50		339.2	173.0	58,668		1.347	52,967	1.216
Zone 1 (WQCV)	3.75		371.5	188.6	70,050		1.608	69,036	1.585
	4.00		403.7	204.2	82,440		1.893	88,077	2.022
	4.25		436.0	219.8	95,837		2.200	110,340	2.533
	4.50		468.2	235.5	110,243		2.531	136,079	3.124
	4.75		500.5	251.1	125,656		2.885	165,546	3.800
	5.00		532.7	266.7	142,077		3.262	198,991	4.568
	5.25		565.0	282.3	159,506		3.662	236,668	5.433
	5.50		597.2	298.0	177,942		4.085	278,828	6.401
	5.75		611.3	305.4	186,698		4.286	324,926	7.459
	6.00		613.3	307.4	188,535		4.328	371,830	8.536
Zone 2 (EURV)	6.03		613.5	307.6	188,756		4.333	377,489	8.666
	6.25		615.3	309.4	190,381		4.371	419,194	9.623
Floor	6.50		617.3	311.4	192,234		4.413	467,021	10.721
	6.75		619.3	313.4	194,095		4.456	515,312	11.830
	7.00		621.3	315.4	195,965		4.499	564,069	12.949
	7.25		623.3	317.4	197,842		4.542	613,295	14.079
Zone 3 (100-year)	7.29		623.6	317.7	198,143		4.549	621,215	14.261
	7.50		625.3	319.4	199,728		4.585	662,991	15.220
	7.75		627.3	321.4	201,621		4.629	713,159	16.372
	8.00		629.3	323.4	203,523		4.672	763,802	17.534
	8.25		631.3	325.4	205,432		4.716	814,921	18.708
	8.50		633.3	327.4	207,349		4.760	866,519	19.893
	8.75		635.3	329.4	209,275		4.804	918,597	21.088
	9.00		637.3	331.4	211,208		4.849	971,157	22.295
	9.25		639.3	333.4	213,150		4.893	1,024,201	23.512
	9.50		641.3	335.4	215,099		4.938	1,077,732	24.741
	9.75		643.3	337.4	217,057		4.983	1,131,752	25.981
	10.00		645.3	339.4	219,022		5.028	1,186,261	27.233
	10.25		647.3	341.4	220,995		5.073	1,241,263	28.495
	10.50		649.3	343.4	222,977		5.119	1,296,760	29.770
	10.75		651.3	345.4	224,966		5.165	1,352,752	31.055
	11.00		653.3	347.4	226,964		5.210	1,409,243	32.352
	11.25		655.3	349.4	228,969		5.256	1,466,235	33.660
	11.50		657.3	351.4	230,983		5.303	1,523,729	34.980
	11.75		659.3	353.4	233,004		5.349	1,581,727	36.311
	12.00		661.3	355.4	235,033		5.396	1,640,231	37.655
	12.25		663.3	357.4	237,071		5.442	1,699,244	39.009
	12.50		665.3	359.4	239,116		5.489	1,758,767	40.376
	12.75		667.3	361.4	241,170		5.536	1,818,803	41.754
	13.00		669.3	363.4	243,231		5.584	1,879,353	43.144
	13.25		671.3	365.4	245,301		5.631	1,940,419	44.546
	13.50		673.3	367.4	247,378		5.679	2,002,004	45.960
	13.75		675.3	369.4	249,463		5.727	2,064,109	47.385
	14.00		677.3	371.4	251,557		5.775	2,126,736	48.823

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 614 (Basins 614), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.39	1.068	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.36	4.777	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	4.861	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
	Total (all zones)	10.706		

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

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

Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

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)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.979E-02	ft^2
Depth at top of Zone using Orifice Plate =	3.39	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	13.60	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	2.85	sq. inches (diameter = 1-7/8 inches)	Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.13	2.26					
Orifice Area (sq. inches)	2.85	2.85	2.85					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected		Calculated Parameters for Vertical Orifice	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 2 Weir	Zone 3 Weir		Calculated Parameters for Overflow Weir	Zone 2 Weir	Zone 3 Weir	
Overflow Weir Front Edge Height, Ho =	3.39	5.36	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.39		feet
Overflow Weir Front Edge Length =	4.00		feet	Overflow Weir Slope Length =	4.00		feet
Overflow Weir Grate Slope =	0.00		H:V	Grate Open Area / 100-yr Orifice Area =	52.41		
Horiz. Length of Weir Sides =	4.00		feet	Overflow Grate Open Area w/o Debris =	11.14		ft^2
Overflow Grate Type =	Type C Grate	Select Grate Type		Overflow Grate Open Area w/ Debris =	5.57		ft^2
Debris Clogging % =	50%		%				

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

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

	Zone 2 Restrictor	Zone 3 Restrictor		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 2 Restrictor	Zone 3 Restrictor	
Depth to Invert of Outlet Pipe =	2.50		ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.21		ft^2
Outlet Pipe Diameter =	18.00		inches	Outlet Orifice Centroid =	0.16		feet
Restrictor Plate Height Above Pipe Invert =	3.20		inches	Half-Central Angle of Restrictor Plate on Pipe =	0.87		radians

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway	
Spillway Invert Stage=	5.37	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.21 feet
Spillway Crest Length =	1000.00	feet	Stage at Top of Freeboard =	6.58 feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	4.43 acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	11.07 acre-ft

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

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	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	1.068	5.845	3.178	4.503	5.945	9.935	13.374	17.935	29.726
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.178	4.503	5.945	9.935	13.374	17.935	29.726
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.5	1.2	2.8	48.9	85.0	132.1	245.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.03	0.49	0.85	1.32	2.45
Peak Inflow Q (cfs) =	N/A	N/A	46.3	66.8	88.4	160.8	220.7	293.8	481.4
Peak Outflow Q (cfs) =	0.4	2.8	2.6	2.7	2.8	83.5	162.7	257.5	559.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.3	1.0	1.7	1.9	1.9	2.3
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.20	0.19	0.2	0.2	0.2	0.2	0.2	0.2
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) =	38	54	47	51	55	51	48	43	32
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	51	56	61	61	59	57	52
Maximum Ponding Depth (ft) =	3.39	5.36	4.36	4.83	5.26	5.46	5.51	5.56	5.70
Area at Maximum Ponding Depth (acres) =	1.24	3.85	2.33	3.00	3.66	4.00	4.10	4.19	4.28
Maximum Volume Stored (acre-ft) =	1.074	5.846	2.760	4.036	5.433	6.199	6.442	6.649	7.202

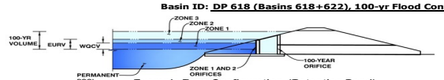
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 618 (Basins 618+622), 100-yr Flood Control Only



Example Zone Configuration (Retention Pond)

Watershed Information

Flood Control Only

	Flood Control Only	
	No BMP	
Watershed Area =	156.61	acres
Watershed Length =	5,600	ft
Watershed Length to Centroid =	3,528	ft
Watershed Slope =	0.021	ft/ft
Watershed Imperviousness =	75.29%	percent
Percentage Hydrologic Soil Group A =	15.0%	percent
Percentage Hydrologic Soil Group B =	22.8%	percent
Percentage Hydrologic Soil Groups C/D =	62.2%	percent
Target WQCV Drain Time =	N/A	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	2.358	acre-feet	2.358	acre-feet
Excess Urban Runoff Volume (EURV) =	12.426	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	7.863	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	10.883	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	14.442	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	21.127	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	27.025	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	34.095	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	53.368	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	7.361	acre-feet		
Approximate 5-yr Detention Volume =	10.419	acre-feet		
Approximate 10-yr Detention Volume =	13.154	acre-feet		
Approximate 25-yr Detention Volume =	16.643	acre-feet		
Approximate 50-yr Detention Volume =	18.915	acre-feet		
Approximate 100-yr Detention Volume =	21.892	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (100-year)	21.892	acre-feet
Select Zone 2 Storage Volume (Optional)		acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	21.892	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	15.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.010	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	0	ft^2
Surcharge Volume Length (L_{ISV}) =	0.0	ft
Surcharge Volume Width (W_{ISV}) =	0.0	ft
Depth of Basin Floor (H_{FLOOR}) =	0.00	ft
Length of Basin Floor (L_{FLOOR}) =	265.0	ft
Width of Basin Floor (W_{FLOOR}) =	132.5	ft
Area of Basin Floor (A_{FLOOR}) =	35,105	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{MAIN}) =	15.00	ft
Length of Main Basin (L_{MAIN}) =	385.0	ft
Width of Main Basin (W_{MAIN}) =	252.5	ft
Area of Main Basin (A_{MAIN}) =	97,200	ft^2
Volume of Main Basin (V_{MAIN}) =	953,602	ft^3
Calculated Total Basin Volume (V_{total}) =	**21.892**	acre-feet

Depth Increment = 0.25 ft

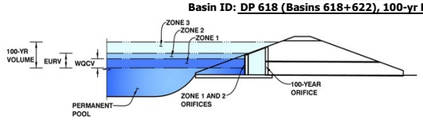
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		265.0	132.5	35,105		0.806		
	0.25		267.0	134.5	35,904		0.824	8,876	0.204
	0.50		269.0	136.5	36,711		0.843	17,953	0.412
	0.75		271.0	138.5	37,526		0.861	27,232	0.625
	1.00		273.0	140.5	38,349		0.880	36,717	0.843
	1.25		275.0	142.5	39,180		0.899	46,407	1.065
	1.50		277.0	144.5	40,019		0.919	56,307	1.293
	1.75		279.0	146.5	40,866		0.938	66,418	1.525
	2.00		281.0	148.5	41,721		0.958	76,741	1.762
	2.25		283.0	150.5	42,584		0.978	87,279	2.004
	2.50		285.0	152.5	43,455		0.998	98,033	2.251
	2.75		287.0	154.5	44,333		1.018	109,007	2.502
	3.00		289.0	156.5	45,220		1.038	120,201	2.759
	3.25		291.0	158.5	46,115		1.059	131,617	3.022
	3.50		293.0	160.5	47,018		1.079	143,259	3.289
	3.75		295.0	162.5	47,929		1.100	155,127	3.561
	4.00		297.0	164.5	48,848		1.121	167,224	3.839
	4.25		299.0	166.5	49,775		1.143	179,552	4.122
	4.50		301.0	168.5	50,710		1.164	192,112	4.410
	4.75		303.0	170.5	51,653		1.186	204,907	4.704
	5.00		305.0	172.5	52,604		1.208	217,939	5.003
	5.25		307.0	174.5	53,563		1.230	231,210	5.308
	5.50		309.0	176.5	54,530		1.252	244,721	5.618
	5.75		311.0	178.5	55,504		1.274	258,475	5.934
	6.00		313.0	180.5	56,487		1.297	272,474	6.255
	6.25		315.0	182.5	57,478		1.320	286,720	6.582
	6.50		317.0	184.5	58,477		1.342	301,214	6.915
	6.75		319.0	186.5	59,484		1.366	315,959	7.253
	7.00		321.0	188.5	60,499		1.389	330,957	7.598
	7.25		323.0	190.5	61,522		1.412	346,209	7.948
	7.50		325.0	192.5	62,553		1.436	361,718	8.304
	7.75		327.0	194.5	63,592		1.460	377,486	8.666
	8.00		329.0	196.5	64,639		1.484	393,515	9.034
	8.25		331.0	198.5	65,694		1.508	409,806	9.408
	8.50		333.0	200.5	66,757		1.533	426,363	9.788
	8.75		335.0	202.5	67,828		1.557	443,185	10.174
	9.00		337.0	204.5	68,906		1.582	460,277	10.567
	9.25		339.0	206.5	69,993		1.607	477,639	10.965
	9.50		341.0	208.5	71,088		1.632	495,274	11.370
	9.75		343.0	210.5	72,191		1.657	513,184	11.781
	10.00		345.0	212.5	73,302		1.683	531,371	12.199
	10.25		347.0	214.5	74,421		1.708	549,836	12.622
	10.50		349.0	216.5	75,548		1.734	568,582	13.053
	10.75		351.0	218.5	76,683		1.760	587,610	13.490
	11.00		353.0	220.5	77,826		1.787	606,924	13.933
	11.25		355.0	222.5	78,977		1.813	626,524	14.383
	11.50		357.0	224.5	80,136		1.840	646,413	14.840
	11.75		359.0	226.5	81,303		1.866	666,592	15.303
	12.00		361.0	228.5	82,477		1.893	687,065	15.773
	12.25		363.0	230.5	83,660		1.921	707,832	16.250
	12.50		365.0	232.5	84,851		1.948	728,896	16.733
	12.75		367.0	234.5	86,050		1.975	750,258	17.224
	13.00		369.0	236.5	87,257		2.003	771,921	17.721
	13.25		371.0	238.5	88,472		2.031	793,887	18.225
	13.50		373.0	240.5	89,695		2.059	816,158	18.736
	13.75		375.0	242.5	90,926		2.087	838,736	19.255
	14.00		377.0	244.5	92,165		2.116	861,622	19.780
	14.25		379.0	246.5	93,412		2.144	884,819	20.313
	14.50		381.0	248.5	94,667		2.173	908,328	20.852
	14.75		383.0	250.5	95,930		2.202	932,153	21.399
Zone 1 (100-year)	14.98		384.8	252.3	97,099		2.229	954,351	21.909
	15.00		385.0	252.5	97,200		2.231	956,294	21.953
	15.25		387.0	254.5	98,479		2.261	980,754	22.515
	15.50		389.0	256.5	99,766		2.290	1,005,534	23.084
	15.75		391.0	258.5	101,061		2.320	1,030,637	23.660
	16.00		393.0	260.5	102,364		2.350	1,056,065	24.244
	16.25		395.0	262.5	103,675		2.380	1,081,820	24.835
	16.50		397.0	264.5	104,994		2.410	1,107,904	25.434
	16.75		399.0	266.5	106,321		2.441	1,134,318	26.040
	17.00		401.0	268.5	107,656		2.471	1,161,065	26.654
	17.25		403.0	270.5	108,999		2.502	1,188,146	27.276
	17.50		405.0	272.5	110,350		2.533	1,215,565	27.906
	17.75		407.0	274.5	111,709		2.564	1,243,322	28.543
	18.00		409.0	276.5	113,076		2.596	1,271,420	29.188
	18.25		411.0	278.5	114,450		2.627	1,299,860	29.841
	18.50		413.0	280.5	115,833		2.659	1,328,646	30.502
	18.75		415.0	282.5	117,224		2.691	1,357,778	31.170
	19.00		417.0	284.5	118,623		2.723	1,387,258	31.847
	19.25		419.0	286.5	120,030		2.756	1,417,086	32.532
	19.50		421.0	288.5	121,445		2.788	1,447,274	33.225
	19.75		423.0	290.5	122,868		2.821	1,477,813	33.926
	20.00		425.0	292.5	124,299		2.854	1,508,709	34.635
	20.25		427.0	294.5	125,738		2.887	1,539,963	35.353
	20.50		429.0	296.5	127,185		2.920	1,571,578	36.078
	20.75		431.0	298.5	128,640		2.953	1,603,556	36.813
	21.00		433.0	300.5	130,103		2.987	1,635,899	37.555
	21.25		435.0	302.5	131,573		3.021	1,668,608	38.306
	21.50		437.0	304.5	133,052		3.054	1,701,686	39.065
	21.75		439.0	306.5	134,539		3.089	1,735,135	39.833
	22.00		441.0	308.5	136,034		3.123	1,768,957	40.610
	22.25		443.0	310.5	137,537		3.157	1,803,153	41.395
	22.50		445.0	312.5	139,048		3.192	1,837,726	42.188
	22.75		447.0	314.5	140,567		3.227	1,872,677	42.991
	23.00		449.0	316.5	142,094		3.262	1,908,010	43.802
	23.25		451.0	318.5	143,629		3.297	1,943,725	44.622
	23.50		453.0	320.5	145,172		3.333	1,979,825	45.451
	23.75		455.0	322.5	146,723		3.368	2,016,312	46.288
	24.00		457.0	324.5	148,282		3.404	2,053,187	47.135
	24.25		459.0	326.5	149,848		3.440	2,090,453	47.990

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 618 (Basins 618+622), 100-yr Flood Control Only



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (100-year)	14.98	21.892	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 2				Select Zone 2 Outlet Type
Zone 3				Select Zone 3 Outlet Type
Total (all zones)		21.892		

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

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

Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

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)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
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	sq. inches	Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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 Rectangular	Not Selected		Calculated Parameters for Vertical Orifice	Zone 1 Rectangular	Not Selected	
Invert of Vertical Orifice =	0.00		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	24.17		ft^2
Depth at top of Zone using Vertical Orifice =	14.98		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	2.42		feet
Vertical Orifice Height =	58.00		inches				
Vertical Orifice Width =	60.00		inches				

Size Vertical Orifice to drain (EURV - WQCV) Only

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		Calculated Parameters for Overflow Weir	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 =			ft^2
Overflow Grate Type =	Select Grate Type	Select Grate Type		Overflow Grate Open Area w/ Debris =			ft^2
Debris Clogging % =			%				

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

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

	Not Selected	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =			ft^2
Circular Orifice Diameter =			inches	Outlet Orifice Centroid =			feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=		ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=		feet
Spillway Crest Length =		feet	Stage at Top of Freeboard =		feet
Spillway End Slopes =		H:V	Basin Area at Top of Freeboard =		acres
Freeboard above Max Water Surface =		feet	Basin Volume at Top of Freeboard =		acre-ft

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

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	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	2.358	12.426	7.863	10.883	14.442	21.127	27.025	34.095	53.368
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	7.863	10.883	14.442	21.127	27.025	34.095	53.368
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.8	2.5	18.8	70.0	106.3	156.3	279.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.12	0.45	0.68	1.00	1.79
Peak Inflow Q (cfs) =	N/A	N/A	94.5	129.2	170.5	266.8	341.7	409.8	670.2
Peak Outflow Q (cfs) =	52.0	309.6	59.6	86.2	117.2	195.3	235.4	233.9	377.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	34.8	6.2	2.8	2.2	1.5	1.4
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	Vertical Orifice 1
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) =	9	3	5	4	4	3	3	4	3
Time to Drain 99% of Inflow Volume (hours) =	**21**	6	10	8	7	6	5	8	4
Maximum Ponding Depth (ft) =	2.61	10.14	2.62	3.21	3.80	5.23	6.51	6.46	12.96
Area at Maximum Ponding Depth (acres) =	1.01	1.70	1.01	1.05	1.10	1.23	1.34	1.34	2.00
Maximum Volume Stored (acre-ft) =	2.361	12.435	2.361	2.969	3.616	5.283	6.915	6.848	17.641

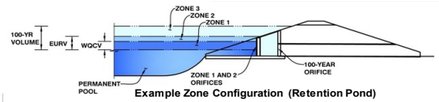
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 618 (Basins 618+622), EURV



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	=	**EDB**
Watershed Area =	156.61	acres
Watershed Length =	5,600	ft
Watershed Length to Centroid =	3,528	ft
Watershed Slope =	0.021	ft/ft
Watershed Imperviousness =	75.29%	percent
Percentage Hydrologic Soil Group A =	15.0%	percent
Percentage Hydrologic Soil Group B =	22.8%	percent
Percentage Hydrologic Soil Groups C/D =	62.2%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	2.358	acre-feet	2.358	acre-feet
Excess Urban Runoff Volume (EURV) =	12.426	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	7.863	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	10.883	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	14.442	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	21.127	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	27.025	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	34.095	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	53.368	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	7.361	acre-feet		
Approximate 5-yr Detention Volume =	10.419	acre-feet		
Approximate 10-yr Detention Volume =	13.154	acre-feet		
Approximate 25-yr Detention Volume =	16.643	acre-feet		
Approximate 50-yr Detention Volume =	18.915	acre-feet		
Approximate 100-yr Detention Volume =	21.892	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	2.358	acre-feet
Zone 2 Volume (EURV - Zone 1)	10.068	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	9.466	acre-feet
Total Detention Basin Volume =	21.892	acre-feet
Initial Surcharge Volume (ISV) =	308	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	616	ft^2
Surcharge Volume Length (L_{ISV}) =	24.8	ft
Surcharge Volume Width (W_{ISV}) =	24.8	ft
Depth of Basin Floor (H_{FLOOR}) =	3.65	ft
Length of Basin Floor (L_{FLOOR}) =	769.4	ft
Width of Basin Floor (W_{FLOOR}) =	389.8	ft
Area of Basin Floor (A_{FLOOR}) =	299,941	ft^2
Volume of Basin Floor (V_{FLOOR}) =	382,220	ft^3
Depth of Main Basin (H_{MAIN}) =	1.85	ft
Length of Main Basin (L_{MAIN}) =	784.2	ft
Width of Main Basin (W_{MAIN}) =	404.6	ft
Area of Main Basin (A_{MAIN}) =	317,317	ft^2
Volume of Main Basin (V_{MAIN}) =	570,889	ft^3
Calculated Total Basin Volume (V_{total}) =	**21.895**	acre-feet

Depth Increment = 0.25 ft

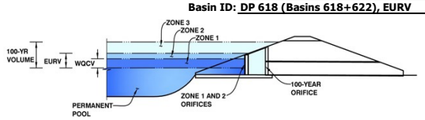
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		24.8	24.8	616		0.014		
ISV	0.50		24.8	24.8	616		0.014	308	0.007
	0.75		24.8	24.8	616		0.014	462	0.011
	1.00		24.8	24.8	616		0.014	616	0.014
	1.25		75.8	49.8	3,778		0.087	1,112	0.026
	1.50		126.8	74.8	9,490		0.218	2,718	0.062
	1.75		177.8	99.8	17,751		0.408	6,070	0.139
	2.00		228.8	124.8	28,563		0.656	11,806	0.271
	2.25		279.8	149.8	41,925		0.962	20,564	0.472
	2.50		330.8	174.8	57,837		1.328	32,981	0.757
	2.75		381.8	199.8	76,298		1.752	49,695	1.141
	3.00		432.8	224.8	97,310		2.234	71,343	1.638
	3.25		483.8	249.8	120,872		2.775	98,562	2.263
	3.50		534.8	274.8	146,983		3.374	131,991	3.030
	3.75		585.8	299.8	175,645		4.032	172,266	3.955
	4.00		636.8	324.8	206,857		4.749	220,026	5.051
	4.25		687.8	349.8	240,619		5.524	275,907	6.334
	4.50		738.8	374.8	276,930		6.357	340,548	7.818
Zone 1 (WQCV)	4.53		744.9	377.8	281,459		6.461	348,923	8.010
	4.75		770.2	390.6	300,869		6.907	413,842	9.501
	5.00		772.2	392.6	303,195		6.960	489,350	11.234
	5.25		774.2	394.6	305,529		7.014	565,440	12.981
	5.50		776.2	396.6	307,870		7.068	642,115	14.741
	5.75		778.2	398.6	310,220		7.122	719,376	16.515
	6.00		780.2	400.6	312,578		7.176	797,226	18.302
	6.25		782.2	402.6	314,943		7.230	875,666	20.103
Floor	6.50		784.2	404.6	317,317		7.285	954,698	21.917
	6.75		786.2	406.6	319,699		7.339	1,034,325	23.745
	7.00		788.2	408.6	322,089		7.394	1,114,548	25.587
	7.25		790.2	410.6	324,486		7.449	1,195,370	27.442
	7.50		792.2	412.6	326,892		7.504	1,276,792	29.311
Zone 2 (EURV)	7.55		792.6	413.0	327,374		7.515	1,293,149	29.687
	7.75		794.2	414.6	329,306		7.560	1,358,817	31.194
	8.00		796.2	416.6	331,727		7.615	1,441,446	33.091
	8.25		798.2	418.6	334,157		7.671	1,524,681	35.002
	8.50		800.2	420.6	336,595		7.727	1,608,525	36.927
	8.75		802.2	422.6	339,040		7.783	1,692,979	38.865
	9.00		804.2	424.6	341,494		7.840	1,778,046	40.818
	9.25		806.2	426.6	343,956		7.896	1,863,727	42.785
	9.50		808.2	428.6	346,426		7.953	1,950,024	44.766
Zone 3 (100-year)	9.67		809.6	430.0	348,110		7.991	2,009,060	46.122
	9.75		810.2	430.6	348,903		8.010	2,036,940	46.762
	10.00		812.2	432.6	351,389		8.067	2,124,477	48.771
	10.25		814.2	434.6	353,883		8.124	2,212,635	50.795
	10.50		816.2	436.6	356,384		8.181	2,301,419	52.833
	10.75		818.2	438.6	358,894		8.239	2,390,828	54.886
	11.00		820.2	440.6	361,412		8.297	2,480,866	56.953
	11.25		822.2	442.6	363,937		8.355	2,571,535	59.034
	11.50		824.2	444.6	366,471		8.413	2,662,836	61.130
	11.75		826.2	446.6	369,013		8.471	2,754,771	63.241
	12.00		828.2	448.6	371,563		8.530	2,847,343	65.366
	12.25		830.2	450.6	374,120		8.589	2,940,553	67.506
	12.50		832.2	452.6	376,686		8.648	3,034,404	69.660
	12.75		834.2	454.6	379,260		8.707	3,128,897	71.830
	13.00		836.2	456.6	381,841		8.766	3,224,034	74.014
	13.25		838.2	458.6	384,431		8.825	3,319,818	76.213
	13.50		840.2	460.6	387,029		8.885	3,416,250	78.426
	13.75		842.2	462.6	389,635		8.945	3,513,333	80.655
	14.00		844.2	464.6	392,248		9.005	3,611,068	82.899
	14.25		846.2	466.6	394,870		9.065	3,709,458	85.157
	14.50		848.2	468.6	397,500		9.125	3,808,504	87.431
	14.75		850.2	470.6	400,137		9.186	3,908,208	89.720
	15.00		852.2	472.6	402,783		9.247	4,008,573	92.024
	15.25		854.2	474.6	405,437		9.308	4,109,601	94.343
	15.50		856.2	476.6	408,098		9.369	4,211,292	96.678
	15.75		858.2	478.6	410,768		9.430	4,313,650	99.028

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 618 (Basins 618+622), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.29	2.358	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.18	10.068	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	9.466	Not Utilized	Zone 3 Not Utilized
	Total (all zones)	21.892		

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 Diameter =	N/A	inches

Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.29	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	13.20	inches
Orifice Plate: Orifice Area per Row =	6.35	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	4.410E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.10	2.19					
Orifice Area (sq. inches)	6.35	6.35	6.35					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.29	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.29	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	21.60	N/A	
Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	6.00		inches

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.52	N/A	ft^2
Outlet Orifice Centroid =	0.29	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.23	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.19	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	1000.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.27	feet
Stage at Top of Freeboard =	6.46	feets
Basin Area at Top of Freeboard =	7.28	acres
Basin Volume at Top of Freeboard =	21.63	acre-ft

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	2.358	12.426	7.863	10.883	14.442	21.127	27.025	34.095	53.368
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	7.863	10.883	14.442	21.127	27.025	34.095	53.368
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.8	2.5	18.8	70.0	106.3	156.3	279.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.12	0.45	0.68	1.00	1.79
Peak Inflow Q (cfs) =	N/A	N/A	94.5	129.2	170.5	266.8	341.7	431.2	670.2
Peak Outflow Q (cfs) =	0.9	6.7	6.4	6.6	22.4	132.9	231.4	350.3	656.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.6	1.2	1.9	2.2	2.2	2.3
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.49	0.47	0.5	0.5	0.5	0.5	0.5	0.5
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) =	38	54	49	53	56	52	49	45	37
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	54	58	63	61	60	58	54
Maximum Ponding Depth (ft) =	3.29	5.18	4.34	4.78	5.22	5.31	5.37	5.43	5.55
Area at Maximum Ponding Depth (acres) =	2.87	7.00	5.78	6.91	7.01	7.03	7.04	7.05	7.08
Maximum Volume Stored (acre-ft) =	2.376	12.490	6.786	9.708	12.770	13.402	13.754	14.176	15.095

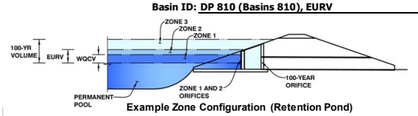
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 810 (Basins 810), EURV



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	63.86	acres
Watershed Length =	3,575	ft
Watershed Length to Centroid =	1,789	ft
Watershed Slope =	0.023	ft/ft
Watershed Imperviousness =	76.73%	percent
Percentage Hydrologic Soil Group A =	5.8%	percent
Percentage Hydrologic Soil Group B =	76.8%	percent
Percentage Hydrologic Soil Groups C/D =	17.4%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	acre-feet	0.986	acre-feet
Excess Urban Runoff Volume (EURV) =	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	acre-feet		
Approximate 5-yr Detention Volume =	acre-feet		
Approximate 10-yr Detention Volume =	acre-feet		
Approximate 25-yr Detention Volume =	acre-feet		
Approximate 50-yr Detention Volume =	acre-feet		
Approximate 100-yr Detention Volume =	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	0.986	acre-feet
Zone 2 Volume (EURV - Zone 1)	4.381	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	3.825	acre-feet
Total Detention Basin Volume =	9.192	acre-feet
Initial Surcharge Volume (ISV) =	129	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.008	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	258	ft^2
Surcharge Volume Length (L_{ISV}) =	16.1	ft
Surcharge Volume Width (W_{ISV}) =	16.1	ft
Depth of Basin Floor (H_{FLOOR}) =	3.83	ft
Length of Basin Floor (L_{FLOOR}) =	510.1	ft
Width of Basin Floor (W_{FLOOR}) =	255.4	ft
Area of Basin Floor (A_{FLOOR}) =	130,300	ft^2
Volume of Basin Floor (V_{FLOOR}) =	174,076	ft^3
Depth of Main Basin (H_{MAIN}) =	1.67	ft
Length of Main Basin (L_{MAIN}) =	523.5	ft
Width of Main Basin (W_{MAIN}) =	268.8	ft
Area of Main Basin (A_{MAIN}) =	140,706	ft^2
Volume of Main Basin (V_{MAIN}) =	226,234	ft^3
Calculated Total Basin Volume (V_{total}) =	**9.196**	acre-feet

Depth Increment = 0.25 ft

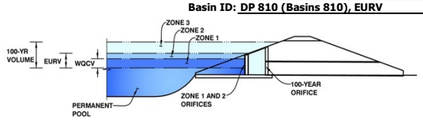
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		16.1	16.1	258		0.006		
ISV	0.50		16.1	16.1	258		0.006	129	0.003
	0.75		16.1	16.1	258		0.006	193	0.004
	1.00		16.1	16.1	258		0.006	258	0.006
	1.25		48.3	31.7	1,530		0.035	460	0.011
	1.50		80.6	47.3	3,810		0.087	1,107	0.025
	1.75		112.8	62.9	7,098		0.163	2,449	0.056
	2.00		145.1	78.6	11,394		0.262	4,740	0.109
	2.25		177.3	94.2	16,698		0.383	8,231	0.189
	2.50		209.6	109.8	23,010		0.528	13,173	0.302
	2.75		241.8	125.4	30,329		0.696	19,819	0.455
	3.00		274.1	141.1	38,656		0.887	28,421	0.652
	3.25		306.3	156.7	47,991		1.102	39,231	0.901
Zone 1 (WQCV)	3.33		316.6	161.7	51,191		1.175	43,198	0.992
	3.50		338.6	172.3	58,334		1.339	52,501	1.205
	3.75		370.8	187.9	69,684		1.600	68,482	1.572
	4.00		403.1	203.6	82,043		1.883	87,427	2.007
	4.25		435.3	219.2	95,409		2.190	109,587	2.516
	4.50		467.6	234.8	109,783		2.520	135,215	3.104
	4.75		499.8	250.4	125,165		2.873	164,563	3.778
Floor	4.83		510.1	255.4	130,300		2.991	174,781	4.012
	5.00		511.5	256.8	131,343		3.015	197,020	4.523
	5.25		513.5	258.8	132,883		3.051	230,048	5.281
Zone 2 (EURV)	5.28		513.7	259.0	133,069		3.055	234,038	5.373
	5.50		515.5	260.8	134,432		3.086	263,463	6.048
	5.75		517.5	262.8	135,988		3.122	297,265	6.824
	6.00		519.5	264.8	137,553		3.158	331,458	7.609
	6.25		521.5	266.8	139,125		3.194	366,042	8.403
Zone 3 (100-year)	6.50		523.5	268.8	140,706		3.230	401,021	9.206
	6.75		525.5	270.8	142,295		3.267	436,396	10.018
	7.00		527.5	272.8	143,891		3.303	472,169	10.840
	7.25		529.5	274.8	145,496		3.340	508,342	11.670
	7.50		531.5	276.8	147,108		3.377	544,917	12.510
	7.75		533.5	278.8	148,729		3.414	581,897	13.359
	8.00		535.5	280.8	150,357		3.452	619,282	14.217
	8.25		537.5	282.8	151,994		3.489	657,076	15.084
	8.50		539.5	284.8	153,638		3.527	695,280	15.961
	8.75		541.5	286.8	155,291		3.565	733,896	16.848
	9.00		543.5	288.8	156,951		3.603	772,926	17.744
	9.25		545.5	290.8	158,620		3.641	812,372	18.650
	9.50		547.5	292.8	160,297		3.680	852,237	19.565
	9.75		549.5	294.8	161,981		3.719	892,521	20.489
	10.00		551.5	296.8	163,674		3.757	933,228	21.424
	10.25		553.5	298.8	165,374		3.796	974,359	22.368
	10.50		555.5	300.8	167,083		3.836	1,015,916	23.322
	10.75		557.5	302.8	168,799		3.875	1,057,901	24.286
	11.00		559.5	304.8	170,524		3.915	1,100,316	25.260
	11.25		561.5	306.8	172,256		3.954	1,143,163	26.243
	11.50		563.5	308.8	173,997		3.994	1,186,445	27.237
	11.75		565.5	310.8	175,745		4.035	1,230,162	28.241
	12.00		567.5	312.8	177,502		4.075	1,274,318	29.254
	12.25		569.5	314.8	179,266		4.115	1,318,914	30.278
	12.50		571.5	316.8	181,039		4.156	1,363,952	31.312
	12.75		573.5	318.8	182,820		4.197	1,409,434	32.356
	13.00		575.5	320.8	184,608		4.238	1,455,362	33.411
	13.25		577.5	322.8	186,405		4.279	1,501,739	34.475
	13.50		579.5	324.8	188,209		4.321	1,548,565	35.550
	13.75		581.5	326.8	190,022		4.362	1,595,844	36.636
	14.00		583.5	328.8	191,842		4.404	1,643,577	37.731
	14.25		585.5	330.8	193,671		4.446	1,691,766	38.838
	14.50		587.5	332.8	195,507		4.488	1,740,413	39.954
	14.75		589.5	334.8	197,352		4.531	1,789,520	41.082
	15.00		591.5	336.8	199,204		4.573	1,839,090	42.220
	15.25		593.5	338.8	201,065		4.616	1,889,123	43.368
	15.50		595.5	340.8	202,934		4.659	1,939,623	44.528
	15.75		597.5	342.8	204,810		4.702	1,990,591	45.698

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 810 (Basins 810), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.33	0.986	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.28	4.381	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	3.825	Not Utilized	Zone 3 Not Utilized
Total (all zones)		9.192		

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 Diameter =	N/A	inches	

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.33	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	13.30	inches
Orifice Plate: Orifice Area per Row =	2.65	sq. inches (diameter = 1-13/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.840E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.11	2.22					
Orifice Area (sq. inches)	2.65	2.65	2.65					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.33	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.33	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	54.86	N/A	
Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	3.10		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.20	N/A	ft^2
Outlet Orifice Centroid =	0.15	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	0.86	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.29	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	1000.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.16	feet
Stage at Top of Freeboard =	6.45	feet
Basin Area at Top of Freeboard =	3.22	acres
Basin Volume at Top of Freeboard =	9.04	acre-ft

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	0.986	5.367	3.261	4.496	5.952	8.664	11.063	13.930	21.754
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.261	4.496	5.952	8.664	11.063	13.930	21.754
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.4	0.7	8.8	33.2	50.3	73.2	130.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.14	0.52	0.79	1.15	2.04
Peak Inflow Q (cfs) =	N/A	N/A	44.2	60.6	79.8	122.0	156.4	196.7	305.2
Peak Outflow Q (cfs) =	0.4	2.7	2.5	2.6	5.3	67.6	115.5	162.2	357.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	3.5	0.6	2.0	2.3	2.2	2.7
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.19	0.19	0.2	0.2	0.2	0.2	0.2	0.2
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) =	38	53	48	51	55	51	49	45	37
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	52	57	62	60	59	57	54
Maximum Ponding Depth (ft) =	3.33	5.28	4.40	4.84	5.30	5.37	5.40	5.43	5.53
Area at Maximum Ponding Depth (acres) =	1.18	3.05	2.37	2.99	3.06	3.07	3.07	3.08	3.09
Maximum Volume Stored (acre-ft) =	0.992	5.373	2.835	4.042	5.403	5.618	5.740	5.833	6.141

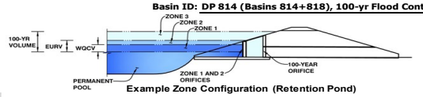
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 814 (Basins 814+818), 100-yr Flood Control Only



Example Zone Configuration (Retention Pond)

Watershed Information

Flood Control Only

Flood Control Only

	No BMP	
Watershed Area =	210.53	acres
Watershed Length =	4,665	ft
Watershed Length to Centroid =	2,450	ft
Watershed Slope =	0.019	ft/ft
Watershed Imperviousness =	64.54%	percent
Percentage Hydrologic Soil Group A =	8.7%	percent
Percentage Hydrologic Soil Group B =	45.0%	percent
Percentage Hydrologic Soil Groups C/D =	46.3%	percent
Target WQCV Drain Time =	N/A	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	2.656	acre-feet	2.656 acre-feet
Excess Urban Runoff Volume (EURV) =	14.210	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	8.937	acre-feet	0.85 inches
5-yr Runoff Volume (P1 = 1.12 in.) =	12.514	acre-feet	1.12 inches
10-yr Runoff Volume (P1 = 1.4 in.) =	17.051	acre-feet	1.40 inches
25-yr Runoff Volume (P1 = 1.87 in.) =	26.080	acre-feet	1.87 inches
50-yr Runoff Volume (P1 = 2.3 in.) =	33.878	acre-feet	2.30 inches
100-yr Runoff Volume (P1 = 2.79 in.) =	43.453	acre-feet	2.79 inches
500-yr Runoff Volume (P1 = 4.16 in.) =	69.294	acre-feet	4.16 inches
Approximate 2-yr Detention Volume =	8.255	acre-feet	
Approximate 5-yr Detention Volume =	11.858	acre-feet	
Approximate 10-yr Detention Volume =	15.324	acre-feet	
Approximate 25-yr Detention Volume =	19.392	acre-feet	
Approximate 50-yr Detention Volume =	22.076	acre-feet	
Approximate 100-yr Detention Volume =	26.029	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (100-year)	26.029	acre-feet
Select Zone 2 Storage Volume (Optional)		acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	26.029	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	25.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.010	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	0	ft^2
Surcharge Volume Length (L_{ISV}) =	0.0	ft
Surcharge Volume Width (W_{ISV}) =	0.0	ft
Depth of Basin Floor (H_{FLOOR}) =	0.00	ft
Length of Basin Floor (L_{FLOOR}) =	145.1	ft
Width of Basin Floor (W_{FLOOR}) =	72.6	ft
Area of Basin Floor (A_{FLOOR}) =	10,528	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{MAIN}) =	25.00	ft
Length of Main Basin (L_{MAIN}) =	345.1	ft
Width of Main Basin (W_{MAIN}) =	272.6	ft
Area of Main Basin (A_{MAIN}) =	94,060	ft^2
Volume of Main Basin (V_{MAIN}) =	1,133,811	ft^3
Calculated Total Basin Volume (V_{total}) =	**26.029**	acre-feet

Depth Increment = 0.25 ft

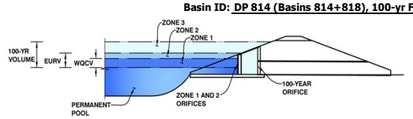
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		145.1	72.6	10,528		0.242		
	0.25		147.1	74.6	10,967		0.252	2,687	0.062
	0.50		149.1	76.6	11,415		0.262	5,484	0.126
	0.75		151.1	78.6	11,870		0.273	8,395	0.193
	1.00		153.1	80.6	12,333		0.283	11,420	0.262
	1.25		155.1	82.6	12,805		0.294	14,562	0.334
	1.50		157.1	84.6	13,284		0.305	17,823	0.409
	1.75		159.1	86.6	13,771		0.316	21,205	0.487
	2.00		161.1	88.6	14,267		0.328	24,710	0.567
	2.25		163.1	90.6	14,770		0.339	28,339	0.651
	2.50		165.1	92.6	15,281		0.351	32,095	0.737
	2.75		167.1	94.6	15,801		0.363	35,980	0.826
	3.00		169.1	96.6	16,328		0.375	39,996	0.918
	3.25		171.1	98.6	16,863		0.387	44,145	1.013
	3.50		173.1	100.6	17,407		0.400	48,429	1.112
	3.75		175.1	102.6	17,958		0.412	52,849	1.213
	4.00		177.1	104.6	18,517		0.425	57,408	1.318
	4.25		179.1	106.6	19,085		0.438	62,108	1.426
	4.50		181.1	108.6	19,660		0.451	66,951	1.537
	4.75		183.1	110.6	20,243		0.465	71,939	1.651
	5.00		185.1	112.6	20,835		0.478	77,074	1.769
	5.25		187.1	114.6	21,434		0.492	82,357	1.891
	5.50		189.1	116.6	22,041		0.506	87,791	2.015
	5.75		191.1	118.6	22,657		0.520	93,378	2.144
	6.00		193.1	120.6	23,280		0.534	99,120	2.275
	6.25		195.1	122.6	23,911		0.549	105,019	2.411
	6.50		197.1	124.6	24,551		0.564	111,076	2.550
	6.75		199.1	126.6	25,198		0.578	117,295	2.693
	7.00		201.1	128.6	25,853		0.594	123,676	2.839
	7.25		203.1	130.6	26,517		0.609	130,222	2.989
	7.50		205.1	132.6	27,188		0.624	136,935	3.144
	7.75		207.1	134.6	27,867		0.640	143,817	3.302
	8.00		209.1	136.6	28,554		0.656	150,869	3.463
	8.25		211.1	138.6	29,250		0.671	158,095	3.629
	8.50		213.1	140.6	29,953		0.688	165,495	3.799
	8.75		215.1	142.6	30,664		0.704	173,072	3.973
	9.00		217.1	144.6	31,384		0.720	180,828	4.151
	9.25		219.1	146.6	32,111		0.737	188,764	4.333
	9.50		221.1	148.6	32,846		0.754	196,884	4.520
	9.75		223.1	150.6	33,590		0.771	205,188	4.710
	10.00		225.1	152.6	34,341		0.788	213,679	4.905
	10.25		227.1	154.6	35,100		0.806	222,359	5.105
	10.50		229.1	156.6	35,868		0.823	231,230	5.308
	10.75		231.1	158.6	36,643		0.841	240,294	5.516
	11.00		233.1	160.6	37,426		0.859	249,552	5.729
	11.25		235.1	162.6	38,218		0.877	259,008	5.946
	11.50		237.1	164.6	39,017		0.896	268,662	6.168
	11.75		239.1	166.6	39,824		0.914	278,517	6.394
	12.00		241.1	168.6	40,640		0.933	288,575	6.625
	12.25		243.1	170.6	41,463		0.952	298,837	6.860
	12.50		245.1	172.6	42,294		0.971	309,307	7.101
	12.75		247.1	174.6	43,134		0.990	319,985	7.346
	13.00		249.1	176.6	43,981		1.010	330,874	7.596
	13.25		251.1	178.6	44,836		1.029	341,976	7.851
	13.50		253.1	180.6	45,700		1.049	353,293	8.110
	13.75		255.1	182.6	46,571		1.069	364,827	8.375
	14.00		257.1	184.6	47,450		1.089	376,579	8.645
	14.25		259.1	186.6	48,338		1.110	388,553	8.920
	14.50		261.1	188.6	49,233		1.130	400,749	9.200
	14.75		263.1	190.6	50,136		1.151	413,170	9.485
	15.00		265.1	192.6	51,048		1.172	425,818	9.775
	15.25		267.1	194.6	51,967		1.193	438,694	10.071
	15.50		269.1	196.6	52,894		1.214	451,802	10.372
	15.75		271.1	198.6	53,830		1.236	465,142	10.678
	16.00		273.1	200.6	54,773		1.257	478,717	10.990
	16.25		275.1	202.6	55,724		1.279	492,529	11.307
	16.50		277.1	204.6	56,683		1.301	506,580	11.629
	16.75		279.1	206.6	57,651		1.323	520,871	11.958
	17.00		281.1	208.6	58,626		1.346	535,406	12.291
	17.25		283.1	210.6	59,609		1.368	550,185	12.631
	17.50		285.1	212.6	60,601		1.391	565,211	12.975
	17.75		287.1	214.6	61,600		1.414	580,486	13.326
	18.00		289.1	216.6	62,607		1.437	596,012	13.683
	18.25		291.1	218.6	63,623		1.461	611,791	14.045
	18.50		293.1	220.6	64,646		1.484	627,824	14.413
	18.75		295.1	222.6	65,677		1.508	644,114	14.787
	19.00		297.1	224.6	66,717		1.532	660,663	15.167
	19.25		299.1	226.6	67,764		1.556	677,473	15.553
	19.50		301.1	228.6	68,819		1.580	694,546	15.945
	19.75		303.1	230.6	69,883		1.604	711,884	16.343
Zone 1 (100-year)	19.95		304.7	232.2	70,739		1.624	725,946	16.665
	20.00		305.1	232.6	70,954		1.629	729,488	16.747
	20.25		307.1	234.6	72,033		1.654	747,361	17.157
	20.50		309.1	236.6	73,121		1.679	765,505	17.574

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 814 (Basins 814+818), 100-yr Flood Control Only



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (100-year)	24.93	26.029	Rectangular Orifice
Zone 2			Select Zone 2 Outlet Type
Zone 3			Select Zone 3 Outlet Type
Total (all zones)		26.029	

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

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

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)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
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	sq. inches	Elliptical Slot Area =	N/A	ft^2

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 Rectangular	Not Selected		Calculated Parameters for Vertical Orifice	Zone 1 Rectangular	Not Selected	
Invert of Vertical Orifice =	0.00		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	30.00		ft^2
Depth at top of Zone using Vertical Orifice =	6.50		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	2.50		feet
Vertical Orifice Height =	60.00		inches				
Vertical Orifice Width =	72.00		inches				

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		Calculated Parameters for Overflow Weir	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 =			ft^2
Overflow Grate Type =	Select Grate Type	Select Grate Type		Overflow Grate Open Area w/ Debris =			ft^2
Debris Clogging % =			%				

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

	Not Selected	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =			ft^2
Circular Orifice Diameter =			inches	Outlet Orifice Centroid =			feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway	
Spillway Invert Stage=		ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	feet
Spillway Crest Length =		feet	Stage at Top of Freeboard =	feet
Spillway End Slopes =		H:V	Basin Area at Top of Freeboard =	acres
Freeboard above Max Water Surface =		feet	Basin Volume at Top of Freeboard =	acre-ft

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

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	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	2.656	14.210	8.937	12.514	17.051	26.080	33.878	43.453	69.294
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	8.937	12.514	17.051	26.080	33.878	19.688	69.294
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.6	5.5	35.7	125.8	188.7	272.4	482.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.03	0.17	0.60	0.90	1.29	2.29
Peak Inflow Q (cfs) =	N/A	N/A	126.1	174.4	239.1	392.2	509.2	324.7	1027.4
Peak Outflow Q (cfs) =	235.5	550.4	115.3	161.6	222.7	330.6	399.0	281.5	615.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	29.4	6.2	2.6	2.1	1.0	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	Vertical Orifice 1
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) =	1	1	2	2	2	2	2	2	2
Time to Drain 99% of Inflow Volume (hours) =	**2**	1	3	3	3	3	2	6	2
Maximum Ponding Depth (ft) =	6.69	18.37	3.43	4.13	4.93	7.74	10.13	6.30	20.66
Area at Maximum Ponding Depth (acres) =	0.57	1.47	0.40	0.43	0.47	0.64	0.80	0.55	1.69
Maximum Volume Stored (acre-ft) =	2.658	14.221	1.080	1.369	1.736	3.289	5.008	2.433	17.843

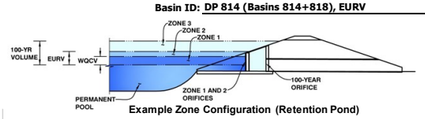
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 814 (Basins 814+818), EURV



Example Zone Configuration (Retention Pond)

Watershed Information

	EDB	
Watershed Area =	210.53	acres
Watershed Length =	4,665	ft
Watershed Length to Centroid =	2,450	ft
Watershed Slope =	0.019	ft/ft
Watershed Imperviousness =	64.54%	percent
Percentage Hydrologic Soil Group A =	8.7%	percent
Percentage Hydrologic Soil Group B =	45.0%	percent
Percentage Hydrologic Soil Groups C/D =	46.3%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Run CUHP

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	2.656 acre-feet	2.656	acre-feet
Excess Urban Runoff Volume (EURV) =	14.210 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	8.937 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	12.514 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	17.051 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	26.080 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	33.878 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	43.453 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	69.294 acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	8.255 acre-feet		
Approximate 5-yr Detention Volume =	11.858 acre-feet		
Approximate 10-yr Detention Volume =	15.324 acre-feet		
Approximate 25-yr Detention Volume =	19.392 acre-feet		
Approximate 50-yr Detention Volume =	22.076 acre-feet		
Approximate 100-yr Detention Volume =	26.029 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	2.656	acre-feet
Zone 2 Volume (EURV - Zone 1)	11.554	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	11.819	acre-feet
Total Detention Basin Volume =	26.029	acre-feet
Initial Surcharge Volume (ISV) =	347	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	694	ft^2
Surcharge Volume Length (L_{ISV}) =	26.3	ft
Surcharge Volume Width (W_{ISV}) =	26.3	ft
Depth of Basin Floor (H_{FLOOR}) =	4.37	ft
Length of Basin Floor (L_{FLOOR}) =	917.8	ft
Width of Basin Floor (W_{FLOOR}) =	463.3	ft
Area of Basin Floor (A_{FLOOR}) =	425,273	ft^2
Volume of Basin Floor (V_{FLOOR}) =	645,520	ft^3
Depth of Main Basin (H_{MAIN}) =	1.13	ft
Length of Main Basin (L_{MAIN}) =	926.9	ft
Width of Main Basin (W_{MAIN}) =	472.4	ft
Area of Main Basin (A_{MAIN}) =	437,840	ft^2
Volume of Main Basin (V_{MAIN}) =	487,641	ft^3
Calculated Total Basin Volume (V_{total}) =	**26.030**	acre-feet

Depth Increment = 0.25 ft

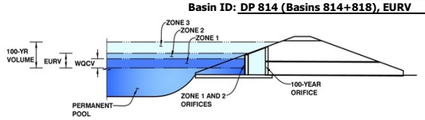
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		26.3	26.3	694		0.016		
ISV	0.50		26.3	26.3	694		0.016	347	0.008
	0.75		26.3	26.3	694		0.016	521	0.012
	1.00		26.3	26.3	694		0.016	694	0.016
	1.25		77.3	51.3	3,972		0.091	1,224	0.028
	1.50		128.3	76.3	9,799		0.225	2,892	0.066
	1.75		179.3	101.3	18,176		0.417	6,336	0.145
	2.00		230.3	126.3	29,104		0.668	12,193	0.280
	2.25		281.3	151.3	42,581		0.978	21,101	0.484
	2.50		332.3	176.3	58,608		1.345	33,696	0.774
	2.75		383.3	201.3	77,186		1.772	50,617	1.162
	3.00		434.3	226.3	98,313		2.257	72,502	1.664
	3.25		485.3	251.3	121,991		2.801	99,986	2.295
Zone 1 (WQCV)	3.38		511.9	264.3	135,311		3.106	116,704	2.679
	3.50		536.3	276.3	148,218		3.403	133,709	3.070
	3.75		587.3	301.3	176,995		4.063	174,308	4.002
	4.00		638.3	326.3	208,323		4.782	222,420	5.106
	4.25		689.3	351.3	242,200		5.560	278,682	6.398
	4.50		740.3	376.3	278,628		6.396	343,732	7.891
	4.75		791.3	401.3	317,605		7.291	418,208	9.601
	5.00		842.3	426.3	359,132		8.245	502,747	11.541
	5.25		893.3	451.3	403,210		9.256	597,987	13.728
Zone 2 (EURV)	5.31		905.6	457.3	414,168		9.508	622,507	14.291
Floor	5.37		917.8	463.3	425,273		9.763	647,690	14.869
	5.50		918.9	464.4	426,710		9.796	703,069	16.140
	5.75		920.9	466.4	429,481		9.860	810,092	18.597
	6.00		922.9	468.4	432,259		9.923	917,810	21.070
	6.25		924.9	470.4	435,046		9.987	1,026,223	23.559
Zone 3 (100-year)	6.50		926.9	472.4	437,840		10.051	1,135,333	26.064
	6.75		928.9	474.4	440,643		10.116	1,245,143	28.585
	7.00		930.9	476.4	443,453		10.180	1,355,655	31.122
	7.25		932.9	478.4	446,272		10.245	1,466,871	33.675
	7.50		934.9	480.4	449,098		10.310	1,578,792	36.244
	7.75		936.9	482.4	451,933		10.375	1,691,420	38.830
	8.00		938.9	484.4	454,775		10.440	1,804,759	41.432
	8.25		940.9	486.4	457,626		10.506	1,918,809	44.050
	8.50		942.9	488.4	460,484		10.571	2,033,572	46.684
	8.75		944.9	490.4	463,351		10.637	2,149,051	49.335
	9.00		946.9	492.4	466,225		10.703	2,265,248	52.003
	9.25		948.9	494.4	469,108		10.769	2,382,165	54.687
	9.50		950.9	496.4	471,998		10.836	2,499,803	57.388
	9.75		952.9	498.4	474,897		10.902	2,618,164	60.105
	10.00		954.9	500.4	477,803		10.969	2,737,252	62.839
	10.25		956.9	502.4	480,718		11.036	2,857,067	65.589
	10.50		958.9	504.4	483,640		11.103	2,977,611	68.357
	10.75		960.9	506.4	486,571		11.170	3,098,887	71.141
	11.00		962.9	508.4	489,509		11.238	3,220,897	73.942
	11.25		964.9	510.4	492,456		11.305	3,343,643	76.759
	11.50		966.9	512.4	495,410		11.373	3,467,126	79.594
	11.75		968.9	514.4	498,373		11.441	3,591,349	82.446
	12.00		970.9	516.4	501,343		11.509	3,716,313	85.315
	12.25		972.9	518.4	504,322		11.578	3,842,021	88.201
	12.50		974.9	520.4	507,308		11.646	3,968,474	91.104
	12.75		976.9	522.4	510,303		11.715	4,095,676	94.024
	13.00		978.9	524.4	513,305		11.784	4,223,627	96.961
	13.25		980.9	526.4	516,316		11.853	4,352,329	99.916
	13.50		982.9	528.4	519,334		11.922	4,481,785	102.888
	13.75		984.9	530.4	522,361		11.992	4,611,997	105.877
	14.00		986.9	532.4	525,395		12.061	4,742,966	108.884
	14.25		988.9	534.4	528,438		12.131	4,874,695	111.908
	14.50		990.9	536.4	531,488		12.201	5,007,186	114.949
	14.75		992.9	538.4	534,547		12.272	5,140,440	118.008
	15.00		994.9	540.4	537,613		12.342	5,274,460	121.085
	15.25		996.9	542.4	540,688		12.412	5,409,248	124.179
	15.50		998.9	544.4	543,770		12.483	5,544,805	127.291

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 814 (Basins 814+818), EURV



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.38	2.656	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.31	11.554	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3 (100-year)	6.50	11.819	Not Utilized	Zone 3 Not Utilized
Total (all zones)		26.029		

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 Diameter =	N/A	inches	Calculate Underdrain Orifice Diameter to match Target WQCV Drain Time

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.38	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	21.20	inches
Orifice Plate: Orifice Area per Row =	7.09	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	4.924E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

Size Plate to match WQCV Drain Time

Size Plate to drain (EURV - WQCV) based on a specified time. (WQCV treated by Filtration or an Upstream BMP)

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.13	2.25					
Orifice Area (sq. inches)	7.09	7.09	7.09					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

Size Vertical Orifice to drain (EURV - WQCV) Only

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.38	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Size Overflow Weir to match 90% of Predevelopment 100-year Peak Runoff Rate

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.38	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	19.36	N/A	
Overflow Grate Open Area w/o Debris =	11.14	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.57	N/A	ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	6.50		inches

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

Size Outlet Plate to pass Developed 100-yr Peak Runoff Rate w/o Detention

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.58	N/A	ft^2
Outlet Orifice Centroid =	0.32	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.29	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.51	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	1000.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.36	feet
Stage at Top of Freeboard =	7.87	feet
Basin Area at Top of Freeboard =	10.41	acres
Basin Volume at Top of Freeboard =	40.08	acre-ft

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.12	1.40	1.87	2.30	2.79	4.16
CUHP Runoff Volume (acre-ft) =	2.656	14.210	8.937	12.514	17.051	26.080	33.878	43.453	69.294
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	8.937	12.514	17.051	26.080	33.878	43.453	69.294
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.6	5.5	35.7	125.8	188.7	272.4	482.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.03	0.17	0.60	0.90	1.29	2.29
Peak Inflow Q (cfs) =	N/A	N/A	126.1	174.4	239.1	392.2	509.2	653.8	1027.4
Peak Outflow Q (cfs) =	1.0	7.6	7.2	7.4	7.7	8.1	132.1	342.0	805.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.3	0.2	0.1	0.7	1.3	1.7
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.55	0.53	0.5	0.6	0.6	0.6	0.6	0.6
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) =	38	54	50	53	58	67	66	62	52
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	54	59	65	77	77	75	71
Maximum Ponding Depth (ft) =	3.38	5.31	4.49	4.97	5.45	6.36	6.63	6.74	6.92
Area at Maximum Ponding Depth (acres) =	3.11	9.51	6.33	8.09	9.78	10.01	10.08	10.11	10.16
Maximum Volume Stored (acre-ft) =	2.679	14.291	7.764	11.215	15.651	24.559	27.272	28.483	30.308

Appendix F-3
Master Plan SWMM Input

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EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
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  City of Greeley
  Storm Drainage Master Plan
  Oklahoma and South Basins Baseline Hydrology


[TITLE]
;;Project Title/Notes
City of Greeley
Storm Drainage Master Plan
Oklahoma and South Basins Baseline Hydrology
Matrix Design Group, Inc. 2022
Option 4 - Concept Design
EURV at DP 121, 134, 146, 150
100-yr Flood Control at DP 134, 150

[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             12:00:00
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         0:00:20
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         12.566
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 "R:\22.906.007 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221
Models\CUHP_SWMM\CUHP\DCIA_1\15_Fut_100yr_0mi^2_GreeleyOS_DCIA_1.txt"

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
CONSTANT         0.0
DRY_ONLY         NO

[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
109              4779       0          0          0          0
110              4794       0          0          0          0
113              4784       0          0          0          0
114              4798       0          0          0          0
115              4816.7     0          0          0          0
117              4818       0          0          0          0
118              4830       0          0          0          0
119              4834       0          0          0          0
121              4835       0          0          0          0
122              4983       0          0          0          0
126              4999       0          0          0          0
129              4835       0          0          0          0
130              4910       0          0          0          0
133              4917       0          0          0          0
134              4945       0          0          0          0
138              4970       0          0          0          0
139              4817       0          0          0          0
141              4827       0          0          0          0
142              4820       0          0          0          0
146              4849       0          0          0          0
149              4869       0          0          0          0
150              4890       0          0          0          0
154              4904       0          0          0          0
210              4770       0          0          0          0
219              4771       0          0          0          0
220              4777       0          0          0          0
221              4790.6     0          0          0          0
223              4793       0          0          0          0
224              4810       0          0          0          0
225              4839       0          0          0          0
226              4850       0          0          0          0
228              4864       0          0          0          0
231              4790.8     0          0          0          0
232              4810       0          0          0          0
235              4845       0          0          0          0
236              4847       0          0          0          0
237              4846       0          0          0          0
239              4850       0          0          0          0
240              4849       0          0          0          0
241              4862       0          0          0          0
243              4863       0          0          0          0
244              4894       0          0          0          0
245              4980       0          0          0          0
247              4981       0          0          0          0
248              4986       0          0          0          0
250              5015       0          0          0          0
256              4851       0          0          0          0
252              4990       0          0          0          0
259              4863       0          0          0          0
260              4905       0          0          0          0
263              4922       0          0          0          0
264              4960       0          0          0          0
268              4970       0          0          0          0
309              4778       0          0          0          0
310              4779       0          0          0          0
314              4839       0          0          0          0
410              4793       0          0          0          0
414              4796       0          0          0          0
418              4802       0          0          0          0
422              4800       0          0          0          0
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426             4810       0          0          0          0
509             4826       0          0          0          0
510             4856       0          0          0          0
513             4880       0          0          0          0
514             4931       0          0          0          0
518             4940       0          0          0          0
609             4832       0          0          0          0
610             4858       0          0          0          0
613             4888       0          0          0          0
614             4899       0          0          0          0
617             4942       0          0          0          0
618             4950       0          0          0          0
622             4981       0          0          0          0
710             4975       0          0          0          0
809             4965       0          0          0          0
810             4969       0          0          0          0
813             4967       0          0          0          0
814             4970       0          0          0          0
818             4990       0          0          0          0
515             4879       0          0          0          0
616             4941       0          0          0          0

[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
O_100           4778       FREE                        NO
O_210           4754       FREE                        NO
O_220           4769       FREE                        NO
O_300           4775       FREE                        NO
O_410           4779       FREE                        NO
O_414           4781       FREE                        NO
O_418           4784       FREE                        NO
O_422           4789       FREE                        NO
O_426           4793       FREE                        NO
O_500           4804       FREE                        NO
O_600           4820       FREE                        NO
O_710           4961       FREE                        NO
O_800           4960       FREE                        NO

[STORAGE]
;;Name           Elev.    MaxDepth   InitDepth  Shape      Curve Type/Params            SurDepth  Fevap
Psi      Ksat     IMD
;;-------------- -------- ---------- ---------- ---------- ---------------------------- --------- --------
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D_EURV_121      4835     10         0          TABULAR    D_EURV_121                   0         0
D_EURV_150      4870     10         0          TABULAR    D_EURV_150                   0         0
D_EURV_134      4940     10         0          TABULAR    D_EURV_134                   0         0
D_EURV_146      4827     10         0          TABULAR    D_EURV_146                   0         0
D_FC_134        4939     10         0          TABULAR    D_FC_134                     0         0
D_FC_150        4869     10         0          TABULAR    D_FC_150                     0         0
D_EURV_225      4840     10         0          TABULAR    D_EURV_225                   0         0
D_EURV_245      4980     10         0          TABULAR    D_EURV_245                   0         0
D_EURV_263      4922     10         0          TABULAR    D_EURV_263                   0         0
D_EURV_236      4846     10         0          TABULAR    D_EURV_236                   0         0
D_EURV_244      4863     10         0          TABULAR    D_EURV_244                   0         0
D_EURV_256      4851.5   10         0          TABULAR    D_EURV_256                   0         0
D_FC_245        4980     10         0          TABULAR    D_FC_245                     0         0
D_FC_263        4922     10         0          TABULAR    D_FC_263                     0         0
D_EURV_510      4879     10         0          TABULAR    D_EURV_510                   0         0
D_FC_510        4879     10         0          TABULAR    D_FC_510                     0         0
D_EURV_614      4889     10         0          TABULAR    D_EURV_614                   0         0
D_EURV_618      4941     10         0          TABULAR    D_EURV_618                   0         0
D_FC_618        4941     10         0          TABULAR    D_FC_618                     0         0
D_EURV_810      4965     10         0          TABULAR    D_EURV_810                   0         0
D_EURV_814      4967     10         0          TABULAR    D_EURV_814                   0         0
D_FC_184        0        10         0          TABULAR    D_FC_814                     0         0

[CONDUITS]
;;Name           From Node        To Node          Length     Roughness  InOffset   OutOffset  InitFlow
MaxFlow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ----------
--------
DL_109          109              O_100            11.88      0.01       0          0          0          0
DL_110          110              109              157.65     0.01       0          0          0          0
DL_114          114              113              299.75     0.01       0          0          0          0
DL_118          118              117              163.54     0.01       0          0          0          0
DL_121          121              119              71.39      0.01       0          0          0          0
DL_122          122              D_EURV_121       314.61     0.01       0          0          0          0
DL_129          129              119              51.02      0.01       0          0          0          0
DL_130          130              129              235.94     0.01       0          0          0          0
DL_134          134              D_EURV_134       214.69     0.01       0          0          0          0
DL_142          142              139              112.30     0.01       0          0          0          0
DL_150          150              D_EURV_150       280.05     0.01       0          0          0          0
DL_210          210              O_210            198.34     0.01       0          0          0          0
DL_219          219              O_220            12.79      0.01       0          0          0          0
DL_220          220              219              239.57     0.01       0          0          0          0
DL_223          223              221              55.56      0.01       0          0          0          0
DL_224          224              223              150.97     0.01       0          0          0          0
DL_226          226              D_EURV_225       235.05     0.01       0          0          0          0
DL_231          231              221              59.69      0.01       0          0          0          0
DL_232          232              231              238.21     0.01       0          0          0          0
DL_236          236              D_EURV_236       18.27      0.01       0          0          0          0
DL_237          237              235              21.32      0.01       0          0          0          0
DL_240          240              237              121.37     0.01       0          0          0          0
DL_243          243              241              54.47      0.01       0          0          0          0
DL_244          244              D_EURV_244       238.80     0.01       0          0          0          0
DL_247          247              D_EURV_245       23.77      0.01       0          0          0          0
DL_248          248              247              146.80     0.01       0          0          0          0
DL_252          252              D_EURV_245       191.47     0.01       0          0          0          0
DL_256          256              D_EURV_256       29.90      0.035      0          0          0          0
DL_259          259              241              41.68      0.01       0          0          0          0
DL_260          260              259              177.64     0.01       0          0          0          0
DL_264          264              D_EURV_263       240.21     0.01       0          0          0          0
DL_309          309              O_300            10.54      0.01       0          0          0          0
DL_310          310              309              116.14     0.01       0          0          0          0
DL_410          410              O_410            110.50     0.01       0          0          0          0
DL_414          414              O_414            95.89      0.01       0          0          0          0
DL_418          418              O_418            213.42     0.01       0          0          0          0
DL_422          422              O_422            87.13      0.01       0          0          0          0
DL_426          426              O_426            204.94     0.01       0          0          0          0
DL_509          509              O_500            10         0.01       0          0          0          0
DL_510          510              509              125.31     0.01       0          0          0          0
DL_514          514              513              289.06     0.01       0          0          0          0
DL_518          518              513              320.57     0.01       0          0          0          0
DL_609          609              O_600            147        0.01       0          0          0          0
DL_610          610              609              118.83     0.01       0          0          0          0
DL_614          614              D_EURV_614       298.82     0.01       0          0          0          0
DL_618          618              617              238.73     0.01       0          0          0          0
DL_710          710              O_710            202.60     0.01       0          0          0          0
DL_809          809              O_800            15.11      0.01       0          0          0          0
DL_810          810              D_EURV_810       400        0.01       0          0          0          0
DL_814          814              D_EURV_814       400        0.01       0          0          0          0
L_114           113              109              144        0.035      0          0          0          0
L_115           115              113              3260       0.035      0          0          0          0
L_117           117              115              86         0.01       0          0          0          0
L_119           119              117              1087       0.035      0          0          0          0
L_126           126              D_EURV_121       5178       0.035      0          0          0          0
L_133           133              129              2743       0.035      0          0          0          0
L_138           138              D_EURV_134       2426       0.035      0          0          0          0
L_139           139              115              73         0.01       0          0          0          0
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L_141            141              139              542        0.01       0          0          0          0
DL_146           146              D_EURV_146       400        0.035      0          0          0          0
L_149            149              141              1479       0.035      0          0          0          0
L_154            154              D_EURV_150       1625       0.035      0          0          0          0
L_221            221              219              2511       0.035      0          0          0          0
L_225            225              223              1810       0.035      0          0          0          0
L_228            228              D_EURV_225       847        0.035      0          0          0          0
L_235            235              231              3274       0.035      0          0          0          0
L_239            239              237              288        0.035      0          0          0          0
L_241            241              239              1092       0.035      0          0          0          0
L_245            245              243              4101       0.035      0          0          0          0
L_250            250              247              2063       0.035      0          0          0          0
L_263            263              259              2459       0.035      0          0          0          0
L_268            268              D_EURV_263       1464       0.035      0          0          0          0
L_314            314              309              2623       0.035      0          0          0          0
L_613            613              609              3459       0.035      0          0          0          0
L_622            622              617              1661       0.035      0          0          0          0
L_813            813              809              190        0.035      0          0          0          0
L_818            818              D_EURV_814       1740       0.035      0          0          0          0
DL_515           513              D_EURV_510       400        0.01       0          0          0          0
DL_616           617              D_EURV_618       400        0.01       0          0          0          0
L_513            515              509              3358       .035       0          0          0          0
L_617            616              613              2214       0.035      0          0          0          0

[OUTLETS]
;;Name           From Node        To Node          Offset     Type            QTable/Qcoeff    Qexpon
Gated
;;-------------- ---------------- ---------------- ---------- --------------- ---------------- ---------- --
------
O_EURV_134       D_EURV_134       D_FC_134         0          TABULAR/HEAD    O_EURV_134                  NO
O_EURV_150       D_EURV_150       D_FC_150         0          TABULAR/HEAD    O_EURV_150                  NO
O_EURV_121       D_EURV_121       121              0          TABULAR/HEAD    O_EURV_121                  NO
O_EURV_146       D_EURV_146       141              0          TABULAR/HEAD    O_EURV_146                  NO
O_FC_150         D_FC_150         149              0          TABULAR/HEAD    O_FC_150                    NO
O_FC_134         D_FC_134         133              0          TABULAR/HEAD    O_FC_134                    NO
O_EURV_225       D_EURV_225       225              0          TABULAR/HEAD    O_EURV_225                  NO
O_EURV_245       D_EURV_245       D_FC_245         0          TABULAR/HEAD    O_EURV_245                  NO
O_EURV_263       D_EURV_263       D_FC_263         0          TABULAR/HEAD    O_EURV_263                  NO
O_EURV_236       D_EURV_236       235              0          TABULAR/HEAD    O_EURV_236                  NO
O_EURV_244       D_EURV_244       243              0          TABULAR/HEAD    O_EURV_244                  NO
O_EURV_256       D_EURV_256       239              0          TABULAR/HEAD    O_EURV_256                  NO
O_FC_263         D_FC_263         263              0          TABULAR/HEAD    O_FC_263                    NO
O_FC_245         D_FC_245         245              0          TABULAR/HEAD    O_FC_245                    NO
O_EURV_510       D_EURV_510       D_FC_510         0          TABULAR/HEAD    O_EURV_510                  NO
O_EURV_614       D_EURV_614       613              0          TABULAR/HEAD    O_EURV_614                  NO
O_EURV_618       D_EURV_618       D_FC_618         0          TABULAR/DEPTH   O_EURV_618                  NO
O_EURV_810       D_EURV_810       809              0          TABULAR/HEAD    O_EURV_810                  NO
O_EURV_814       D_EURV_814       D_FC_184         0          TABULAR/DEPTH   O_EURV_814                  NO
O_FC_814         D_FC_184         813              0          TABULAR/HEAD    O_FC_814                    NO
O_FC_510         D_FC_510         515              0          TABULAR/HEAD    O_FC_510                    NO
O_FC_618         D_FC_618         616              0          TABULAR/HEAD    O_FC_618                    NO

[XSECTIONS]
;;Link            Shape        Geom1            Geom2      Geom3      Geom4      Barrels    Culvert
;;-------------- ------------ ---------------- ---------- ---------- ---------- ---------- ----------
DL_109           DUMMY        0                0          0          0          1
DL_110           DUMMY        0                0          0          0          1
DL_114           DUMMY        0                0          0          0          1
DL_118           DUMMY        0                0          0          0          1
DL_121           DUMMY        0                0          0          0          1
DL_122           DUMMY        0                0          0          0          1
DL_129           DUMMY        0                0          0          0          1
DL_130           DUMMY        0                0          0          0          1
DL_134           DUMMY        0                0          0          0          1
DL_142           DUMMY        0                0          0          0          1
DL_150           DUMMY        0                0          0          0          1
DL_210           DUMMY        0                0          0          0          1
DL_219           DUMMY        0                0          0          0          1
DL_220           DUMMY        0                0          0          0          1
DL_223           DUMMY        0                0          0          0          1
DL_224           DUMMY        0                0          0          0          1
DL_226           DUMMY        0                0          0          0          1
DL_231           DUMMY        0                0          0          0          1
DL_232           DUMMY        0                0          0          0          1
DL_236           DUMMY        0                0          0          0          1
DL_237           DUMMY        0                0          0          0          1
DL_240           DUMMY        0                0          0          0          1
DL_243           DUMMY        0                0          0          0          1
DL_244           DUMMY        0                0          0          0          1
DL_247           DUMMY        0                0          0          0          1
DL_248           DUMMY        0                0          0          0          1
DL_252           DUMMY        0                0          0          0          1
DL_256           DUMMY        0                0          0          0          1
DL_259           DUMMY        0                0          0          0          1
DL_260           DUMMY        0                0          0          0          1
DL_264           DUMMY        0                0          0          0          1
DL_309           DUMMY        0                0          0          0          1
DL_310           DUMMY        0                0          0          0          1
DL_410           DUMMY        0                0          0          0          1
DL_414           DUMMY        0                0          0          0          1
DL_418           DUMMY        0                0          0          0          1
DL_422           DUMMY        0                0          0          0          1
DL_426           DUMMY        0                0          0          0          1
DL_509           DUMMY        0                0          0          0          1
DL_510           DUMMY        0                0          0          0          1
DL_514           DUMMY        0                0          0          0          1
DL_518           DUMMY        0                0          0          0          1
DL_609           DUMMY        0                0          0          0          1
DL_610           DUMMY        0                0          0          0          1
DL_614           DUMMY        0                0          0          0          1
DL_618           DUMMY        0                0          0          0          1
DL_710           DUMMY        0                0          0          0          1
DL_809           DUMMY        0                0          0          0          1
DL_810           DUMMY        0                0          0          0          1
DL_814           DUMMY        0                0          0          0          1
L_114            TRIANGULAR   10               200        0          0          1
L_115            TRAPEZOIDAL  10               118        5          5          1
L_117            TRAPEZOIDAL  10               10         2          2          1
L_119            TRAPEZOIDAL  10               89         5          5          1
L_126            TRAPEZOIDAL  10               30         2          2          1
L_133            TRAPEZOIDAL  10               75         8          8          1
L_138            TRAPEZOIDAL  10               86         5          5          1
L_139            TRAPEZOIDAL  10               20         2          2          1
L_141            TRAPEZOIDAL  10               30         2          2          1
DL_146           DUMMY        0                0          0          0          1
L_149            TRAPEZOIDAL  10               80         5          5          1
L_154            TRAPEZOIDAL  10               79         5          5          1
L_221            TRAPEZOIDAL  10               140        5          5          1
L_225            TRAPEZOIDAL  10               90         5          5          1
L_228            TRAPEZOIDAL  10               20         2          2          1
L_235            TRAPEZOIDAL  10               190        5          5          1
L_239            TRAPEZOIDAL  10               140        5          5          1
L_241            TRAPEZOIDAL  10               100        5          5          1
L_245            TRAPEZOIDAL  10               110        5          5          1
L_250            TRAPEZOIDAL  10               10         50         50         1
L_263            TRAPEZOIDAL  10               40         5          5          1
L_268            TRAPEZOIDAL  10               20         2          2          1
L_314            TRAPEZOIDAL  10               50         2          2          1
L_613            TRAPEZOIDAL  10               100        3          3          1
L_622            TRAPEZOIDAL  10               101        5          5          1
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L_813            TRIANGULAR   10               200        0          0          1
L_818            TRAPEZOIDAL  10               20         15         15         1
DL_515           DUMMY        0                0          0          0          1
DL_616           DUMMY        0                0          0          0          1
L_513            TRAPEZOIDAL  10               50         1          1          1
L_617            TRAPEZOIDAL  10               80         2          2          1

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
O_EURV_121       Rating     0          0.00
O_EURV_121                  0.5        0.12
O_EURV_121                  0.75       0.15
O_EURV_121                  1          0.17
O_EURV_121                  1.25       0.19
O_EURV_121                  1.5        0.29
O_EURV_121                  1.75       0.34
O_EURV_121                  2          0.39
O_EURV_121                  2.25       0.43
O_EURV_121                  2.5        0.46
O_EURV_121                  2.75       0.56
O_EURV_121                  3          0.63
O_EURV_121                  3.25       0.69
O_EURV_121                  3.5        0.74
O_EURV_121                  3.75       0.79
O_EURV_121                  4          1.31
O_EURV_121                  4.25       1.95
O_EURV_121                  4.37       1.97
O_EURV_121                  4.5        1.99
O_EURV_121                  4.75       2.02
O_EURV_121                  5          2.06
O_EURV_121                  5.25       57.66
O_EURV_121                  5.5        545.74
O_EURV_121                  5.75       1295.54
O_EURV_121                  5.8        1469.64
O_EURV_121                  6          2235.66
O_EURV_121                  6.25       3334.04
O_EURV_121                  6.5        4571.17
O_EURV_121                  6.75       5933.55
O_EURV_121                  7          7411.16
O_EURV_121                  7.25       8996.17
O_EURV_121                  7.34       9591.80
O_EURV_121                  7.5        10682.24
O_EURV_121                  7.75       12464.13
O_EURV_121                  8          14337.40
O_EURV_121                  8.25       16298.23
O_EURV_121                  8.5        18343.29
O_EURV_121                  8.75       20469.65
O_EURV_121                  9          22674.72
O_EURV_121                  9.25       24956.15
O_EURV_121                  9.5        27311.84
O_EURV_121                  9.75       29739.88
O_EURV_121                  10         32238.52
;
;60% WQCV, 100% EURV
O_EURV_134       Rating     0          0.00
O_EURV_134                  0.5        0.11
O_EURV_134                  0.75       0.13
O_EURV_134                  1          0.15
O_EURV_134                  1.25       0.23
O_EURV_134                  1.5        0.28
O_EURV_134                  1.75       0.32
O_EURV_134                  2          0.36
O_EURV_134                  2.25       0.42
O_EURV_134                  2.5        0.50
O_EURV_134                  2.75       0.56
O_EURV_134                  3          0.61
O_EURV_134                  3.25       0.65
O_EURV_134                  3.31       0.66
O_EURV_134                  3.5        2.83
O_EURV_134                  3.75       4.40
O_EURV_134                  4          4.49
O_EURV_134                  4.25       4.58
O_EURV_134                  4.5        4.67
O_EURV_134                  4.75       4.75
O_EURV_134                  5          4.84
O_EURV_134                  5.07       4.86
O_EURV_134                  5.25       4.92
O_EURV_134                  5.29       4.93
O_EURV_134                  5.5        273.50
O_EURV_134                  5.75       911.99
O_EURV_134                  6          1766.08
O_EURV_134                  6.25       2791.52
O_EURV_134                  6.5        3964.06
O_EURV_134                  6.75       5267.79
O_EURV_134                  7          6691.22
O_EURV_134                  7.25       8225.59
O_EURV_134                  7.5        9863.91
O_EURV_134                  7.75       11600.45
O_EURV_134                  8          13430.40
O_EURV_134                  8.25       15349.69
O_EURV_134                  8.5        17354.74
O_EURV_134                  8.75       19442.47
O_EURV_134                  9          21610.10
O_EURV_134                  9.25       23855.19
O_EURV_134                  9.5        26175.53
O_EURV_134                  9.75       28569.10
O_EURV_134                  10         31034.10
;
;60% WQCV, 100% EURV
O_EURV_146       Rating     0          0.00
O_EURV_146                  0.5        0.02
O_EURV_146                  0.75       0.02
O_EURV_146                  1          0.03
O_EURV_146                  1.25       0.05
O_EURV_146                  1.5        0.05
O_EURV_146                  1.75       0.06
O_EURV_146                  2          0.08
O_EURV_146                  2.25       0.09
O_EURV_146                  2.5        0.10
O_EURV_146                  2.75       0.11
O_EURV_146                  2.82       0.11
O_EURV_146                  2.93       0.38
O_EURV_146                  3          0.38
O_EURV_146                  3.25       0.39
O_EURV_146                  3.5        0.40
O_EURV_146                  3.75       0.41
O_EURV_146                  4          0.42
O_EURV_146                  4.17       0.42
O_EURV_146                  4.25       56.00
O_EURV_146                  4.5        544.05
O_EURV_146                  4.75       1293.82
O_EURV_146                  5          2233.92
O_EURV_146                  5.25       3332.28
O_EURV_146                  5.5        4569.37
O_EURV_146                  5.75       5931.73
O_EURV_146                  6          7409.32
O_EURV_146                  6.25       8994.30
O_EURV_146                  6.5        10680.35
O_EURV_146                  6.75       12462.22
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O_EURV_146                7          14335.46
O_EURV_146                7.25       16296.27
O_EURV_146                7.5        18341.31
O_EURV_146                7.75       20467.65
O_EURV_146                8          22672.69
O_EURV_146                8.25       24954.10
O_EURV_146                8.5        27309.77
O_EURV_146                8.75       29737.79
O_EURV_146                9          32236.41
O_EURV_146                9.25       34804.04
O_EURV_146                9.5        37439.19
O_EURV_146                9.75       40140.52
O_EURV_146                10         42906.74
;
;301'x599'
O_EURV_150       Rating     0          0.00
O_EURV_150                  0.5        0.08
O_EURV_150                  0.75       0.10
O_EURV_150                  1          0.12
O_EURV_150                  1.25       0.18
O_EURV_150                  1.5        0.22
O_EURV_150                  1.75       0.25
O_EURV_150                  2          0.28
O_EURV_150                  2.25       0.32
O_EURV_150                  2.5        0.39
O_EURV_150                  2.75       0.44
O_EURV_150                  3          0.47
O_EURV_150                  3.25       0.51
O_EURV_150                  3.5        1.89
O_EURV_150                  3.75       2.78
O_EURV_150                  3.95       2.82
O_EURV_150                  4          2.83
O_EURV_150                  4.25       2.89
O_EURV_150                  4.5        2.94
O_EURV_150                  4.75       3.00
O_EURV_150                  5          3.05
O_EURV_150                  5.25       195.20
O_EURV_150                  5.5        791.77
O_EURV_150                  5.75       1615.16
O_EURV_150                  6          2615.09
O_EURV_150                  6.12       3149.62
O_EURV_150                  6.25       3765.28
O_EURV_150                  6.5        5048.85
O_EURV_150                  6.75       6453.76
O_EURV_150                  7          7970.86
O_EURV_150                  7.25       9592.93
O_EURV_150                  7.5        11314.07
O_EURV_150                  7.65       12392.22
O_EURV_150                  7.75       13129.34
O_EURV_150                  8          15034.56
O_EURV_150                  8.25       17026.09
O_EURV_150                  8.5        19100.75
O_EURV_150                  8.75       21255.75
O_EURV_150                  9          23488.57
O_EURV_150                  9.25       25796.98
O_EURV_150                  9.5        28178.95
O_EURV_150                  9.75       30632.61
O_EURV_150                  10         33156.28
;
;60"x48", 100-YR Flood Control Only (overdetention)
O_FC_134         Rating     0          0.00
O_FC_134                    0.25       0.90
O_FC_134                    0.5        3.16
O_FC_134                    0.75       6.58
O_FC_134                    1          11.08
O_FC_134                    1.25       16.59
O_FC_134                    1.5        23.07
O_FC_134                    1.75       30.50
O_FC_134                    2          38.84
O_FC_134                    2.25       48.07
O_FC_134                    2.5        58.17
O_FC_134                    2.75       69.12
O_FC_134                    3          80.91
O_FC_134                    3.25       93.52
O_FC_134                    3.5        106.95
O_FC_134                    3.75       121.17
O_FC_134                    4          136.19
O_FC_134                    4.25       144.45
O_FC_134                    4.5        152.26
O_FC_134                    4.75       159.69
O_FC_134                    5          166.80
O_FC_134                    5.25       173.61
O_FC_134                    5.5        180.16
O_FC_134                    5.75       186.48
O_FC_134                    6          192.60
O_FC_134                    6.25       198.53
O_FC_134                    6.5        204.28
O_FC_134                    6.75       209.88
O_FC_134                    7          215.33
O_FC_134                    7.25       220.65
O_FC_134                    7.5        225.84
O_FC_134                    7.75       230.92
O_FC_134                    8          235.88
O_FC_134                    8.25       240.75
O_FC_134                    8.5        245.52
O_FC_134                    8.75       250.19
O_FC_134                    9          254.78
O_FC_134                    9.25       259.29
O_FC_134                    9.5        263.73
O_FC_134                    9.75       268.09
O_FC_134                    10         272.38
;
;60"x50" , 100-yr Flood Control (overdetention)
O_FC_150         Rating     0          0.00
O_FC_150                    0.25       0.86
O_FC_150                    0.5        3.01
O_FC_150                    0.75       6.27
O_FC_150                    1          10.56
O_FC_150                    1.25       15.81
O_FC_150                    1.5        22.00
O_FC_150                    1.75       29.08
O_FC_150                    2          37.03
O_FC_150                    2.25       45.83
O_FC_150                    2.5        55.45
O_FC_150                    2.75       65.89
O_FC_150                    3          77.13
O_FC_150                    3.25       89.16
O_FC_150                    3.5        101.96
O_FC_150                    3.75       115.52
O_FC_150                    4          129.83
O_FC_150                    4.25       144.89
O_FC_150                    4.5        160.68
O_FC_150                    4.75       174.65
O_FC_150                    5          183.47
O_FC_150                    5.25       191.87
O_FC_150                    5.5        199.93
O_FC_150                    5.75       207.67
O_FC_150                    6          215.13
O_FC_150                    6.25       222.35
O_FC_150                    6.5        229.33
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O_FC_150                  6.75      236.11
O_FC_150                  7         242.70
O_FC_150                  7.25      249.12
O_FC_150                  7.5       255.37
O_FC_150                  7.75      261.48
O_FC_150                  8         267.45
O_FC_150                  8.25      273.28
O_FC_150                  8.5       278.99
O_FC_150                  8.75      284.59
O_FC_150                  9         290.09
O_FC_150                  9.25      295.47
O_FC_150                  9.5       300.77
O_FC_150                  9.75      305.97
O_FC_150                  10        311.08
;
;60% WQCV, 100% EURV
O_EURV_225       Rating   0         0.00
O_EURV_225                0.5       0.07
O_EURV_225                0.75      0.09
O_EURV_225                1         0.11
O_EURV_225                1.25      0.15
O_EURV_225                1.5       0.19
O_EURV_225                1.75      0.22
O_EURV_225                2         0.25
O_EURV_225                2.25      0.27
O_EURV_225                2.5       0.33
O_EURV_225                2.75      0.38
O_EURV_225                3         0.41
O_EURV_225                3.25      0.44
O_EURV_225                3.5       0.61
O_EURV_225                3.75      2.30
O_EURV_225                3.84      2.32
O_EURV_225                4         2.35
O_EURV_225                4.25      2.40
O_EURV_225                4.5       2.44
O_EURV_225                4.75      2.48
O_EURV_225                5         2.53
O_EURV_225                5.25      2.57
O_EURV_225                5.5       355.61
O_EURV_225                5.75      1033.27
O_EURV_225                5.9       1541.82
O_EURV_225                6         1916.93
O_EURV_225                6.25      2967.21
O_EURV_225                6.5       4161.63
O_EURV_225                6.75      5485.16
O_EURV_225                7         6926.84
O_EURV_225                7.25      8478.24
O_EURV_225                7.46      9861.22
O_EURV_225                7.5       10132.59
O_EURV_225                7.75      11884.35
O_EURV_225                8         13728.82
O_EURV_225                8.25      15662.02
O_EURV_225                8.5       17680.47
O_EURV_225                8.75      19781.12
O_EURV_225                9         21961.27
O_EURV_225                9.25      24218.51
O_EURV_225                9.5       26550.67
O_EURV_225                9.75      28955.76
O_EURV_225                10        31432.00
;
;60% WQCV, 100% EURV
O_EURV_236       Rating   0         0.00
O_EURV_236                0.5       0.03
O_EURV_236                0.75      0.04
O_EURV_236                1         0.04
O_EURV_236                1.25      0.07
O_EURV_236                1.5       0.08
O_EURV_236                1.75      0.09
O_EURV_236                2         0.10
O_EURV_236                2.25      0.13
O_EURV_236                2.5       0.15
O_EURV_236                2.75      0.16
O_EURV_236                3         0.18
O_EURV_236                3.11      0.18
O_EURV_236                3.25      0.78
O_EURV_236                3.5       0.79
O_EURV_236                3.75      0.81
O_EURV_236                3.88      0.82
O_EURV_236                4         0.83
O_EURV_236                4.25      0.84
O_EURV_236                4.5       0.86
O_EURV_236                4.59      0.86
O_EURV_236                4.75      175.24
O_EURV_236                5         760.81
O_EURV_236                5.25      1576.31
O_EURV_236                5.5       2569.74
O_EURV_236                5.75      3714.26
O_EURV_236                6         4992.72
O_EURV_236                6.25      6392.92
O_EURV_236                6.5       7905.65
O_EURV_236                6.75      9523.61
O_EURV_236                7         11240.86
O_EURV_236                7.25      13052.42
O_EURV_236                7.5       14954.08
O_EURV_236                7.75      16942.19
O_EURV_236                8         19013.55
O_EURV_236                8.25      21165.35
O_EURV_236                8.5       23395.08
O_EURV_236                8.75      25700.48
O_EURV_236                9         28079.51
O_EURV_236                9.25      30530.31
O_EURV_236                9.5       33051.19
O_EURV_236                9.75      35640.58
O_EURV_236                10        38297.06
;
;60% WQCV, 100% EURV
O_EURV_244       Rating   0         0.00
O_EURV_244                0.5       0.06
O_EURV_244                0.75      0.08
O_EURV_244                1         0.09
O_EURV_244                1.25      0.13
O_EURV_244                1.5       0.16
O_EURV_244                1.75      0.19
O_EURV_244                2         0.21
O_EURV_244                2.25      0.24
O_EURV_244                2.5       0.29
O_EURV_244                2.75      0.32
O_EURV_244                3         0.35
O_EURV_244                3.25      0.38
O_EURV_244                3.5       2.21
O_EURV_244                3.68      2.29
O_EURV_244                3.75      2.30
O_EURV_244                4         2.35
O_EURV_244                4.25      2.40
O_EURV_244                4.5       2.44
O_EURV_244                4.75      2.48
O_EURV_244                5         2.53
O_EURV_244                5.25      11.06
O_EURV_244                5.5       423.86
O_EURV_244                5.75      1129.46
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O_EURV_244                5.86      1505.84
O_EURV_244                6         2034.71
O_EURV_244                6.25      3103.27
O_EURV_244                6.5       4313.87
O_EURV_244                6.75      5652.10
O_EURV_244                7         7107.36
O_EURV_244                7.09      7658.26
O_EURV_244                7.25      8671.44
O_EURV_244                7.5       10337.76
O_EURV_244                7.75      12100.87
O_EURV_244                8         13956.19
O_EURV_244                8.25      15899.79
O_EURV_244                8.5       17928.26
O_EURV_244                8.75      20038.59
O_EURV_244                9         22228.11
O_EURV_244                9.25      24494.45
O_EURV_244                9.5       26835.46
O_EURV_244                9.75      29249.18
O_EURV_244                10        31733.84
;
;60% WQCV, 100% EURV
O_EURV_245       Rating     0         0.00
O_EURV_245                0.5       0.18
O_EURV_245                0.75      0.22
O_EURV_245                1         0.25
O_EURV_245                1.25      0.37
O_EURV_245                1.5       0.46
O_EURV_245                1.75      0.53
O_EURV_245                2         0.59
O_EURV_245                2.25      0.65
O_EURV_245                2.5       0.81
O_EURV_245                2.75      0.91
O_EURV_245                3         1.00
O_EURV_245                3.25      1.07
O_EURV_245                3.5       1.62
O_EURV_245                3.75      5.87
O_EURV_245                4         7.60
O_EURV_245                4.25      7.75
O_EURV_245                4.5       7.90
O_EURV_245                4.75      8.05
O_EURV_245                5         8.19
O_EURV_245                5.25      8.33
O_EURV_245                5.5       89.49
O_EURV_245                5.75      604.01
O_EURV_245                6         1370.87
O_EURV_245                6.25      2324.70
O_EURV_245                6.5       3434.89
O_EURV_245                6.75      4682.58
O_EURV_245                7         6054.61
O_EURV_245                7.25      7541.17
O_EURV_245                7.5       9134.57
O_EURV_245                7.75      10828.58
O_EURV_245                8         12618.03
O_EURV_245                8.14      13660.14
O_EURV_245                8.25      14498.52
O_EURV_245                8.5       16466.29
O_EURV_245                8.75      18518.05
O_EURV_245                9         20650.89
O_EURV_245                9.25      22862.23
O_EURV_245                9.5       25149.76
O_EURV_245                9.75      27511.39
O_EURV_245                10        29945.23
;
;60% WQCV, 100% EURV
O_EURV_256       Rating     0         0.00
O_EURV_256                0.5       0.06
O_EURV_256                0.75      0.07
O_EURV_256                1         0.08
O_EURV_256                1.25      0.11
O_EURV_256                1.5       0.14
O_EURV_256                1.75      0.17
O_EURV_256                2         0.19
O_EURV_256                2.25      0.20
O_EURV_256                2.5       0.25
O_EURV_256                2.75      0.29
O_EURV_256                3         0.31
O_EURV_256                3.25      0.34
O_EURV_256                3.43      0.35
O_EURV_256                3.5       0.83
O_EURV_256                3.75      1.85
O_EURV_256                4         1.89
O_EURV_256                4.25      1.93
O_EURV_256                4.5       1.96
O_EURV_256                4.75      2.00
O_EURV_256                5         2.03
O_EURV_256                5.25      2.07
O_EURV_256                5.28      2.07
O_EURV_256                5.5       270.60
O_EURV_256                5.75      909.05
O_EURV_256                5.8       1064.50
O_EURV_256                6         1763.09
O_EURV_256                6.25      2788.48
O_EURV_256                6.5       3960.98
O_EURV_256                6.75      5264.66
O_EURV_256                7         6688.05
O_EURV_256                7.25      8222.38
O_EURV_256                7.5       9860.65
O_EURV_256                7.75      11597.15
O_EURV_256                8         13427.07
O_EURV_256                8.25      15346.31
O_EURV_256                8.5       17351.32
O_EURV_256                8.75      19439.01
O_EURV_256                9         21606.60
O_EURV_256                9.25      23851.65
O_EURV_256                9.5       26171.95
O_EURV_256                9.75      28565.49
O_EURV_256                10        31030.45
;
;60% WQCV, 100% EURV
O_EURV_263       Rating     0         0.00
O_EURV_263                0.5       0.10
O_EURV_263                0.75      0.12
O_EURV_263                1         0.14
O_EURV_263                1.25      0.21
O_EURV_263                1.5       0.26
O_EURV_263                1.75      0.30
O_EURV_263                2         0.33
O_EURV_263                2.25      0.40
O_EURV_263                2.5       0.47
O_EURV_263                2.75      0.52
O_EURV_263                3         0.56
O_EURV_263                3.25      0.60
O_EURV_263                3.5       3.86
O_EURV_263                3.75      4.08
O_EURV_263                4         4.17
O_EURV_263                4.25      4.25
O_EURV_263                4.5       4.33
O_EURV_263                4.7       4.39
O_EURV_263                4.75      4.41
O_EURV_263                5         4.49
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O_EURV_263                  5.15        4.53
O_EURV_263                  5.25        85.59
O_EURV_263                  5.5         600.04
O_EURV_263                  5.75        1366.84
O_EURV_263                  6           2320.61
O_EURV_263                  6.25        3430.75
O_EURV_263                  6.5         4678.37
O_EURV_263                  6.75        6050.34
O_EURV_263                  7           7536.85
O_EURV_263                  7.25        9130.19
O_EURV_263                  7.5         10824.15
O_EURV_263                  7.75        12613.54
O_EURV_263                  8           14493.98
O_EURV_263                  8.25        16461.70
O_EURV_263                  8.5         18513.40
O_EURV_263                  8.75        20646.19
O_EURV_263                  9           22857.48
O_EURV_263                  9.25        25144.96
O_EURV_263                  9.5         27506.54
O_EURV_263                  9.75        29940.32
O_EURV_263                  10          32444.58
;
;60"x60" 100-yr Detention Only (overdetention)
O_FC_245          Rating    0           0.00
O_FC_245                    0.25        0.84
O_FC_245                    0.5         2.95
O_FC_245                    0.75        6.14
O_FC_245                    1           10.34
O_FC_245                    1.25        15.48
O_FC_245                    1.5         21.53
O_FC_245                    1.75        28.46
O_FC_245                    2           36.24
O_FC_245                    2.25        44.86
O_FC_245                    2.5         54.28
O_FC_245                    2.75        64.50
O_FC_245                    3           75.50
O_FC_245                    3.25        87.27
O_FC_245                    3.5         99.80
O_FC_245                    3.75        113.07
O_FC_245                    4           127.09
O_FC_245                    4.25        141.82
O_FC_245                    4.5         157.28
O_FC_245                    4.75        173.45
O_FC_245                    5           190.33
O_FC_245                    5.25        199.62
O_FC_245                    5.5         208.49
O_FC_245                    5.75        217.01
O_FC_245                    6           225.20
O_FC_245                    6.25        233.10
O_FC_245                    6.5         240.75
O_FC_245                    6.75        248.16
O_FC_245                    7           255.35
O_FC_245                    7.25        262.35
O_FC_245                    7.5         269.17
O_FC_245                    7.75        275.81
O_FC_245                    8           282.30
O_FC_245                    8.25        288.65
O_FC_245                    8.5         294.86
O_FC_245                    8.75        300.94
O_FC_245                    9           306.90
O_FC_245                    9.25        312.74
O_FC_245                    9.5         318.48
O_FC_245                    9.75        324.12
O_FC_245                    10          329.66
;
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;60"x25" 100-yr Detention Only (overdetention)
O_FC_263          Rating    0           0.00
O_FC_263                    0.25        1.10
O_FC_263                    0.5         3.87
O_FC_263                    0.75        8.06
O_FC_263                    1           13.56
O_FC_263                    1.25        20.31
O_FC_263                    1.5         28.25
O_FC_263                    1.75        37.34
O_FC_263                    2           47.54
O_FC_263                    2.25        55.13
O_FC_263                    2.5         60.57
O_FC_263                    2.75        65.56
O_FC_263                    3           70.19
O_FC_263                    3.25        74.53
O_FC_263                    3.5         78.64
O_FC_263                    3.75        82.54
O_FC_263                    4           86.27
O_FC_263                    4.25        89.84
O_FC_263                    4.5         93.27
O_FC_263                    4.75        96.59
O_FC_263                    5           99.79
O_FC_263                    5.25        102.89
O_FC_263                    5.5         105.90
O_FC_263                    5.75        108.83
O_FC_263                    6           111.68
O_FC_263                    6.25        114.46
O_FC_263                    6.5         117.18
O_FC_263                    6.75        119.83
O_FC_263                    7           122.43
O_FC_263                    7.25        124.97
O_FC_263                    7.5         127.46
O_FC_263                    7.75        129.91
O_FC_263                    8           132.30
O_FC_263                    8.25        134.66
O_FC_263                    8.5         136.98
O_FC_263                    8.75        139.25
O_FC_263                    9           141.49
O_FC_263                    9.25        143.70
O_FC_263                    9.5         145.87
O_FC_263                    9.75        148.01
O_FC_263                    10          150.12
;
;60% WQCV, 100% EURV
O_EURV_510        Rating    0           0.00
O_EURV_510                  0.5         0.12
O_EURV_510                  0.75        0.15
O_EURV_510                  1           0.17
O_EURV_510                  1.25        0.25
O_EURV_510                  1.5         0.31
O_EURV_510                  1.75        0.36
O_EURV_510                  2           0.40
O_EURV_510                  2.25        0.43
O_EURV_510                  2.5         0.55
O_EURV_510                  2.75        0.61
O_EURV_510                  3           0.67
O_EURV_510                  3.25        0.72
O_EURV_510                  3.4         0.75
O_EURV_510                  3.5         1.58
O_EURV_510                  3.75        4.73
O_EURV_510                  4           4.82
O_EURV_510                  4.25        4.92
O_EURV_510                  4.5         5.01
O_EURV_510                  4.75        5.10
O_EURV_510                  5           5.19
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O_EURV_510                5.25       5.28
O_EURV_510                5.36       5.32
O_EURV_510                5.5        146.05
O_EURV_510                5.66       474.37
O_EURV_510                5.75       709.05
O_EURV_510                6          1508.71
O_EURV_510                6.25       2489.14
O_EURV_510                6.5        3622.36
O_EURV_510                6.75       4890.66
O_EURV_510                7          6281.57
O_EURV_510                7.25       7785.65
O_EURV_510                7.5        9395.49
O_EURV_510                7.75       11105.05
O_EURV_510                8          12909.29
O_EURV_510                8.25       14803.95
O_EURV_510                8.5        16785.32
O_EURV_510                8.75       18850.19
O_EURV_510                9          20995.72
O_EURV_510                9.25       23219.36
O_EURV_510                9.5        25518.84
O_EURV_510                9.75       27892.10
O_EURV_510                10         30337.29
;
;60"x42" 100-yr Flood Control Only
O_FC_510         Rating     0          0.00
O_FC_510                    0.25       0.94
O_FC_510                    0.5        3.29
O_FC_510                    0.75       6.86
O_FC_510                    1          11.54
O_FC_510                    1.25       17.29
O_FC_510                    1.5        24.05
O_FC_510                    1.75       31.79
O_FC_510                    2          40.48
O_FC_510                    2.25       50.10
O_FC_510                    2.5        60.63
O_FC_510                    2.75       72.04
O_FC_510                    3          84.33
O_FC_510                    3.25       97.48
O_FC_510                    3.5        111.47
O_FC_510                    3.75       119.16
O_FC_510                    4          126.39
O_FC_510                    4.25       133.23
O_FC_510                    4.5        139.73
O_FC_510                    4.75       145.95
O_FC_510                    5          151.91
O_FC_510                    5.25       157.64
O_FC_510                    5.5        163.17
O_FC_510                    5.75       168.52
O_FC_510                    6          173.71
O_FC_510                    6.25       178.75
O_FC_510                    6.5        183.64
O_FC_510                    6.75       188.42
O_FC_510                    7          193.07
O_FC_510                    7.25       197.61
O_FC_510                    7.5        202.05
O_FC_510                    7.75       206.40
O_FC_510                    8          210.66
O_FC_510                    8.25       214.83
O_FC_510                    8.5        218.92
O_FC_510                    8.75       222.94
O_FC_510                    9          226.88
O_FC_510                    9.25       230.76
O_FC_510                    9.5        234.58
O_FC_510                    9.75       238.33
O_FC_510                    10         242.02
;
;60% WQCV, 100% EURV
O_EURV_614         Rating     0          0.00
O_EURV_614                    0.5        0.07
O_EURV_614                    0.75       0.08
O_EURV_614                    1          0.10
O_EURV_614                    1.25       0.14
O_EURV_614                    1.5        0.17
O_EURV_614                    1.75       0.20
O_EURV_614                    2          0.22
O_EURV_614                    2.25       0.24
O_EURV_614                    2.5        0.31
O_EURV_614                    2.75       0.35
O_EURV_614                    3          0.38
O_EURV_614                    3.25       0.41
O_EURV_614                    3.5        1.37
O_EURV_614                    3.75       2.53
O_EURV_614                    4          2.58
O_EURV_614                    4.25       2.63
O_EURV_614                    4.5        2.68
O_EURV_614                    4.75       2.72
O_EURV_614                    5          2.77
O_EURV_614                    5.25       2.82
O_EURV_614                    5.5        143.54
O_EURV_614                    5.75       706.51
O_EURV_614                    6          1506.12
O_EURV_614                    6.03       1614.92
O_EURV_614                    6.25       2486.51
O_EURV_614                    6.5        3619.69
O_EURV_614                    6.75       4887.96
O_EURV_614                    7          6278.83
O_EURV_614                    7.25       7782.87
O_EURV_614                    7.29       8033.50
O_EURV_614                    7.5        9392.67
O_EURV_614                    7.75       11102.20
O_EURV_614                    8          12906.41
O_EURV_614                    8.25       14801.03
O_EURV_614                    8.5        16782.37
O_EURV_614                    8.75       18847.20
O_EURV_614                    9          20992.69
O_EURV_614                    9.25       23216.30
O_EURV_614                    9.5        25515.75
O_EURV_614                    9.75       27888.98
O_EURV_614                    10         30334.13
;
;60% WQCV, 100% EURV
O_EURV_618         Rating     0          0.00
O_EURV_618                    0.5        0.15
O_EURV_618                    0.75       0.18
O_EURV_618                    1          0.21
O_EURV_618                    1.25       0.32
O_EURV_618                    1.5        0.39
O_EURV_618                    1.75       0.45
O_EURV_618                    2          0.50
O_EURV_618                    2.25       0.60
O_EURV_618                    2.5        0.71
O_EURV_618                    2.75       0.78
O_EURV_618                    3          0.85
O_EURV_618                    3.25       0.91
O_EURV_618                    3.5        3.45
O_EURV_618                    3.75       6.06
O_EURV_618                    4          6.19
O_EURV_618                    4.25       6.31
O_EURV_618                    4.5        6.43
O_EURV_618                    4.53       6.44
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O_EURV_618                4.75      6.55
O_EURV_618                5         6.67
O_EURV_618                5.25      50.88
O_EURV_618                5.5       525.21
O_EURV_618                5.75      1266.45
O_EURV_618                6         2199.78
O_EURV_618                6.25      3292.34
O_EURV_618                6.5       4524.27
O_EURV_618                6.75      5881.93
O_EURV_618                7         7355.16
O_EURV_618                7.25      8936.07
O_EURV_618                7.5       10618.28
O_EURV_618                7.55      10966.40
O_EURV_618                7.75      12396.50
O_EURV_618                8         14266.26
O_EURV_618                8.25      16223.71
O_EURV_618                8.5       18265.53
O_EURV_618                8.75      20388.76
O_EURV_618                9         22590.79
O_EURV_618                9.25      24869.27
O_EURV_618                9.5       27222.10
O_EURV_618                9.67      28863.49
O_EURV_618                9.75      29647.34
O_EURV_618                10        32143.25
;
;60"x58", 100-yr Flood Control Only
O_FC_618         Rating   0         0.00
O_FC_618                  0.25      0.85
O_FC_618                  0.5       2.98
O_FC_618                  0.75      6.21
O_FC_618                  1         10.45
O_FC_618                  1.25      15.64
O_FC_618                  1.5       21.76
O_FC_618                  1.75      28.76
O_FC_618                  2         36.63
O_FC_618                  2.25      45.33
O_FC_618                  2.5       54.85
O_FC_618                  2.75      65.18
O_FC_618                  3         76.30
O_FC_618                  3.25      88.19
O_FC_618                  3.5       100.85
O_FC_618                  3.75      114.27
O_FC_618                  4         128.43
O_FC_618                  4.25      143.32
O_FC_618                  4.5       158.95
O_FC_618                  4.75      175.29
O_FC_618                  5         187.03
O_FC_618                  5.25      195.87
O_FC_618                  5.5       204.32
O_FC_618                  5.75      212.45
O_FC_618                  6         220.27
O_FC_618                  6.25      227.82
O_FC_618                  6.5       235.14
O_FC_618                  6.75      242.23
O_FC_618                  7         249.12
O_FC_618                  7.25      255.82
O_FC_618                  7.5       262.35
O_FC_618                  7.75      268.73
O_FC_618                  8         274.95
O_FC_618                  8.25      281.04
O_FC_618                  8.5       287.00
O_FC_618                  8.75      292.84
O_FC_618                  9         298.56
O_FC_618                  9.25      304.18
O_FC_618                  9.5       309.69
O_FC_618                  9.75      315.11
O_FC_618                  10        320.44
;
;60% WQCV, 100% EURV
O_EURV_810       Rating   0         0.00
O_EURV_810                0.5       0.06
O_EURV_810                0.75      0.08
O_EURV_810                1         0.09
O_EURV_810                1.25      0.13
O_EURV_810                1.5       0.16
O_EURV_810                1.75      0.19
O_EURV_810                2         0.21
O_EURV_810                2.25      0.24
O_EURV_810                2.5       0.29
O_EURV_810                2.75      0.32
O_EURV_810                3         0.35
O_EURV_810                3.25      0.38
O_EURV_810                3.33      0.39
O_EURV_810                3.5       2.21
O_EURV_810                3.75      2.41
O_EURV_810                4         2.46
O_EURV_810                4.25      2.51
O_EURV_810                4.5       2.56
O_EURV_810                4.75      2.60
O_EURV_810                4.83      2.62
O_EURV_810                5         2.65
O_EURV_810                5.25      2.69
O_EURV_810                5.28      2.70
O_EURV_810                5.5       291.63
O_EURV_810                5.75      940.12
O_EURV_810                6         1801.67
O_EURV_810                6.25      2833.35
O_EURV_810                6.5       4011.37
O_EURV_810                6.75      5320.05
O_EURV_810                7         6748.04
O_EURV_810                7.25      8286.66
O_EURV_810                7.5       9928.97
O_EURV_810                7.75      11669.30
O_EURV_810                8         13502.88
O_EURV_810                8.25      15425.62
O_EURV_810                8.5       17434.01
O_EURV_810                8.75      19524.95
O_EURV_810                9         21695.70
O_EURV_810                9.25      23943.81
O_EURV_810                9.5       26267.08
O_EURV_810                9.75      28663.52
O_EURV_810                10        31131.31
;
;60% WQCV, 100% EURV
O_EURV_814       Rating   0         0.00
O_EURV_814                0.5       0.17
O_EURV_814                0.75      0.21
O_EURV_814                1         0.24
O_EURV_814                1.25      0.35
O_EURV_814                1.5       0.43
O_EURV_814                1.75      0.50
O_EURV_814                2         0.56
O_EURV_814                2.25      0.61
O_EURV_814                2.5       0.77
O_EURV_814                2.75      0.86
O_EURV_814                3         0.94
O_EURV_814                3.25      1.01
O_EURV_814                3.38      1.04
O_EURV_814                3.5       2.14
O_EURV_814                3.75      6.75
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O_EURV_814                4          6.89
O_EURV_814                4.25       7.02
O_EURV_814                4.5        7.16
O_EURV_814                4.75       7.29
O_EURV_814                5          7.42
O_EURV_814                5.25       7.55
O_EURV_814                5.31       7.58
O_EURV_814                5.37       7.61
O_EURV_814                5.5        7.68
O_EURV_814                5.75       7.80
O_EURV_814                6          7.92
O_EURV_814                6.25       8.04
O_EURV_814                6.5        8.16
O_EURV_814                6.75       361.27
O_EURV_814                7          1039.01
O_EURV_814                7.25       1922.74
O_EURV_814                7.5        2973.09
O_EURV_814                7.75       4167.58
O_EURV_814                8          5491.18
O_EURV_814                8.25       6932.94
O_EURV_814                8.5        8484.40
O_EURV_814                8.75       10138.82
O_EURV_814                9          11890.64
O_EURV_814                9.25       13735.19
O_EURV_814                9.5        15668.45
O_EURV_814                9.75       17686.96
O_EURV_814                10         19787.68
;
;72"x60" 100-yr Flood Control Only
O_FC_814          Rating  0          0.00
O_FC_814                  0.25       1.01
O_FC_814                  0.5        3.54
O_FC_814                  0.75       7.37
O_FC_814                  1          12.40
O_FC_814                  1.25       18.58
O_FC_814                  1.5        25.84
O_FC_814                  1.75       34.15
O_FC_814                  2          43.49
O_FC_814                  2.25       53.83
O_FC_814                  2.5        65.14
O_FC_814                  2.75       77.40
O_FC_814                  3          90.60
O_FC_814                  3.25       104.73
O_FC_814                  3.5        119.76
O_FC_814                  3.75       135.69
O_FC_814                  4          152.50
O_FC_814                  4.25       170.19
O_FC_814                  4.5        188.74
O_FC_814                  4.75       208.14
O_FC_814                  5          228.39
O_FC_814                  5.25       239.54
O_FC_814                  5.5        250.19
O_FC_814                  5.75       260.41
O_FC_814                  6          270.24
O_FC_814                  6.25       279.72
O_FC_814                  6.5        288.90
O_FC_814                  6.75       297.79
O_FC_814                  7          306.42
O_FC_814                  7.25       314.82
O_FC_814                  7.5        323.00
O_FC_814                  7.75       330.97
O_FC_814                  8          338.76
O_FC_814                  8.25       346.38
O_FC_814                  8.5        353.83
O_FC_814                  8.75       361.12
O_FC_814                  9          368.27
O_FC_814                  9.25       375.29
O_FC_814                  9.5        382.18
O_FC_814                  9.75       388.94
O_FC_814                  10         395.59
;
;322'x640'
D_EURV_121        Storage 0          530
D_EURV_121                0.5        530
D_EURV_121                0.75       530
D_EURV_121                1          530
D_EURV_121                1.25       2135
D_EURV_121                1.5        4749
D_EURV_121                1.75       8370
D_EURV_121                2          13000
D_EURV_121                2.25       18637
D_EURV_121                2.5        25281
D_EURV_121                2.75       32934
D_EURV_121                3          41595
D_EURV_121                3.25       51263
D_EURV_121                3.5        61939
D_EURV_121                3.75       73623
D_EURV_121                4          86315
D_EURV_121                4.25       100014
D_EURV_121                4.37       106948
D_EURV_121                4.5        114721
D_EURV_121                4.75       130437
D_EURV_121                5          147159
D_EURV_121                5.25       164890
D_EURV_121                5.5        183629
D_EURV_121                5.75       203375
D_EURV_121                5.8        205966
D_EURV_121                6          207508
D_EURV_121                6.25       209441
D_EURV_121                6.5        211383
D_EURV_121                6.75       213333
D_EURV_121                7          215291
D_EURV_121                7.25       217257
D_EURV_121                7.34       217967
D_EURV_121                7.5        219231
D_EURV_121                7.75       221213
D_EURV_121                8          223202
D_EURV_121                8.25       225200
D_EURV_121                8.5        227206
D_EURV_121                8.75       229220
D_EURV_121                9          231242
D_EURV_121                9.25       233272
D_EURV_121                9.5        235309
D_EURV_121                9.75       237355
D_EURV_121                10         239409
;
;360'x716'
D_EURV_134        Storage 0          442
D_EURV_134                0.5        442
D_EURV_134                0.75       442
D_EURV_134                1          442
D_EURV_134                1.25       2667
D_EURV_134                1.5        6670
D_EURV_134                1.75       12450
D_EURV_134                2          20008
D_EURV_134                2.25       29343
D_EURV_134                2.5        40457
D_EURV_134                2.75       53348
D_EURV_134                3          68017
D_EURV_134                3.25       84464
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D_EURV_134                3.31       88676
D_EURV_134                3.5        102689
D_EURV_134                3.75       122691
D_EURV_134                4          144471
D_EURV_134                4.25       168029
D_EURV_134                4.5        193365
D_EURV_134                4.75       220479
D_EURV_134                5          249370
D_EURV_134                5.07       257778
D_EURV_134                5.25       259329
D_EURV_134                5.29       259675
D_EURV_134                5.5        261491
D_EURV_134                5.75       263660
D_EURV_134                6          265838
D_EURV_134                6.25       268023
D_EURV_134                6.5        270217
D_EURV_134                6.75       272418
D_EURV_134                7          274628
D_EURV_134                7.25       276845
D_EURV_134                7.5        279070
D_EURV_134                7.75       281304
D_EURV_134                8          283545
D_EURV_134                8.25       285795
D_EURV_134                8.5        288052
D_EURV_134                8.75       290318
D_EURV_134                9          292591
D_EURV_134                9.25       294873
D_EURV_134                9.5        297162
D_EURV_134                9.75       299460
D_EURV_134                10         301765
;
;105'x209'
D_EURV_146       Storage  0          76
D_EURV_146                0.5        76
D_EURV_146                0.75       76
D_EURV_146                1          76
D_EURV_146                1.25       738
D_EURV_146                1.5        2049
D_EURV_146                1.75       4010
D_EURV_146                2          6622
D_EURV_146                2.25       9883
D_EURV_146                2.5        13794
D_EURV_146                2.75       18356
D_EURV_146                2.82       19749
D_EURV_146                2.93       22042
D_EURV_146                3          22219
D_EURV_146                3.25       22854
D_EURV_146                3.5        23498
D_EURV_146                3.75       24150
D_EURV_146                4          24809
D_EURV_146                4.17       25262
D_EURV_146                4.25       25477
D_EURV_146                4.5        26153
D_EURV_146                4.75       26836
D_EURV_146                5          27528
D_EURV_146                5.25       28227
D_EURV_146                5.5        28935
D_EURV_146                5.75       29651
D_EURV_146                6          30374
D_EURV_146                6.25       31106
D_EURV_146                6.5        31846
D_EURV_146                6.75       32593
D_EURV_146                7          33349
D_EURV_146                7.25       34112
D_EURV_146                7.5        34884
D_EURV_146                7.75       35664
D_EURV_146                8          36451
D_EURV_146                8.25       37247
D_EURV_146                8.5        38051
D_EURV_146                8.75       38862
D_EURV_146                9          39682
D_EURV_146                9.25       40509
D_EURV_146                9.5        41345
D_EURV_146                9.75       42189
D_EURV_146                10         43040
;
;301'x599'
D_EURV_150       Storage  0          349
D_EURV_150                0.5        349
D_EURV_150                0.75       349
D_EURV_150                1          349
D_EURV_150                1.25       2023
D_EURV_150                1.5        5009
D_EURV_150                1.75       9306
D_EURV_150                2          14914
D_EURV_150                2.25       21834
D_EURV_150                2.5        30065
D_EURV_150                2.75       39606
D_EURV_150                3          50460
D_EURV_150                3.25       62624
D_EURV_150                3.5        76100
D_EURV_150                3.75       90886
D_EURV_150                3.95       103660
D_EURV_150                4          106984
D_EURV_150                4.25       124394
D_EURV_150                4.5        143114
D_EURV_150                4.75       163146
D_EURV_150                5          180475
D_EURV_150                5.25       182280
D_EURV_150                5.5        184093
D_EURV_150                5.75       185914
D_EURV_150                6          187742
D_EURV_150                6.12       188623
D_EURV_150                6.25       189579
D_EURV_150                6.5        191424
D_EURV_150                6.75       193277
D_EURV_150                7          195137
D_EURV_150                7.25       197006
D_EURV_150                7.5        198883
D_EURV_150                7.65       200013
D_EURV_150                7.75       200768
D_EURV_150                8          202660
D_EURV_150                8.25       204561
D_EURV_150                8.5        206470
D_EURV_150                8.75       208387
D_EURV_150                9          210311
D_EURV_150                9.25       212244
D_EURV_150                9.5        214185
D_EURV_150                9.75       216134
D_EURV_150                10         218090
;
;111'x223'
D_FC_134         Storage  0          24808
D_FC_134                  0.25       25480
D_FC_134                  0.5        26160
D_FC_134                  0.75       26849
D_FC_134                  1          27545
D_FC_134                  1.25       28249
D_FC_134                  1.5        28961
D_FC_134                  1.75       29682
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D_FC_134                2          30410
D_FC_134                2.25       31146
D_FC_134                2.5        31890
D_FC_134                2.75       32643
D_FC_134                3          33403
D_FC_134                3.25       34171
D_FC_134                3.5        34947
D_FC_134                3.75       35731
D_FC_134                4          36524
D_FC_134                4.25       37324
D_FC_134                4.5        38132
D_FC_134                4.75       38948
D_FC_134                5          39773
D_FC_134                5.25       40605
D_FC_134                5.5        41445
D_FC_134                5.75       42293
D_FC_134                6          43150
D_FC_134                6.25       44014
D_FC_134                6.5        44886
D_FC_134                6.75       45766
D_FC_134                7          46655
D_FC_134                7.25       47551
D_FC_134                7.5        48455
D_FC_134                7.75       49367
D_FC_134                8          50288
D_FC_134                8.25       51216
D_FC_134                8.5        52152
D_FC_134                8.75       53096
D_FC_134                9          54048
D_FC_134                9.25       55009
D_FC_134                9.5        55977
D_FC_134                9.75       56953
D_FC_134                10         57937
;
;88'x175'
D_FC_150        Storage    0          15359
D_FC_150                   0.25       15888
D_FC_150                   0.5        16426
D_FC_150                   0.75       16972
D_FC_150                   1          17526
D_FC_150                   1.25       18088
D_FC_150                   1.5        18657
D_FC_150                   1.75       19235
D_FC_150                   2          19821
D_FC_150                   2.25       20415
D_FC_150                   2.5        21017
D_FC_150                   2.75       21626
D_FC_150                   3          22244
D_FC_150                   3.25       22870
D_FC_150                   3.5        23504
D_FC_150                   3.75       24146
D_FC_150                   4          24795
D_FC_150                   4.25       25453
D_FC_150                   4.5        26119
D_FC_150                   4.75       26793
D_FC_150                   5          27475
D_FC_150                   5.25       28164
D_FC_150                   5.5        28862
D_FC_150                   5.75       29568
D_FC_150                   6          30282
D_FC_150                   6.25       31003
D_FC_150                   6.5        31733
D_FC_150                   6.75       32471
D_FC_150                   7          33217
D_FC_150                   7.25       33971
D_FC_150                   7.5        34732
D_FC_150                   7.75       35502
D_FC_150                   8          36280
D_FC_150                   8.25       37066
D_FC_150                   8.5        37860
D_FC_150                   8.75       38661
D_FC_150                   9          39471
D_FC_150                   9.25       40289
D_FC_150                   9.5        41115
D_FC_150                   9.75       41949
D_FC_150                   10         42790
;
;354'x713'
D_EURV_225      Storage    0          311
D_EURV_225                 0.5        311
D_EURV_225                 0.75       311
D_EURV_225                 1          311
D_EURV_225                 1.25       1659
D_EURV_225                 1.5        4014
D_EURV_225                 1.75       7378
D_EURV_225                 2          11749
D_EURV_225                 2.25       17128
D_EURV_225                 2.5        23515
D_EURV_225                 2.75       30910
D_EURV_225                 3          39312
D_EURV_225                 3.25       48723
D_EURV_225                 3.5        59141
D_EURV_225                 3.75       70567
D_EURV_225                 3.84       74927
D_EURV_225                 4          83001
D_EURV_225                 4.25       96442
D_EURV_225                 4.5        110892
D_EURV_225                 4.75       126349
D_EURV_225                 5          142814
D_EURV_225                 5.25       160287
D_EURV_225                 5.5        178768
D_EURV_225                 5.75       198256
D_EURV_225                 5.9        210433
D_EURV_225                 6          218752
D_EURV_225                 6.25       240256
D_EURV_225                 6.5        253679
D_EURV_225                 6.75       255822
D_EURV_225                 7          257972
D_EURV_225                 7.25       260130
D_EURV_225                 7.46       261950
D_EURV_225                 7.5        262297
D_EURV_225                 7.75       264471
D_EURV_225                 8          266654
D_EURV_225                 8.25       268844
D_EURV_225                 8.5        271042
D_EURV_225                 8.75       273249
D_EURV_225                 9          275463
D_EURV_225                 9.25       277686
D_EURV_225                 9.5        279916
D_EURV_225                 9.75       282154
D_EURV_225                 10         284401
;
;155'x311'
D_EURV_236      Storage    0          122
D_EURV_236                 0.5        122
D_EURV_236                 0.75       122
D_EURV_236                 1          122
D_EURV_236                 1.25       873
D_EURV_236                 1.5        2274
D_EURV_236                 1.75       4325
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D_EURV_236              2         7026
D_EURV_236              2.25      10376
D_EURV_236              2.5       14377
D_EURV_236              2.75      19028
D_EURV_236              3         24329
D_EURV_236              3.11      26867
D_EURV_236              3.25      30279
D_EURV_236              3.5       36880
D_EURV_236              3.75      44131
D_EURV_236              3.88      48158
D_EURV_236              4         48606
D_EURV_236              4.25      49545
D_EURV_236              4.5       50493
D_EURV_236              4.59      50835
D_EURV_236              4.75      51448
D_EURV_236              5         52411
D_EURV_236              5.25      53382
D_EURV_236              5.5       54361
D_EURV_236              5.75      55348
D_EURV_236              6         56343
D_EURV_236              6.25      57346
D_EURV_236              6.5       58358
D_EURV_236              6.75      59377
D_EURV_236              7         60404
D_EURV_236              7.25      61439
D_EURV_236              7.5       62482
D_EURV_236              7.75      63533
D_EURV_236              8         64592
D_EURV_236              8.25      65659
D_EURV_236              8.5       66734
D_EURV_236              8.75      67818
D_EURV_236              9         68909
D_EURV_236              9.25      70008
D_EURV_236              9.5       71115
D_EURV_236              9.75      72230
D_EURV_236              10        73353
;
;274'x549'
D_EURV_244      Storage 0         256
D_EURV_244              0.5       256
D_EURV_244              0.75      256
D_EURV_244              1         256
D_EURV_244              1.25      1527
D_EURV_244              1.5       3805
D_EURV_244              1.75      7091
D_EURV_244              2         11385
D_EURV_244              2.25      16687
D_EURV_244              2.5       22997
D_EURV_244              2.75      30314
D_EURV_244              3         38639
D_EURV_244              3.25      47972
D_EURV_244              3.5       58313
D_EURV_244              3.68      66382
D_EURV_244              3.75      69662
D_EURV_244              4         82018
D_EURV_244              4.25      95382
D_EURV_244              4.5       109754
D_EURV_244              4.75      125134
D_EURV_244              5         141522
D_EURV_244              5.25      151233
D_EURV_244              5.5       152886
D_EURV_244              5.75      154548
D_EURV_244              5.86      155282
D_EURV_244              6         156218
D_EURV_244              6.25      157895
D_EURV_244              6.5       159581
D_EURV_244              6.75      161275
D_EURV_244              7         162976
D_EURV_244              7.09      163591
D_EURV_244              7.25      164686
D_EURV_244              7.5       166404
D_EURV_244              7.75      168129
D_EURV_244              8         169863
D_EURV_244              8.25      171605
D_EURV_244              8.5       173354
D_EURV_244              8.75      175112
D_EURV_244              9         176878
D_EURV_244              9.25      178652
D_EURV_244              9.5       180433
D_EURV_244              9.75      182223
D_EURV_244              10        184021
;
;488'x968'
D_EURV_245      Storage 0         747
D_EURV_245              0.5       747
D_EURV_245              0.75      747
D_EURV_245              1         747
D_EURV_245              1.25      4098
D_EURV_245              1.5       10000
D_EURV_245              1.75      18452
D_EURV_245              2         29454
D_EURV_245              2.25      43006
D_EURV_245              2.5       59107
D_EURV_245              2.75      77759
D_EURV_245              3         98961
D_EURV_245              3.25      122713
D_EURV_245              3.5       149014
D_EURV_245              3.75      177866
D_EURV_245              4         209268
D_EURV_245              4.25      243220
D_EURV_245              4.5       279721
D_EURV_245              4.75      318773
D_EURV_245              5         360375
D_EURV_245              5.25      404527
D_EURV_245              5.5       451229
D_EURV_245              5.75      474217
D_EURV_245              6         477138
D_EURV_245              6.25      480067
D_EURV_245              6.5       483003
D_EURV_245              6.75      485948
D_EURV_245              7         488901
D_EURV_245              7.25      491861
D_EURV_245              7.5       494830
D_EURV_245              7.75      497807
D_EURV_245              8         500791
D_EURV_245              8.14      502466
D_EURV_245              8.25      503784
D_EURV_245              8.5       506785
D_EURV_245              8.75      509793
D_EURV_245              9         512810
D_EURV_245              9.25      515835
D_EURV_245              9.5       518867
D_EURV_245              9.75      521908
D_EURV_245              10        524957
;
;282'x567'
D_EURV_256      Storage 0         232
D_EURV_256              0.5       232
D_EURV_256              0.75      232
D_EURV_256              1         232
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D_EURV_256                1.25       1282
D_EURV_256                1.5        3132
D_EURV_256                1.75       5781
D_EURV_256                2          9229
D_EURV_256                2.25       13476
D_EURV_256                2.5        18523
D_EURV_256                2.75       24370
D_EURV_256                3          31016
D_EURV_256                3.25       38461
D_EURV_256                3.43       44316
D_EURV_256                3.5        46705
D_EURV_256                3.75       55749
D_EURV_256                4          65592
D_EURV_256                4.25       76235
D_EURV_256                4.5        87677
D_EURV_256                4.75       99918
D_EURV_256                5          112959
D_EURV_256                5.25       126799
D_EURV_256                5.28       128514
D_EURV_256                5.5        141439
D_EURV_256                5.75       156878
D_EURV_256                5.8        160062
D_EURV_256                6          161424
D_EURV_256                6.25       163133
D_EURV_256                6.5        164851
D_EURV_256                6.75       166577
D_EURV_256                7          168311
D_EURV_256                7.25       170053
D_EURV_256                7.5        171802
D_EURV_256                7.75       173560
D_EURV_256                8          175326
D_EURV_256                8.25       177100
D_EURV_256                8.5        178881
D_EURV_256                8.75       180671
D_EURV_256                9          182469
D_EURV_256                9.25       184275
D_EURV_256                9.5        186089
D_EURV_256                9.75       187910
D_EURV_256                10         189740
;
;329'x652'
D_EURV_263        Storage   0          405
D_EURV_263                  0.5        405
D_EURV_263                  0.75       405
D_EURV_263                  1          405
D_EURV_263                  1.25       2571
D_EURV_263                  1.5        6515
D_EURV_263                  1.75       12236
D_EURV_263                  2          19736
D_EURV_263                  2.25       29013
D_EURV_263                  2.5        40068
D_EURV_263                  2.75       52901
D_EURV_263                  3          67512
D_EURV_263                  3.25       83900
D_EURV_263                  3.5        102066
D_EURV_263                  3.75       122010
D_EURV_263                  4          143732
D_EURV_263                  4.25       167231
D_EURV_263                  4.5        192508
D_EURV_263                  4.7        214010
D_EURV_263                  4.75       214402
D_EURV_263                  5          216368
D_EURV_263                  5.15       217551
D_EURV_263                  5.25       218342
D_EURV_263                  5.5        220323
D_EURV_263                  5.75       222313
D_EURV_263                  6          224311
D_EURV_263                  6.25       226316
D_EURV_263                  6.5        228330
D_EURV_263                  6.75       230352
D_EURV_263                  7          232381
D_EURV_263                  7.25       234419
D_EURV_263                  7.5        236465
D_EURV_263                  7.75       238518
D_EURV_263                  8          240580
D_EURV_263                  8.25       242650
D_EURV_263                  8.5        244727
D_EURV_263                  8.75       246813
D_EURV_263                  9          248907
D_EURV_263                  9.25       251008
D_EURV_263                  9.5        253118
D_EURV_263                  9.75       255236
D_EURV_263                  10         257361
;
;Peak Shaving
D_FC_245          Storage   0          46690
D_FC_245                    0.25       47611
D_FC_245                    0.5        48539
D_FC_245                    0.75       49476
D_FC_245                    1          50421
D_FC_245                    1.25       51374
D_FC_245                    1.5        52334
D_FC_245                    1.75       53303
D_FC_245                    2          54280
D_FC_245                    2.25       55264
D_FC_245                    2.5        56257
D_FC_245                    2.75       57258
D_FC_245                    3          58267
D_FC_245                    3.25       59283
D_FC_245                    3.5        60308
D_FC_245                    3.75       61341
D_FC_245                    4          62382
D_FC_245                    4.25       63430
D_FC_245                    4.5        64487
D_FC_245                    4.75       65552
D_FC_245                    5          66625
D_FC_245                    5.25       67705
D_FC_245                    5.5        68794
D_FC_245                    5.75       69891
D_FC_245                    6          70996
D_FC_245                    6.25       72108
D_FC_245                    6.5        73229
D_FC_245                    6.75       74358
D_FC_245                    7          75495
D_FC_245                    7.25       76639
D_FC_245                    7.5        77792
D_FC_245                    7.75       78953
D_FC_245                    8          80122
D_FC_245                    8.25       81298
D_FC_245                    8.5        82483
D_FC_245                    8.75       83676
D_FC_245                    9          84877
D_FC_245                    9.25       86085
D_FC_245                    9.5        87302
D_FC_245                    9.75       88527
D_FC_245                    10         89760
;
;Peak Shaving
D_FC_263          Storage   0          21608
D_FC_263                    0.25       22236
```

```
D_FC_263                 0.5        22871
D_FC_263                 0.75       23515
D_FC_263                 1          24166
D_FC_263                 1.25       24826
D_FC_263                 1.5        25494
D_FC_263                 1.75       26169
D_FC_263                 2          26853
D_FC_263                 2.25       27545
D_FC_263                 2.5        28244
D_FC_263                 2.75       28952
D_FC_263                 3          29668
D_FC_263                 3.25       30391
D_FC_263                 3.5        31123
D_FC_263                 3.75       31863
D_FC_263                 4          32610
D_FC_263                 4.25       33366
D_FC_263                 4.5        34130
D_FC_263                 4.75       34901
D_FC_263                 5          35681
D_FC_263                 5.25       36469
D_FC_263                 5.5        37264
D_FC_263                 5.75       38068
D_FC_263                 6          38879
D_FC_263                 6.25       39699
D_FC_263                 6.5        40527
D_FC_263                 6.75       41362
D_FC_263                 7          42206
D_FC_263                 7.25       43058
D_FC_263                 7.5        43917
D_FC_263                 7.75       44785
D_FC_263                 8          45661
D_FC_263                 8.25       46544
D_FC_263                 8.5        47436
D_FC_263                 8.75       48336
D_FC_263                 9          49243
D_FC_263                 9.25       50159
D_FC_263                 9.5        51083
D_FC_263                 9.75       52014
D_FC_263                 10         52954
;
;411'x818'
D_EURV_510       Storage 0          495
D_EURV_510               0.5        495
D_EURV_510               0.75       495
D_EURV_510               1          495
D_EURV_510               1.25       2797
D_EURV_510               1.5        6877
D_EURV_510               1.75       12735
D_EURV_510               2          20370
D_EURV_510               2.25       29783
D_EURV_510               2.5        40974
D_EURV_510               2.75       53943
D_EURV_510               3          68690
D_EURV_510               3.25       85214
D_EURV_510               3.4        95982
D_EURV_510               3.5        103516
D_EURV_510               3.75       123596
D_EURV_510               4          145453
D_EURV_510               4.25       169089
D_EURV_510               4.5        194502
D_EURV_510               4.75       221693
D_EURV_510               5          250662
D_EURV_510               5.25       281408
D_EURV_510               5.36       295500
D_EURV_510               5.5        313933
D_EURV_510               5.66       335681
D_EURV_510               5.75       336566
D_EURV_510               6          339029
D_EURV_510               6.25       341500
D_EURV_510               6.5        343979
D_EURV_510               6.75       346467
D_EURV_510               7          348962
D_EURV_510               7.25       351465
D_EURV_510               7.5        353976
D_EURV_510               7.75       356495
D_EURV_510               8          359022
D_EURV_510               8.25       361558
D_EURV_510               8.5        364101
D_EURV_510               8.75       366652
D_EURV_510               9          369211
D_EURV_510               9.25       371778
D_EURV_510               9.5        374354
D_EURV_510               9.75       376937
D_EURV_510               10         379528
;
;120'x240'
D_FC_510         Storage 0          28943
D_FC_510                 0.25       29669
D_FC_510                 0.5        30402
D_FC_510                 0.75       31144
D_FC_510                 1          31894
D_FC_510                 1.25       32652
D_FC_510                 1.5        33417
D_FC_510                 1.75       34191
D_FC_510                 2          34973
D_FC_510                 2.25       35763
D_FC_510                 2.5        36561
D_FC_510                 2.75       37366
D_FC_510                 3          38180
D_FC_510                 3.25       39002
D_FC_510                 3.5        39832
D_FC_510                 3.75       40670
D_FC_510                 4          41515
D_FC_510                 4.25       42369
D_FC_510                 4.5        43231
D_FC_510                 4.75       44101
D_FC_510                 5          44978
D_FC_510                 5.25       45864
D_FC_510                 5.5        46758
D_FC_510                 5.75       47660
D_FC_510                 6          48570
D_FC_510                 6.25       49487
D_FC_510                 6.5        50413
D_FC_510                 6.75       51347
D_FC_510                 7          52289
D_FC_510                 7.25       53238
D_FC_510                 7.5        54196
D_FC_510                 7.75       55162
D_FC_510                 8          56136
D_FC_510                 8.25       57118
D_FC_510                 8.5        58107
D_FC_510                 8.75       59105
D_FC_510                 9          60111
D_FC_510                 9.25       61125
D_FC_510                 9.5        62147
D_FC_510                 9.75       63176
D_FC_510                 10         64214
;
;304'x610'
D_EURV_614       Storage 0          279
```

```
D_EURV_614                0.5         279
D_EURV_614                0.75        279
D_EURV_614                1           279
D_EURV_614                1.25        1583
D_EURV_614                1.5         3894
D_EURV_614                1.75        7214
D_EURV_614                2           11541
D_EURV_614                2.25        16876
D_EURV_614                2.5         23219
D_EURV_614                2.75        30570
D_EURV_614                3           38928
D_EURV_614                3.25        48294
D_EURV_614                3.5         58668
D_EURV_614                3.75        70050
D_EURV_614                4           82440
D_EURV_614                4.25        95837
D_EURV_614                4.5         110243
D_EURV_614                4.75        125656
D_EURV_614                5           142077
D_EURV_614                5.25        159506
D_EURV_614                5.5         177942
D_EURV_614                5.75        186698
D_EURV_614                6           188535
D_EURV_614                6.03        188756
D_EURV_614                6.25        190381
D_EURV_614                6.5         192234
D_EURV_614                6.75        194095
D_EURV_614                7           195965
D_EURV_614                7.25        197842
D_EURV_614                7.29        198143
D_EURV_614                7.5         199728
D_EURV_614                7.75        201621
D_EURV_614                8           203523
D_EURV_614                8.25        205432
D_EURV_614                8.5         207349
D_EURV_614                8.75        209275
D_EURV_614                9           211208
D_EURV_614                9.25        213150
D_EURV_614                9.5         215099
D_EURV_614                9.75        217057
D_EURV_614                10          219022
;
;405'x784'
D_EURV_618        Storage   0           616
D_EURV_618                  0.5         616
D_EURV_618                  0.75        616
D_EURV_618                  1           616
D_EURV_618                  1.25        3778
D_EURV_618                  1.5         9490
D_EURV_618                  1.75        17751
D_EURV_618                  2           28563
D_EURV_618                  2.25        41925
D_EURV_618                  2.5         57837
D_EURV_618                  2.75        76298
D_EURV_618                  3           97310
D_EURV_618                  3.25        120872
D_EURV_618                  3.5         146983
D_EURV_618                  3.75        175645
D_EURV_618                  4           206857
D_EURV_618                  4.25        240619
D_EURV_618                  4.5         276930
D_EURV_618                  4.53        281459
D_EURV_618                  4.75        300869
D_EURV_618                  5           303195
D_EURV_618                  5.25        305529
D_EURV_618                  5.5         307870
D_EURV_618                  5.75        310220
D_EURV_618                  6           312578
D_EURV_618                  6.25        314943
D_EURV_618                  6.5         317317
D_EURV_618                  6.75        319699
D_EURV_618                  7           322089
D_EURV_618                  7.25        324486
D_EURV_618                  7.5         326892
D_EURV_618                  7.55        327374
D_EURV_618                  7.75        329306
D_EURV_618                  8           331727
D_EURV_618                  8.25        334157
D_EURV_618                  8.5         336595
D_EURV_618                  8.75        339040
D_EURV_618                  9           341494
D_EURV_618                  9.25        343956
D_EURV_618                  9.5         346426
D_EURV_618                  9.67        348110
D_EURV_618                  9.75        348903
D_EURV_618                  10          351389
;
;133'x265'
D_FC_618          Storage   0           35105
D_FC_618                    0.25        35904
D_FC_618                    0.5         36711
D_FC_618                    0.75        37526
D_FC_618                    1           38349
D_FC_618                    1.25        39180
D_FC_618                    1.5         40019
D_FC_618                    1.75        40866
D_FC_618                    2           41721
D_FC_618                    2.25        42584
D_FC_618                    2.5         43455
D_FC_618                    2.75        44333
D_FC_618                    3           45220
D_FC_618                    3.25        46115
D_FC_618                    3.5         47018
D_FC_618                    3.75        47929
D_FC_618                    4           48848
D_FC_618                    4.25        49775
D_FC_618                    4.5         50710
D_FC_618                    4.75        51653
D_FC_618                    5           52604
D_FC_618                    5.25        53563
D_FC_618                    5.5         54530
D_FC_618                    5.75        55504
D_FC_618                    6           56487
D_FC_618                    6.25        57478
D_FC_618                    6.5         58477
D_FC_618                    6.75        59484
D_FC_618                    7           60499
D_FC_618                    7.25        61522
D_FC_618                    7.5         62553
D_FC_618                    7.75        63592
D_FC_618                    8           64639
D_FC_618                    8.25        65694
D_FC_618                    8.5         66757
D_FC_618                    8.75        67828
D_FC_618                    9           68906
D_FC_618                    9.25        69993
D_FC_618                    9.5         71088
D_FC_618                    9.75        72191
D_FC_618                    10          73302
;
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;255'x510'
D_EURV_810       Storage    0          258
D_EURV_810                  0.5        258
D_EURV_810                  0.75       258
D_EURV_810                  1          258
D_EURV_810                  1.25       1530
D_EURV_810                  1.5        3810
D_EURV_810                  1.75       7098
D_EURV_810                  2          11394
D_EURV_810                  2.25       16698
D_EURV_810                  2.5        23010
D_EURV_810                  2.75       30329
D_EURV_810                  3          38656
D_EURV_810                  3.25       47991
D_EURV_810                  3.33       51191
D_EURV_810                  3.5        58334
D_EURV_810                  3.75       69684
D_EURV_810                  4          82043
D_EURV_810                  4.25       95409
D_EURV_810                  4.5        109783
D_EURV_810                  4.75       125165
D_EURV_810                  4.83       130300
D_EURV_810                  5          131343
D_EURV_810                  5.25       132883
D_EURV_810                  5.28       133069
D_EURV_810                  5.5        134432
D_EURV_810                  5.75       135988
D_EURV_810                  6          137553
D_EURV_810                  6.25       139125
D_EURV_810                  6.5        140706
D_EURV_810                  6.75       142295
D_EURV_810                  7          143891
D_EURV_810                  7.25       145496
D_EURV_810                  7.5        147108
D_EURV_810                  7.75       148729
D_EURV_810                  8          150357
D_EURV_810                  8.25       151994
D_EURV_810                  8.5        153638
D_EURV_810                  8.75       155291
D_EURV_810                  9          156951
D_EURV_810                  9.25       158620
D_EURV_810                  9.5        160297
D_EURV_810                  9.75       161981
D_EURV_810                  10         163674
;
;60% WQCV, 100% EURV
D_EURV_814       Storage    0          694
D_EURV_814                  0.5        694
D_EURV_814                  0.75       694
D_EURV_814                  1          694
D_EURV_814                  1.25       3972
D_EURV_814                  1.5        9799
D_EURV_814                  1.75       18176
D_EURV_814                  2          29104
D_EURV_814                  2.25       42581
D_EURV_814                  2.5        58608
D_EURV_814                  2.75       77186
D_EURV_814                  3          98313
D_EURV_814                  3.25       121991
D_EURV_814                  3.38       135311
D_EURV_814                  3.5        148218
D_EURV_814                  3.75       176995
D_EURV_814                  4          208323
D_EURV_814                  4.25       242200
D_EURV_814                  4.5        278628
D_EURV_814                  4.75       317605
D_EURV_814                  5          359132
D_EURV_814                  5.25       403210
D_EURV_814                  5.31       414168
D_EURV_814                  5.37       425273
D_EURV_814                  5.5        426710
D_EURV_814                  5.75       429481
D_EURV_814                  6          432259
D_EURV_814                  6.25       435046
D_EURV_814                  6.5        437840
D_EURV_814                  6.75       440643
D_EURV_814                  7          443453
D_EURV_814                  7.25       446272
D_EURV_814                  7.5        449098
D_EURV_814                  7.75       451933
D_EURV_814                  8          454775
D_EURV_814                  8.25       457626
D_EURV_814                  8.5        460484
D_EURV_814                  8.75       463351
D_EURV_814                  9          466225
D_EURV_814                  9.25       469108
D_EURV_814                  9.5        471998
D_EURV_814                  9.75       474897
D_EURV_814                  10         477803
;
;100-yr Flood Control
D_FC_814         Storage    0          10528
D_FC_814                    0.25       10967
D_FC_814                    0.5        11415
D_FC_814                    0.75       11870
D_FC_814                    1          12333
D_FC_814                    1.25       12805
D_FC_814                    1.5        13284
D_FC_814                    1.75       13771
D_FC_814                    2          14267
D_FC_814                    2.25       14770
D_FC_814                    2.5        15281
D_FC_814                    2.75       15801
D_FC_814                    3          16328
D_FC_814                    3.25       16863
D_FC_814                    3.5        17407
D_FC_814                    3.75       17958
D_FC_814                    4          18517
D_FC_814                    4.25       19085
D_FC_814                    4.5        19660
D_FC_814                    4.75       20243
D_FC_814                    5          20835
D_FC_814                    5.25       21434
D_FC_814                    5.5        22041
D_FC_814                    5.75       22657
D_FC_814                    6          23280
D_FC_814                    6.25       23911
D_FC_814                    6.5        24551
D_FC_814                    6.75       25198
D_FC_814                    7          25853
D_FC_814                    7.25       26517
D_FC_814                    7.5        27188
D_FC_814                    7.75       27867
D_FC_814                    8          28554
D_FC_814                    8.25       29250
D_FC_814                    8.5        29953
D_FC_814                    8.75       30664
D_FC_814                    9          31384
D_FC_814                    9.25       32111
D_FC_814                    9.5        32846
```

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D_FC_814                  9.75       33590
D_FC_814                  10         34341

[REPORT]
;;Reporting Options
INPUT      YES
CONTROLS   YES
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS 0.000 0.000 10000.000 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
109              5102.566           6684.379
110              5239.481           6606.235
113              5099.162           6645.950
114              4946.247           6388.140
115              5455.307           5936.453
117              5459.502           5892.031
118              5393.226           5742.525
119              5584.348           5675.863
121              5588.201           5604.578
122              5390.914           5359.510
126              5835.196           4448.324
129              5608.238           5630.780
130              5814.773           5516.723
133              5852.814           5092.560
134              6082.961           5023.505
138              6053.073           4613.128
139              5481.851           5918.234
141              5586.592           5875.000
142              5558.916           5836.544
146              5641.061           5888.617
149              5854.563           5627.800
150              5955.032           5354.501
154              6148.045           5356.145
210              4613.128           6728.003
219              4397.696           6681.739
220              4413.147           6442.663
221              4737.430           6129.888
223              4741.638           6074.484
224              4626.040           5977.381
225              4708.147           5673.292
226              4561.305           5461.043
228              4769.382           5447.172
231              4777.088           6085.273
232              4995.954           5991.253
235              4968.403           5326.564
236              4998.650           5289.105
237              4954.531           5310.381
239              4932.182           5235.627
240              4838.933           5273.389
241              4932.953           4990.559
243              4898.274           4948.559
244              4713.317           4797.511
245              4708.479           4122.848
247              4719.922           4037.843
248              4856.273           4020.885
250              4826.816           3603.701
256              4988.067           5209.735
252              4541.461           4006.507
259              4946.825           4951.256
260              5080.533           4834.309
263              4997.820           4448.561
264              5177.636           4266.266
268              5105.447           4097.591
309              4131.983           6508.642
310              4245.916           6486.109
314              4240.223           5865.922
410              3935.754           6190.992
414              3846.369           6111.383
418              3782.123           5931.215
422              3685.754           6016.411
426              3600.559           5792.947
509              3353.701           5776.274
510              3478.537           5787.198
513              3854.749           5117.318
514              3795.083           4834.478
518              4172.703           5076.463
609              3219.186           5620.030
610              3325.755           5567.466
613              3512.570           4814.944
614              3482.198           4517.667
617              3867.318           4429.469
618              4100.262           4377.240
622              4099.162           4095.670
710              3302.327           4304.182
809              3213.687           3986.208
810              3339.820           4029.579
813              3240.223           3939.246
814              3658.196           3738.446
818              3491.620           3597.940
515              3750.030           5255.801
616              3738.725           4497.414
O_100            5103.352           6696.229
O_210            4629.888           6925.628
O_220            4389.665           6691.690
O_300            4125.698           6517.109
O_410            3896.648           6294.344
O_414            3805.168           6197.975
O_418            3747.207           6141.760
O_422            3607.542           6054.818
O_426            3497.905           5970.321
O_500            3351.955           5783.170
O_600            3208.799           5625.349
O_710            3202.514           4372.207
O_800            3201.117           3994.588
D_EURV_121       5577.408           5583.357
D_EURV_150       5886.408           5602.604
D_EURV_134       5913.704           5036.569
D_EURV_146       5624.300           5885.183
D_FC_134         5883.609           5070.864
D_FC_150         5873.810           5614.852
D_EURV_225       4713.895           5639.835
D_EURV_245       4716.652           4053.100
D_EURV_263       4994.551           4398.431
D_EURV_236       4983.466           5307.050
D_EURV_244       4792.517           4863.956
D_EURV_256       4956.319           5234.581
D_FC_245         4712.293           4089.473
D_FC_263         4996.458           4422.679
D_EURV_510       3805.968           5204.412
D_FC_510         3790.594           5248.810
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D_EURV_614       3498.040          4722.144
D_EURV_618       3807.759          4454.555
D_FC_618         3771.679          4479.668
D_EURV_810       3256.521          3998.958
D_EURV_814       3243.156          3900.561
D_FC_184         3245.556          3922.260

[VERTICES]
;;Link           X-Coord           Y-Coord
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L_115            5351.781          6110.903
L_115            5348.987          6145.819
L_115            5337.814          6156.992
L_115            5336.418          6172.355
L_115            5321.054          6189.115
L_115            5316.865          6211.461
L_115            5308.485          6231.014
L_115            5295.915          6236.601
L_115            5272.172          6268.724
L_115            5272.172          6285.484
L_115            5255.412          6299.450
L_115            5249.825          6362.299
L_115            5234.462          6377.662
L_115            5228.876          6411.182
L_115            5209.323          6439.115
L_115            5189.770          6462.858
L_115            5171.613          6493.584
L_115            5160.440          6500.567
L_115            5168.820          6529.897
L_115            5164.630          6556.433
L_115            5142.284          6564.813
L_115            5119.937          6588.556
L_115            5117.144          6603.919
L_115            5103.177          6615.093
L_115            5092.004          6626.266
L_119            5538.879          5725.570
L_119            5519.613          5759.479
L_119            5472.603          5820.361
L_119            5471.062          5862.747
L_126            5736.167          4561.883
L_126            5736.167          4662.068
L_126            5766.993          4709.849
L_126            5777.782          4751.464
L_126            5756.204          4836.236
L_126            5740.791          4916.384
L_126            5723.836          4924.091
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L_126            5642.147          5096.717
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L_126            5583.577          5529.824
L_126            5571.247          5546.779
L_126            5577.412          5574.522
L_133            5846.369          5101.955
L_133            5824.022          5110.335
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L_138            6106.145          4842.179
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L_149            5828.645          5643.881
L_149            5790.883          5682.414
L_149            5767.764          5710.928
L_149            5747.727          5722.488
L_149            5732.314          5731.736
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L_154            5888.268          5596.369
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L_221            4638.792          6320.051
L_221            4633.205          6341.000
L_221            4589.909          6378.710
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L_221            4546.613          6454.129
L_221            4525.663          6469.492
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L_225            4707.730          5677.597
L_225            4690.775          5726.919
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L_225	4735.473	5992.024
L_225	4744.721	6041.346
L_228	4766.299	5472.603
L_228	4758.593	5489.558
L_228	4746.262	5515.760
L_228	4737.014	5537.338
L_228	4716.977	5555.834
L_228	4720.060	5572.788
L_228	4729.308	5595.908
L_228	4724.684	5614.404
L_235	4968.211	5371.648
L_235	4946.632	5411.722
L_235	4923.513	5428.676
L_235	4908.100	5457.961
L_235	4888.063	5491.870
L_235	4875.732	5516.531
L_235	4864.943	5550.439
L_235	4872.650	5581.265
L_235	4852.613	5632.129
L_235	4846.447	5649.083
L_235	4854.154	5672.203
L_235	4849.530	5741.561
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L_235	4834.117	5968.133
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L_235	4797.125	6034.410
L_235	4792.502	6060.612
L_235	4792.502	6072.942
L_239	4927.559	5257.976
L_239	4936.806	5278.013
L_239	4943.742	5292.656
L_241	4944.513	5016.762
L_241	4932.953	5034.487
L_241	4921.393	5052.982
L_241	4915.228	5095.368
L_241	4913.687	5127.736
L_241	4920.623	5157.791
L_241	4925.247	5204.031
L_241	4933.724	5217.902
L_245	4650.123	4284.256
L_245	4614.673	4375.193
L_245	4613.132	4413.725
L_245	4628.545	4441.469
L_245	4645.499	4478.460
L_245	4679.408	4535.489
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L_245	4771.887	4641.839
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L_245	4771.887	4735.859
L_245	4779.593	4786.722
L_245	4785.758	4817.548
L_245	4801.171	4839.126
L_245	4825.832	4851.457
L_245	4842.787	4840.667
L_245	4858.200	4859.163
L_245	4867.448	4891.531
L_245	4878.237	4905.402
L_245	4884.402	4920.815
L_250	4844.972	3642.458
L_250	4839.385	3949.721
L_250	4801.676	3974.860
L_250	4763.966	3998.603
L_250	4722.067	4029.330
L_263	4994.413	4465.258
L_263	4979.050	4480.622
L_263	4979.050	4533.694
L_263	4991.620	4554.644
L_263	4979.050	4579.784
L_263	4981.844	4648.219
L_263	4970.670	4671.962
L_263	4990.223	4697.102
L_263	4986.034	4743.191
L_263	5019.553	4787.884
L_263	5019.553	4813.024
L_263	4984.637	4838.163
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L_263	4955.307	4874.476
L_263	4962.291	4910.789
L_263	4946.927	4928.946
L_268	5082.402	4144.029
L_268	5037.709	4199.895
L_268	5020.950	4215.258
L_268	5004.190	4258.554
L_268	4998.603	4275.314
L_268	5006.983	4297.661
L_268	4998.603	4314.420
L_268	4998.603	4360.510
L_268	4993.017	4371.683
L_268	4994.413	4395.426
L_314	4240.573	5898.045
L_314	4228.003	5942.737
L_314	4222.416	6043.296
L_314	4216.830	6061.453
L_314	4229.399	6100.559
L_314	4232.193	6150.838
L_314	4246.159	6173.184
L_314	4232.193	6206.704
L_314	4232.193	6286.313
L_314	4219.623	6294.693
L_314	4214.036	6331.006
L_314	4202.863	6346.369
L_314	4188.897	6400.838
L_314	4184.707	6427.374
L_314	4158.170	6460.894
L_314	4152.584	6476.257
L_314	4144.204	6481.844
L_314	4145.601	6497.207
L_613	3499.127	4890.931
L_613	3501.920	4956.573
L_613	3485.161	4973.333
L_613	3482.367	5008.249
L_613	3462.814	5052.942
L_613	3461.418	5085.065
L_613	3437.675	5094.841
L_613	3426.501	5126.964
L_613	3388.792	5156.294
L_613	3359.462	5195.400
L_613	3349.686	5207.970
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L_613	3316.166	5233.109

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L_613            3299.406           5255.456
L_613            3285.440           5298.752
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L_613            3251.920           5501.266
L_613            3263.094           5529.199
L_613            3260.300           5558.528
L_613            3243.541           5582.271
L_613            3228.177           5600.428
L_622            4100.559           4153.020
L_622            4069.832           4213.076
L_622            4011.173           4271.735
L_622            3993.017           4316.428
L_622            3956.704           4363.914
L_622            3917.598           4391.847
L_622            3899.441           4394.640
L_818            3470.670           3615.223
L_818            3417.598           3625.000
L_818            3399.441           3625.000
L_818            3395.251           3647.346
L_818            3384.078           3651.536
L_818            3368.715           3678.073
L_818            3344.972           3719.972
L_818            3339.385           3746.508
L_818            3317.039           3777.235
L_818            3311.453           3802.374
L_818            3298.883           3813.547
L_818            3283.520           3848.464
L_818            3251.397           3884.777
L_818            3244.413           3895.950
DL_515           3854.777           5151.165
DL_515           3825.689           5173.844
DL_616           3837.184           4441.001
L_513            3703.436           5286.741
L_513            3697.096           5335.654
L_513            3665.393           5361.017
L_513            3664.487           5371.886
L_513            3613.762           5428.952
L_513            3599.270           5444.350
L_513            3599.270           5456.125
L_513            3557.603           5514.096
L_513            3522.277           5528.589
L_513            3517.748           5541.270
L_513            3499.632           5559.386
L_513            3467.929           5591.995
L_513            3421.733           5619.169
L_513            3403.618           5634.567
L_513            3398.183           5667.176
L_513            3387.313           5687.104
L_513            3393.654           5713.372
L_513            3359.233           5753.227
L_617            3735.819           4526.891
L_617            3685.094           4556.782
L_617            3661.543           4582.144
L_617            3642.522           4583.050
L_617            3618.971           4632.869
L_617            3617.159           4661.855
L_617            3603.572           4667.289
L_617            3581.833           4720.731
L_617            3534.732           4771.456

[Polygons]
;;Storage Node   X-Coord            Y-Coord
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[BACKDROP]
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Models\CUHP_SWMM\SWMM\Backgrounds\Background_basemap.jpg"
DIMENSIONS 0.000 2873.094 10000.000 7126.906
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Appendix F-4
Master Plan SWMM Output

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
  ---------------------------------------------------------------

  City of Greeley
  Storm Drainage Master Plan
  Oklahoma and South Basins Baseline Hydrology EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.3)

  City of Greeley
  Storm Drainage Master Plan
  Oklahoma and South Basins Baseline Hydrology
  WARNING 08: elevation drop exceeds length for Conduit DL_509
  WARNING 10: crest elevation is below downstream invert for regulator Link O_FC_814

  *************
  Element Count
  *************
  Number of rain gages ...... 0
  Number of subcatchments ... 0
  Number of nodes ........... 116
  Number of links ........... 103
  Number of pollutants ...... 0
  Number of land uses ....... 0


  ************
  Node Summary
  ************
                                       Invert      Max.    Ponded    External
  Name                 Type             Elev.     Depth      Area    Inflow
  ----------------------------------------------------------------------------
  109                  JUNCTION       4779.00     10.00       0.0
  110                  JUNCTION       4794.00      0.00       0.0
  113                  JUNCTION       4784.00     10.00       0.0
  114                  JUNCTION       4798.00      0.00       0.0
  115                  JUNCTION       4816.70     10.00       0.0
  117                  JUNCTION       4818.00     10.00       0.0
  118                  JUNCTION       4830.00      0.00       0.0
  119                  JUNCTION       4834.00     10.00       0.0
  121                  JUNCTION       4835.00      0.00       0.0
  122                  JUNCTION       4983.00      0.00       0.0
  126                  JUNCTION       4999.00     10.00       0.0
  129                  JUNCTION       4835.00     10.00       0.0
  130                  JUNCTION       4910.00      0.00       0.0
  133                  JUNCTION       4917.00     10.00       0.0
  134                  JUNCTION       4945.00      0.00       0.0
  138                  JUNCTION       4970.00     10.00       0.0
  139                  JUNCTION       4817.00     10.00       0.0
  141                  JUNCTION       4827.00     10.00       0.0
  142                  JUNCTION       4820.00      0.00       0.0
  146                  JUNCTION       4849.00      0.00       0.0
  149                  JUNCTION       4869.00     10.00       0.0
  150                  JUNCTION       4890.00      0.00       0.0
  154                  JUNCTION       4904.00     10.00       0.0
  210                  JUNCTION       4770.00      0.00       0.0
  219                  JUNCTION       4771.00     10.00       0.0
  220                  JUNCTION       4777.00      0.00       0.0
  221                  JUNCTION       4790.60     10.00       0.0
  223                  JUNCTION       4793.00     10.00       0.0
  224                  JUNCTION       4810.00      0.00       0.0
  225                  JUNCTION       4839.00     10.00       0.0
  226                  JUNCTION       4850.00      0.00       0.0
  228                  JUNCTION       4864.00     10.00       0.0
  231                  JUNCTION       4790.80     10.00       0.0
  232                  JUNCTION       4810.00      0.00       0.0
  235                  JUNCTION       4845.00     10.00       0.0
  236                  JUNCTION       4847.00      0.00       0.0
  237                  JUNCTION       4846.00     10.00       0.0
  239                  JUNCTION       4850.00     10.00       0.0
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  244                  JUNCTION       4894.00      0.00       0.0
  245                  JUNCTION       4980.00     10.00       0.0
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  248                  JUNCTION       4986.00      0.00       0.0
  250                  JUNCTION       5015.00     10.00       0.0
  256                  JUNCTION       4851.00      0.00       0.0
  252                  JUNCTION       4990.00      0.00       0.0
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  260                  JUNCTION       4905.00      0.00       0.0
  263                  JUNCTION       4922.00     10.00       0.0
  264                  JUNCTION       4960.00      0.00       0.0
  268                  JUNCTION       4970.00     10.00       0.0
  309                  JUNCTION       4778.00     10.00       0.0
  310                  JUNCTION       4779.00      0.00       0.0
  314                  JUNCTION       4839.00     10.00       0.0
  410                  JUNCTION       4793.00      0.00       0.0
  414                  JUNCTION       4796.00      0.00       0.0
  418                  JUNCTION       4802.00      0.00       0.0
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  814                  JUNCTION       4970.00      0.00       0.0
  818                  JUNCTION       4990.00     10.00       0.0
  515                  JUNCTION       4879.00     10.00       0.0
  616                  JUNCTION       4941.00     10.00       0.0
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  O_210                OUTFALL        4754.00      0.00       0.0
  O_220                OUTFALL        4769.00      0.00       0.0
  O_300                OUTFALL        4775.00      0.00       0.0
  O_410                OUTFALL        4779.00      0.00       0.0
  O_414                OUTFALL        4781.00      0.00       0.0
  O_418                OUTFALL        4784.00      0.00       0.0
  O_422                OUTFALL        4789.00      0.00       0.0
  O_426                OUTFALL        4793.00      0.00       0.0
  O_500                OUTFALL        4804.00      0.00       0.0
  O_600                OUTFALL        4820.00      0.00       0.0
  O_710                OUTFALL        4961.00      0.00       0.0
  O_800                OUTFALL        4960.00      0.00       0.0
  D_EURV_121           STORAGE        4835.00     10.00       0.0
  D_EURV_150           STORAGE        4870.00     10.00       0.0
  D_EURV_134           STORAGE        4940.00     10.00       0.0
  D_EURV_146           STORAGE        4827.00     10.00       0.0
  D_FC_134             STORAGE        4939.00     10.00       0.0
  D_FC_150             STORAGE        4869.00     10.00       0.0
```

D_EURV_225	STORAGE	4840.00	10.00	0.0
D_EURV_245	STORAGE	4980.00	10.00	0.0
D_EURV_263	STORAGE	4922.00	10.00	0.0
D_EURV_236	STORAGE	4846.00	10.00	0.0
D_EURV_244	STORAGE	4863.00	10.00	0.0
D_EURV_256	STORAGE	4851.50	10.00	0.0
D_FC_245	STORAGE	4980.00	10.00	0.0
D_FC_263	STORAGE	4922.00	10.00	0.0
D_EURV_510	STORAGE	4879.00	10.00	0.0
D_FC_510	STORAGE	4879.00	10.00	0.0
D_EURV_614	STORAGE	4889.00	10.00	0.0
D_EURV_618	STORAGE	4941.00	10.00	0.0
D_FC_618	STORAGE	4941.00	10.00	0.0
D_EURV_810	STORAGE	4965.00	10.00	0.0
D_EURV_814	STORAGE	4967.00	10.00	0.0
D_FC_184	STORAGE	0.00	10.00	0.0

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
DL_109	109	O_100	CONDUIT	11.9	8.4475	0.0100
DL_110	110	109	CONDUIT	157.7	9.5581	0.0100
DL_114	114	113	CONDUIT	299.8	4.6757	0.0100
DL_118	118	117	CONDUIT	163.5	7.3575	0.0100
DL_121	121	119	CONDUIT	71.4	1.4009	0.0100
DL_122	122	D_EURV_121	CONDUIT	314.6	53.3094	0.0100
DL_129	129	119	CONDUIT	51.0	1.9604	0.0100
DL_130	130	129	CONDUIT	235.9	33.5267	0.0100
DL_134	134	D_EURV_134	CONDUIT	214.7	2.3296	0.0100
DL_142	142	139	CONDUIT	112.3	2.6724	0.0100
DL_150	150	D_EURV_150	CONDUIT	280.1	7.1599	0.0100
DL_210	210	O_210	CONDUIT	198.3	8.0933	0.0100
DL_219	219	O_220	CONDUIT	12.8	15.8320	0.0100
DL_220	220	219	CONDUIT	239.6	2.5053	0.0100
DL_223	223	221	CONDUIT	55.6	4.3237	0.0100
DL_224	224	223	CONDUIT	151.0	11.3326	0.0100
DL_226	226	D_EURV_225	CONDUIT	235.1	4.2583	0.0100
DL_231	231	221	CONDUIT	59.7	0.3351	0.0100
DL_232	232	231	CONDUIT	238.2	8.0864	0.0100
DL_236	236	D_EURV_236	CONDUIT	18.3	5.4817	0.0100
DL_237	237	235	CONDUIT	21.3	4.6956	0.0100
DL_240	240	237	CONDUIT	121.4	2.4725	0.0100
DL_243	243	241	CONDUIT	54.5	1.8362	0.0100
DL_244	244	D_EURV_244	CONDUIT	238.8	13.0924	0.0100
DL_247	247	D_EURV_245	CONDUIT	23.8	4.2107	0.0100
DL_248	248	247	CONDUIT	146.8	3.4080	0.0100
DL_252	252	D_EURV_245	CONDUIT	191.5	5.2299	0.0100
DL_256	256	D_EURV_256	CONDUIT	29.9	-1.6725	0.0350
DL_259	259	241	CONDUIT	41.7	2.3999	0.0100
DL_260	260	259	CONDUIT	177.6	24.3332	0.0100
DL_264	264	D_EURV_263	CONDUIT	240.2	16.0212	0.0100
DL_309	309	O_300	CONDUIT	10.5	29.6911	0.0100
DL_310	310	309	CONDUIT	116.1	0.8611	0.0100
DL_410	410	O_410	CONDUIT	110.5	12.7726	0.0100
DL_414	414	O_414	CONDUIT	95.9	15.8379	0.0100
DL_418	418	O_418	CONDUIT	213.4	8.4642	0.0100
DL_422	422	O_422	CONDUIT	87.1	12.7266	0.0100
DL_426	426	O_426	CONDUIT	204.9	8.3238	0.0100
DL_509	509	O_500	CONDUIT	10.0	220.0000	0.0100
DL_510	510	509	CONDUIT	125.3	24.6577	0.0100
DL_514	514	513	CONDUIT	289.1	17.9246	0.0100
DL_518	518	513	CONDUIT	320.6	19.0534	0.0100
DL_609	609	O_600	CONDUIT	147.0	8.1906	0.0100
DL_610	610	609	CONDUIT	118.8	22.4233	0.0100
DL_614	614	D_EURV_614	CONDUIT	298.8	3.3484	0.0100
DL_618	618	617	CONDUIT	238.7	3.3529	0.0100
DL_710	710	O_710	CONDUIT	202.6	6.9267	0.0100
DL_809	809	O_800	CONDUIT	15.1	35.0662	0.0100
DL_810	810	D_EURV_810	CONDUIT	400.0	1.0001	0.0100
DL_814	814	D_EURV_814	CONDUIT	400.0	0.7500	0.0100
L_114	113	109	CONDUIT	144.0	3.4743	0.0350
L_115	115	113	CONDUIT	3260.0	1.0031	0.0350
L_117	117	115	CONDUIT	86.0	1.5118	0.0100
L_119	119	117	CONDUIT	1087.0	1.4721	0.0350
L_126	126	D_EURV_121	CONDUIT	5178.0	3.1688	0.0350
L_133	133	129	CONDUIT	2743.0	2.9908	0.0350
L_138	138	D_EURV_134	CONDUIT	2426.0	1.2367	0.0350
L_139	139	115	CONDUIT	73.0	0.4110	0.0100
L_141	141	139	CONDUIT	542.0	1.8453	0.0100
DL_146	146	D_EURV_146	CONDUIT	400.0	5.5083	0.0350
L_149	149	141	CONDUIT	1479.0	2.8409	0.0350
L_154	154	D_EURV_150	CONDUIT	1625.0	2.0928	0.0350
L_221	221	219	CONDUIT	2511.0	0.7806	0.0350
L_225	225	223	CONDUIT	1810.0	2.5423	0.0350
L_228	228	D_EURV_225	CONDUIT	847.0	2.8347	0.0350
L_235	235	231	CONDUIT	3274.0	1.6557	0.0350
L_239	239	237	CONDUIT	288.0	1.3890	0.0350
L_241	241	239	CONDUIT	1092.0	1.0990	0.0350
L_245	245	243	CONDUIT	4101.0	2.8541	0.0350
L_250	250	247	CONDUIT	2063.0	1.6483	0.0350
L_263	263	259	CONDUIT	2459.0	2.4000	0.0350
L_268	268	D_EURV_263	CONDUIT	1464.0	3.2805	0.0350
L_314	314	309	CONDUIT	2623.0	2.3262	0.0350
L_613	613	609	CONDUIT	3459.0	1.6192	0.0350
L_622	622	617	CONDUIT	1661.0	2.3486	0.0350
L_813	813	809	CONDUIT	190.0	1.0527	0.0350
L_818	818	D_EURV_814	CONDUIT	1740.0	1.3220	0.0350
DL_515	513	D_EURV_510	CONDUIT	400.0	0.2500	0.0100
DL_616	617	D_EURV_618	CONDUIT	400.0	0.2500	0.0100
L_513	515	509	CONDUIT	3358.0	1.5785	0.0350
L_617	616	613	CONDUIT	2214.0	2.3945	0.0350
O_EURV_134	D_EURV_134	D_FC_134	OUTLET			
O_EURV_150	D_EURV_150	D_FC_150	OUTLET			
O_EURV_121	D_EURV_121	121	OUTLET			
O_EURV_146	D_EURV_146	141	OUTLET			
O_FC_150	D_FC_150	149	OUTLET			
O_FC_134	D_FC_134	133	OUTLET			
O_EURV_225	D_EURV_225	225	OUTLET			
O_EURV_245	D_EURV_245	D_FC_245	OUTLET			
O_EURV_263	D_EURV_263	D_FC_263	OUTLET			
O_EURV_236	D_EURV_236	235	OUTLET			
O_EURV_244	D_EURV_244	243	OUTLET			
O_EURV_256	D_EURV_256	239	OUTLET			
O_FC_263	D_FC_263	263	OUTLET			
O_FC_245	D_FC_245	245	OUTLET			
O_EURV_510	D_EURV_510	D_FC_510	OUTLET			
O_EURV_614	D_EURV_614	613	OUTLET			
O_EURV_618	D_EURV_618	D_FC_618	OUTLET			
O_EURV_810	D_EURV_810	809	OUTLET			
O_EURV_814	D_EURV_814	D_FC_184	OUTLET			
O_FC_814	D_FC_184	813	OUTLET			
O_FC_510	D_FC_510	515	OUTLET			
O_FC_618	D_FC_618	616	OUTLET			

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Cross Section Summary

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Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
DL_109	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_110	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_114	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_118	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_121	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_122	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_129	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_130	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_134	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_142	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_150	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_210	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_219	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_220	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_223	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_224	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_226	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_231	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_232	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_236	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_237	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_240	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_243	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_244	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_247	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_248	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_252	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_256	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_259	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_260	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_264	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_309	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_310	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_410	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_414	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_418	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_422	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_426	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_509	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_510	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_514	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_518	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_609	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_610	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_614	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_618	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_710	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_809	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_810	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_814	DUMMY	0.00	0.00	0.00	0.00	1	0.00
L_114	TRIANGULAR	10.00	1000.00	4.98	200.00	1	23063.49
L_115	TRAPEZOIDAL	10.00	1680.00	7.64	218.00	1	27704.67
L_117	TRAPEZOIDAL	10.00	300.00	5.48	50.00	1	17042.38
L_119	TRAPEZOIDAL	10.00	1390.00	7.28	189.00	1	26891.70
L_126	TRAPEZOIDAL	10.00	500.00	6.69	70.00	1	13419.02
L_133	TRAPEZOIDAL	10.00	1550.00	6.56	235.00	1	39885.90
L_138	TRAPEZOIDAL	10.00	1360.00	7.23	186.00	1	24019.97
L_139	TRAPEZOIDAL	10.00	400.00	6.18	60.00	1	12832.80
L_141	TRAPEZOIDAL	10.00	500.00	6.69	70.00	1	35840.68
DL_146	DUMMY	0.00	0.00	0.00	0.00	1	0.00
L_149	TRAPEZOIDAL	10.00	1300.00	7.14	180.00	1	34506.54
L_154	TRAPEZOIDAL	10.00	1290.00	7.13	179.00	1	29345.37
L_221	TRAPEZOIDAL	10.00	1900.00	7.85	240.00	1	28155.59
L_225	TRAPEZOIDAL	10.00	1400.00	7.29	190.00	1	35639.86
L_228	TRAPEZOIDAL	10.00	400.00	6.18	60.00	1	9629.49
L_235	TRAPEZOIDAL	10.00	2400.00	8.22	290.00	1	53401.95
L_239	TRAPEZOIDAL	10.00	1900.00	7.85	240.00	1	37558.48
L_241	TRAPEZOIDAL	10.00	1500.00	7.43	200.00	1	25412.99
L_245	TRAPEZOIDAL	10.00	1600.00	7.55	210.00	1	44159.42
L_250	TRAPEZOIDAL	10.00	5100.00	5.05	1010.00	1	81811.71
L_263	TRAPEZOIDAL	10.00	900.00	6.34	140.00	1	20275.83
L_268	TRAPEZOIDAL	10.00	400.00	6.18	60.00	1	10359.03
L_314	TRAPEZOIDAL	10.00	700.00	7.39	90.00	1	17197.82
L_613	TRAPEZOIDAL	10.00	1300.00	7.96	160.00	1	28007.61
L_622	TRAPEZOIDAL	10.00	1510.00	7.44	201.00	1	37441.25
L_813	TRIANGULAR	10.00	1000.00	4.98	200.00	1	12695.23
L_818	TRAPEZOIDAL	10.00	1700.00	5.30	320.00	1	25231.25
DL_515	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_616	DUMMY	0.00	0.00	0.00	0.00	1	0.00
L_513	TRAPEZOIDAL	10.00	600.00	7.66	70.00	1	12441.65
L_617	TRAPEZOIDAL	10.00	1000.00	8.02	120.00	1	26318.93

****
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 12:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Routing Time Step ..... 20.00 sec

****
Control Actions Taken
****

Flow Routing Continuity	Volume acre-feet	Volume 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	566.887	184.729
External Outflow	485.145	158.092
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	88.217	28.747
Continuity Error (%)	-1.142	

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Highest Flow Instability Indexes
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All links are stable.


************************
Routing Time Step Summary
************************
Minimum Time Step           :    20.00 sec
Average Time Step           :    20.00 sec
Maximum Time Step           :    20.00 sec
% of Time in Steady State   :     0.00
Average Iterations per Step :     1.00
% of Steps Not Converging   :     0.00


******************
Analysis begun on:  Wed Jun  7 08:29:48 2023
Analysis ended on:  Wed Jun  7 08:29:49 2023
Total elapsed time: 00:00:01
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Appendix F-5
Master Plan Hydrology Summary

Design Point		Drainage Area	Existing Conditions	Future Conditions Do Nothing	Future Conditions Concept Design
Number	Type	(acres)	Q_{100}	Q_{100}	Q_{100}
109	JUNCTION	755	1,042	1,446	990
110	BASIN	71	73	73	73
113	JUNCTION	684	969	1,375	924
114	BASIN	112	157	157	157
115	JUNCTION	572	845	1,278	818
117	JUNCTION	364	527	821	504
118	BASIN	38	53	53	53
119	JUNCTION	326	477	770	462
121	JUNCTION	143	168	251	243
122	BASIN	123	143	235	232
126	BASIN	20	31	31	31
129	JUNCTION	183	312	523	257
130	BASIN	47	63	65	65
133	JUNCTION	137	255	473	209
134	BASIN	53	84	159	158
138	BASIN	83	177	336	337
139	JUNCTION	208	326	465	316
141	JUNCTION	188	303	444	294
142	BASIN	20	23	23	23
146	BASIN	40	38	49	48
149	JUNCTION	149	268	401	249
150	BASIN	60	90	100	100
154	BASIN	89	181	316	314
210	BASIN	49	90	90	90
219	JUNCTION	1,058	1,401	2,273	1,208
220	BASIN	100	134	134	134
221	JUNCTION	958	1,282	2,160	1,117
223	JUNCTION	191	302	397	360
224	BASIN	64	102	102	102
225	JUNCTION	127	202	297	276
226	BASIN	61	124	157	155
228	BASIN	66	84	143	141
231	JUNCTION	767	1,002	1,772	872
232	BASIN	106	138	139	139
235	JUNCTION	661	877	1,663	778
236	BASIN	60	75	106	104
237	JUNCTION	601	803	1,558	702
239	JUNCTION	579	772	1,525	680
240	BASIN	22	33	33	33
241	JUNCTION	486	677	1,343	562
243	JUNCTION	294	414	901	361
244	BASIN	90	116	237	235
245	JUNCTION	203	302	680	266
247	JUNCTION	140	232	509	508

Design Point		Drainage Area	Existing Conditions	Future Conditions Do Nothing	Future Conditions Concept Design
Number	Type	(acres)	Q_{100}	Q_{100}	Q_{100}
248	BASIN	97	152	372	372
250	BASIN	44	87	182	181
252	BASIN	63	71	173	172
256	BASIN	94	97	183	180
259	JUNCTION	192	263	445	201
260	BASIN	65	95	99	99
263	JUNCTION	127	171	351	137
264	BASIN	69	90	196	195
268	BASIN	59	82	158	157
309	JUNCTION	157	258	270	267
310	BASIN	88	111	111	111
314	BASIN	69	155	168	166
410	BASIN	13	19	19	19
414	BASIN	12	20	20	20
418	BASIN	40	54	54	54
422	BASIN	4	3	3	3
426	BASIN	43	53	53	53
509	JUNCTION	292	386	613	336
510	BASIN	123	174	175	175
513	JUNCTION	168	214	456	453
514	BASIN	89	101	229	228
518	BASIN	80	117	227	225
609	JUNCTION	363	525	955	481
610	BASIN	106	135	146	146
613	JUNCTION	257	405	852	370
614	BASIN	100	182	322	319
617	JUNCTION	157	238	554	544
618	BASIN	54	95	217	217
622	BASIN	103	149	359	359
710	BASIN	43	70	163	163
809	JUNCTION	274	369	848	362
810	BASIN	64	82	200	199
813	JUNCTION	211	287	650	281
814	BASIN	111	150	350	350
818	BASIN	100	140	312	310
O_100	OUTFALL	755	1,042	1,446	990
O_210	OUTFALL	49	90	90	90
O_220	OUTFALL	1,058	1,401	2,273	1,208
O_300	OUTFALL	157	258	270	267
O_410	OUTFALL	13	19	19	19
O_414	OUTFALL	12	20	20	20
O_418	OUTFALL	40	54	54	54
O_422	OUTFALL	4	3	3	3
O_426	OUTFALL	43	53	53	53

Design Point		Drainage Area	Existing Conditions	Future Conditions Do Nothing	Future Conditions Concept Design
Number	Type	(acres)	Q_{100}	Q_{100}	Q_{100}
O_500	OUTFALL	292	386	613	336
O_600	OUTFALL	363	525	955	481
O_710	OUTFALL	43	70	163	163
O_800	OUTFALL	274	369	848	362

Design Point		Drainage Area	Future Conditions Concept Design Peak Flows (cfs)						
Number	Type	(acres)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
109	JUNCTION	755	9	13	85	380	659	990	1,618
110	BASIN	71	1	5	13	35	51	73	125
113	JUNCTION	684	9	11	79	356	618	924	1,495
114	BASIN	112	1	6	26	75	111	157	273
115	JUNCTION	572	9	11	81	326	560	818	1,267
117	JUNCTION	364	6	9	41	195	340	504	838
118	BASIN	38	0	2	8	25	37	53	92
119	JUNCTION	326	6	8	39	183	316	462	754
121	JUNCTION	143	2	2	31	111	171	243	412
122	BASIN	123	26	45	69	129	175	232	380
126	BASIN	20	2	3	6	15	22	31	53
129	JUNCTION	183	5	7	15	102	181	257	371
130	BASIN	47	3	7	15	34	47	65	110
133	JUNCTION	137	5	5	14	88	152	209	272
134	BASIN	53	25	39	56	93	122	158	253
138	BASIN	83	70	103	136	206	263	337	521
139	JUNCTION	208	3	4	41	152	231	316	430
141	JUNCTION	188	3	3	38	143	216	294	391
142	BASIN	20	1	2	4	11	17	23	40
146	BASIN	40	4	7	12	25	35	48	80
149	JUNCTION	149	3	3	31	123	185	249	311
150	BASIN	60	6	14	25	52	73	100	166
154	BASIN	89	49	79	112	185	243	314	500
210	BASIN	49	1	7	18	45	65	90	154
219	JUNCTION	1,058	19	20	81	416	757	1,208	2,216
220	BASIN	100	1	4	21	63	94	134	234
221	JUNCTION	958	19	20	79	390	708	1,117	2,018
223	JUNCTION	191	2	7	39	155	245	360	634
224	BASIN	64	1	7	20	50	73	102	175
225	JUNCTION	127	2	3	40	129	195	276	473
226	BASIN	61	20	34	50	89	119	155	251
228	BASIN	66	17	29	44	80	107	141	230
231	JUNCTION	767	17	18	66	318	573	872	1,514
232	BASIN	106	1	10	26	68	98	139	238
235	JUNCTION	661	17	18	65	292	521	778	1,310
236	BASIN	60	9	17	28	56	77	104	173
237	JUNCTION	601	16	17	61	267	476	702	1,160
239	JUNCTION	579	16	17	60	261	464	680	1,111
240	BASIN	22	0	1	5	16	23	33	58
241	JUNCTION	486	14	15	55	223	394	562	866
243	JUNCTION	294	10	11	38	128	249	361	568
244	BASIN	90	37	58	82	139	182	235	375
245	JUNCTION	203	8	8	32	103	192	266	330
247	JUNCTION	140	101	147	195	309	398	508	799

Design Point		Drainage Area	Future Conditions Concept Design Peak Flows (cfs)						
Number	Type	(acres)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
248	BASIN	97	82	118	155	232	295	372	574
250	BASIN	44	36	54	72	109	140	181	282
252	BASIN	63	34	50	66	106	136	172	269
256	BASIN	94	21	33	51	99	135	180	295
259	JUNCTION	192	4	10	21	97	146	201	299
260	BASIN	65	3	10	21	50	71	99	168
263	JUNCTION	127	4	4	18	75	105	137	150
264	BASIN	69	37	55	74	119	153	195	305
268	BASIN	59	26	40	56	94	122	157	249
309	JUNCTION	157	13	22	48	131	190	267	462
310	BASIN	88	0	1	10	49	75	111	199
314	BASIN	69	16	26	44	89	124	166	275
410	BASIN	13	0	1	3	9	13	19	33
414	BASIN	12	0	1	3	9	14	20	34
418	BASIN	40	1	4	10	26	38	54	92
422	BASIN	4	0	0	0	0	1	3	7
426	BASIN	43	0	1	7	24	37	53	93
509	JUNCTION	292	7	20	40	153	237	336	508
510	BASIN	123	7	20	40	90	127	175	295
513	JUNCTION	168	74	115	161	269	352	453	719
515	JUNCTION	168	5	5	23	110	156	209	242
514	BASIN	89	40	61	83	137	178	228	360
518	BASIN	80	34	55	78	133	174	225	359
609	JUNCTION	363	9	18	34	160	311	481	844
610	BASIN	106	7	18	34	75	106	146	245
613	JUNCTION	257	9	9	29	123	247	370	623
616	JUNCTION	157	6	6	24	87	161	234	320
614	BASIN	100	49	78	112	187	248	319	511
617	JUNCTION	157	109	159	212	335	429	544	849
618	BASIN	54	50	71	91	135	170	217	333
622	BASIN	103	77	112	147	224	286	359	556
710	BASIN	43	37	53	68	102	129	163	251
809	JUNCTION	274	10	10	21	73	161	362	622
810	BASIN	64	44	63	83	125	159	199	308
813	JUNCTION	211	7	7	8	8	125	281	396
814	BASIN	111	70	102	135	214	275	350	544
818	BASIN	100	53	78	110	183	241	310	494
O_100	OUTFALL	755	9	13	85	380	659	990	1,618
O_210	OUTFALL	49	1	7	18	45	65	90	154
O_220	OUTFALL	1,058	19	20	81	416	757	1,208	2,216
O_300	OUTFALL	157	13	22	48	131	190	267	462
O_410	OUTFALL	13	0	1	3	9	13	19	33
O_414	OUTFALL	12	0	1	3	9	14	20	34
O_418	OUTFALL	40	1	4	10	26	38	54	92

Design Point		Drainage Area	Future Conditions Concept Design Peak Flows (cfs)						
Number	Type	(acres)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
O_422	OUTFALL	4	0	0	0	0	1	3	7
O_426	OUTFALL	43	0	1	7	24	37	53	93
O_500	OUTFALL	292	7	20	40	153	237	336	508
O_600	OUTFALL	363	9	18	34	160	311	481	844
O_710	OUTFALL	43	37	53	68	102	129	163	251
O_800	OUTFALL	274	10	10	21	73	161	362	622

Design Point		Drainage Area	Future Conditions Concept Design Peak Volume (arce-ft)						
Number	Type	(acres)	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_{500}
109	JUNCTION	755	7	10	22	55	82	118	202
110	BASIN	71	0	1	2	5	7	11	20
113	JUNCTION	684	7	9	20	50	75	107	183
114	BASIN	112	0	1	2	7	11	17	30
115	JUNCTION	572	7	9	18	43	64	91	153
117	JUNCTION	364	5	6	11	27	41	57	98
118	BASIN	38	0	0	1	2	4	6	10
119	JUNCTION	326	5	6	11	25	37	52	88
121	JUNCTION	143	1	2	4	11	16	23	40
122	BASIN	123	3	5	7	13	17	23	38
126	BASIN	20	0	0	1	1	2	3	6
129	JUNCTION	183	4	5	6	14	21	30	48
130	BASIN	47	0	1	2	4	5	8	13
133	JUNCTION	137	3	4	5	11	16	22	35
134	BASIN	53	2	3	4	6	8	11	17
138	BASIN	83	4	5	7	11	14	18	28
139	JUNCTION	208	2	3	7	16	23	33	54
141	JUNCTION	188	2	3	6	14	21	30	48
142	BASIN	20	0	0	1	1	2	3	5
146	BASIN	40	1	1	2	4	5	7	12
149	JUNCTION	149	2	3	5	11	17	24	37
150	BASIN	60	1	1	2	5	7	10	17
154	BASIN	89	3	4	6	10	14	18	29
210	BASIN	49	0	0	1	3	5	7	13
219	JUNCTION	1,058	13	17	33	79	118	168	282
220	BASIN	100	0	0	2	6	10	15	27
221	JUNCTION	958	13	18	31	73	109	153	255
223	JUNCTION	191	2	3	6	14	21	30	54
224	BASIN	64	0	1	2	4	7	10	17
225	JUNCTION	127	2	2	4	10	14	20	36
226	BASIN	61	2	3	4	7	9	12	19
228	BASIN	66	2	3	4	7	9	12	21
231	JUNCTION	767	12	15	25	59	87	123	201
232	BASIN	106	0	1	3	7	11	16	29
235	JUNCTION	661	12	15	24	52	77	108	172
236	BASIN	60	1	2	3	6	8	11	18
237	JUNCTION	601	12	14	22	48	71	98	156
239	JUNCTION	579	12	14	21	47	68	95	150
240	BASIN	22	0	0	0	1	2	3	6
241	JUNCTION	486	10	13	19	41	59	82	125
243	JUNCTION	294	7	8	13	26	37	50	79
244	BASIN	90	3	5	7	11	14	18	29
245	JUNCTION	203	6	7	10	18	26	35	52
247	JUNCTION	140	7	10	13	19	24	31	48

Design Point		Drainage Area	Future Conditions Concept Design Peak Volume (arce-ft)						
Number	Type	(acres)	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_{500}
248	BASIN	97	5	7	9	13	17	21	33
250	BASIN	44	2	3	4	5	7	9	14
252	BASIN	63	3	4	6	8	11	14	21
256	BASIN	94	2	3	5	9	13	17	28
259	JUNCTION	192	3	4	7	15	22	31	46
260	BASIN	65	0	1	2	5	7	10	18
263	JUNCTION	127	3	4	5	10	15	21	28
264	BASIN	69	3	4	6	9	12	15	23
268	BASIN	59	2	3	4	7	9	12	19
309	JUNCTION	157	1	2	4	11	16	24	42
310	BASIN	88	0	0	1	5	8	12	22
314	BASIN	69	1	2	3	6	9	12	20
410	BASIN	13	0	0	0	1	1	2	4
414	BASIN	12	0	0	0	1	1	2	3
418	BASIN	40	0	0	1	3	4	6	11
422	BASIN	4	0	0	0	0	0	0	1
426	BASIN	43	0	0	1	3	4	6	11
509	JUNCTION	292	4	6	10	23	34	47	75
510	BASIN	123	1	2	4	10	14	20	35
513	JUNCTION	168	6	9	13	20	26	34	55
514	BASIN	89	3	5	7	11	14	18	29
518	BASIN	80	2	4	6	9	12	16	26
609	JUNCTION	363	7	9	15	31	44	61	104
610	BASIN	106	1	2	4	9	12	17	30
613	JUNCTION	257	6	8	11	22	32	44	72
614	BASIN	100	3	5	7	12	15	20	32
617	JUNCTION	157	8	11	15	21	27	34	54
618	BASIN	54	3	4	5	7	9	12	18
622	BASIN	103	5	7	10	14	18	23	35
710	BASIN	43	2	3	4	6	8	10	15
809	JUNCTION	274	7	9	10	13	22	34	61
810	BASIN	64	3	5	6	9	11	14	22
813	JUNCTION	211	5	7	7	7	14	23	42
814	BASIN	111	5	7	10	14	19	24	37
818	BASIN	100	3	5	7	12	15	20	32
515	JUNCTION	168	1	1	2	4	6	9	13
616	JUNCTION	157	1	2	2	5	7	9	14
O_100	OUTFALL	755	7	10	22	55	82	118	202
O_210	OUTFALL	49	0	0	1	3	5	7	13
O_220	OUTFALL	1,058	13	17	33	79	118	168	282
O_300	OUTFALL	157	1	2	4	11	16	24	42
O_410	OUTFALL	13	0	0	0	1	1	2	4
O_414	OUTFALL	12	0	0	0	1	1	2	3
O_418	OUTFALL	40	0	0	1	3	4	6	11

Design Point		Drainage Area	Future Conditions Concept Design Peak Volume (arce-ft)						
Number	Type	(acres)	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_{500}
O_422	OUTFALL	4	0	0	0	0	0	0	1
O_426	OUTFALL	43	0	0	1	3	4	6	11
O_500	OUTFALL	292	4	6	10	23	34	47	75
O_600	OUTFALL	363	7	9	15	31	44	61	104
O_710	OUTFALL	43	2	3	4	6	8	10	15
O_800	OUTFALL	274	7	9	10	13	22	34	61

Appendix F-6
Master Plan HY-8 Culverts

Culvert Data: Structure#101, Reach 100

Site Data: Structure#101

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4778.22 ft
Outlet Station: 52.00 ft
Outlet Elevation: 4777.89 ft
Number of Barrels: 3

Culvert Data Summary: Structure#101

Barrel Shape: Concrete Box
Barrel Span: 12.00 ft
Barrel Rise: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall
Inlet Depression: None

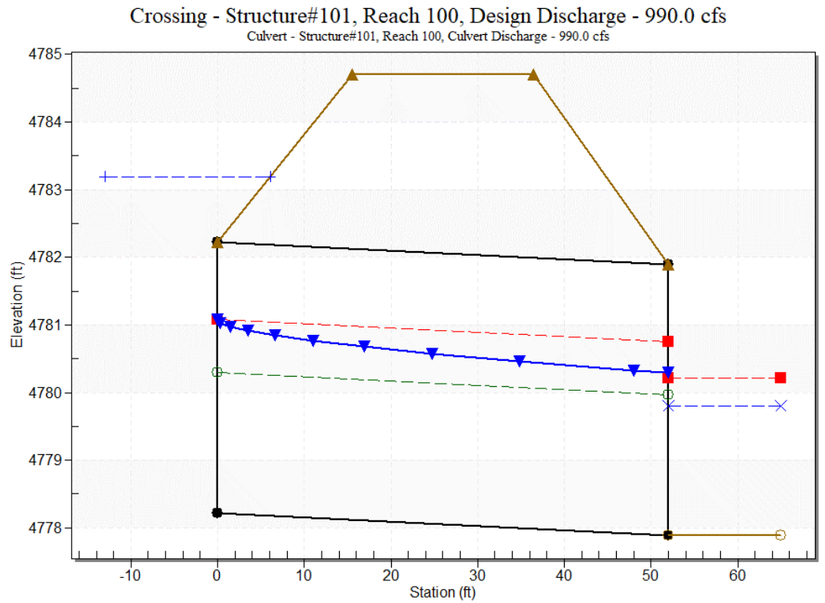
Table 1 - Culvert Summary Table: Structure#101

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	13.00 cfs	13.00 cfs	4778.49	0.27	0.046	1-JS1t	0.13	0.16	0.38	0.38	0.96	3.08
10 Year	85.00 cfs	85.00 cfs	4779.17	0.95	0.438	1-JS1t	0.43	0.56	0.76	0.76	3.11	4.92
100 Year	990.00 cfs	990.00 cfs	4783.19	4.97	3.727	5-S2n	2.08	2.86	2.40	1.91	11.45	9.09

Culvert Barrel Data: Structure#101

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4778.22 ft,
Outlet Elevation (invert): 4777.89 ft
Culvert Length: 52.00 ft,
Culvert Slope: 0.0063

Water Surface Profile Plot for Culvert: Structure#101



Tailwater Data for Crossing: Structure#101

Table 2: Downstream Channel Rating Curve (Crossing: Structure#101)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
13.00	4778.27	0.38	3.08	0.54	1.25
85.00	4778.65	0.76	4.92	1.09	1.41
990.00	4779.80	1.91	9.09	2.73	1.64

Tailwater Channel Data: Structure#101

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 30.00 (_:1)
Channel Slope: 0.0230
Channel Manning's n: 0.0240
Channel Invert Elevation: 4777.89 ft

Roadway Data for Crossing: Structure#101

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4784.70 ft
Roadway Surface: Paved
Roadway Top Width: 21.00 ft

Culvert Data: Structure#102, Reach 100

Site Data: Structure#102

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4782.03 ft
Outlet Station: 60.00 ft
Outlet Elevation: 4781.65 ft
Number of Barrels: 2

Culvert Data Summary: Structure#102

Barrel Shape: Concrete Box
Barrel Span: 10.00 ft
Barrel Rise: 6.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall
Inlet Depression: None

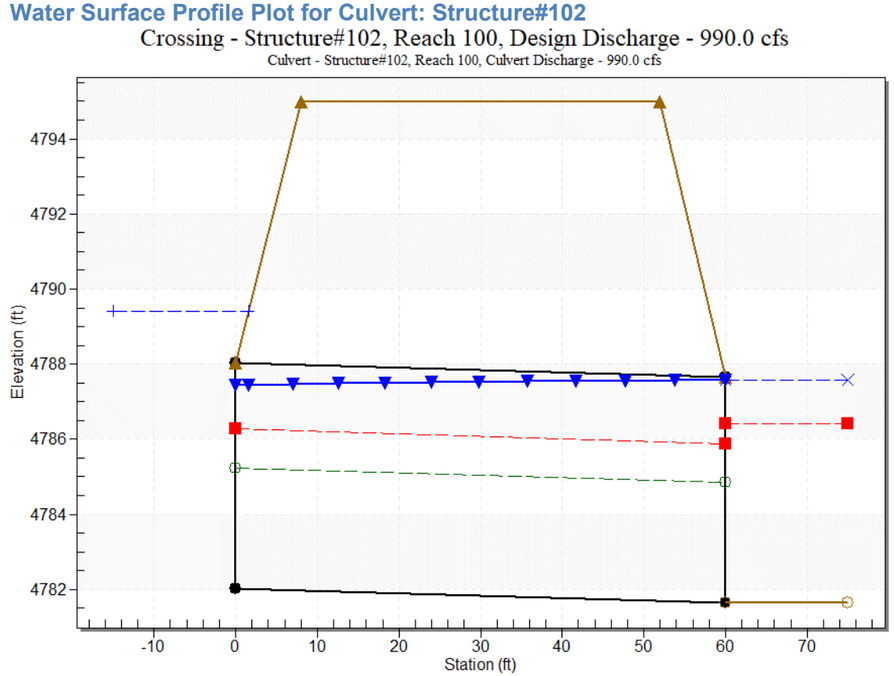
Table 3 - Culvert Summary Table: Structure#102

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	13.00 cfs	13.00 cfs	4782.83	0.40	0.801	1-S1t	0.19	0.24	1.17	1.17	0.56	1.91
10 Year	85.00 cfs	85.00 cfs	4784.11	1.41	2.077	1-S1t	0.63	0.82	2.36	2.36	1.80	3.05
100 Year	990.00 cfs	990.00 cfs	4789.39	7.34	7.363	1-S1t	3.21	4.24	5.93	5.93	8.35	5.63

Culvert Barrel Data: Structure#102

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4782.03 ft,
Outlet Elevation (invert): 4781.65 ft
Culvert Length: 60.00 ft,
Culvert Slope: 0.0063

Water Surface Profile Plot for Culvert: Structure#102



Tailwater Data for Crossing: Structure#102

Table 4: Downstream Channel Rating Curve (Crossing: Structure#102)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
13.00	4782.82	1.17	1.91	0.51	0.44
85.00	4784.01	2.36	3.05	1.03	0.49
990.00	4787.58	5.93	5.63	2.59	0.58

Tailwater Channel Data - Structure#102

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 5.00 (_:1)
Channel Slope: 0.0070
Channel Manning's n: 0.0450
Channel Invert Elevation: 4781.65 ft

Roadway Data for Crossing: Structure#102

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4794.98 ft
Roadway Surface: Paved
Roadway Top Width: 44.00 ft

Culvert Data: Structure#103, Reach 142

Site Data: Structure#103

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4861.72 ft
Outlet Station: 295.00 ft
Outlet Elevation: 4858.55 ft
Number of Barrels: 1

Culvert Data Summary: Structure#103

Barrel Shape: Concrete Box
Barrel Span: 6.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall
Inlet Depression: None

Table 5 - Culvert Summary Table: Structure#103

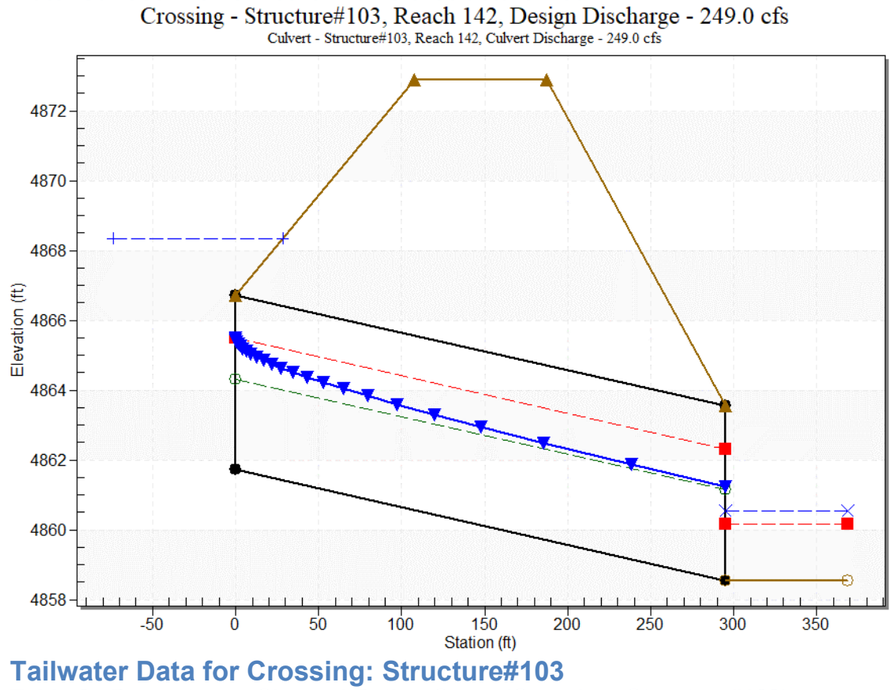
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	3.00 cfs	3.00 cfs	4862.06	0.34	0.0*	1-S2n	0.14	0.20	0.14	0.19	3.52	1.12
10 Year	31.00 cfs	31.00 cfs	4863.32	1.60	0.0*	1-S2n	0.62	0.94	0.62	0.70	8.29	2.40
100 Year	249.00 cfs	249.00 cfs	4868.34	6.62	3.690	5-S2n	2.59	3.77	2.68	1.99	15.46	4.29

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data: Structure#103

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4861.72 ft,
Outlet Elevation (invert): 4858.55 ft
Culvert Length: 295.02 ft,
Culvert Slope: 0.0107

Water Surface Profile Plot for Culvert: Structure#103



Tailwater Data for Crossing: Structure#103

Table 6 - Downstream Channel Rating Curve (Crossing: Structure#103)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
3.00	4858.74	0.19	1.12	0.14	0.48
31.00	4859.25	0.70	2.40	0.54	0.58
249.00	4860.54	1.99	4.29	1.53	0.67

Tailwater Channel Data: Structure#103

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 12.70 ft
Side Slope (H:V): 8.30 (_:1)
Channel Slope: 0.0123
Channel Manning's n: 0.0450
Channel Invert Elevation: 4858.55 ft

Roadway Data for Crossing: Structure#103

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4872.88 ft
Roadway Surface: Paved
Roadway Top Width: 80.00 ft

Culvert Data: Structure#104, Reach 134

Site Data: Structure#104

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4921.39 ft
Outlet Station: 127.00 ft
Outlet Elevation: 4919.92 ft
Number of Barrels: 1

Culvert Data Summary: Structure#104

Barrel Shape: Concrete Box
Barrel Span: 6.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 7 - Culvert Summary Table: Structure#104

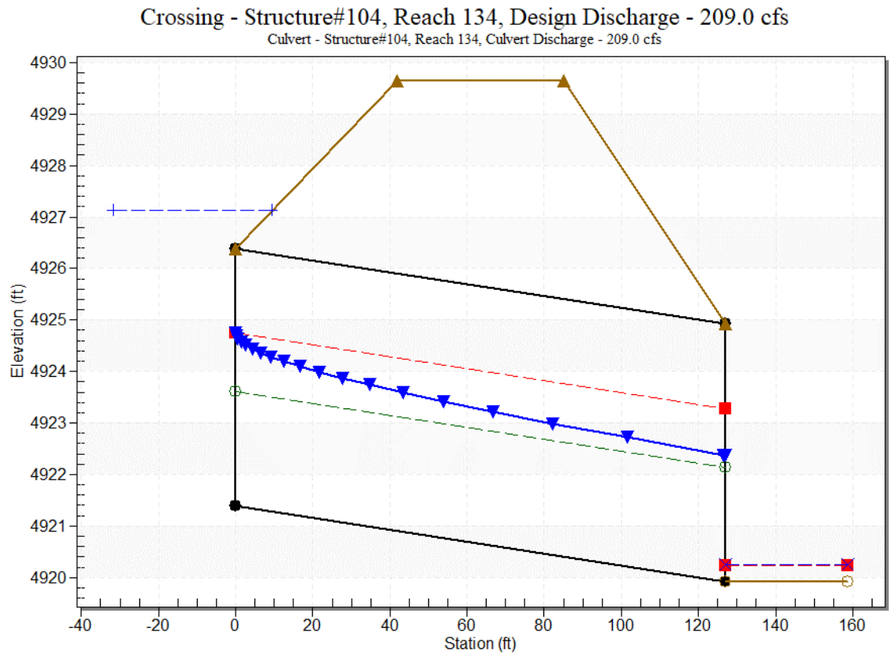
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Years	5.00 cfs	5.00 cfs	4921.86	0.47	0.0*	1-S2n	0.19	0.28	0.19	0.05	4.44	0.83
10 Years	14.00 cfs	14.00 cfs	4922.33	0.94	0.0*	1-S2n	0.37	0.55	0.37	0.09	6.37	1.15
100 Years	209.00 cfs	209.00 cfs	4927.13	5.74	3.277	5-S2n	2.22	3.35	2.45	0.33	14.21	2.43

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data: Structure#104

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4921.39 ft,
Outlet Elevation (invert): 4919.92 ft
Culvert Length: 127.01 ft,
Culvert Slope: 0.0116

Water Surface Profile Plot for Culvert: Structure#104



Tailwater Data for Crossing: Structure#104

Table 8 - Downstream Channel Rating Curve (Crossing: Structure#104)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
5.00	4919.97	0.05	0.83	0.14	0.73
14.00	4920.01	0.09	1.15	0.24	0.79
209.00	4920.25	0.33	2.43	0.94	0.96

Tailwater Channel Data: Structure#104

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 100.00 ft
Side Slope (H:V): 500.00 (_:1)
Channel Slope: 0.0460
Channel Manning's n: 0.0450
Channel Invert Elevation: 4919.92 ft

Roadway Data for Crossing: Structure#104

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4929.64 ft
Roadway Surface: Paved
Roadway Top Width: 43.00 ft

Culvert Data: Structure#201, Reach 221

Site Data: Structure#201

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4761.00 ft
Outlet Station: 30.46 ft
Outlet Elevation: 4760.40 ft
Number of Barrels: 3

Culvert Data Summary: Structure#201

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 6.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall
Inlet Depression: None

Table 9 - Culvert Summary Table: Structure#201, Reach 200

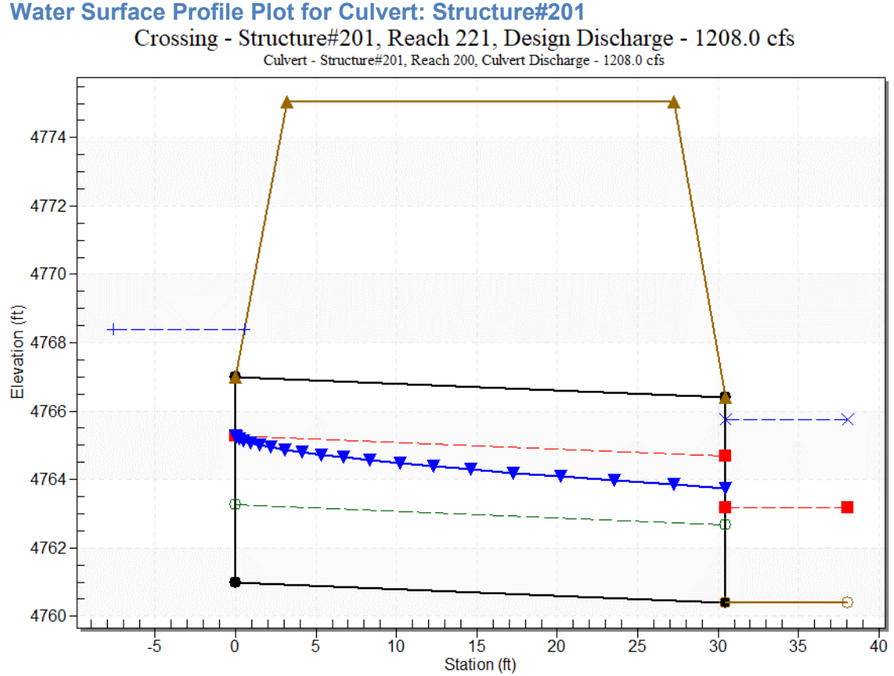
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	20.00 cfs	20.00 cfs	4761.47	0.47	0.0*	1-JS1t	0.16	0.28	0.52	0.52	1.61	0.92
10 Year	81.00 cfs	81.00 cfs	4762.19	1.19	0.587	1-JS1t	0.38	0.71	1.18	1.18	2.86	1.54
100 Year	1208.00 cfs	1208.00 cfs	4768.40	7.40	6.469	5-S2n	2.26	4.29	3.35	5.36	15.04	3.67

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data: Structure#201

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4761.00 ft,
Outlet Elevation (invert): 4760.40 ft
Culvert Length: 30.47 ft,
Culvert Slope: 0.0197

Water Surface Profile Plot for Culvert: Structure#201



Tailwater Data for Crossing: Structure#201

Table 10 - Downstream Channel Rating Curve (Crossing: Structure#201)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
20.00	4760.92	0.52	0.92	0.06	0.23
81.00	4761.58	1.18	1.54	0.15	0.26
1208.00	4765.76	5.36	3.67	0.67	0.32

Tailwater Channel Data: Structure#201

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 40.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0020
Channel Manning's n: 0.0450
Channel Invert Elevation: 4760.40 ft

Roadway Data for Crossing: Structure#201

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4775.04 ft
Roadway Surface: Gravel
Roadway Top Width: 24.00 ft

Culvert Data: Structure#202, Reach 260

Site Data: Structure#202

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4949.72 ft
Outlet Station: 145.00 ft
Outlet Elevation: 4944.32 ft
Number of Barrels: 2

Culvert Data Summary: Structure#202

Barrel Shape: Concrete Box
Barrel Span: 4.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 11 - Culvert Summary Table: Structure#202, Reach 260

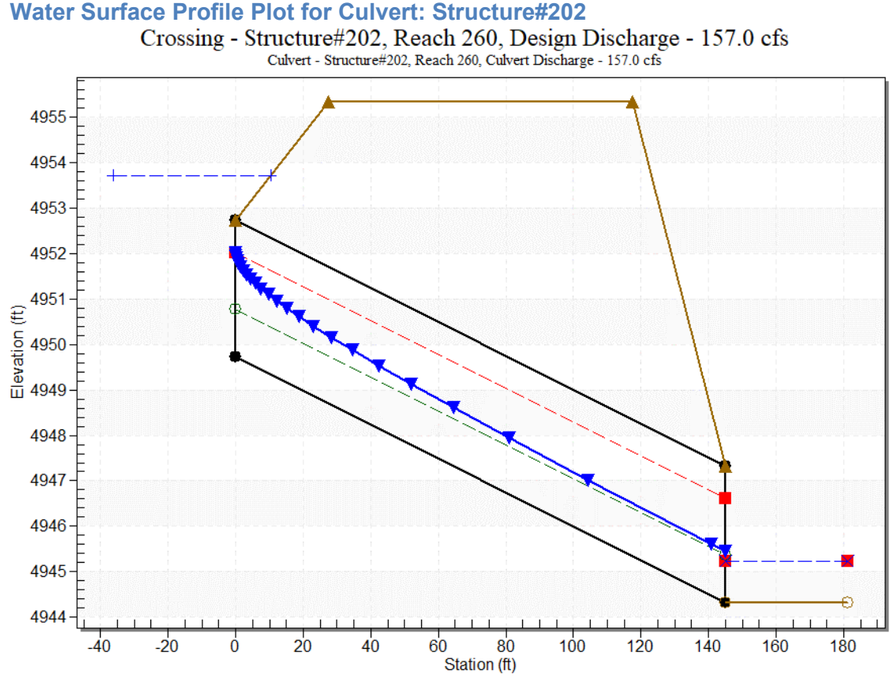
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	40.00 cfs	40.00 cfs	4951.24	1.52	0.0*	1-S2n	0.42	0.92	0.42	0.40	11.88	3.15
10 Year	56.00 cfs	56.00 cfs	4951.62	1.90	0.0*	1-S2n	0.52	1.15	0.52	0.49	13.34	3.57
100 Year	157.00 cfs	157.00 cfs	4953.72	4.00	0.0*	5-S2n	1.05	2.29	1.13	0.90	17.30	5.19

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data: Structure#202

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4949.72 ft,
Outlet Elevation (invert): 4944.32 ft
Culvert Length: 145.10 ft,
Culvert Slope: 0.0372

Water Surface Profile Plot for Culvert: Structure#202



Tailwater Data for Crossing: Structure#202

Table 12 - Downstream Channel Rating Curve (Crossing: Structure#202)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
40.00	4944.73	0.40	3.15	0.82	0.90
56.00	4944.81	0.49	3.57	1.01	0.93
157.00	4945.22	0.90	5.19	1.85	1.02

Tailwater Channel Data - Structure#202

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 30.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0329
Channel Manning's n: 0.0450
Channel Invert Elevation: 4944.32 ft

Roadway Data for Crossing: Structure#203

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4955.33 ft
Roadway Surface: Gravel
Roadway Top Width: 90.00 ft

Culvert Data: Structure#203, Reach 260

Site Data: Structure#203

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4976.58 ft
Outlet Station: 327.00 ft
Outlet Elevation: 4970.79 ft
Number of Barrels: 2

Culvert Data Summary: Structure#203

Barrel Shape: Concrete Box
Barrel Span: 4.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall
Inlet Depression: None

Table 13 - Culvert Summary Table: Structure#203

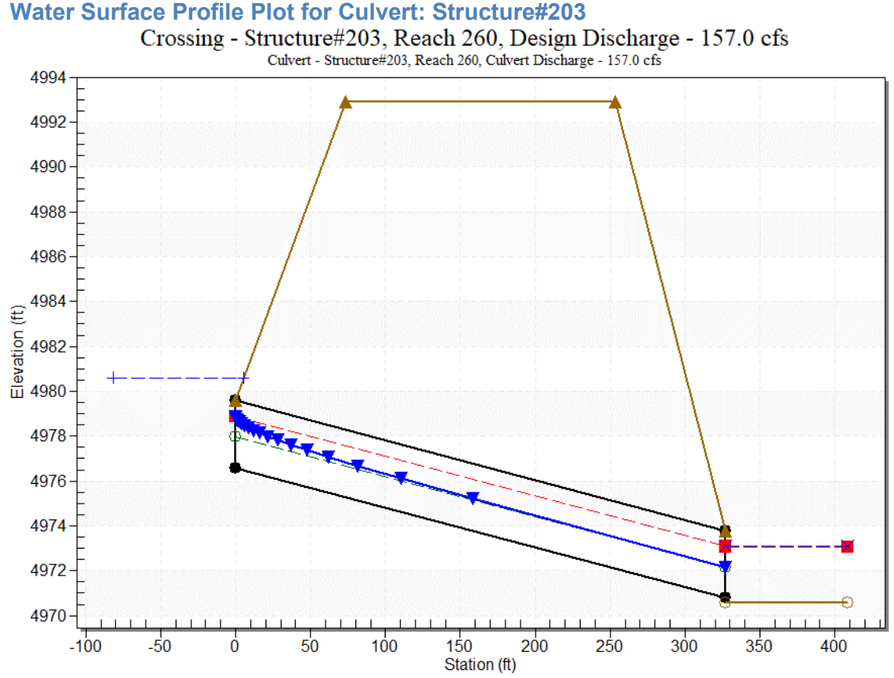
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	40.00 cfs	40.00 cfs	4978.13	1.55	0.0*	1-S2n	0.54	0.92	0.54	1.52	9.31	4.34
10 Year	56.00 cfs	56.00 cfs	4978.51	1.93	0.0*	1-S2n	0.67	1.15	0.69	1.72	10.10	4.72
100 Year	157.00 cfs	157.00 cfs	4980.60	4.02	0.0*	5-S2n	1.37	2.29	1.37	2.53	14.37	6.11

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data: Structure#203

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4976.58 ft,
Outlet Elevation (invert): 4970.79 ft
Culvert Length: 327.05 ft,
Culvert Slope: 0.0177

Water Surface Profile Plot for Culvert: Structure#203



Tailwater Data for Crossing: Structure#203

Table 14 - Downstream Channel Rating Curve (Crossing: Structure#203)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
40.00	4972.10	1.52	4.34	2.46	0.88
56.00	4972.30	1.72	4.72	2.79	0.90
157.00	4973.11	2.53	6.11	4.11	0.96

Tailwater Channel Data: Structure#203

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0260
Channel Manning's n: 0.0450
Channel Invert Elevation: 4970.58 ft

Roadway Data for Crossing: Structure#203

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4992.89 ft
Roadway Surface: Paved
Roadway Top Width: 180.00 ft

Culvert Data: Structure#301, Reach 300

Site Data: Structure#301

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4786.49 ft
Outlet Station: 35.60 ft
Outlet Elevation: 4786.34 ft
Number of Barrels: 1

Culvert Data Summary: Structure#301

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall
Inlet Depression: None

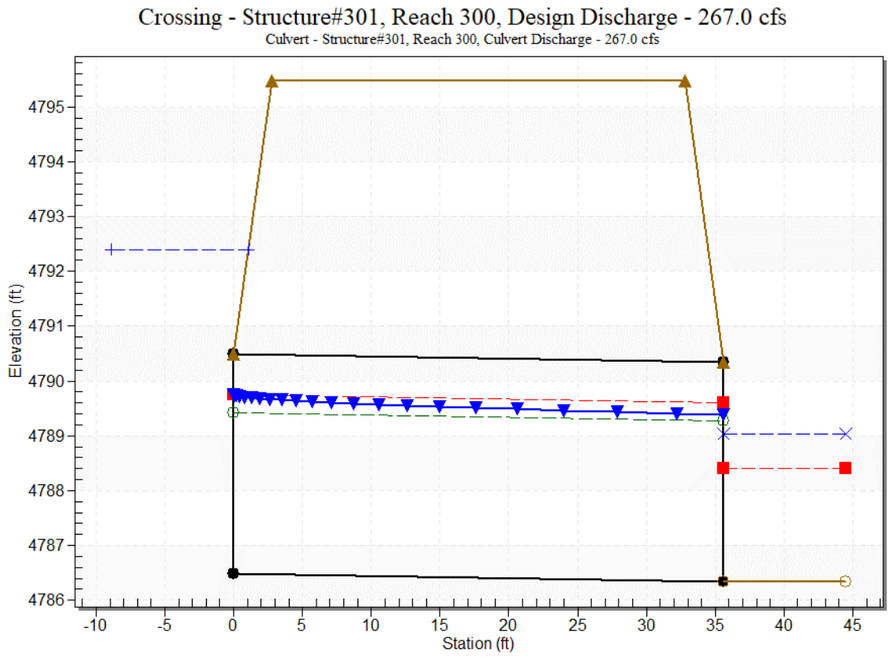
Table 15 - Culvert Summary Table: Structure#301

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	22.00 cfs	22.00 cfs	4787.55	1.06	0.608	1-JS1t	0.55	0.62	0.75	0.75	3.68	2.21
10 Year	48.00 cfs	48.00 cfs	4788.26	1.77	1.044	1-S2n	0.91	1.04	0.93	1.14	6.45	2.79
100 Year	267.00 cfs	267.00 cfs	4792.40	5.91	5.210	5-S2n	2.92	3.26	3.05	2.69	10.95	4.48

Culvert Barrel Data: Structure#301

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4786.49 ft,
Outlet Elevation (invert): 4786.34 ft
Culvert Length: 35.60 ft,
Culvert Slope: 0.0042

Water Surface Profile Plot for Culvert: Structure#301



Tailwater Data for Crossing: Structure#301

Table 16: Downstream Channel Rating Curve (Crossing: Structure#301)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
22.00	4787.09	0.75	2.21	0.42	0.50
48.00	4787.48	1.14	2.79	0.64	0.53
267.00	4789.03	2.69	4.48	1.51	0.60

Tailwater Channel Data: Structure#301

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 4.50 (_:1)
Channel Slope: 0.0090
Channel Manning's n: 0.0450
Channel Invert Elevation: 4786.34 ft

Roadway Data for Crossing: Structure#301

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4795.47 ft
Roadway Surface: Gravel
Roadway Top Width: 30.00 ft

Culvert Data: Structure#501, Reach 500

Site Data: Structure#501

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4821.39 ft
Outlet Station: 88.00 ft
Outlet Elevation: 4816.39 ft
Number of Barrels: 2

Culvert Data Summary: Structure#501

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall
Inlet Depression: None

Table 17 - Culvert Summary Table: Structure#501

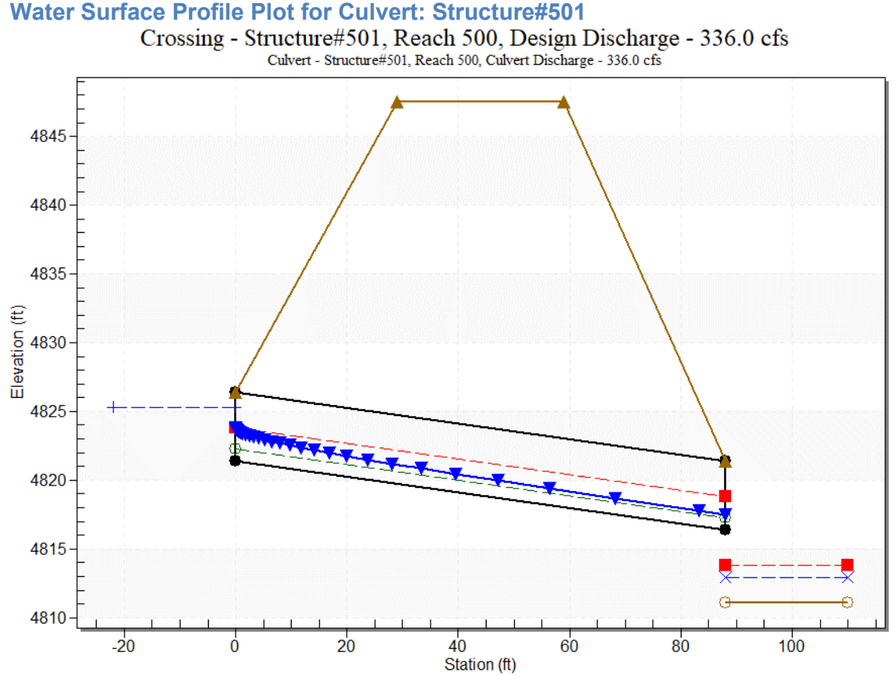
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	20.00 cfs	20.00 cfs	4821.98	0.59	0.0*	1-S2n	0.15	0.36	0.15	0.64	8.45	7.02
10 Year	40.00 cfs	40.00 cfs	4822.33	0.94	0.0*	1-S2n	0.23	0.58	0.23	0.83	10.95	8.35
100 Year	336.00 cfs	336.00 cfs	4825.30	3.91	0.0*	1-S2n	0.88	2.39	1.08	1.84	19.42	14.21

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data: Structure#501

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4821.39 ft,
Outlet Elevation (invert): 4816.39 ft
Culvert Length: 88.14 ft,
Culvert Slope: 0.0568

Water Surface Profile Plot for Culvert: Structure#501



Tailwater Data for Crossing: Structure#501

Table 18 - Downstream Channel Rating Curve (Crossing: Structure#501)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
20.00	4811.74	0.64	7.02	8.36	2.19
40.00	4811.93	0.83	8.35	10.84	2.29
336.00	4812.94	1.84	14.21	24.09	2.61

Tailwater Channel Data - Structure#501

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 7.00 (_:1)
Channel Slope: 0.2100
Channel Manning's n: 0.0450
Channel Invert Elevation: 4811.10 ft

Roadway Data for Crossing: Structure#501

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4847.50 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Culvert Data: Structure#601, Reach 600

Site Data: Structure#601

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4826.99 ft
Outlet Station: 120.50 ft
Outlet Elevation: 4825.15 ft
Number of Barrels: 2

Culvert Data Summary: Structure#601

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall (Ke=0.5)
Inlet Depression: None

Table 19 - Culvert Summary Table: Structure#601

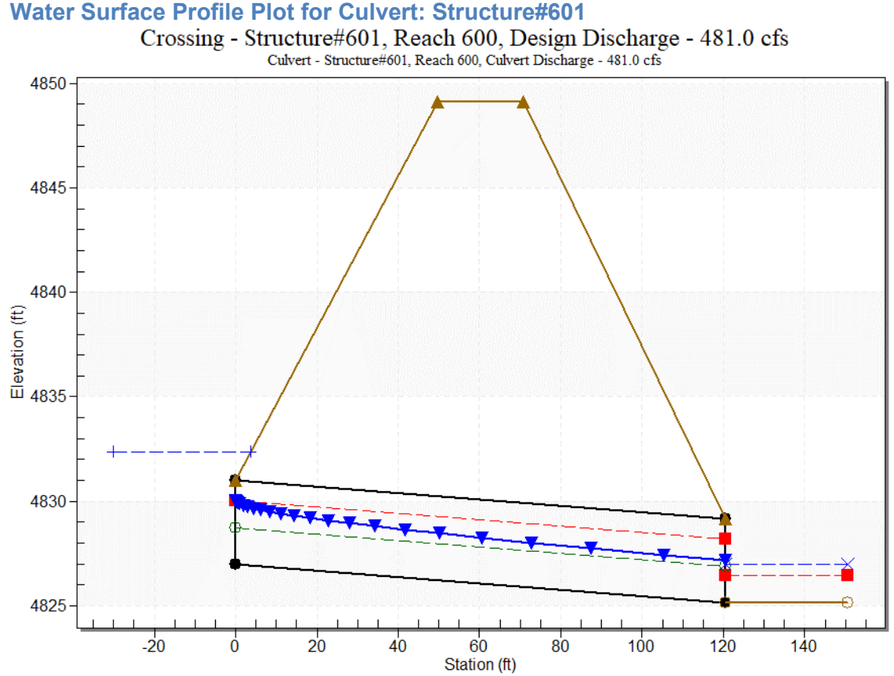
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	18.00 cfs	18.00 cfs	4827.56	0.57	0.0*	1-S2n	0.21	0.34	0.21	0.32	5.30	1.21
10 Year	34.00 cfs	34.00 cfs	4827.87	0.88	0.0*	1-S2n	0.31	0.52	0.31	0.45	6.76	1.50
100 Year	481.00 cfs	481.00 cfs	4832.34	5.35	3.296	5-S2n	1.73	3.04	2.01	1.84	14.99	3.27

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data: Structure#601

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4826.99 ft,
Outlet Elevation (invert): 4825.15 ft
Culvert Length: 120.51 ft,
Culvert Slope: 0.0153

Water Surface Profile Plot for Culvert: Structure#601



Tailwater Data for Crossing: Structure#601

Table 20: Downstream Channel Rating Curve (Crossing: Structure#601)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
18.00	4825.47	0.32	1.21	0.15	0.41
34.00	4825.60	0.45	1.50	0.21	0.43
481.00	4826.99	1.84	3.27	0.86	0.52

Tailwater Channel Data: Structure#601

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 40.00 ft
Side Slope (H:V): 21.90 (_:1)
Channel Slope: 0.0075
Channel Manning's n: 0.0450
Channel Invert Elevation: 4825.15 ft

Roadway Data for Crossing: Structure#601

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4849.11 ft
Roadway Surface: Gravel
Roadway Top Width: 21.00 ft

Culvert Data: Structure#602, Reach 600

Site Data: Structure#602

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4832.33 ft
Outlet Station: 41.00 ft
Outlet Elevation: 4832.02 ft
Number of Barrels: 1

Culvert Data Summary: Structure#602

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 6.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall
Inlet Depression: None

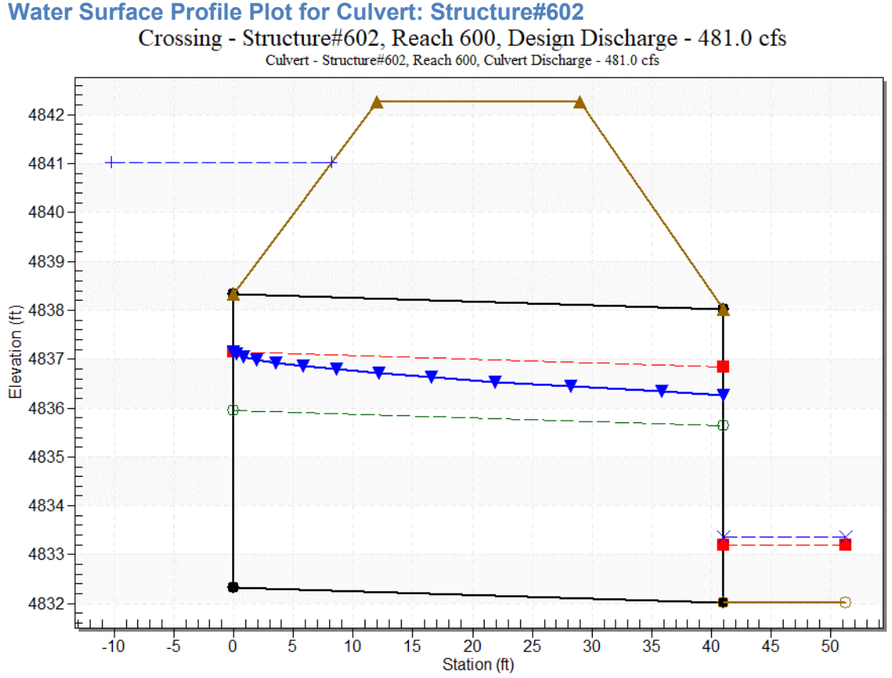
Table 21 - Culvert Summary Table: Structure#602

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	18.00 cfs	18.00 cfs	4833.25	0.92	0.233	1-S2n	0.40	0.54	0.41	0.21	5.43	1.53
10 Year	34.00 cfs	34.00 cfs	4833.74	1.41	0.527	1-S2n	0.60	0.82	0.64	0.30	6.67	1.93
100 Year	481.00 cfs	481.00 cfs	4841.02	8.69	7.571	5-S2n	3.63	4.82	4.25	1.34	14.16	4.55

Culvert Barrel Data: Structure#602

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4832.33 ft,
Outlet Elevation (invert): 4832.02 ft
Culvert Length: 41.00 ft,
Culvert Slope: 0.0076

Water Surface Profile Plot for Culvert: Structure#602



Tailwater Data for Crossing: Structure#602

Table 1 - Downstream Channel Rating Curve (Crossing: Structure#602)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
18.00	4832.23	0.21	1.53	0.25	0.61
34.00	4832.32	0.30	1.93	0.36	0.65
481.00	4833.36	1.34	4.55	1.59	0.80

Tailwater Channel Data: Structure#602

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 52.00 ft
Side Slope (H:V): 20.00 (_:1)
Channel Slope: 0.0190
Channel Manning's n: 0.0450
Channel Invert Elevation: 4832.02 ft

Roadway Data for Crossing: Structure#602

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4842.26 ft
Roadway Surface: Paved
Roadway Top Width: 17.00 ft

Culvert Data: Structure#603, Reach 614

Site Data: Structure#603

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4918.96 ft
Outlet Station: 234.00 ft
Outlet Elevation: 4917.04 ft
Number of Barrels: 1

Culvert Data Summary: Structure#603

Barrel Shape: Concrete Box
Barrel Span: 6.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall
Inlet Depression: None

Table 23 - Culvert Summary Table: Structure#603

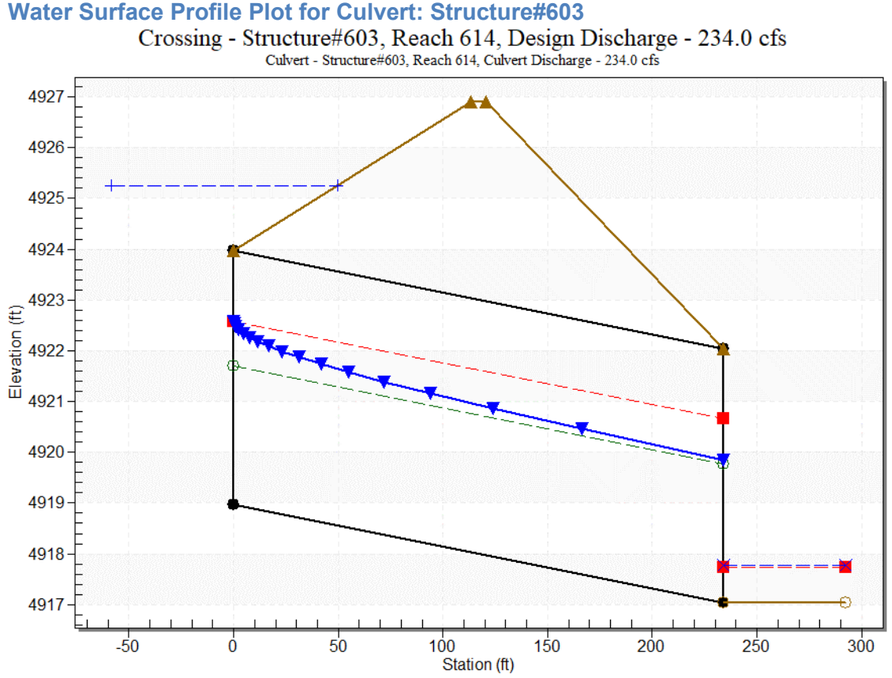
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	6.00 cfs	6.00 cfs	4919.50	0.54	0.0*	1-S2n	0.24	0.31	0.24	0.08	4.19	1.04
10 Year	24.00 cfs	24.00 cfs	4920.31	1.35	0.0*	1-S2n	0.58	0.79	0.58	0.19	6.96	1.80
100 Year	234.00 cfs	234.00 cfs	4925.25	6.29	3.718	5-S2n	2.73	3.61	2.81	0.74	13.85	4.43

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data: Structure#603

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4918.96 ft,
Outlet Elevation (invert): 4917.04 ft
Culvert Length: 234.01 ft,
Culvert Slope: 0.0082

Water Surface Profile Plot for Culvert: Structure#603



Tailwater Data for Crossing: Structure#603, Reach 614

Table 24 - Downstream Channel Rating Curve (Crossing: Structure#603)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
6.00	4917.12	0.08	1.04	0.14	0.64
24.00	4917.23	0.19	1.80	0.33	0.73
234.00	4917.78	0.74	4.43	1.28	0.92

Tailwater Channel Data: Structure#603

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 70.00 ft
Side Slope (H:V): 2.00 (_:1)
Channel Slope: 0.0278
Channel Manning's n: 0.0450
Channel Invert Elevation: 4917.04 ft

Roadway Data for Crossing: Structure#603

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4926.90 ft
Roadway Surface: Gravel
Roadway Top Width: 7.00 ft

Culvert Data: Structure#801, Reach 800

Site Data: Structure#801

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4960.15 ft
Outlet Station: 71.00 ft
Outlet Elevation: 4960.01 ft
Number of Barrels: 1

Culvert Data Summary: Structure#801

Barrel Shape: Concrete Box
Barrel Span: 9.00 ft
Barrel Rise: 5.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall
Inlet Depression: None

Table 25 - Culvert Summary Table: Structure#801

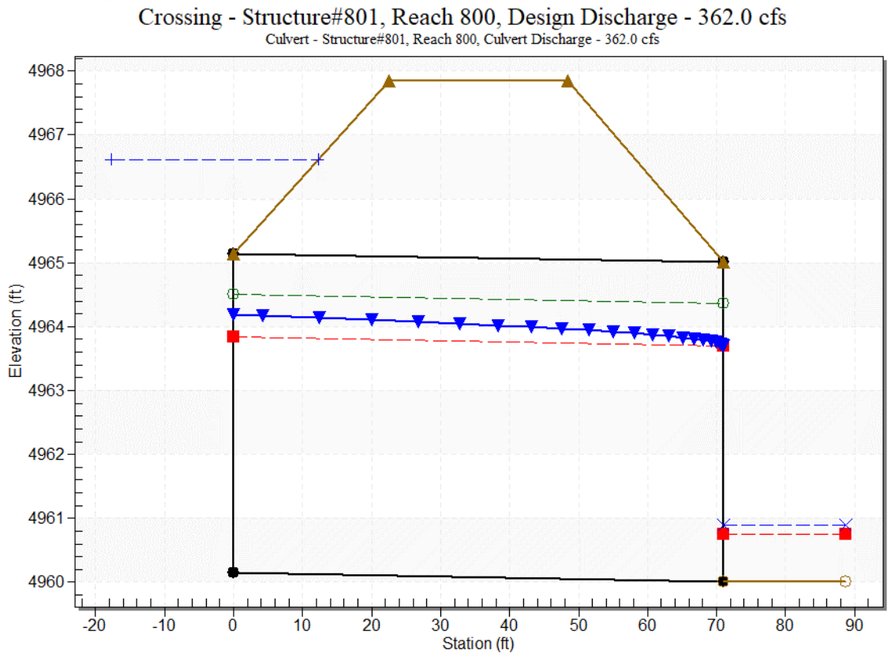
Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5 Year	10.00 cfs	10.00 cfs	4960.73	0.58	0.580	2-M2c	0.40	0.34	0.34	0.10	3.30	0.98
10 Year	21.00 cfs	21.00 cfs	4961.10	0.95	0.950	2-M2c	0.63	0.55	0.55	0.16	4.22	1.32
100-YR	362.00 cfs	362.00 cfs	4966.62	6.47	6.351	7-M2c	4.36	3.69	3.69	0.88	10.90	4.09

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data: Structure#801

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4960.15 ft,
Outlet Elevation (invert): 4960.01 ft
Culvert Length: 71.00 ft,
Culvert Slope: 0.0019

Water Surface Profile Plot for Culvert: Structure#801



Tailwater Data for Crossing: Structure#801

Table 26: Downstream Channel Rating Curve (Crossing: Structure#801)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
10.00	4960.11	0.10	0.98	0.12	0.54
21.00	4960.17	0.16	1.32	0.18	0.58
362.00	4960.89	0.88	4.09	1.02	0.77

Tailwater Channel Data: Structure#801

Tailwater Channel Option: Rectangular Channel
Bottom Width: 100.00 ft
Channel Slope: 0.0185
Channel Manning's n: 0.0450
Channel Invert Elevation: 4960.01 ft

Roadway Data for Crossing: Structure#801

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4967.84 ft
Roadway Surface: Paved
Roadway Top Width: 26.00 ft

Appendix G – Master Plan Maps

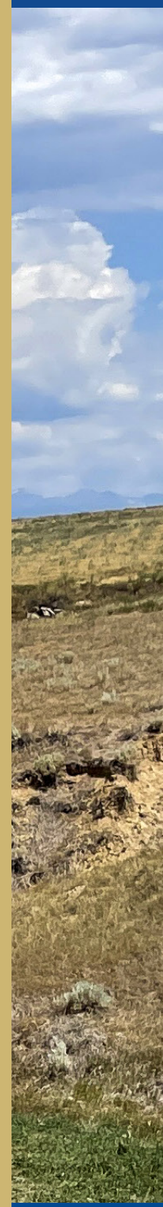
Click here for Figure G-1: Major Drainageway 100

Click here for Figure G-2: Major Drainageways 200, 300

Click here for Figure G-3: Major Drainageways 500, 600, 800

Appendix H – Funding Sources

(funding sources were not included with this study)



Sponsor: City of Greeley Colorado

Consultant: Matrix