Comprehensive Drainage Plan
Oklahoma Basins 700 & 800
Concept Design Report

July 2024

Sponsor: City of Greeley Colorado

Consultant: Matrix

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7/31/2024

Mr. Ryan Davis, PE, PTOE
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RE: Comprehensive Drainage Plan Oklahoma Basins 700 & 800
PO – 20231851 – Bolton & Menk – US 34 & WCR 17
Concept Design Report Final

Dear Mr. Davis:

Matrix Design Group, Inc. is pleased to submit the enclosed *Concept Design Report* for the Oklahoma Basins 700 & 800. The analysis in this report follows the previously submitted *Alternatives Analysis Report* and *Baseline Hydrology Report*. We have addressed the City of Greeley comments on the *Concept Design Report Draft,* received July 29, 2024, and incorporated revisions into the attached document. Responses to comments for each project phase are included in Appendix A of the report.

The report format and submittal are intended to follow the requirements of the *City of Greeley Master Plan Procedures / Preparation Guide* (2001), 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 City of Greeley Master Plan Template Checklist for this report is attached.

The *Concept Design 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, improving 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

CC: Mr. Aaron Stines, PE, City of Greeley

EXECUTIVE SUMMARY

This study creates a master plan framework for two drainage basins: the Oklahoma Basins 700 and 800. Recommendations are provided on how the City of Greeley and the Town of Windsor 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. No public meetings were held during the study.

Updated hydrologic information on both existing and future conditions in the Oklahoma 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).

Due to the vast size of the Oklahoma Basin, it was divided into 12 main contributing major drainageways. Major drainageways have been defined as natural runoff collection reaches that include more than 130 acres of contributing area. This study comprises major drainageways 700 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. 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 Basin. 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 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 ponds are shown below:

Flood Control Pond No.	Volume (ac-ft)	Area (ac)
D_FC_711	6.5	1.3
D_FC_823	20	5
D_FC_838	17.3	3.3
D_FC_842	2.4	0.6

EURV Basin No.	Volume (ac-ft)	Area (ac)
D_EURV_711	2.4	0.6
D_EURV_820	5.5	1.3
D_EURV_830	5.6	1.5
D_EURV_840	5.4	3.1
D_EURV_842	14.3	9.5
D_EURV_844	9.4	2.3

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}	Future Conditions Do Nothing Q_{100}	Future Conditions Concept Design Q_{100}
700	90	160	172	110
800	696	1,039	2,072	306

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. Major drainageway 800 was split up into three reaches. These reaches were 800, 829, and 843. Major drainageway 700 has a singular reach. Only two areas, one being the 700 outfall and the other being the channel upstream of the existing Southgate detention basin, require further channel improvements to become stable in the future.

Existing drainageway crossings occur at roadways and railroads. Each crossing location was examined, and culvert calculations performed to determine the existing performance. 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 Number	Concept Design Q100 (cfs)	Structure Size/Type
702	111	1-48" RCP
704	170	2-48" RCP
801	535	2-9'x4' CBC
804	283	1-6'x5' CBC
805	283	2-8'x3' CBC
807	311	1-12'x4' CBC
808	292	1-12'x4' CBC
809	528	2-10'x4' 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 700 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 are two culverts that need improvements. The capital cost for the Master Plan improvements is estimated to be $1,043,298 while the cost of maintenance and operation for 50 years is estimated to be $198,750.

Major Drainageway 800 within the Oklahoma Basin comprises of three reaches. While hydraulic analysis shows that the existing channel conditions are mostly stable, channel improvements will be necessary with new development. There are six culverts that need improvements. The capital cost for the Master Plan improvements is estimated to be $11,561,232 while the cost of maintenance and operation for 50 years is estimated to be $1,454,950.

Total costs for the Oklahoma Basin are estimated to be $14,876,170. 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 Cost	Total Cost[b]
700	$14,596	$66,000	$34,047	$494,988	$1,043,298	$198,750	$1,242,048
800	$119,017	$1,762,349	$4,759,500	$4,759,500	$11,561,232	$1,454,950	$13,016,182
Study Totals	$133,613	$1,828,349	$4,793,547	$5,254,488	$12,604,530	$1,653,700	$14,258,230

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

b.Total cost includes capital cost plus operations and maintenance cost 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 Oklahoma Basins 700 & 800. This project is solely sponsored by Greeley, but Matrix is a sub-consultant to Bolton & Menk. The Agreement for this CDP Oklahoma Basins 700 & 800 is Change Order #1 for the US 34 & WCR 17 Design (project 12658), executed on April 16, 2024.

1.2 Purpose and Scope

This study provides the framework for the Oklahoma 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 watershed is 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 Basins 700 and 800 (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. 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 5.2, version 5.2.4. Compile this information in an interim Baseline Hydrology Report for review by project sponsors.
7. 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.
8. Develop drainageway improvement alternatives that address future drainage impacts.
9. 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.
10. Sponsor acceptance of the selected alternative via a Selected Plan.
11. Prepare a Concept Design Report which further evaluates the feasibility of the selected improvements. Include detailed cost estimates of concept design improvements.

There is no existing regulatory floodplain within the Study Area. The major problems identified in the Oklahoma Basin 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.

1.3 Planning Process

A kickoff meeting with Greeley was held on January 31, 2024. Progress meetings were held once or twice per month (as needed) to update sponsors on the project status. Public workshops were not included for this study. 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 5.2 of EPA SWMM since the CUHP multiple runs functionality does not always work with the latest version of SWMM (5.2.4). The analysis examined existing, proposed, and planned developments in the study area.

The basin delineations were based upon 1-foot contour mapping. Subbasins were further subdivided to calculate peak flows at critical locations or if basins were larger than 130 acres which is the threshold for major drainage systems that has been established by MHFD through regional experience. Basins were modeled using a 2-hour rainfall storm, with no area corrections, per criteria.

Two hydrologic models were produced for this study:

1. Baseline hydrology for existing conditions,
2. Baseline hydrology for future fully-developed conditions.

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 in February 2024.

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* and *2016 Windsor 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

A detailed survey was not performed for this project. Measurements of existing roadway crossings were completed by Matrix in April 2024.

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
Aaron Stines	City of Greeley	Project Manager
Karen Reynolds	City of Greeley	Stormwater Manager
Brian Hathaway	City of Greeley	Water Quality and Regulations Manager
Brian Fischer	City of Greeley	Oklahoma & South Basins PM
Drew Beck	Matrix Design Group	Officer in Charge
Ben Liu	Matrix Design Group	Project Manager
Andrew Greer	Matrix Design Group	Project Engineer
Sabastian Ortega	Matrix Design Group	Project Engineer
Ellie Garza	Matrix Design Group	Project Landscape Architect
Nastaran Khodaei	Matrix Design Group	GIS Analyst
Sarah Beckingham	Matrix Design Group	GIS Analyst
Chris Martin	Matrix Design Group	GIS Manager

CHAPTER 2 - THE WHY

2.1 Overview

2.1.1 Project Area

The total project area is 1.32 square miles and Figure 2-1 shows the project area, jurisdictional limits, and a vicinity map.

General topography of the watershed slopes from high ground in the south towards the Oklahoma mainstem drainageway in the north. The average slope is approximately 2 percent. The highest elevation of the Study Area is 5060 feet above sea level; and the lowest point is the Oklahoma Drainageway immediately upstream of the WCR 17 bridge at an elevation of 4816 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 study reaches of this study. Note that this study does not include analysis of the main Oklahoma Drainageway but does include two tributaries, identified as Major Drainageways 700 and 800.

2.1.2 History

The study area is partially undeveloped. The flatter upstream areas have historically been used for agriculture. North of US-34 there are a limited number of homesteads, one residential neighborhood, and immediately adjacent to US-34 are multiple large business/industrial parks. Drainageways have remained natural adjacent to undeveloped areas, with riparian wetlands forming large extents. We have not discovered a past history of channel instability or severe flooding.

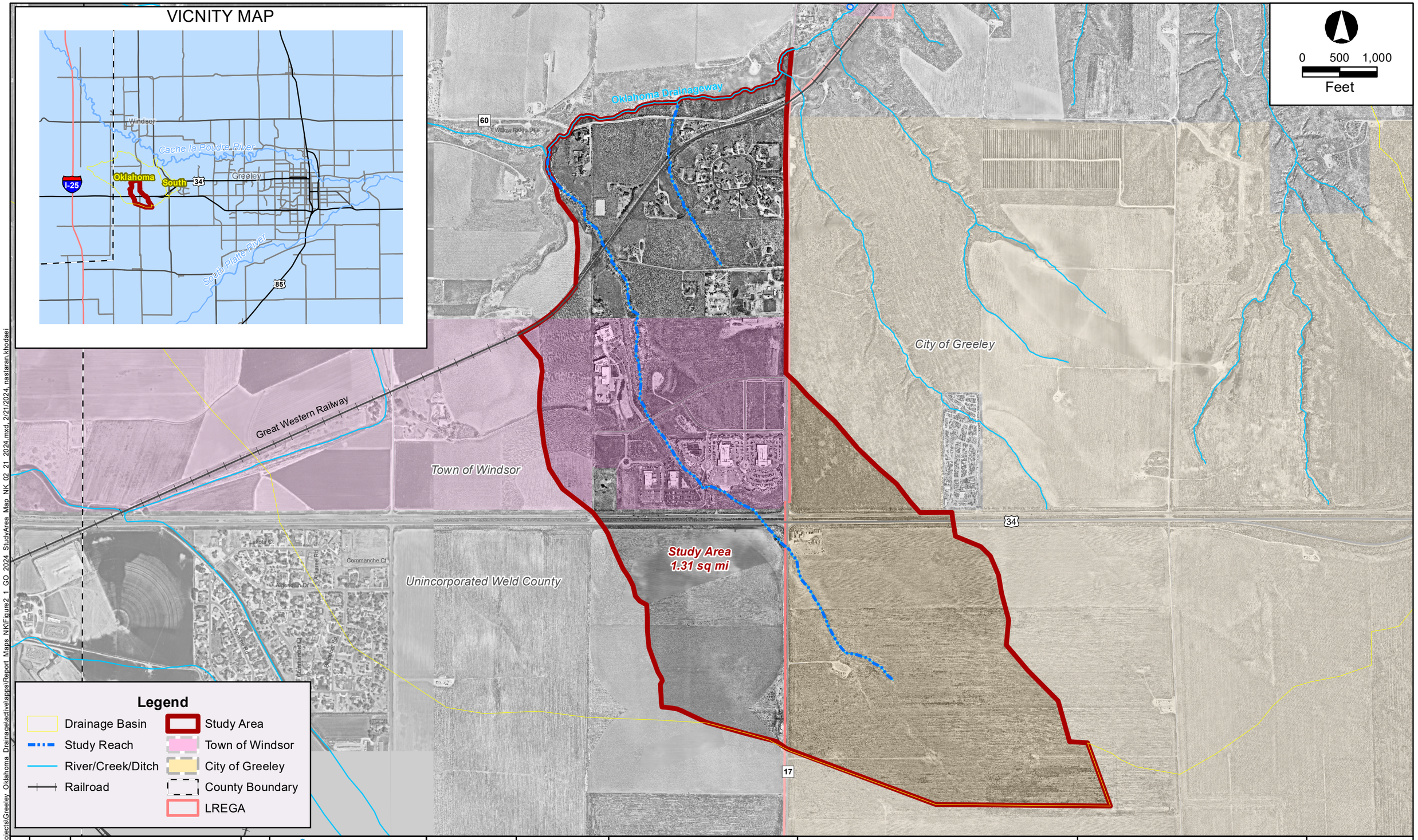
2.1.3 Relevant Information from Past Plans

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 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, and the *2016 Windsor Comprehensive Plan,* which represented a 20-year development road map.

VICNITY MAP



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No.	DATE	DESCRIPTION	APPR.

Matrix
Excellence by Design

designed by: _____
drawn by: NK
checked by: BI
project no.: 23.1447.001
date: 02/08/2024

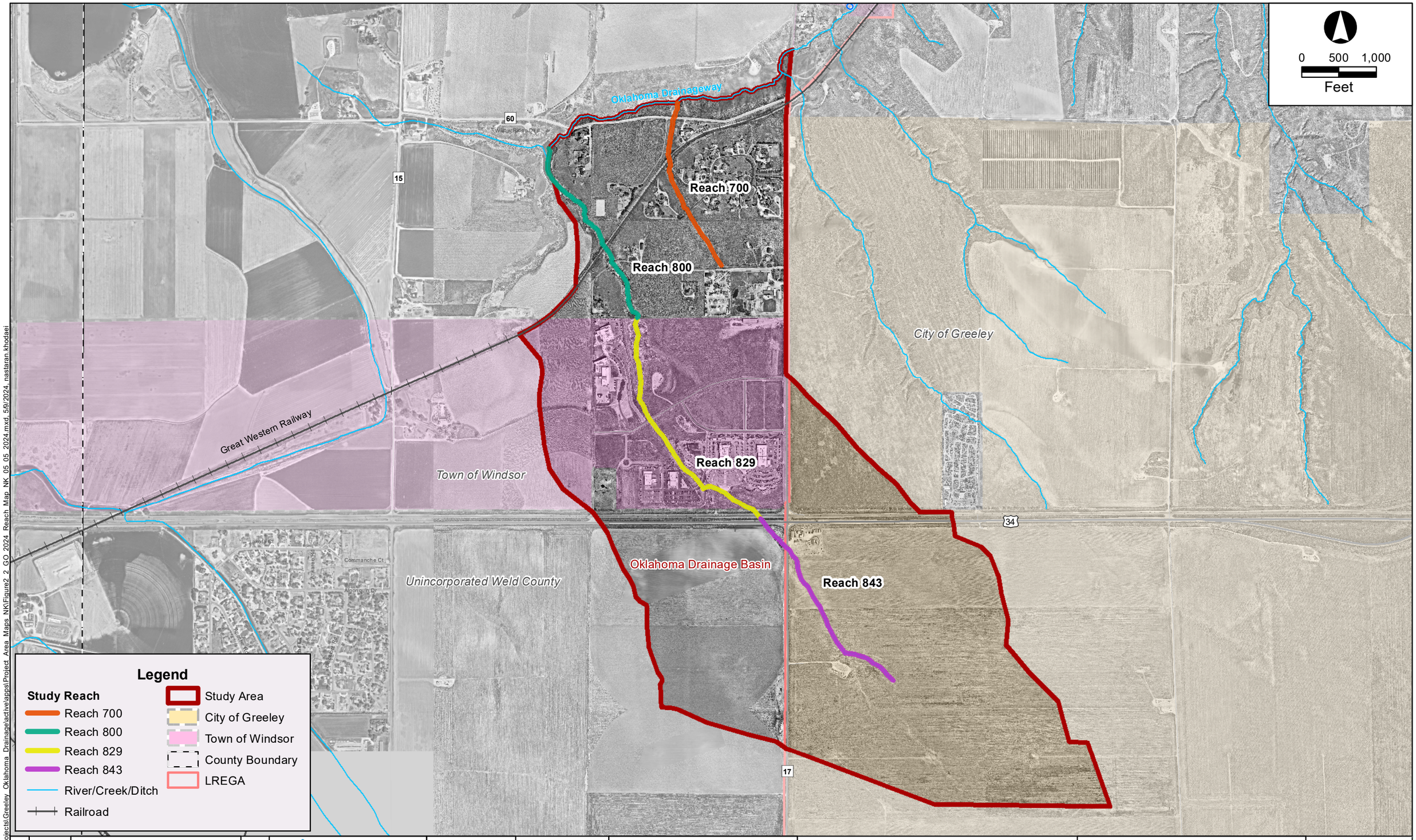
City of Greeley, Colorado

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA DRAINAGE BASINS 700 & 800

STUDY AREA MAP

FIGURE
2-1



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Matrix Excellence by Design

designed by:
drawn by: NK
checked by: BL
project no.: 23.1447.001
date: 02/08/2024

City of Greeley Colorado

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA DRAINAGE BASINS 700 & 800

REACH MAP

FIGURE
2-2

2.3 Existing Conditions

2.3.1 Reach Description

The study area includes two significant drainageways (700 and 800) that have been subdivided into four study reaches. Figure 2-2 shows these reaches and current jurisdictional limits. All study reaches except for 843 are outside the existing city limits and the Long Range Expected Growth Area (LREGA) of Greeley. All study reaches are in either a natural state or constructed open channel, and 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 drainageway.

Reach 700: Oklahoma Basin Primary Tributary

Reach 700 is the only defined reach for Major Drainageway 700, which is the first tributary west of WCR-17. It covers approximately 2,400 feet (Sta. 0+00 – 24+00), extending from the Oklahoma Drainageway south to Gratitude Lane. This drainageway is generally poorly defined, although the short section between WCR-60 and the Great Western Railway appears to feature a constructed ditch and small storage area as seen in Figure 2-3 and Figure 2-4. Immediately upstream of the Great Western Railway there is a small constructed embankment across the drainageway (Figure 2-4), and farther upstream a fenced off area covered in bushes and trees, seen in Figure 2-5.

Figure 2-3 Reach 700

Figure 2-4 Reach 700

Figure 2-5 Reach 700

Reach 800: Oklahoma Basin Primary Tributary

Major Drainageway 800, which is the second tributary west of WCR-17, contains three reaches. Reach 800 is the downstream-most reach, extending approximately 2,800 feet (Sta. 0+00 – 28+00) from the Oklahoma Drainageway south to the existing Town of Windsor boundary. The confluence of Reach 800 and the Oklahoma Drainageway is a constructed wet pond as seen in Figure 2-6. This pond also collects runoff from another tributary to the west. Large portions of Reach 800 are covered with wetland vegetation, seen in Figure 2-7. There is an existing stagnant pond/wetland

area immediately upstream of Gratitude Lane, shown in Figure 2-8. Nearby property owners mentioned that this used to be a more significant wet pond with clean (flowing) water.

Figure 2-6 Reach 800

Figure 2-7 Reach 800

Figure 2-8 Reach 800

Reach 829: Oklahoma Basin Primary Tributary

Reach 829 is the middle reach of Major Drainageway 800, comprising the portion within the existing Town of Windsor limits. Reach 829 extends approximately 3,500 feet (Sta. 28+00 – 63+00) from the Windsor boundary southeast to US-34. The downstream portion of Reach 829 is a large constructed detention basin for the Southgate development. As shown in Figure 2-9, this detention basin appears to have received a fair amount of sedimentation since construction and is currently full of reedy vegetation. Between the constructed detention basin and Southgate Drive, the existing drainageway does not appear to be stable, the channel profile and alignment appear to be changing due to erosive water forces as shown in Figure 2-10.

The section between Southgate Drive and the Kia access road features a small rectangular concrete low-flow channel and three drop structures that extend across the floodplain (Figure 2-11). This existing low-flow channel is overgrown and damaged. Upstream of the Kia access road, an existing 48-in RCP storm drain conveys smaller flows, with overflows traveling over the grassed surface. This 48-in RCP connects to another rectangular concrete low-flow channel, seen in Figure 2-12, that extends to US-34. Portions of this concrete are failing due to channel bed movement.

Figure 2-9 Reach 829

Figure 2-10 Reach 829

Figure 2-11 Reach 829

Figure 2-12 Reach 829

Reach 843: Oklahoma Basin Primary Tributary

Reach 843 is the upstream-most reach of Major Drainageway 800, extending approximately 2,900 feet (Sta. 63+00 – 92+00) from US-34 southeast to existing farming fields. Between the US-34 and WCR-17 culverts, the drainageway has a poorly defined earthen low-flow channel with large portions covered in vegetation, seen in Figure 2-13. Upstream of WCR-17, there is very little channel definition through the actively farmed fields.

Figure 2-13 Reach 843

2.3.2 Existing Crossings

Table 2-1 provides an inventory of the existing crossing structures, and Figure 2-14 shows the locations of the existing crossing structures.

2.3.3 Land Use

Existing vegetation within the study area is primarily grasses. The area north of US-34 contains both native grasses in undeveloped portions and lawn or landscaped grasses in the developed portions. The area south of US-34 contains agricultural crops. Existing land use within the study area is varied with rural, commercial, industrial, and residential uses throughout the study area, with the more intensive uses such as car dealerships, business parks, and college complexes located within the Town of Windsor portion. The paved thoroughfares of US-34 and WCR-17 pass through the study area. Existing land use was compiled in ArcGIS by combining parcel, roadway, and land use data obtained from Greeley with aerial imagery. Publicly owned land is shown in Figure 2-15.

2.3.4 Flood History

No stream gage information was found for the study area. Many portions of the Oklahoma Basin are undeveloped or historical farm uses, where infiltration 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. No reach was identified as ecologically significant.

2.4 Public Engagement

The technical team will reach out to stakeholders such as the Town of Windsor to obtain the best available data. Workshops with the general public are not included in this study, but multiple public engagement meetings and a public-facing website were created for the previously broader Oklahoma and South Basins study.

2.5 Future Trends

This study does not intend to update or change the general future trends documented in the *2060 Comprehensive Plan* and *2016 Windsor Comprehensive Plan.* Rather, the future trends identified in City of Greeley, Town of Windsor, and Weld County 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 Town of Windsor has seen extensive development through metropolitan districts in recent years. Two existing metropolitan districts near 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 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.

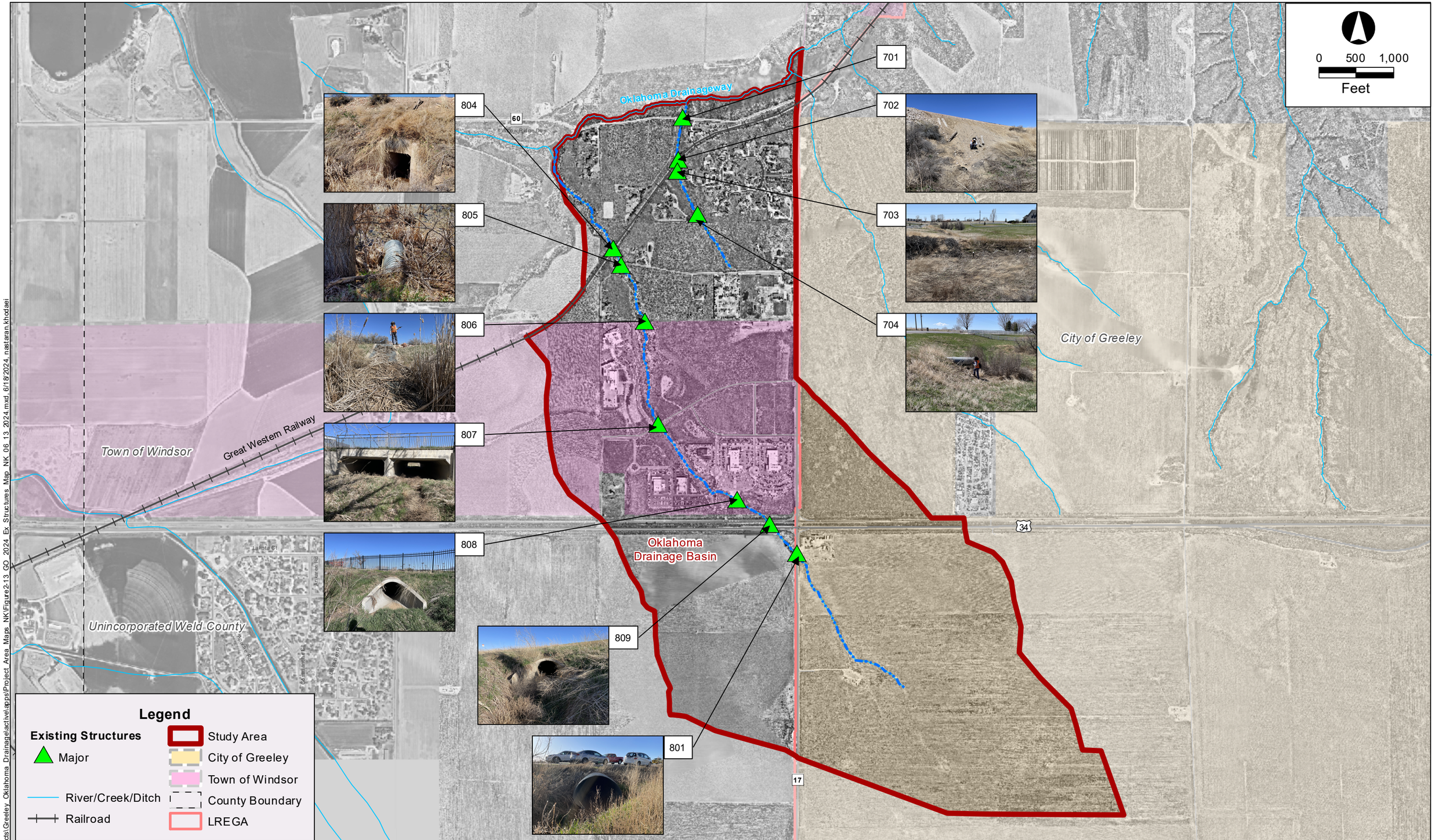
2.5.1 Near-Term Developments

The Delantero project is an 822-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 broader 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. It is expected to add thousands of housing units to the area along with more limited commercial and industrial developments.

There is also an Uptown development project located immediately southeast of WCR-17 and US-34 (adjacent to Delantero). We do not have much information on this development yet.

Table 2-1 Major Crossing Structure Inventory

Structure Number	Reach Number	Location	Crossing Type	Structure Description	Structure Station	Existing Structure Size/Type	Approximate Culvert Length (LF)	Future Storm Event Capacity	Existing Capacity (CFS)
702	700	Great Western Railway	Railroad	Culvert	8+00	1-24" CMP	97	10-Year	47
704	700	Windsong Rd	Roadway	Culvert	16+00	1-30" CMP	89	5-Year	37
801	843	CR-17	Roadway	Culvert	69+00	1-48" CMP	74	< 2-Year	138
804	800	Great Western Railway	Railroad	Culvert	17+00	1-5'x6.3' CBC	90	< 2-Year	98
805	800	Private Land	Dirt Road	Culvert	19+00	1 -24" CMP	62	< 2-Year	25
807	829	Southgate Dr	Roadway	Culvert	42+00	2- 12'x5' CBC	80	50-Year	1247
808	829	Private Land	Fencing	Culvert	58+00	1-48" RCP	527	< 2-Year	150
809	843	US-34	Roadway	Culvert	63+00	1-48" RCP	304	< 2-Year	176



No.	DATE	DESCRIPTION	APPR.

Matrix
Excellence by Design

designed by: _____
drawn by: NK
checked by: BL
project no.: 23.1447.001
date: 02/08/2024

Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA DRAINAGE BASINS 700 & 800

EXISTING STRUCTURES

FIGURE
2-14

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0 500 1,000
Feet

Oklahoma Drainageway

Oklahoma Drainage Basin

City of Greeley

Town of Windsor

Unincorporated Weld County

Great Western Railway

60

15

34

17

Willow Ridge Rd

Lakota Ct

Commanche Ct

Algonquin Dr

Warner Rd

Columbine Ct

Forest Oak Rd

Legend

- Study Reach
- River/Creek/Ditch
- Railroad
- Study Area
- City of Greeley
- Town of Windsor
- County Boundary
- LREGA

Note: No public owned land found within the study area

No.	DATE	DESCRIPTION	APPR.

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designed by:
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Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA DRAINAGE BASINS 700 & 800

PUBLIC OWNED LAND

FIGURE
2-15

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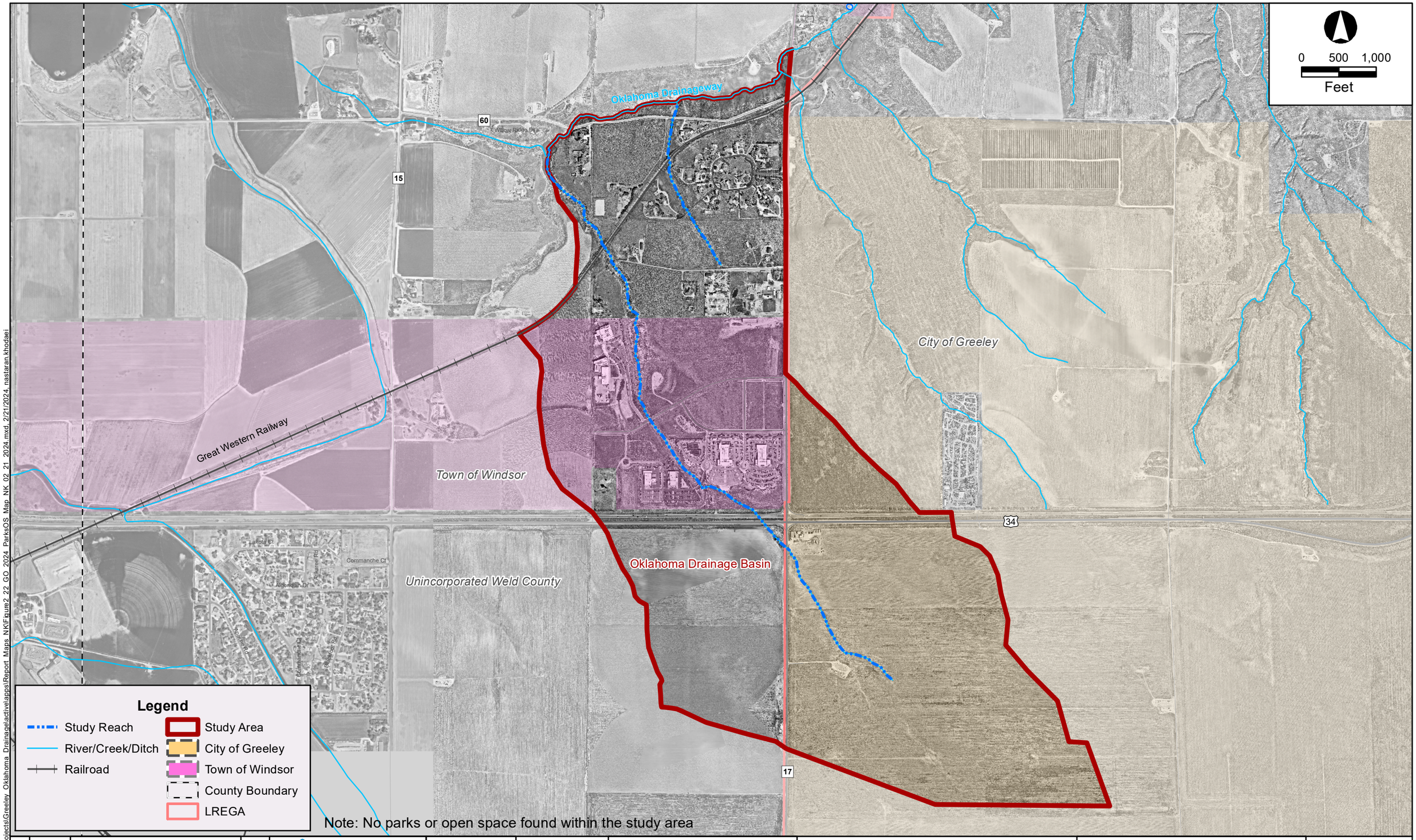

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No.	DATE	DESCRIPTION	APPR.

Matrix Excellence by Design

designed by:
drawn by: NK
checked by: BL
project no.: 23.1447.001
date: 02/08/2024

City of Greeley, Colorado

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA DRAINAGE BASINS 700 & 800

PARKS AND OPEN SPACE

FIGURE
2-16

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. The study area contains reaches of varying stability and existing culverts at roadways and railways.

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). For this study, the correction factors were not used. From the *USDCM*, Table 5-1: Storm Duration and Area Adjustment for CUHP modeling in the *USDCM* (reproduced below in Table 3-1) 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

The Oklahoma Basins 700 and 800 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 3-2) 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	0.84	1.12	1.40	1.87	2.31	2.80	4.18
6-Hour Point Rainfall	1.28	1.67	2.08	2.78	3.41	4.13	6.19

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 3-3). These recommended storm distributions take into account the "leading intensity" nature of storms in the Front Range and 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 railroad. The main Oklahoma Drainageway serves as the downstream boundary for subbasins within the Oklahoma Basin. Watershed boundaries will be verified with upcoming fieldwork.

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 (mi^2)	Subbasin Area (acre)			Number of Subbasins
		Average	Minimum	Maximum	
Oklahoma	1.32	70	22	127	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 Existing Area (%)	Percent of Future Area (%)
Employment Uses, Business Parks	Business: Suburban Areas	75	10.5	62.2
Land Suitable for Future Development, Residential Low Density	Residential Lot, Single-family: 2.5 acres or larger	12	4.5	9.1
Land Suitable for Future Development, Residential Medium Density	Residential Lot, Single-family: 0.75 - 2.5 acres	20	6.3	6.3
Land Suitable for Future Development, Residential High Density	Residential Lot, Single-family: 0.25 acres or less	45	-	8.8
Industrial Uses, Light Industrial Parks	Industrial: Light Areas	80	2.7	2.7
Open Space, Moderately Sensitive Ecologically Significant Land	Undeveloped Areas	2	72.0	6.9
Pavement	Paved Streets	100	3.3	3.3
Gravel Road or Lot	Gravel (Packed) Streets	40	0.7	0.7

*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 C 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	
Infiltration Rate	High	Moderate	Low	Very Low	Total
Area (acre)	223	272	335	12	842
% Area	27	32	40	1	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.

0 500 1,000
Feet

Oklahoma Drainageway

60

Willow Ridge Dr

15

Great Western Railway

City of Greeley

Town of Windsor

34

Lakota Ct

Commanche Ct

Algonquin Dr

Killarney Rd

Oklahoma Drainage Basin

Unincorporated Weld County

Cummings Ct

Blarney Cir Rd

17

Legend

- Impervious Surface
- Study Reach
- River/Creek/Ditch
- Railroad
- Study Area
- City of Greeley
- Town of Windsor
- County Boundary
- LREGA

No.	DATE	DESCRIPTION	APPR.

Matrix
Excellence by Design

designed by:
drawn by: NK
checked by: BL
project no.: 23.1447.001
date: 02/08/2024

City of Greeley, Colorado

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA DRAINAGE BASINS 700 & 800

IMPERVIOUS SURFACES

FIGURE
3-1

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3.1.5 Detention

No detention areas were modeled for the Baseline Hydrology, following a 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, although the Southgate detention basin in Reach 829 may have been intended to provide regional detention. 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 5.2 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 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 lower than the flow rates documented in the *Town of Windsor Master Drainage Plan* (2003) for existing conditions and higher for 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* and *2016 Windsor Comprehensive Plan* for future land uses and impervious areas.
- 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 both inadvertent and proposed detention in their hydrologic models. As explained in Section 3.1.5, this study does not include detention.

3.1.8 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 5.2 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	Study Outfalls into Mainstem Drainageway	0808	1,402	O_620, O_712, O_714, O_803	842	1,695	1,362	(20)	1,692	2,445	44

Note Windsor future peak flows represent a detained release

Table 3-10 Peak Flows at Key Locations

Locations[1]	Design Points / Conveyance Elements	Total Drainage Area		Station[2]	Existing Conditions Peak Flows (cfs)						Future Conditions Peak Flow (cfs)					
		(acres)	(mi^2)	(ft)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
Reach 700 Outfall at Oklahoma Mainstem	O_708	90	0.14	0+00	13	24	42	85	118	160	15	28	47	93	128	172
Reach 800 Outfall at Oklahoma Mainstem	O_803	696	1.09	0+00	63	108	192	494	722	1,039	348	515	709	1,203	1,591	2,072
Reach 800 Culvert at US-34	809	401	0.63	63+00	7	34	96	275	407	578	252	362	485	782	1,018	1,300

[1] Direct flow areas 620 and 714 not included in reach summaries

Table 3-11 Runoff Volume at Key Locations

Locations[1]	Design Points / Conveyance Elements	Total Drainage Area		Station[2]	Existing Conditions Runoff Volume (ac-ft)						Future Conditions Runoff Volume (ac-ft)					
		(acres)	(mi^2)	(ft)	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}
Reach 700 Outfall at Oklahoma Mainstem	O_708	90	0.14	0+00	1.4	2.6	4.4	8.3	11.6	15.8	1.6	2.8	4.6	8.5	11.9	16.1
Reach 800 Outfall at Oklahoma Mainstem	O_803	696	1.09	0+00	6.7	13.1	25.1	54.6	79.5	111.7	30.7	43.9	59.2	88.1	114.5	145.8
Reach 800 Culvert at US-34	809	401	0.63	63+00	0.8	3.4	9.9	27.3	41.4	60.5	18.7	26.6	35.9	52.8	68.4	86.5

[1] Direct flow areas 620 and 714 not included in reach summaries

3.2 Hydraulic Analysis

3.2.1 Evaluation of Existing Facilities

There are 9 existing culvert crossings located within the study area. Refer to Figure 2-14 for the locations of existing crossing structures. Culvert sizes and material were observed during the Matrix field visit on March 12, 2024. 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. None of the existing crossings has a 100-year capacity. Table 2-1 summarizes the existing capacities, and Table 3-19 shows the proposed culvert improvements for the study area.

HY-8 version 7.80.2 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. Table 3-12 shows a summary of Manning's n used in the model based on the culvert material. It should be noted that the manning's n values used in the HY-8 models are different compared to the SWMM models as the HY-8 models are being used for a culvert analysis while the SWMM models are being used for a runoff analysis. 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)	0.011-0.012
Corrugated Steel (CMP)	0.024
Concrete Box Culvert	0.013
Polyvinyl Chloride (PVC)	0.013

Crossing 804 is a unique structure as its inlet is a concrete box culvert with its outlet becoming a wooden box culvert. There are also two restrictor plates inside of the structure shortening the opening. To simulate this, an embankment depth of 60 inches was placed into the crossing model. Crossing 701 while noted, was excluded from the study due to its inlet possibly being located inside of a pond. This could not be confirmed due to the pond being located inside private property.

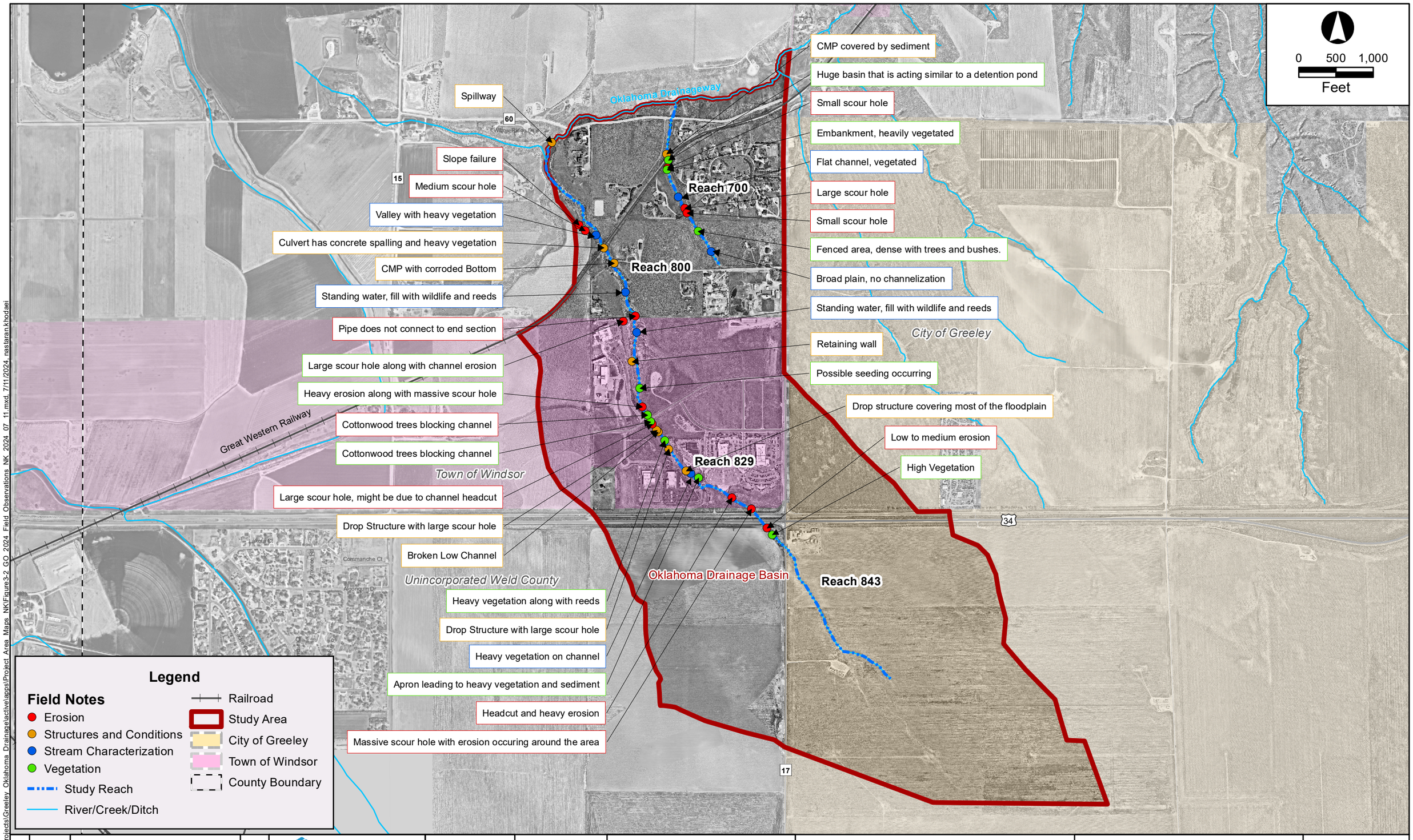
Structure 806 and 703 were not included in the report. Structure 806 was deemed an outlet structure for the existing Southgate detention basin and Structure 703 was located at the end of a small embankment. Due to these situations, it was decided to not design 100-year pipe conveyance for either pipe.

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. Figure 3-2 presents the observations made during field assessments. Observations were grouped into four categories: erosion, structures and conditions, stream characterization and vegetation. Detailed geomorphic analyses were not performed as part of this study, but the general health and shape of existing flood valleys were noted.

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: NK
checked by: BL
project no.: 23.1447.001
date: 04/16/2024

City of Greeley, Colorado

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA DRAINAGE BASINS 700 & 800

Field Observations

FIGURE
3-2

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 of the 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 was 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 700 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, then included detention and 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. 1' of freeboard was assumed and included in corridor width recommendations.

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). 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	
		700	800
1	Do Nothing except crossing structure upgrades	x	x
2	Detention in all major tributaries	x	x
3	Channel only improvements	x	x
4	LID, detention, and channel improvements	x	x

All of the options except 1 (Do Nothing) include some form of channel improvements. This improvement would be at L_829 which is located right after culvert 807 and L_708 which is located by reach 700 outfall. Both locations experience heavy erosion and steep channels. 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 Detention workbook version 4.06 was used to design the detention basins. With the exception of (pre-existing) Detention Basin 823, conceptual detention basins assumed the minimum rectangular footprint with 4:1 side slopes that would result in the required volume. 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. Note depth-area rating tables were provided up to ten feet to provide calculation robustness in larger storms. Also the (pre-existing) Detention Basin 823 utilizes a 10-foot max design depth to match the existing design.

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 Option 2 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)
D711	700	712	6.5	90.0	1.6	176	127
D823	829	820/830/824/844	43	327.0	6.3	793	356
D841	843	842/850	25	210.6	12.2	647	41
D844	844	844	17	126.7	4.4	523	204

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 proposed 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 feet of freeboard. The peak discharge in each reach is dependent on upstream conditions.

For this alternatives analysis, simple trapezoidal cross sections 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 3-3 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 disconnecting the runoff generated from impervious surfaces. 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. EURV and flood control were placed upstream of any channels that had a velocity greater than 5 ft/s. 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.

The hydraulic results and required channels parameters for each option are shown in Table 3-16, Table 3-17, and Table 3-18. Results discussions for each major drainageway follows.

Table 3-15 Option 4 LID Detention Basin Summary

Detention Facility No.	Reach Location	Contributing Subbasins	Drainage Area (acre)	% Future Imperv.	EURV Ponds				Flood Control 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)
D_EURV_711	700	712	90.0	30.2%	2.40	0.60	170	155	6.5	1.3	155.2	110.8
D_EURV_820	829	820	81.0	69.80%	5.50	1.30	332	240	-	-	-	-
D_EURV_830	829	830	829.0	67.80%	5.60	1.50	293	193	-	-	-	-
D_EURV_840	843	840	63.0	76.5%	5.40	3.10	200	165	-	-	-	-
D_EURV_842	843	842/850	210.5	68.6%	14.30	9.50	646	328	2.4	0.6	328.3	284.0
D_EURV_844	N/A (Upstream of 843)	844	126.5	76.2%	9.40	2.30	523	382	-	-	-	-
D_FC_823	829	820/830/844/842/840	327.0	73.0%	-	-	-	-	43.1	6.3	474.7	282.7
D_FC_838	829	844	126.5	76.2%	-	-	-	-	17.3	3.3	524.4	292.0

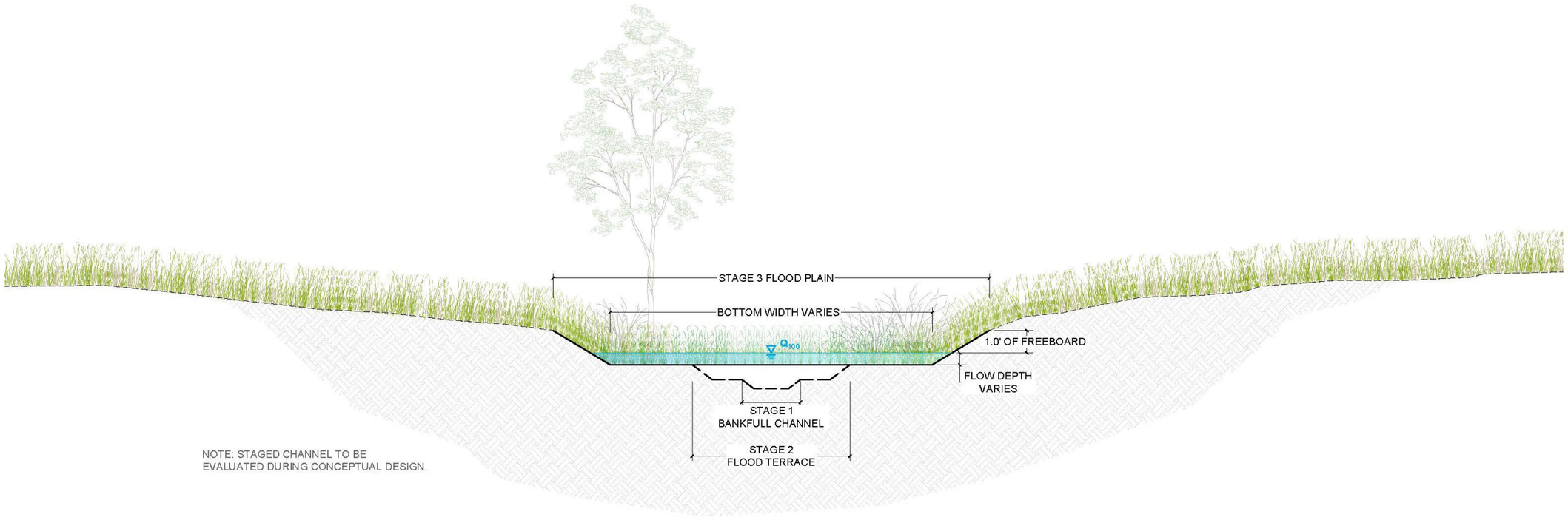

Figure 3-3 Typical Channel Cross Section

Table 3-16 100-Year Channel Velocities

100-Yr Velocity (ft/s)						
Reach	SWMM Link	Existing	Option 1 Do Nothing	Option 2 Detention	Option 3 Channel Improvements	Option 4 LID
700	L_708	10.4	10.7	9.6	5.0	9.1
700	L_709	5.4	5.6	5.0	4.8	4.7
700	L_710	4.3	4.4	3.9	4.4	3.7
700	L_711	4.1	4.2	4.1	4.2	3.4
700	L_712	3.7	3.7	3.7	3.7	3.7
700	L_713	2.9	3.0	3.0	3.0	3.0
800	L_808	4.9	6.3	3.6	5.0	3.2
800	L_811	5.3	6.8	3.7	4.9	3.4
800	L_819	3.5	4.6	2.4	4.6	2.2
829	L_823	3.1	4.1	2.6	4.1	1.7
829	L_829	8.0	10.6	6.4	4.9	5.9
829	L_834	3.3	4.3	2.8	4.3	2.6
829	OV_836	6.2	8.6	4.4	5.0	3.4
829	L_838	4.4	5.5	3.8	5.0	2.6
843	L_839	3.0	4.0	2.5	4.0	3.4
843	L_841	4.7	6.3	4.5	5.0	4.6
843	L_850	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 2 Detention**	**Option 3 Channel Improvements**	**Option 4 LID**
700	L_708	160	172	128	172	111
700	L_709	160	172	128	172	111
700	L_710	160	172	129	172	111
700	L_711	160	172	172	172	170
700	L_712	160	173	173	173	170
700	L_713	160	173	173	173	170
800	L_808	1023	2049	412	2032	298
800	L_811	928	1882	355	1871	283
800	L_819	928	1882	355	1872	283
829	L_823	709	1504	434	1498	311
829	L_829	711	1511	434	1506	311
829	L_834	576	1290	340	1289	292
829	OV_836	331	1053	95	806	46
829	L_838	577	1300	341	1300	524
843	L_839	372	844	203	844	528
843	L_841	290	306	305	306	304
843	L_850	139	649	41	649	284

Table 3-18 Proposed Channel Geometry

Reach	SWMM Link	Reach Length (LF)	Option 1- Do Nothing		Option 2 Detention		Option 3 Channel Improvements		Option 4 LID	
			Top Width (ft)	Depth (ft)	Top Width (ft)	Depth (ft)	Top Width (ft)	Depth (ft)	Top Width (ft)	Depth (ft)
700	L_708	202	40	0.7	39	0.6	187	0.2	39	0.5
700	L_709	560	70	0.6	69	0.5	94	0.5	69	0.5
700	L_710	154	87	0.5	87	0.5	87	0.5	87	0.4
700	L_711	615	92	0.5	93	0.6	92	0.5	94	0.7
700	L_712	485	133	0.4	133	0.4	133	0.4	133	0.4
700	L_713	338	88	0.9	88	0.9	88	0.9	88	0.9
800	L_808	1197	105	4.2	90	1.7	179	2.8	88	1.3
800	L_811	183	150	2.3	133	0.9	176	2.6	130	0.7
800	L_819	761	150	3.3	137	1.2	150	3.3	136	1.0
829	L_823	943	265	1.5	257	0.7	265	1.5	258	0.8
829	L_829	290	102	1.7	96	0.9	127	3.2	95	0.7
829	L_834	1040	107	2.3	92	1.1	107	2.3	91	1.0
829	OV_363	442	91	1.2	64	0.3	141	0.9	61	0.2
829	L_838	314	105	2.2	75	1.2	133	1.7	99	2.0
843	L_839	541	137	1.1	125	0.5	137	1.1	131	0.8
843	L_841	190	200	3.6	200	1.3	200	3.6	200	2.6
843	L_850	1740	76	1.7	78	1.8	76	1.7	76	1.7

Table 3-19 Proposed Crossing Structures

Structure Number	Reach Number	Structure Size and Type				Design Q100 Capacity (CFS)a			
		Option 1	Option 2	Option 3	Option 4	Option 1	Option 2	Option 3	Option 4
702	700	2-42" RCP	2-36" RCP	2-42" RCP	1-48" RCP	172	128	172	111
704	700	2-48" RCP	2-48" RCP	2-48" RCP	2-48" RCP	172	172	172	170
801	843	2-9'x5' CBC	1 - 6'x4' CBC	2-9'x5' CBC	2-9'x4' CBC	846	203	846	535
804	800	2-10'x8' CBC	1-6'x7' CBC	2-10'x8' CBC	1-6'x5' CBC	2057	413	2045	283
805	800	10-10'x3' CBC	3-8'x3' CBC	10-10'x3' CBC	2-8'x3' CBC	1882	355	1872	283
807	829	3-12'x5' CBC	1-12'x4' CBC	3-12'x5' CBC	1-12'x4' CBC	1511	435	1507	311
808	829	3-12'x5' CBC	1-12'x4' CBC	3-12'x5' CBC	1-12'x4' CBC	1300	341	1300	292
809	843	2-12'x7' CBC	1-10'x4' CBC	2-12'x7' CBC	2-10'x4' CBC	1300	341	1300	528

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

Major Drainageway 700

Option 1 was considered infeasible due to velocities significantly exceeding 5 ft/s near the outfall of the reach. Thus, improvements are needed to ensure the reach is stable under future conditions.

Option 2 considered placing a detention basin immediately upstream of the railroad embankment. This was able to reduce the basin peak flows to pre-development levels. However, existing flows exiting the reach were still above 5 ft/s, so channel improvements were proposed for lowest part of Reach 700 (between the Oklahoma Drainageway and the Great Western Railway).

Option 3 has the largest required channel corridors due to the existing channel having the largest velocity between all reaches.

Option 4 incorporates LIDs in future developed areas of the watershed to provide water quality and minor flow reduction. Option 4 also incorporates a singular EURV basin in the same location as the Option 2 detention basin. A regional flood control basin was placed behind the EURV to help with additional peak flow reduction. Existing flows exiting the reach were still above 5 ft/s so channel improvements were proposed for the lowest part of Reach 700.

Major Drainageway 800

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

Option 2 considered placing a detention basin upstream of WCR-17 in Reach 843 along with restoring full function of the existing Southgate detention basin that is located in Reach 829. This was able to reduce large portions of the basin peak flows to pre-development levels. However, channel protection was still proposed for the short, relatively steep section between Southgate Drive and the Southgate detention basin since expected 100-year velocities were above 5 ft/s.

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 upper detention basin, along with a regional flood control basin as a replacement for the detention basin located in the middle of major drainageway 800. Throughout the drainageway, six smaller EURV basins were placed which helped reduce peak runoff. However, channel protection was still proposed for the short, relatively steep section between Southgate Drive and the Southgate detention basin since expected 100-year velocities were above 5 ft/s.

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.

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 alternative options for each major drainageway. The expected capital costs to improve each drainageway for future 100-year flood protection are discussed below.

Major Drainageway 700

Option 3 is the most expensive due to high capital costs involved with improving the entire length of drainageway, and only addresses channel stability. Option 1 has the lowest costs but does not achieve the goals of this study – taking the Do Nothing approach would result in increased risk of future flood damages to people or property within this watershed. Option 4 has slightly lower costs than Option 2 because distributed LID and EURV costs (both construction and maintenance) are expected to be borne by developers.

Major Drainageway 800

Option 1 has the lowest cost but does not achieve the goals of this study – taking the Do Nothing approach would result in increased risk of future flood damages to people or property within this watershed. Options 2 and 3 are the most expensive due to high capital and maintenance costs. Option 2 represents significant investment in multiple regional detention basins, and Option 3 represents significant investment to improve the entire length of drainageway. Option 4 has the lowest expected costs because distributed LID and EURV costs (both construction and maintenance) are expected to be borne by developers. Option 4 does include regional detention costs, but these detention costs will be significantly less than Options 2 since the upstream distributed facilities decrease the required sizes of regional detention facilities.

Table 3-22 Alternative Plans Cost Estimate Summary

Major Drainageway	Alternative	Acquisition Capital Cost	Crossing Improvement Capital Cost	Channel Improvement Capital Cost	Regional Detention Capital Cost	Total Capital Cost[a]	50 Year O & M Cost	Total Cost[b]
700	Option 1: Do Nothing	-	$89,598	-	-	$152,766	$37,200	$189,966
	Option 2: Detention	$17,965	$83,778	$34,515	$497,660	$1,068,165	$237,600	$1,305,765
	Option 3: Channel Improvement	$65,684	$89,598	$504,879	-	$1,079,268	$397,200	$1,476,468
	Option 4: LID	$14,596	$72,138	$34,047	$497,159	$1,043,298	$198,750	$1,242,048
800	Option 1: Do Nothing	-	$5,855,486	-	-	$9,983,604	$337,700	$10,321,304
	Option 2: Detention	$257,121	$1,830,956	$65,637	$6,511,163	$14,592,347	$2,994,350	$17,586,697
	Option 3: Channel Improvement	$274,637	$5,858,648	$3,462,346	-	$16,166,933	$1,484,000	$17,650,933
	Option 4: LID	$114,526	$1,868,805	$65,637	$4,935,532	$8,578,110	$1,404,850	$9,982,960

a.Total cost also includes mobilization, stormwater management/erosion control, engineering, legal/administration, construction management, and contingency estimates.
b.Total cost includes capital cost plus operations and maintenance cost over 50 years.

3.3.6 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 3-2 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
700	Reach 700	(2) Undersized minor roadway crossing structures (1) Undersized railroad crossing structure Informal embankment blocks drainageway	Improve crossing capacity at GWR, WCR-60, and Windsong Rd Formalize detention upstream of GWR and/or Windsong Rd embankment
800	Reach 800	Heavy vegetation impeding flows (1) Undersized/corroded minor roadway crossing structure (1) Undersized railroad crossing structure Flared section not connected to pipe outlet	Improve crossing capacity at GWR and Gratitude Ln Formalize detention upstream of Gratitude Ln embankment Repair existing detention basin outlet
	Reach 829	Localized bank erosion Existing detention basin contains sediment and reeds (2) Undersized minor roadway crossing structures Trees in channel impeding flows Headcuts and entrenchment in low-flow channel (5) Scour holes at culvert outlets and drop structures	Stabilize banks through erosion-resistant materials or flatten bank slopes Update Southgate detention basin with maintenance plan and additional forebays Improve crossing capacity at Southgate Dr and Kia Access Rd Stabilize channel profile through bed protection and low-flow channel definition Replace trees with more desirable vegetation Stabilize outlets with erosion-resistant materials and/or formalize scour holes
	Reach 843	(2) Undersized major roadway crossing structures (1) Minor channel and bank erosion upstream of culvert	Improve crossing capacity at US-34 and WCR-17 Stabilize banks through erosion-resistant materials or flatten bank slopes Stabilize channel profile through bed protection and low-flow channel definition

3.3.7 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 amenities. 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 some 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 700

Option 4 (LID, detention and channel improvements) is the recommended alternative. Option 2 (detention and channel improvements) scored almost as highly, and since Basin 700 is relatively small Option 2 and Option 4 would likely look similar if implemented. Option 4 gains a slight edge because 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 800

Option 4 (LID, detention and channel improvements) is the recommended alternative. Both Option 2 (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 2. 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

Major Drainageway	Alternative	Constructability	Maintenance	Meets Multiple Objectives	Water Quality	Public Safety	Habitat and Environment	Aesthetics	Criteria Compliance	TOTAL WEIGHTED AVERAGE
		Weighting								Score
		20%	15%	15%	10%	20%	5%	5%	10%	100%
700	Option 1:Do Nothing except crossing structure upgrades	3	0	1	1	0	2	1	0	1.00
	Option 2: Detention and channel improvements	2	2	3	3	2	2	2	3	2.35
	Option 3: Channel only improvements	2	3	2	0	2	2	2	2	1.95
	Option 4: LID, detention and channel improvements	2	2	3	3	3	3	2	2	2.50
800	Option 1:Do Nothing except crossing structure upgrades	3	1	1	1	0	2	1	0	1.15
	Option 2: Detention and channel improvements	2	2	3	3	2	2	2	3	2.35
	Option 3: Channel only improvements	2	2	2	0	2	2	2	2	1.80
	Option 4: LID, detention and channel improvements	2	2	3	3	3	3	2	2	2.50
		Scoring: Opportunity	0 - No Opportunity		1 - Minimal Opportunity		2 - Average Opportunity		3 - High	

Table 3-25 Recommended Plan Cost Estimate

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 Cost	Total Cost[b]
700	$14,596	$66,000	$34,047	$494,988	$1,043,298	$198,750	$1,242,048
800	$119,017	$1,762,349	$4,759,500	$4,759,500	$11,561,232	$1,454,950	$13,016,182
Study Totals	$133,613	$1,828,349	$4,793,547	$5,254,488	$12,604,530	$1,653,700	$14,258,230

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

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

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 Basin 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 of the existing major crossings in this watershed are 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 proposed conceptual plan elements are presented in Figures G-1 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 of Greeley drainage criteria. The total estimated cost of proposed capital improvements within the Oklahoma Basin is $14,876,170.

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.
- 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 5.2.4 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. All crossings were sized to provide at least 1-ft of freeboard. 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 were 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 Cost	Total Cost[b]
700	$14,596	$66,000	$34,047	$494,988	$1,043,298	$198,750	$1,242,048
800	$119,017	$1,762,349	$4,759,500	$4,759,500	$11,561,232	$1,454,950	$13,016,182
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a.Total capital cost also includes mobilization, stormwater management/erosion control, engineering, legal/administration, construction management, and contingency estimates.

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

4.2.1 Vision Statement, Goals, and Objectives

Vision Statement

The vision for the successful implementation of the Oklahoma 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 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 is provided below in Table 4-2, and peak flows and volumes at all design points are included in Appendix F-5.

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		Drainage Area	Existing Conditions (cfs)	Future Conditions Do Nothing (cfs)	Future Conditions Concept Design (cfs)
Number	Type	(acres)	Q_{100}	Q_{100}	Q_{100}
O_708	Outfall	90	160	172	111
O_803	Outfall	696	1,039	2,072	306

[1] Direct flow areas 620 and 714 not included in reach summaries

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 4-1 LID Single Family Residential Example

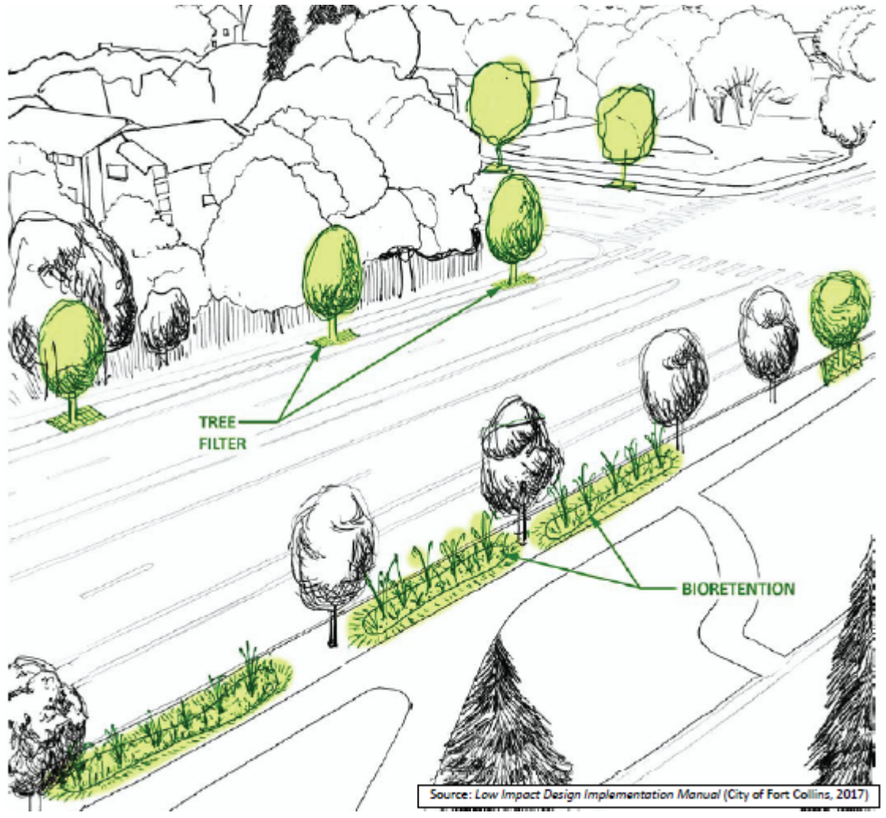

Figure 4-2 LID Street Right of Way Example

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

- **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 through, 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 through 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	Contributing Subbasins	Drainage Area (acre)	% Future Imperv.	EURV Ponds				Flood Control 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)
D_EURV_711	700	712	90.0	30.2%	2.4	0.6	170	155	6.5	1.3	155	111
D_EURV_820	829	820	81.0	69.80%	5.5	1.3	332	240	-	-	-	-
D_EURV_830	829	830	829.0	67.80%	5.6	1.5	293	193	-	-	-	-
D_EURV_840	843	840	63.0	76.5%	5.4	3.1	200	165	-	-	-	-
D_EURV_842	843	842/850	210.5	68.6%	14.3	9.5	646	328	2.4	0.6	328	284
D_EURV_844	N/A (Upstream of 843)	844	126.5	76.2%	9.4	2.3	523	383	-	-	-	-
D_FC_823	829	820/830/844/842/840	327.0	73.0%	-	-	-	-	43.3	6.3	475	283
D_FC_838	829	844	126.5	76.2%	-	-	-	-	17.3	3.3	524	292

Greeley and Windsor 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 Basin.

- Extended Detention Basin;
- Underground Infiltration.

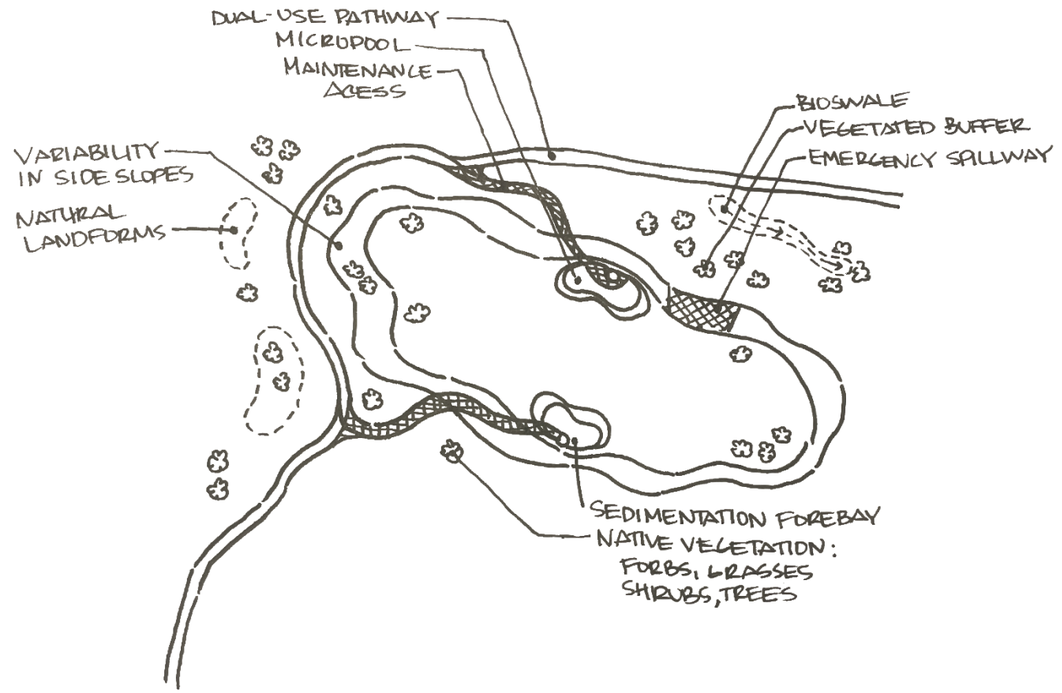

Figure 4-4 Offline basin elements

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 natural elements that can be incorporated into online detention basins (situated within the primary flow channel) to fulfill multiple purposes. The following regional detention facilities are regionally accepted and recommended for use within the Oklahoma Basin:

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

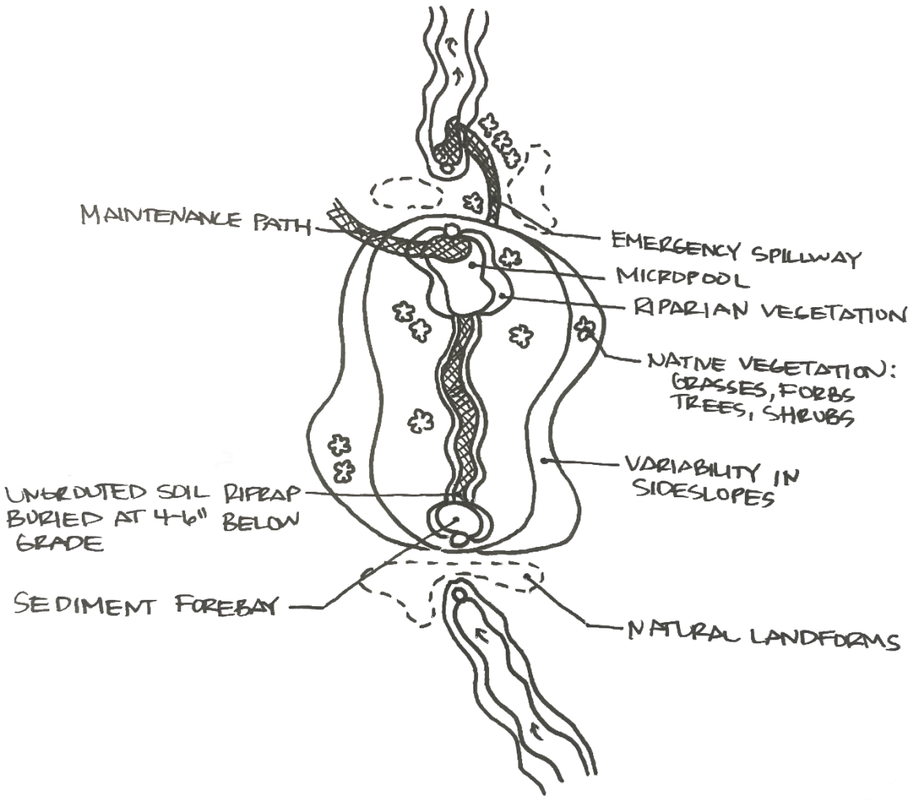

Figure 4-5 Online basin elements

Stormwater Detention Facility Guidelines

Refer to the *Design Criteria and Construction Specifications: Storm Drainage Volume II* (City of Greeley, 2024) 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

At the outfall of Reach 700, channel improvements are recommended due to severe erosion observed in this area, which is likely caused by the steep gradient of the channel. This will require further investigation as the inlet side of the outlet is on private property. Channel improvements are also recommended downstream of the culvert at Southgate Dr. Severe erosion was observed in this area, which is likely caused by the steep gradient of the channel going into an existing detention pond.

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.

Channel Guidelines

Refer to the *Design Criteria and Construction Specifications: Storm Drainage Volume II* (City of Greeley, 2024) 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.

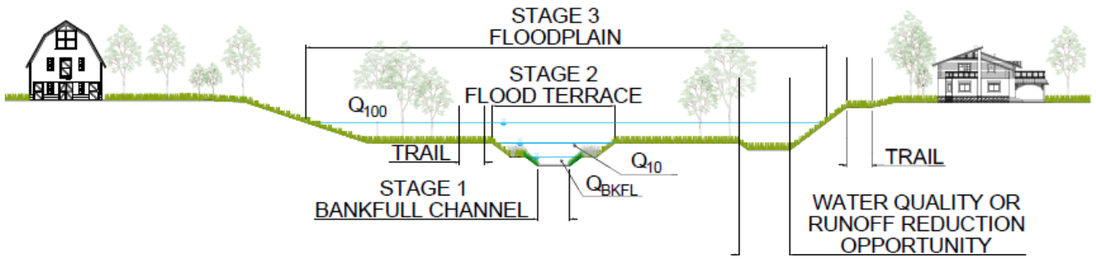

Figure 4-6 Master Plan Channel Typical

Crossing Improvements

Improved major drainageway crossing structures are proposed at all roadway and railroad crossing locations. The Master Plan culverts listed below in Table 4-5 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 4-5 Master Plan Crossing Improvements Summary

Structure Number	Reach Number	SWMM Node	Design Q100 (cfs)	Structure Size/Type	Outlet Velocity (ft/s)
702	700	710	111	1-48" RCP	20
704	700	711	170	2-48" RCP	14.4
801	843	839	535	2-9'x4' CBC	9.9
804	800	809	283	1-6'x5' CBC	25.6
805	800	811	283	2-8'x3' CBC	14.7
807	829	829	311	1-12'x4' CBC	13.3
808	829	836	292	1-12'x4' CBC	17.9
809	843	843	528	1-10'x4' CBC	21

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 to 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 700

Major Drainageway 700 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 are two existing crossings, one next to the Great Western Railway, and one at Windsong Rd

LID and EURV basins are recommended for all new developments. See Table 4-4 for the Master Plan detention sizes.

Riprap is recommended near the outfall of 700 due to significant erosion and steep slopes that result in high water velocities. For the cost estimate, the riprap has been categorized as Type M soil riprap.

Crossing improvements include the removal and replacement of two existing culverts. See Table 4-5 for Master Plan crossing improvements. When these culverts are replaced, the appropriate headwalls, wingwalls, aprons, and energy dissipation features should be designed in detail. Note, existing structure 701 (while not included) should be investigated in the future as it could have a direct impact on outfall 708.

The capital cost of these Master Plan improvements is estimated to be $1,043,298 The cost of maintenance and operation for 50 years is estimated to be $198,750 A detailed cost analysis is provided in Table 4-6.

Table 4-6 Major Drainageway 700 Cost Estimate

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains					
Circular Pipes					
Diameter (in)	**Length (ft)**	**No. of Barrels**			
48-inch	97	1	97	L.F.	$240.00	$23,280.00
48-inch	89	2	178	L.F.	$240.00	$42,720.00
Channel Improvements					
Soil Riprap, Type M		291	C.Y.	$117.00	$34,047.00
Detention/Water Quality Facilities					
Detention (Complete-in-Place)					
Detention Facility 1 (Complete-in-Place)		6.5	AC-FT	$76,152.00	$494,988.00
Removals					
Removal of culvert pipe (D<48")		186	L.F.	$33.00	$6,138.00
Landscaping and Maintenance Improvements					
Reclamation & seeding (native grasses)		1.3	ACRE	$1,670.00	$2,171.00
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				$66,000.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$34,047.00
Detention/Water Quality Facilities				$494,988.00
Removals				$6,138.00
Landscaping and Maintenance Improvements				$2,171.00
Special Items (User Defined)				$0.00
Subtotal Capital Improvement Costs				**$603,344.00**
Additional Capital Improvement Costs				
Dewatering			L.S.	$0.00
Mobilization	5%			$30,167.00
Traffic Control			L.S.	$0.00
Utility Coordination/Relocation			L.S.	$0.00
Stormwater Management/Erosion Control	5%			$30,167.00
Subtotal Additional Capital Improvement Costs				**$60,334.00**
Land Acquisition Costs				
ROW/Easements				$14,596.00
Subtotal Land Acquisition Costs				**$14,596.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$99,552.00
Legal/Administrative	5%			$33,184.00
Contract Admin/Construction Management	10%			$66,368.00
Contingency	25%			$165,920.00
Subtotal Other Costs				**$365,024.00**
Total Capital Improvement Costs				**$1,043,298.00**

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	359	L.F.	$2.00	$718.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, s	1.3	ACRE	$2,505.00	$3,257.00
Total Annual Operation and Maintenance Cost				**$3,975.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$198,750.00**

4.2.5 Major Drainageway 800

Major Drainageway 800 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 6 existing crossings across three reaches.

LID and EURV basins are recommended for all new developments. See Table 4-4 for the Master Plan detention sizes. Note that the largest single improvement cost involves the restoration of function and improvement for the existing Southgate detention basin in Windsor. This study has provided a conservative cost estimate for planning purposes, but there may be opportunities to identify and execute targeted, less costly improvements at this critical stormwater facility during design phases.

Riprap is recommended near the entrance of the existing detention pond, due to significant erosion and steep slopes that result in high water velocities. For the cost estimate, the riprap has been categorized as Type M soil riprap.

Crossing improvements include the removal and replacement of six existing culverts. See Table 4-5 for Master Plan crossing improvements. When these culverts are replaced, the appropriate headwalls, wingwalls, aprons, and energy dissipation features should be designed in detail. Note that we have treated Culvert 805 the same as the other crossings (provide future 100-year conveyance under the roadway), but since this appears to be more of a driveway than a public roadway, we recommend considering smaller solutions that allow overtopping during design phases.

The capital cost of these Master Plan improvements is estimated to be $11,561,232. The cost of maintenance and operation for 50 years is estimated to be $1,454,950. A detailed cost analysis is provided in Table 4-7.

Table 4-7 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)**		
6	5	1	90	L.F.	$1,095.56	$98,601.00
8	3	2	62	L.F.	$2,191.13	$135,850.00
12	4	1	80	L.F.	$1,529.18	$122,335.00
12	4	1	527	L.F.	$1,529.18	$805,879.00
9	4	2	74	L.F.	$2,537.62	$187,784.00
10	4	1	304	L.F.	$1,354.93	$411,900.00
Channel Improvements						
Soil Riprap, Type M		561	C.Y.	$117.00	$65,637.00
Detention/Water Quality Facilities					
Detention (Complete-in-Place)					
Detention Facility 1 (Complete-in-Place)		43	AC-FT	$76,152.00	$3,282,151.00
Detention Facility 2 (Complete-in-Place)		17	AC-FT	$76,152.00	$1,294,584.00
Detention Facility 3 (Complete-in-Place)		2	AC-FT	$76,152.00	$182,765.00
Removals					
Removal of culvert pipe (D<48")		62	L.F.	$33.00	$2,046.00
Removal of culvert pipe (48"<D<84")		905	L.F.	$84.00	$76,020.00
Concrete Box Culvert		170	L.F./CELL	$167.00	$28,390.00
Landscaping and Maintenance Improvements					
Reclamation & seeding (native grasses)		10	ACRE	$1,670.00	$17,034.00
Land Acquisition					
Easement/ROW Acquisition		10.60	ACRE	$11,228.00	$119,017.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$1,762,349.00
Hydraulic Structures			$0.00
Channel Improvements			$65,637.00
Detention/Water Quality Facilities			$4,759,500.00
Removals			$106,456.00
Landscaping and Maintenance Improvements			$17,034.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$6,710,976.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$335,549.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$335,549.00
Subtotal Additional Capital Improvement Costs			**$671,098.00**
Land Acquisition Costs			
ROW/Easements			$119,017.00
Subtotal Land Acquisition Costs			**$119,017.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$1,107,311.00
Legal/Administrative	5%		$369,104.00
Contract Admin/Construction Management	10%		$738,207.00
Contingency	25%		$1,845,519.00
Subtotal Other Costs			**$4,060,141.00**
Total Capital Improvement Costs			**$11,561,232.00**

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	1273	L.F.	$2.00	$2,546.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, st	10.6	ACRE	$2,505.00	$26,553.00
Total Annual Operation and Maintenance Cost				**$29,099.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$1,454,950.00**

4.3 Prioritizing and Phasing

Any downstream flood controls and EURVs in the developed portions of the basin should be prioritized before the upstream undeveloped regions. For undeveloped regions, 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

As the majority of the Oklahoma upper region is 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.

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 and the Town of Windsor 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 and Windsor implement 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 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 Basins 700 and 800. 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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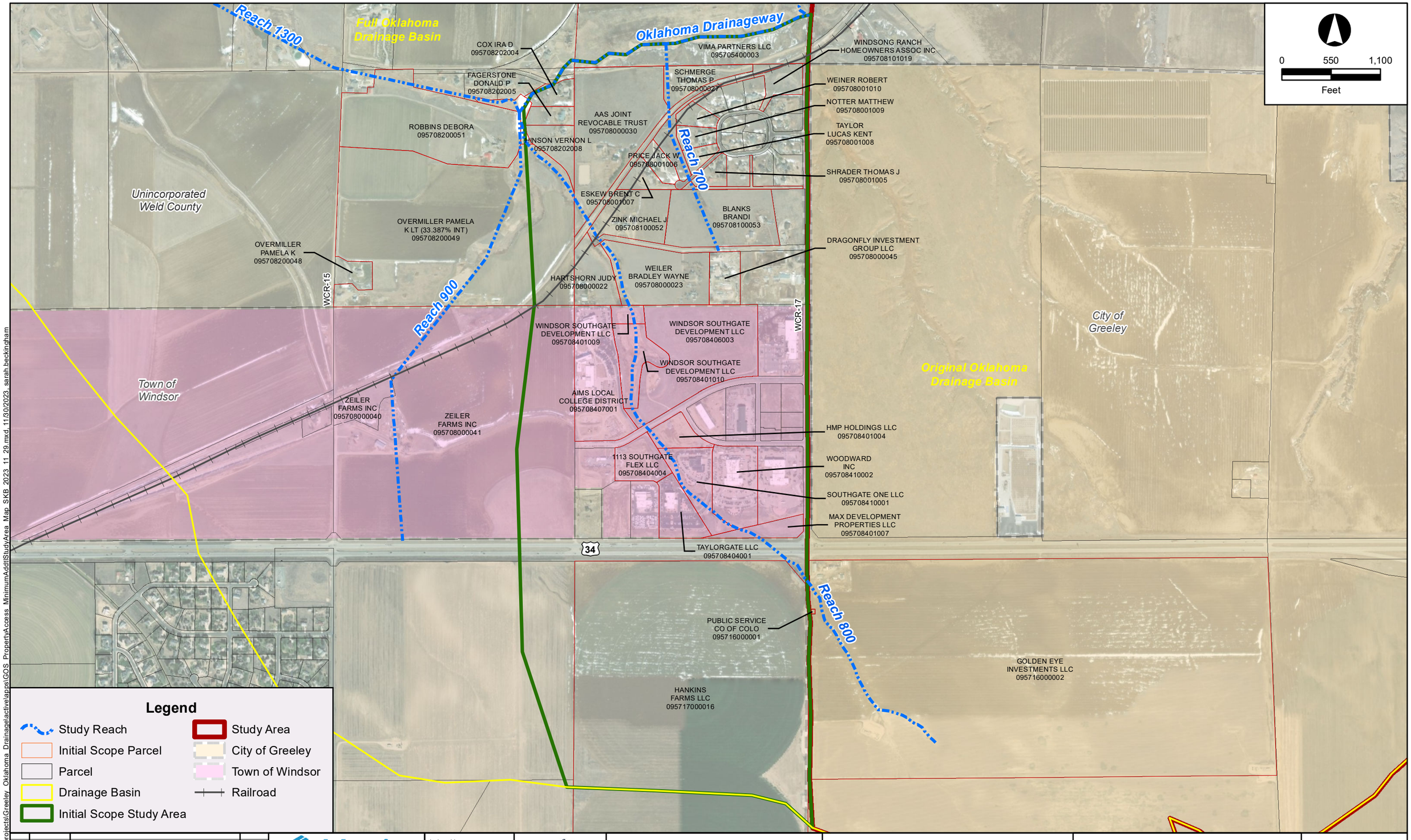
Appendix A – Project Correspondence



Legend

- Study Reach
- Initial Scope Parcel
- Parcel
- Drainage Basin
- Initial Scope Study Area
- Study Area
- City of Greeley
- Town of Windsor
- Railroad

No.	DATE	DESCRIPTION	APPR.

Matrix Excellence by Design

designed by:
drawn by: SL
checked by:
project no.: 22.906.007
date: 10/25/2023

City of Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA & SOUTH BASINS

REACHES 700-900
PARCEL ACCESS MAP

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KICK-OFF MEETING NOTES
Greeley Comprehensive Drainage Plan Oklahoma Basins 700-800
January 31, 2024 at 8am
Teams Meeting

Attendees:

Bhooshan Karnik	City of Greeley	970-573-0331	bhooshan.karnik@greeleygov.com
Aaron Stines	City of Greeley	970-302-0461	aaron.stines@greeleygov.com
Ryan Davis	Bolton & Menk	515-988-8013	ryan.davis@bolton-menk.com
Ben Liu	Matrix Design Group	303-572-0200	ben.liu@matrixdesigngroup.com
Drew Beck	Matrix Design Group	303-572-0200	drew.beck@matrixdesigngroup.com

Key: blue text indicates meeting notes, *red italic underlined text indicates action items*

1. Introductions

a. Roles
   i. Bhooshan = Greeley Deputy Director/Chief Engineer, PM of interchange project
   ii. Aaron = Greeley PM for this study
   iii. Ryan = Bolton Menk PM for interchange project
      1. ICON is BM stormwater consultant (Craig Jacobsen)
      2. Don Sterna is design manager for BM project
   iv. Ben = Matrix PM for this study
   v. Drew = Matrix Director of Water Resources

b. Contact Information (see above)

2. Contract Status

a. Matrix will be subconsultant to Bolton & Menk
   i. *Ryan will send sub-agreement to Greeley today* (under Task 8)
   ii. *Ryan to send Matrix terms and conditions of sub agreement*
      1. Greeley terms will also apply
   iii. Probably will be another week before contract is signed
   iv. Matrix will send invoices directly to Ryan Davis

b. Initial proposal submitted to Greeley November 2, 2023

c. Notice to Proceed received December 19, 2023

d. Revised proposal submitted to Bolton & Menk January 9, 2024

3. Project Purpose

a. Sponsor goals and objectives
   i. Greeley wants to see accurate crossing sizings based on future developments
   ii. Greeley wants to see regional storm approach instead of driven by individual developers, piecemeal approach in other areas has resulted in more flow/sediment than expected at downstream components

b. How this ties into other projects
   i. US34/CR17 intersection project going on now, may turn into interchange in ~20 yrs

   ii. Already in discussions with Delantero/Roache developments, they seem open to regional drainage approach. Delantero would like their plans approved this summer with construction in late 2024, Roache would like to start in 2025

c. Include Town of Windsor and/or Weld County?
   i. Windsor is trying to do drainage study (Wilson & Company, Dan Evans) of WCR-17 crossing – *Ben to reach out, Aaron to send contacts*
   ii. Windsor and Weld County are not sponsors/formal stakeholders
   iii. Greeley long-range area extends to WCR-17

4. Project Schedule

Drainageways 700/800 Schedule		2024						
TASK		Jan	Feb	Mar	Apr	May	Jun	Jul
1	PROJECT MANAGEMENT & COORDINATION	■	■	■	■	■	■	■
2	PROGRESS MEETINGS	■	■	■	■	■	■	■
5	DATA COLLECTION	■	■					
6	BASELINE HYDROLOGY AND HYDRAULICS	■	■					
	Greeley Review		■					
7	ALTERNATIVES ANALYSIS: DWYS 700/800			■	■			
	Greeley Review				■			
8	CONCEPTUAL DESIGN REPORT: DWYS 700/800					■	■	
	Greeley Review						■	
	Final Deliverable							■

a. Who will review and can they be done in 2 weeks?
   i. Aaron will review and can complete reviews in less than 2 weeks
   ii. Submittals should go through Bolton Menk
   iii. Suggest scheduling meeting with Delantero/Roache after Alternatives Analysis

b. *Aaron will get back to us on parcel access timeline*

c. Group accepted above schedule as appropriate
   i. Ben noted that we are currently one week behind due to lengthy contracting process, Matrix cannot submit deliverable until contract is enacted

5. Project Deliverables

a. Parcel access maps submitted to Greeley November 30, 2023

b. Draft land use maps submitted to Greeley January 25, 2024
   i. Aaron says they look reasonable, and also conform to Windsor plans

c. Project Status
   i. Ben provided update on hydrology progress
   ii. Initial modeling expected to be complete this week

d. Future deliverables:
   i. Baseline Hydrology Report
   ii. Alternatives Analysis Report
   iii. Conceptual Design Report

e. Each deliverable report will build on the last

6. **Data Gathering**
   a. Site survey access
      i. We already have access to any property that touches US-34, ¼ mi south and 1/2 mi north that touch WCR-17 (*Ryan will send their access map*)
   b. Are utility locates desired? Not needed for this study
   c. Known existing studies:
      i. Imagine Greeley Comprehensive Plan (2018)
      ii. Windsor Master Drainage Plan (2003)
      iii. Windsor Comprehensive Plan (2016)
         1. Windsor is in middle of updating, draft expected in a week
         2. Our study area is unlikely to change
      iv. Windsor Open Space and Trails Strategic Plan (2022)
      v. Weld County Property Portal (online)
      vi. Delantero preliminary drainage report
   d. Other sources?

7. **Additional Topics**
   a. Copy Ryan on all emails, can also copy Bhooshan

Matrix

Matrix Design Group, Inc.
707 17th Street, Suite 3150
Denver, CO 80202
O 303.572.0200
F 303.572.0202
matrixdesigngroup.com

WINDSOR/GREELEY COORDINATION MEETING NOTES
Greeley Comprehensive Drainage Plan Oklahoma Basins 700-800
February 12, 2024 at 10am
Teams Meeting

Attendees:

Dan Evans	Wilson & Company	Daniel.Evans@wilsonco.com
Aaron Stines	City of Greeley	aaron.stines@greeleygov.com
Ryan Davis	Bolton & Menk	ryan.davis@bolton-menk.com
Ben Liu	Matrix Design Group	ben.liu@matrixdesigngroup.com
Doug Roth	Town of Windsor	droth@windsorgov.com

- Anderson did an analysis/report on this area last July (focus was on WCR-17 crossing)
- During reviews, Doug identified different routing from 2003 Windsor MDP
  - Potential overtopping at WCR-17
  - This triggered Dan's involvement to update Master Plan model
- Windsor needs WCR-17 concept crossing cost estimates by June/July
  - Wilson will have updated models in Mar/Apr
  - They are primarily interested in the upstream part of watershed
- New Windsor comprehensive plan coming out, Doug posted draft link: https://plan.konveio.com/draft-town-windsor-comprehensive-plan
- Aaron confirmed that Greeley is looking to update hydrology for the full Oklahoma Basin
  - CDOT should be involved in SH-257 discussion
- Which detention ponds should be modeled in hydrology/master plan?
  - Ben said their conservative practice was to only count regional or public-maintained facilities
  - Dan says Ft Collins followed FEMA requirements (ponds modeled as full)
  - Doug says maintenance agreements for developer ponds are required, should result in better conditions
- Matrix will send Oklahoma Basins 700 & 800 hydrology to Wilson

GO_BaselineHydrology_Report_Draft-Compiled Comments.pdf Markup Summary

stinesa (19)

Subject: Engineer
Page Label: 7
Author: stinesa
Date: 4/18/2024 11:41:44 AM
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Space:

State the latest version in parenthesis

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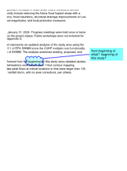
Page Label: 7
Author: ben_liu
Date: 6/14/2024 9:12:56 AM
Status:
Color:
Layer:
Space:

Revised



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from beginning of what? begnning of this study?

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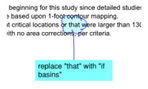
Removed this sentence



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replace "that" with "if basins"

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Author: ben_liu
Date: 6/14/2024 9:27:01 AM
Status:
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Revised

Subject: Engineer
Page Label: 7
Author: stinesa
Date: 4/22/2024 11:29:29 AM
Status:
Color:
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Why was 130 acres selected as threshold area?

Subject: Re: Engineer
Page Label: 7
Author: ben_liu
Date: 6/14/2024 9:27:22 AM
Status:
Color:
Layer:
Space:

Revised

Subject: Engineer
Page Label: 12
Author: stinesa
Date: 4/18/2024 1:19:03 PM
Status:
Color:
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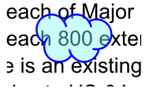
Revised



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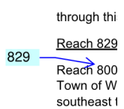
Revised



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829

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Revised

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Space:

Uptown

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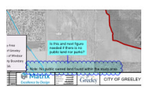
Revised



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Author: stinesa
Date: 4/18/2024 1:33:47 PM
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Space:

Is this and next figure needed if there is no public land nor parks?

Subject: Re: Engineer
Page Label: 16
Author: ben_liu
Date: 6/14/2024 9:30:55 AM
Status:
Color:
Layer:
Space:

This exhibit is still valuable to document the lack of such land

---

Subject: Engineer
Page Label: 17
Author: stinesa
Date: 4/19/2024 8:13:07 AM
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Color:
Layer:
Space:

This map seems unnecessary. The same exact map is produced earlier in the report. Consider removing.

Subject: Re: Engineer
Page Label: 17
Author: ben_liu
Date: 6/14/2024 9:31:05 AM
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Layer:
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This exhibit is still valuable to document the lack of such land

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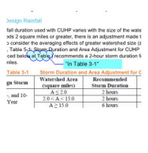

Subject: Engineer
Page Label: 18
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Date: 4/18/2024 1:37:04 PM
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"in Table 3-1"

Subject: Re: Engineer
Page Label: 18
Author: ben_liu
Date: 6/14/2024 9:32:17 AM
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Revised

Subject: Engineer
Page Label: 18
Author: stinesa
Date: 4/18/2024 1:41:15 PM
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"and"

Subject: Re: Engineer
Page Label: 18
Author: ben_liu
Date: 6/14/2024 9:32:37 AM
Status:
Color:
Layer:
Space:

Revised

Subject: Engineer
Page Label: 18
Author: stinesa
Date: 4/19/2024 8:13:26 AM
Status:
Color:
Layer:
Space:

Report starts with stating that the area is 1.32 sq. miles. This portion can be confusing and seems to suggest a correction factor is used. Recommend rewording this section to make what was done more clear.

Subject: Re: Engineer
Page Label: 18
Author: ben_liu
Date: 6/14/2024 9:33:17 AM
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Added additional sentence about not using correction factors.

Subject: Engineer
Page Label: 21
Author: stinesa
Date: 4/19/2024 8:14:22 AM
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Space:

This is confusing. Statement says the study used...,which were not available. consider rewording.

Subject: Re: Engineer
Page Label: 21
Author: ben_liu
Date: 6/14/2024 9:33:47 AM
Status:
Color:
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Space:

Revised

Subject: Engineer
Page Label: 31
Author: stinesa
Date: 4/22/2024 11:30:54 AM
Status:
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Space:

Legend for Interactive figures

Subject: Re: Engineer
Page Label: 31
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Date: 6/14/2024 9:34:37 AM
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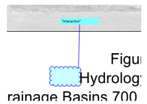
We believe this is already implied



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Date: 4/22/2024 11:30:33 AM
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"interactive"

Subject: Re: Engineer
Page Label: 31
Author: ben_liu
Date: 6/14/2024 9:36:33 AM
Status:
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Layer:
Space:

Revised

Subject: Engineer
Page Label: 62
Author: stinesa
Date: 4/19/2024 8:16:14 AM
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Color:
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Are either of these on the map? Also Freshwater Pond and Forested/Shrub... are very similar in color. Consider removing if not on the map and considering altering color to be distinct.

Subject: Re: Engineer
Page Label: 62
Author: ben_liu
Date: 6/14/2024 9:39:42 AM
Status:
Color:
Layer:
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Revised symbology

Subject: Engineer
Page Label: 63
Author: stinesa
Date: 4/19/2024 8:16:47 AM
Status:
Color:
Layer:
Space:

Shut in well is not indicated in legend.

Subject: Re: Engineer
Page Label: 63
Author: ben_liu
Date: 6/14/2024 9:40:20 AM
Status:
Color:
Layer:
Space:

Revised

July 8, 2024

VIA ELECTRONIC MAIL

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

RE: Alternative Selection – Oklahoma Master Plan Basins 700 & 800

Dear Mr. Ben Liu,

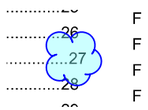
The City of Greeley Stormwater Division has concluded its review of the Alternatives Analysis Report for the Oklahoma Master Plan Basins 700 & 800. The City elects to adopt the recommended plan and selects Option 4: LID, Detention and Channel Improvements for each basin.

Sincerely,

Aaron Stines
Stormwater Engineer
Public Works Department, Stormwater Division
2835 W. 10th Street, Greeley, CO 80631
Aaron.Stines@Greeleygov.com

2024_06_18_GO_Alternatives Analysis_Report-ALS COMMENTS.pdf Markup Summary

Engineer (17)



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Page Label: 5
Author: sabastian.ortega
Date: 7/9/2024 1:46:49 PM
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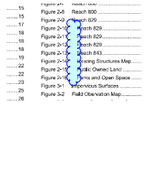
Revised



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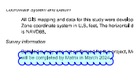
Revised



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Page Label: 8
Author: sabastian.ortega
Date: 7/9/2024 1:47:38 PM
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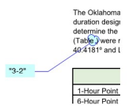
Changed to "Measurements of existing roadway crossings were completed by Matrix in March 2024."



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"3-2"

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Date: 7/9/2024 1:48:03 PM
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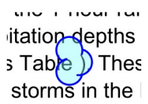
Revised



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Date: 7/9/2024 1:47:51 PM
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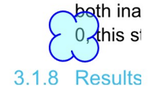
Revised



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Page Label: 23
Author: sabastian.ortega
Date: 7/8/2024 9:56:00 AM
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Color:
Layer:
Space:

Fixed

Subject: Engineer
Page Label: 26
Author: stinesa
Date: 7/3/2024 7:46:23 AM
Status:
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Space:

crossing leaders

Subject: Sticky Note
Page Label: 26
Author: sabastian.ortega
Date: 7/9/2024 1:48:50 PM
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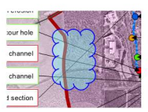
Revised



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Subject: Sticky Note
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Date: 7/9/2024 1:48:54 PM
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Revised

Subject: Engineer
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"Cottonwood"

Subject: Sticky Note
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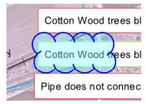
Revised



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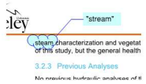
Revised



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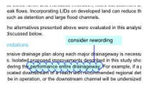
Revised



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consider rewording

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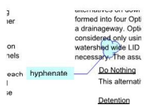
Revised



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hyphenate

Subject: Sticky Note
Page Label: 27
Author: sabastian.ortega
Date: 7/9/2024 1:49:35 PM
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Revised

Subject: Engineer
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Date: 7/3/2024 8:11:06 AM
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","

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Date: 7/9/2024 1:49:31 PM
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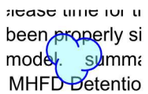
Revised



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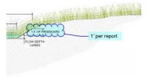
Revised



Subject: Engineer
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Author: stinesa
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1' per report

Subject: Sticky Note
Page Label: 30
Author: sabastian.ortega
Date: 7/9/2024 1:50:01 PM
Status:
Color:
Layer:
Space:

Changed to 1'

Subject: Engineer
Page Label: 96
Author: stinesa
Date: 7/5/2024 11:45:39 AM
Status:
Color:
Layer:
Space:

Provide title for each option selected

Subject: Sticky Note
Page Label: 96
Author: sabastian.ortega
Date: 7/9/2024 1:50:15 PM
Status:
Color:
Layer:
Space:

Revised

Comments from Mary Mateo

Alts Analysis, July 12, 2024
Greeley Comments: Black text
Matrix Responses: Blue text

Referencing Tables 3-14 and 3-15 below, MHFD Detention Workbooks are not included in Appendix E-2 for: D841 EURV 840 EURV 842. Also, there is a workbook for EURV 823, but this is not shown in the tables below.

Table 3-14 Option 2 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)
D711	700	712	6.5	90.0	1.6	172	129
D823	829	820/830/824/844	43	327.0	6.3	793	356
D841	843	842/850	25	210.6	12.2	647	41
D844	844	844	17	126.7	4.4	523	204

Table 3-15 Option 4 LID Detention Basin Summary

Detention Facility No.	Reach Location	Contributing Subbasins	Drainage Area (acre)	% Future Imperv.	EURV Ponds				Flood Control 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)
D_EURV_711	700	712	90.0	30.2%	2.40	0.60	170	155	6.5	1.3	155.2	110.8
D_EURV_820	829	820	81.0	69.80%	5.50	1.30	332	240	-	-	-	-
D_EURV_830	829	830	829.0	67.80%	5.60	1.50	293	193	-	-	-	-
D_EURV_840	843	840	63.0	76.5%	5.40	3.10	200	165	-	-	-	-
D_EURV_842	843	842/850	210.5	68.6%	14.30	9.50	646	328	2.4	0.6	328.3	284.0
D_EURV_844	N/A (Upstream of 843)	844	126.5	76.2%	9.40	2.30	523.28	382.80	-	-	-	-
D_FC_823	829	820/830/844/842/840	327.0	73.0%	-	-	-	-	20.0	5.0	474.7	261.0
D_FC_838	829	844	126.5	76.2%	-	-	-	-	17.3	3.3	524.4	292.0

Response:
EURV 823 was removed, and D841, EURV 840, and EURV 842 are now added to the Appendix.

How were the stage storage tables created for the proposed detention basins?

MHFD detention workbooks created stage storage tables by incorporating a sub-basin characteristic along with variables determined by Matrix. These variables were the same across every workbook, with the sub-basin characteristic being the only difference between them. With the exception of (Pre-existing) Detention Basin 823, conceptual detention basins assumed the minimum rectangular footprint with 4:1 Side slopes that would results in the required volume. This can be found in section 3.3.4 Alternatives Modeling, under option 2.

Discuss the placement of EURV Ponds with Flood Control Ponds and LID for Option 4?

EURV and flood control were placed upstream of any channels that had a velocity greater than 5 ft/s. This can be found in section 3.3.4 Alternatives Modeling, under option 4.

Why is the watershed length for Detention 711 different than that for EURV/Flood Control 711.

Thank you for catching this. This was fixed and replaced back into the report. This can be seen in Appendix E-2.

Per Section 3.3.4 Option 2 – Detention, “The design 100-year depth for the detention basins was six feet to avoid additional requirements associated with jurisdictional dams.” However, the MHFD Detention Workbooks for Option 2, Detention 823 and Option 4, Flood Control 823 show the 100-year volume at 10’ of depth. The areas indicated at stages 8.49’, 9.00’ and 10.00’ of the workbook for Option 2, Detention 823 are all identical, as are the areas indicated at stages 4.00’ through 10.00’ of the workbook for Option 4, Flood Control 823.

823 is an existing detention basin with a previously designed depth of 10 ft. We attempted to keep the concept geometry similar to the original design when possible. This has been written in the report, In section 3.3.4 Alternatives Modeling Option 2.

These measurements were taken from an older report of the area, with the measurements of the existing detention pond. In section 3.3.4 Alternatives Modeling Option 2.

Thank you for noticing Option 4 Flood Control 823 error. We have corrected the rating table to now match the other 823 geometries.

Tables 3-8 and 3-12 use different Manning’s n values for Reinforced Concrete Pipe. Should this be consistent in all applications?

It will be noted in the sections that the Mannings between the HY and SWMM are different. This can be found in section 3.2.1 Evaluation of Existing Facilities.

Section 3.1.7 Last bullet point references Section “0”

Done

Section 3.2.1

Last paragraph references culvert 807 then culvert 803. One of these appears to be a typo.

Next to last paragraph – typo – “possibility” should be possibly.

Done

Section 3.2.2 First paragraph – typo – “steam” characterization should be streaming characterization.

Done

Section 3.3.2 First paragraph – “the performance entire drainageway” should read “the performance of the entire drainageway.”

Done

Section 3.3.4

Option 2 – second paragraph – text missing from next to last sentence.

Option 3 – second paragraph – text missing from last sentence.

Done

On Page 38 of 188 – Heading is 3.3.1 Alternative Plans – should be 3.3.6? Also, reference to Figure 3-3 in this section appears to be incorrect.

Done

Figure 3-3 indicates 1.5’ of freeboard – report indicates 1’ (Sections 3.3.3 and 3.3.4 regarding Channel Improvements).

Done

Comments from BF

Concept Design Draft, July 29, 2024
Greeley Comments: Black text
Matrix Responses: Blue text

- Figure 2-14 is missing an image for design point 701

  The inclusion of Structure 701 in the imagery was not possible for several reasons. Firstly, the property owner did not permit the use of images of their land for Matrix. Second, the pipe is submerged in a private pond- although no size could be verified, we believe it is a small diameter pipe.

- Figure 2-15 and 2-16 seem unnecessary

  The Greeley Project, comprising three main reports, includes a comprehensive analysis of land use. The first report does have areas with public lands along with parks and open spaces. Although the second report covers an area lacking public lands and parks, it still includes maps depicting these features to offer a comprehensive overview of Greeley's land allocation. This approach ensures a complete picture of the city's landscape, highlighting both the presence and absence of public recreational spaces across different sectors

- Pg 18 (25/254) Table 3-10 and 3-11: Are there only 2 key locations (at the outfall)? Would any other points within the model be helpful to have in a table?

  To maintain consistency across drainageways, we initially designated a single key point for both Drainageway 700 and Drainageway 800, with the latter's key point being its outfall. However, upon further consideration, we have decided to add a second key location for Drainageway 800 at structure 809, us-34 upstream of the highway.

- Pg 19 (26/254) I am unclear why culvert 703 is not in the report. Sentence states it is at the end of a small embankment, but why is that reason to remove it from the report? Also what is meant by these two culverts are not in the report? Does that mean they were not modeled? Not accounted for?

  We will change confusing terminology -- 806 is a detention pond outlet pipe and should not be calculated as a culvert. 703 is a small-diameter pipe through a small, informal embankment. Based on our field observations, we believe 703 is intended to provide some positive drainage but it not a major crossing structure. It is possible that this embankment could be removed in the future if the drainageway is improved so we do not wish to include in the major crossing analysis.

- Table 3-13 seems unnecessary

  While Table 3-13 seem unnecessary since both drainageways covers all alternative options, we chose to keep it in the report to facilitate merging this 700 & 800 study into the larger Oklahoma report (that includes more variety).

- Pg 44 (51/254) Stormwater Detention Facility Guidelines references the old City criteria. All references within the master plan should be updated to reference the new criteria. Beyond the references the document should align with the latest criteria.

  Thank you for catching that, the wrong date was written, and all data in the report should be referencing the March 2024 updated report.

Comments from MM

Concept Design Draft, July 29, 2024
Greeley Comments: Black text
Matrix Responses: Blue text

Section 4.2 – 2nd paragraph – City “of” Greeley
This will be fixed in the final concept design.

End of page 39 and beginning of page 40 – text doesn’t flow.
This will be changed to “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.”

Page 41 – Permeable pavement – typo “though” should be “through”
Retention ponds/constructed wetland ponds - typo “though” should be “through”
Thank you for catching those spelling mistakes, that will be fixed in the final version.

End of page 43 and beginning of page 44 – text doesn’t flow.
This was rewritten as “ Figure 4 5 shows natural elements that can be incorporated into online detention basins (situated within the primary flow channel) to fulfill multiple purposes.” Can be found on page 43-44.

Page 44 – Stormwater Detention Facility Guidelines – 1st paragraph – reference current (2024) City of Greeley stormwater criteria.
we will get that fixed.

Page 45 – Channel Guidelines – 1st paragraph - reference current (2024) City of Greeley stormwater criteria.
we will get that fixed.

Page 46 – add period at end of sentence.
Thank you for catching that, we will get that fixed.

Section 4.2.4 3rd paragraph needs reworded.
This was reworded to “ Riprap is recommended near the outfall of 700 due to significant erosion and steep slopes that result in high water velocities. For the cost estimate, the riprap has been categorized as Type M soil riprap.” And can be found in Section 4.2.4 3rd paragraph

Section 4.2.5 3rd paragraph needs reworded.
This was reworded to “ Riprap is recommended near the entrance of the existing detention pond, due to significant erosion and steep slopes that result in high water velocities. For the cost estimate, the riprap has been categorized as Type M soil riprap..” And can be found in Section 4.2.5 3rd paragraph

Tables 4-6 and 4-7 Descriptions under Master Plan O&M Cost Summary are cut off.
The full description can be seen in Appendix F-7. The summaries on Section 4 had to be truncated to fit on a single page with the description.

2024-07-15 GO_Concept Design_Report_Draft-ALS Comments.pdf Markup Summary

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"improve on" or "improving"?

Subject: Sticky Note
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Date: 7/30/2024 3:28:59 PM
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Will remove "Improve of" and replace with improving.

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"Basin."

Subject: Sticky Note
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Change to Basin

Subject: Engineer
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Should this be "surface area of these ponds?" or "water surface area of these facilities?" Just trying to eliminate any confusion.

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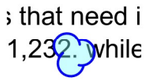
Will be changed to Ponds.



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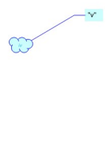
Revised



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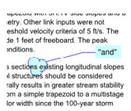

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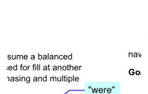

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Fix

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Consider revising this sentence

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fix

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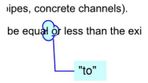

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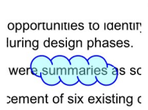

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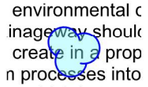

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Repeat of previous page

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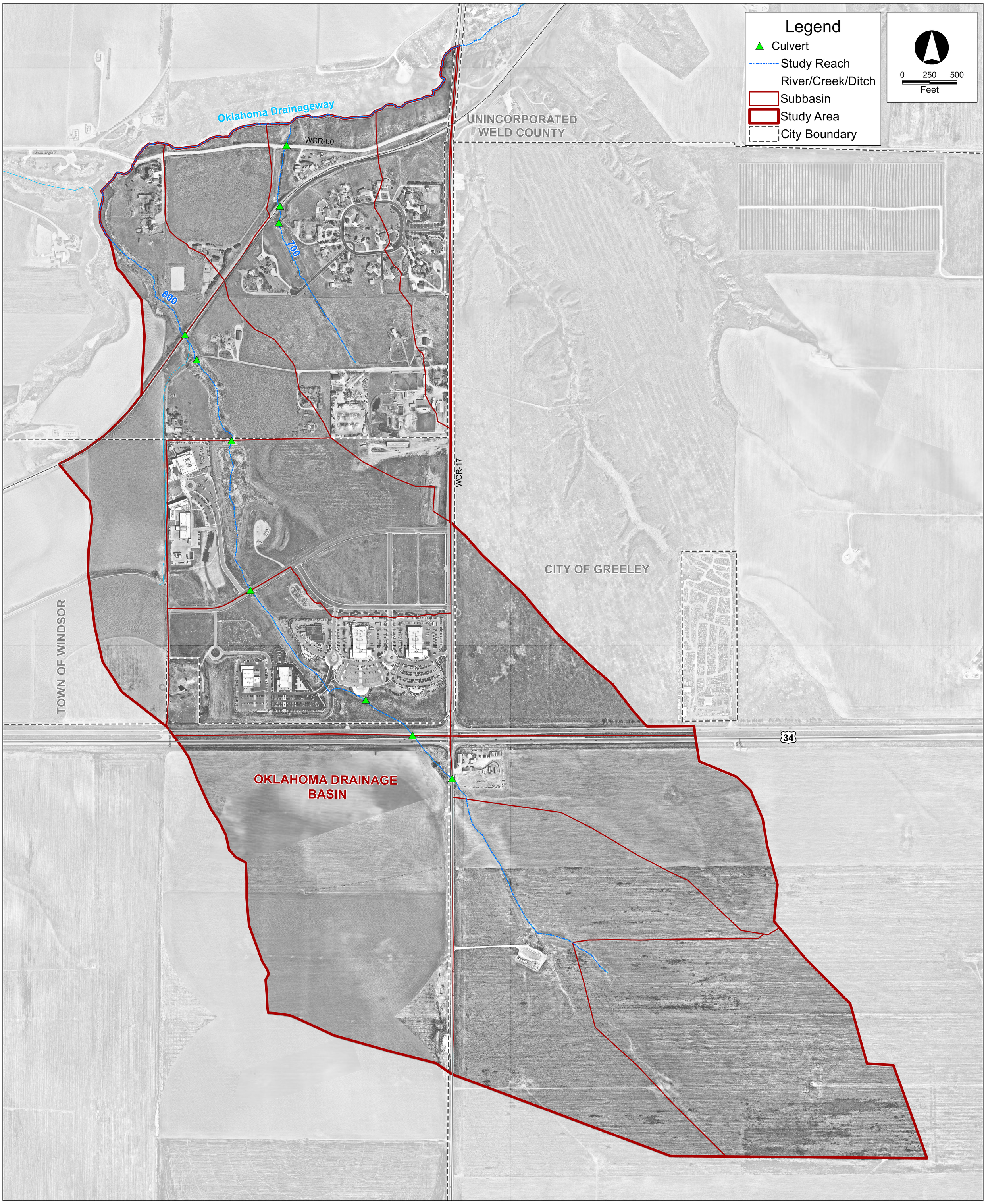
Appendix B – Hydrologic Analysis



Layer Control Instructions

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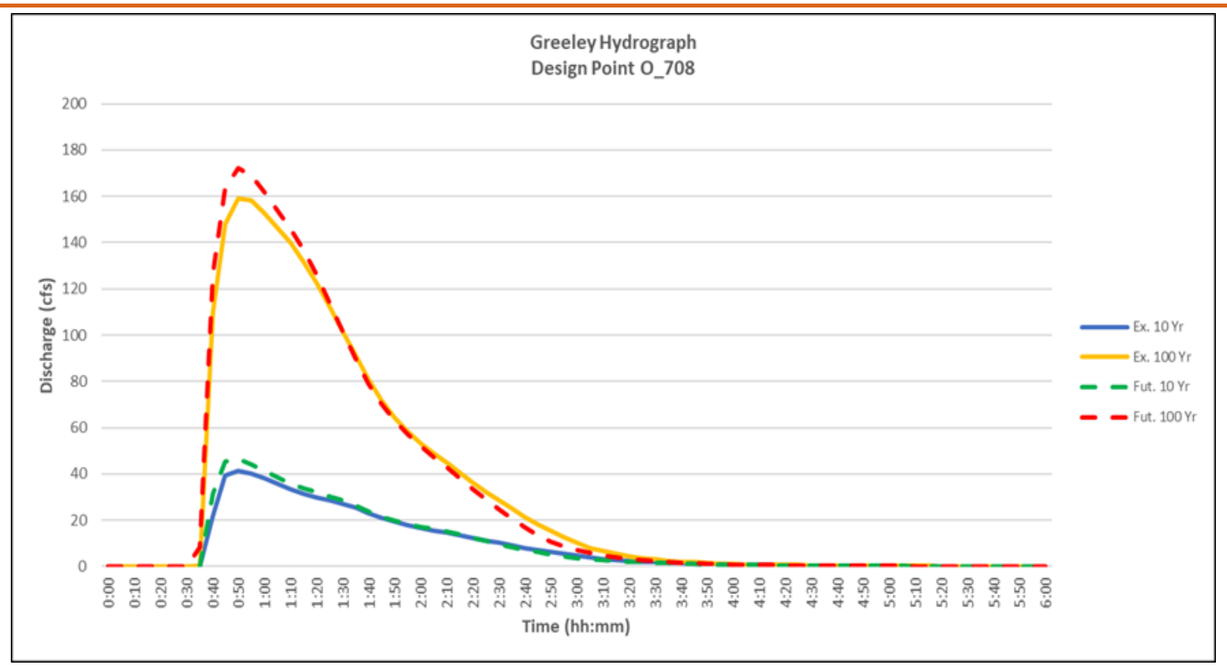
Interactive Figures (Select from Below)

Study Area Map
Existing Land Use Map
Future Land Use Map
Hydrologic Soils Groups
Existing Imperviousness Map
Future Imperviousness Map
Baseline Hydrology SWMM Routing Map

Figure B-1
Interactive Hydrology Map
Oklahoma Drainage Basins 700 & 800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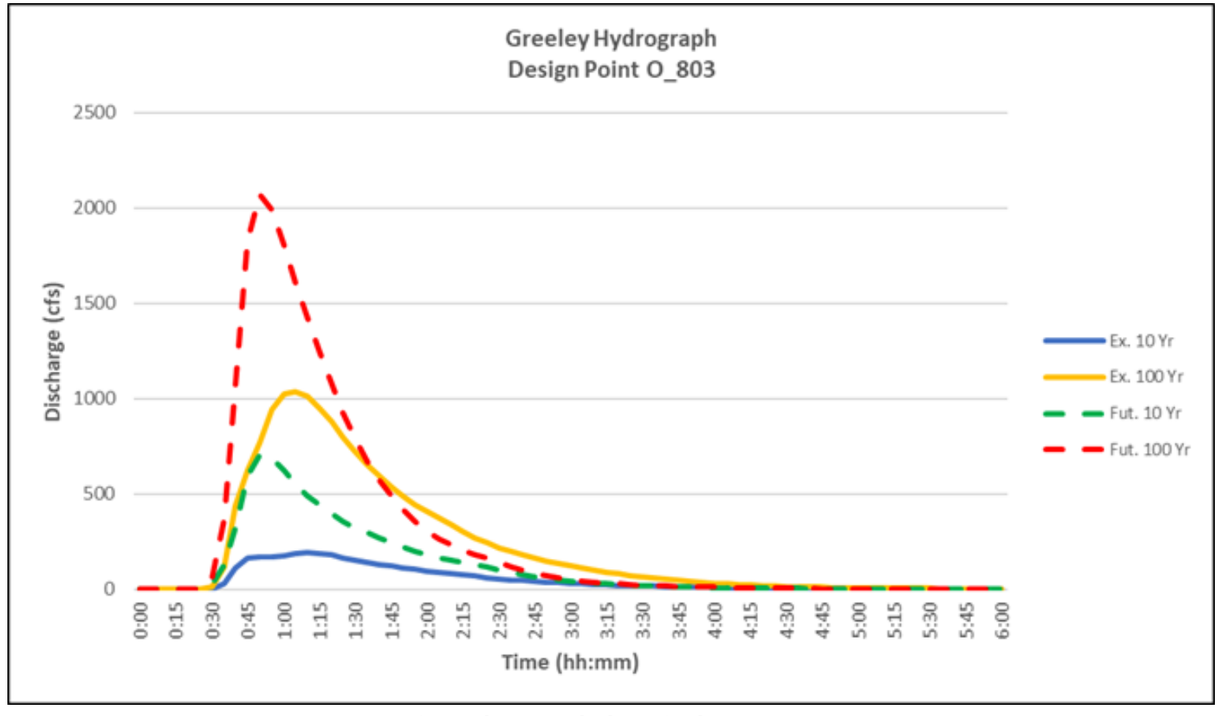
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5:45
6:00
Time (hh:mm)
Ex. 10 Yr
Ex. 100 Yr
Fut. 10 Yr
Fut. 100 Yr

Return Period	2-Year
1Hr Depth	0.84
6Hr Depth	1.28
Area Adjust	0 Sq. Mi.
Time	Depth
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0:10	0.03
0:15	0.07
0:20	0.13
0:25	0.21
0:30	0.11
0:35	0.05
0:40	0.04
0:45	0.03
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1:20	0.02
1:25	0.02
1:30	0.02
1:35	0.02
1:40	0.01
1:45	0.01
1:50	0.01
1:55	0.01
2:00	0.01
2:05	0.00
Total Depth (in)	0.97

Return Period	5-Year
1Hr Depth	1.12
6Hr Depth	1.67
Area Adjust	0 Sq. Mi.
Time	Depth
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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
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6Hr Depth	2.08
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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
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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
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0:15	0.09
0:20	0.15
0:25	0.28
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0:35	0.22
0:40	0.15
0:45	0.09
0:50	0.09
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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	2.31
6Hr Depth	3.41
Area Adjust	0 Sq. Mi.
Time	Depth
0:05	0.03
0:10	0.08
0:15	0.12
0:20	0.18
0:25	0.35
0:30	0.58
0:35	0.28
0:40	0.18
0:45	0.12
0:50	0.12
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)	2.67

Return Period	100-Year
1Hr Depth	2.8
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

"R:\23.1447.001 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\222 Reports\2 Alternatives Analysis\Tables\GO_Alternatives_Tables.xlsx"

								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.
620	620	GREELEY	0.053	0.272	0.598	0.008	23.4	0.35	0.10	3.00	0.50	0.0018	0.00	0.47	0.14	22.29
712	712	GREELEY	0.140	0.346	0.764	0.033	27.3	0.35	0.10	3.00	0.50	0.0018	0.00	0.55	0.16	26.15
714	714	GREELEY	0.035	0.091	0.212	0.030	5.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.10	0.05	4.57
804	804	GREELEY	0.040	0.085	0.381	0.018	10.0	0.35	0.10	5.00	1.00	0.0007	0.00	0.20	0.10	8.06
810	810	GREELEY	0.115	0.242	0.599	0.011	4.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.09	0.05	4.26
820	820	GREELEY	0.127	0.170	0.537	0.021	52.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.86	0.24	51.19
824	824	GREELEY	0.068	0.192	0.421	0.017	13.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.27	0.11	12.63
830	830	GREELEY	0.111	0.121	0.541	0.019	50.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.85	0.23	49.78
840	840	GREELEY	0.100	0.339	0.674	0.023	8.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.16	0.08	7.34
842	842	GREELEY	0.173	0.312	0.834	0.016	2.6	0.35	0.10	3.00	0.50	0.0018	0.00	0.05	0.03	2.37
844	844	GREELEY	0.198	0.278	0.542	0.016	6.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.13	0.07	6.11
850	850	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

		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)
620		0.108	0.097	70.0	6.69	36.4	4.73	11.2	23	122,352	2.06	252,584	60.0	37	252,646	1.10
712		0.103	0.155	37.4	5.95	19.5	4.20	9.9	112	325,181	2.11	686,125	45.0	161	685,320	1.79
714		0.146	0.098	24.4	3.33	12.7	2.35	5.6	44	82,342	1.85	152,497	40.0	50	151,408	2.19
804		0.133	0.095	33.1	3.92	17.2	2.77	6.5	36	92,961	0.87	80,657	40.0	25	80,377	0.99
810		0.147	0.167	48.6	7.74	25.3	5.47	12.9	71	267,236	1.85	493,919	50.0	101	493,780	1.37
820		0.088	0.218	15.1	4.02	7.8	2.84	6.7	253	295,500	2.40	710,118	35.0	292	707,269	3.59
824		0.121	0.113	39.9	4.95	20.7	3.50	8.3	51	157,588	1.95	307,167	45.0	70	306,460	1.62
830		0.088	0.202	14.4	3.73	7.5	2.63	6.2	231	256,828	2.39	612,914	35.0	259	607,571	3.66
840		0.136	0.146	53.1	7.44	27.6	5.26	12.4	56	231,423	1.89	436,328	50.0	82	436,099	1.29
842		0.154	0.210	48.6	9.34	25.3	6.60	15.6	107	402,357	1.83	734,488	50.0	152	733,957	1.37
844		0.140	0.201	35.7	7.00	18.6	4.94	11.7	167	460,600	1.87	861,565	45.0	221	860,656	1.74
850		0.156	0.203	41.6	7.99	21.6	5.64	13.3	113	362,833	1.65	597,107	50.0	142	596,571	1.42

								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.
620	620	GREELEY	0.053	0.272	0.598	0.008	23.5	0.35	0.10	3.00	0.50	0.0018	0.00	0.47	0.14	22.34
712	712	GREELEY	0.140	0.346	0.764	0.033	30.2	0.35	0.10	3.00	0.50	0.0018	0.00	0.60	0.17	29.00
714	714	GREELEY	0.035	0.091	0.212	0.030	12.5	0.35	0.10	3.00	0.50	0.0018	0.00	0.25	0.11	11.63
804	804	GREELEY	0.040	0.085	0.381	0.018	10.0	0.35	0.10	5.00	1.00	0.0007	0.00	0.20	0.10	8.08
810	810	GREELEY	0.115	0.242	0.599	0.011	48.1	0.35	0.10	3.00	0.50	0.0018	0.00	0.84	0.22	47.23
820	820	GREELEY	0.127	0.170	0.537	0.021	69.8	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.30	69.13
824	824	GREELEY	0.068	0.192	0.421	0.017	78.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.32	77.40
830	830	GREELEY	0.111	0.121	0.541	0.019	67.8	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.29	67.16
840	840	GREELEY	0.100	0.339	0.674	0.023	76.5	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	75.96
842	842	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	67.93
844	844	GREELEY	0.198	0.278	0.542	0.016	76.2	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	75.62
850	850	GREELEY	0.156	0.361	0.569	0.023	60.1	0.35	0.10	4.50	0.60	0.0018	0.00	0.90	0.27	59.16

		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)
620		0.107	0.097	70.0	6.69	36.4	4.73	11.1	23	122,352	2.07	252,663	60.0	37	252,726	1.10
712		0.100	0.165	34.2	5.83	17.8	4.12	9.7	123	325,181	2.14	696,996	45.0	173	696,646	1.93
714		0.123	0.085	23.7	3.04	12.3	2.15	5.1	45	82,342	1.94	159,503	40.0	51	157,367	2.27
804		0.133	0.095	33.1	3.92	17.2	2.77	6.5	36	92,961	0.87	80,701	40.0	25	80,421	0.99
810		0.090	0.200	24.7	5.29	12.8	3.74	8.8	140	267,236	2.36	629,730	40.0	190	628,295	2.58
820		0.080	0.244	12.3	3.81	6.4	2.69	6.4	310	295,500	2.62	772,751	35.0	331	753,342	4.07
824		0.078	0.190	15.2	3.71	7.9	2.62	6.2	134	157,588	2.71	427,581	35.0	165	425,111	3.80
830		0.081	0.227	11.7	3.54	6.1	2.50	5.9	283	256,828	2.59	665,619	35.0	294	649,995	4.15
840		0.078	0.224	19.9	4.92	10.3	3.48	8.2	150	231,423	2.70	623,972	40.0	200	618,994	3.13
842		0.081	0.279	19.2	5.61	10.0	3.96	9.3	271	402,357	2.60	1,046,455	40.0	353	1,041,854	3.19
844		0.078	0.299	13.3	4.57	6.9	3.23	7.6	446	460,600	2.69	1,240,016	35.0	523	1,235,897	4.13
850		0.084	0.254	17.9	4.99	9.3	3.53	8.3	262	362,833	2.42	878,086	35.0	316	873,638	3.16

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}
620	Basin	34	3	5	9	19	27	37	3	5	9	19	27	37
712	Basin	90	13	25	42	86	119	161	16	29	47	93	129	173
714	Basin	23	1	4	10	25	36	50	2	6	12	27	38	52
803	Junction	670	63	108	192	494	722	1,039	348	515	709	1,203	1,591	2,072
804	Basin	26	0	1	2	5	14	25	0	1	2	5	14	25
809	Junction	596	66	112	192	491	716	1,024	353	520	714	1,206	1,586	2,058
810	Basin	74	1	8	19	50	72	101	28	43	63	110	146	190
819	Junction	515	67	108	178	448	651	929	337	490	669	1,113	1,460	1,887
820	Basin	81	47	72	103	170	226	292	70	100	133	201	259	331
824	Basin	43	3	8	16	36	51	70	38	53	69	102	130	165
829	Junction	444	40	63	130	345	500	711	284	407	550	900	1,176	1,511
830	Basin	71	40	63	91	150	199	259	61	87	117	177	228	294
839	Junction	253	3	18	59	176	262	372	158	228	309	506	661	846
840	Basin	64	2	7	17	41	59	82	44	63	82	124	160	200
841	Junction	142	1	11	43	136	203	290	117	169	232	385	505	649
842	Basin	111	1	10	28	74	108	152	71	102	137	215	277	353
843	Junction	317	7	34	96	275	407	578	252	362	485	782	1,018	1,300
844	Basin	127	5	19	45	111	160	221	118	166	218	325	415	523
850	Basin	100	1	2	18	65	99	142	56	80	112	186	247	316
O_620	Outfall	34	3	5	9	19	27	37	3	5	9	19	27	37
O_712	Outfall	90	13	24	42	85	118	160	15	28	47	93	128	172
O_714	Outfall	23	1	4	10	25	36	50	2	6	12	27	38	52
O_803	Outfall	696	63	108	192	494	722	1,039	348	515	709	1,203	1,591	2,072

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}
620	Basin	34	0	0	0	1	1	2	0	0	0	1	1	2
712	Basin	90	0	1	1	3	4	5	1	1	1	3	4	5
714	Basin	23	0	0	0	1	1	1	0	0	0	1	1	1
803	Junction	670	2	4	8	18	26	36	10	14	19	29	37	48
804	Basin	26	0	0	0	0	0	1	0	0	0	0	0	1
809	Junction	596	2	4	8	18	26	36	10	14	19	29	37	47
810	Basin	74	0	0	1	2	3	4	1	1	2	3	4	5
819	Junction	515	2	4	7	16	23	32	9	13	18	26	33	42
820	Basin	81	1	1	2	3	4	5	1	2	2	3	4	6
824	Basin	43	0	0	0	1	2	2	1	1	1	2	3	3
829	Junction	444	1	2	5	12	17	24	7	10	14	20	26	33
830	Basin	71	1	1	2	3	3	5	1	1	2	3	4	5
839	Junction	253	0	1	2	6	9	13	4	6	8	12	15	19
840	Basin	64	0	0	1	2	2	3	1	2	2	3	4	5
841	Junction	142	0	0	1	4	7	10	3	4	6	9	11	14
842	Basin	111	0	0	1	2	4	5	2	2	3	5	6	8
843	Junction	317	0	1	3	9	14	20	6	9	12	17	22	28
844	Basin	127	0	0	1	3	4	6	2	3	4	6	7	9
850	Basin	100	0	0	0	2	3	4	1	2	2	4	5	7
O_620	Outfall	34	0	0	0	1	1	2	0	0	0	1	1	2
O_712	Outfall	90	0	1	1	3	4	5	1	1	2	3	4	5
O_714	Outfall	23	0	0	0	1	1	1	0	0	0	1	1	1
O_803	Outfall	696	2	4	8	18	26	36	10	14	19	29	37	48

```
[TITLE]
;;Project Title/Notes
City of Greeley
Storm Drainage Master Plan
Oklahoma Baseline Alternatives
Additional Basins 700-800
Matrix Design Group, Inc. 2024
Scenario ID = Fut_100yr_GO_Do_Nothing

[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:\23.1447.001 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221
Models\CUHP_SWMM\CUHP\7_Ex_100yr_0mi^2_Greeley_7.8.txt"

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

```
[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
620              4920       10         0          0          0
712              4915       10         0          0          0
714              4864       10         0          0          0
803              4866       10         0          0          0
804              4882       10         0          0          0
809              4890       25         0          0          0
810              4925       10         0          0          0
819              4901       10         0          0          0
820              4945       10         0          0          0
824              4961       10         0          0          0
829              4918       15         0          0          0
830              4972       10         0          0          0
839              4965       15         0          0          0
840              4990       10         0          0          0
841              4967       10         0          0          0
842              5000       10         0          0          0
843              4959       15         0          0          0
844              4995       10         0          0          0
850              4990       10         0          0          0
711              4889       10         0          0          0
710              4871       10         0          0          0
709              4866       10         0          0          0
708              4851       10         0          0          0
713              4898       10         0          0          0
811              4893       10         0          0          0
822              4932       10         0          0          0
823              4908       10         0          0          0
834              4932       15         0          0          0
838              4949       15         0          0          0
831              4928.5     15         0          0          0
808              4885       0          0          0          0

[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
O_803            4865       FREE                        NO
O_708            4828       FREE                        NO
O_620            4817       FREE                        NO
O_714            4838       FREE                        NO

[DIVIDERS]
;;Name           Elevation  Diverted Link    Type       Parameters
;;-------------- ---------- ---------------- ---------- ----------
836              4945       OV_836           OVERFLOW   15         0          0          0

[CONDUITS]
;;Name           From Node        To Node          Length     Roughness  InOffset   OutOffset  InitFlow   MaxFlow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- ----------
DL_620           620              O_620            400        0.01       0          0          0          0
DL_714           714              O_714            400        0.01       0          0          0          0
DL_803           803              O_803            400        0.01       0          0          0          0
DL_804           804              803              400        0.01       0          0          0          0
DL_810           810              809              400        0.01       0          0          0          0
```

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DL_820          820             819             400         0.01        0           0           0           0
DL_830          830             829             400         0.01        0           0           0           0
DL_840          840             839             400         0.01        0           0           0           0
DL_842          842             841             400         0.01        0           0           0           0
DL_844          844             843             400         0.01        0           0           0           0
L_808           808             803             1197        0.07        0           0           0           0
L_823           823             819             943         0.04        0           0           0           0
L_839           839             843             541         0.048       0           0           0           0
L_841           841             839             190         .044        0           0           0           0
L_850           850             841             1740        0.044       0           0           0           0
L_708           708             O_708           202         0.035       0           0           0           0
L_709           709             708             560.2       0.03        0           0           0           0
L_710           710             709             154.3       0.04        0           0           0           0
L_711           711             710             615.3       0.04        0           0           0           0
L_713           713             711             338.1       0.07        0           0           0           0
L_712           712             713             485.4       .04         0           0           0           0
L_838           838             836             314.88      0.048       0           0           0           0
L_811           811             809             183         0.045       0           0           0           0
L_843           843             838             304         0.035       0           0           0           0
L_819           819             811             761         0.07        0           0           0           0
L_824           824             822             1270        0.035       0           0           0           0
L_822           822             819             671         0.04        0           0           0           0
L_829           829             823             290         0.035       0           0           0           0
L_836           836             834             442         0.013       0           0           0           0
OV_836          836             834             442         .035        0           0           0           0
L_831           831             829             105         0.04        0           0           0           0
L_834           834             831             1040        0.04        0           0           0           0
L_809           809             808             90          0.013       0           0           0           0

[XSECTIONS]
;;Link           Shape           Geom1           Geom2       Geom3       Geom4       Barrels     Culvert
;;-------------- ------------ ---------------- ---------- ---------- ---------- ---------- ----------
DL_620          DUMMY           0               0           0           0           1
DL_714          DUMMY           0               0           0           0           1
DL_803          DUMMY           0               0           0           0           1
DL_804          DUMMY           0               0           0           0           1
DL_810          DUMMY           0               0           0           0           1
DL_820          DUMMY           0               0           0           0           1
DL_830          DUMMY           0               0           0           0           1
DL_840          DUMMY           0               0           0           0           1
DL_842          DUMMY           0               0           0           0           1
DL_844          DUMMY           0               0           0           0           1
L_808           TRAPEZOIDAL     10              65          3           3           1
L_823           TRAPEZOIDAL     10              235         5           5           1
L_839           TRAPEZOIDAL     15              100         27          10          1
L_841           TRIANGULAR      10              200         0           0           1
L_850           TRAPEZOIDAL     10              20          12          12          1
L_708           TRAPEZOIDAL     10              22          2           2           1
L_709           TRAPEZOIDAL     10              50          4           4           1
L_710           TRAPEZOIDAL     10              70          2           2           1
L_711           TRAPEZOIDAL     10              73          4           4           1
L_713           TRAPEZOIDAL     10              55          10          10          1
L_712           TRAPEZOIDAL     10              106         15          15          1
L_838           TRAPEZOIDAL     15              24          15          15          1
L_811           TRAPEZOIDAL     10              107         6           6           1
L_843           CIRCULAR        15              0           0           0           1
L_819           TRAPEZOIDAL     10              115         3           3           1
L_824           TRAPEZOIDAL     10              657         30          30          1
L_822           TRAPEZOIDAL     10              235         5           5           1
L_829           TRAPEZOIDAL     10              75          3.5         6.5         1
L_836           CIRCULAR        4               0           0           0           1
OV_836          TRAPEZOIDAL     15              40          15          15          1
L_831           TRAPEZOIDAL     15              65          6           6           1
L_834           TRAPEZOIDAL     15              64          6           6           1
L_809           RECT_CLOSED     15              5           0           0           1

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

[TAGS]

[MAP]
DIMENSIONS 0.000 0.000 8882.267 8132.154
Units      None

[COORDINATES]
;;Node           X-Coord         Y-Coord
;;-------------- ---------------- ----------------
620             3176.446        5603.079
712             2895.562        4845.602
714             2396.597        5524.935
803             2046.787        5306.170
804             2224.496        5288.834
809             2304.222        4931.686
810             2221.307        4534.501
819             2458.581        4607.362
820             2858.872        4455.858
824             3212.781        4053.026
829             2531.995        4090.155
830             2310.615        3639.827
839             3222.537        3474.569
840             4296.625        2946.685
841             3225.328        3393.633
842             4116.415        2195.542
843             3098.576        3589.753
844             3175.492        2589.454
850             3628.528        2902.994
711             2728.325        5128.419
710             2635.627        5340.281
709             2645.107        5386.630
708             2650.374        5598.361
713             2796.803        5016.287
811             2326.424        4882.578
822             2779.481        4253.460
823             2482.561        4170.492
834             2793.200        3771.985
838             3041.708        3648.672
831             2539.570        4080.449
808             2290.503        4963.697
```

```
O_803            2037.522          5457.441
O_708            2644.492          5672.936
O_620            3155.399          5761.408
O_714            2402.976          5620.622
836              2952.697          3687.647

[VERTICES]
;;Link           X-Coord           Y-Coord
;;-------------- ----------------- -----------------
DL_803           2026.861          5357.978
DL_803           2038.817          5412.975
DL_810           2232.974          4619.614
DL_810           2245.732          4810.989
DL_830           2525.911          4040.117
DL_840           4169.043          3071.079
DL_840           4092.493          3157.197
DL_840           3953.747          3410.768
DL_840           3583.757          3433.095
DL_840           3315.833          3429.905
DL_842           3580.567          2554.368
DL_842           3454.075          2733.989
DL_842           3356.793          2914.200
DL_842           3278.649          3199.666
DL_844           3186.655          2742.553
DL_844           3202.603          2914.790
DL_844           3193.034          3211.420
DL_844           3164.328          3249.694
DL_844           3183.466          3396.415
L_808            2265.576          5028.444
L_808            2246.438          5036.418
L_808            2206.569          5066.719
L_808            2203.379          5100.210
L_808            2190.621          5159.217
L_808            2137.993          5194.302
L_808            2080.325          5208.102
L_808            2060.399          5283.821
L_823            2485.244          4167.900
L_823            2482.053          4247.674
L_823            2482.053          4378.503
L_850            3608.479          2914.796
L_850            3593.723          2919.982
L_850            3576.180          2921.577
L_850            3539.500          2931.146
L_850            3506.010          2942.309
L_850            3486.872          2971.016
L_850            3467.735          2998.127
L_850            3439.029          3045.970
L_850            3419.891          3090.624
L_850            3389.590          3162.390
L_850            3365.669          3202.259
L_850            3341.747          3250.103
L_850            3308.256          3289.973
L_850            3271.576          3334.626
OV_836           2870.006          3747.691

[Polygons]

[BACKDROP]
FILE       "R:\23.1447.001 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221 Models\CUHP_SWMM\SWMM\Backgrounds\Final
Map.jpg"
DIMENSIONS 735.737 1837.108 8882.267 8132.154

"R:\23.1447.001 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221
Models\CUHP_SWMM\SWMM\Alternatives\Fut_100yr_GO_Do_Nothing.inp"
```

City of Greeley
Storm Drainage Master Plan
Oklahoma Baseline Alternatives

****
Element Count
****
Number of rain gages 0
Number of subcatchments ... 0
Number of nodes 36
Number of links 33
Number of pollutants 0
Number of land uses 0

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
620	JUNCTION	4920.00	10.00	0.0	
712	JUNCTION	4915.00	10.00	0.0	
714	JUNCTION	4864.00	10.00	0.0	
803	JUNCTION	4866.00	10.00	0.0	
804	JUNCTION	4882.00	10.00	0.0	
809	JUNCTION	4890.00	25.00	0.0	
810	JUNCTION	4925.00	10.00	0.0	
819	JUNCTION	4901.00	10.00	0.0	
820	JUNCTION	4945.00	10.00	0.0	
824	JUNCTION	4961.00	10.00	0.0	
829	JUNCTION	4918.00	15.00	0.0	
830	JUNCTION	4972.00	10.00	0.0	
839	JUNCTION	4965.00	15.00	0.0	
840	JUNCTION	4990.00	10.00	0.0	
841	JUNCTION	4967.00	10.00	0.0	
842	JUNCTION	5000.00	10.00	0.0	
843	JUNCTION	4959.00	15.00	0.0	
844	JUNCTION	4995.00	10.00	0.0	
850	JUNCTION	4990.00	10.00	0.0	
711	JUNCTION	4889.00	10.00	0.0	
710	JUNCTION	4871.00	10.00	0.0	
709	JUNCTION	4866.00	10.00	0.0	
708	JUNCTION	4851.00	10.00	0.0	
713	JUNCTION	4898.00	10.00	0.0	
811	JUNCTION	4893.00	10.00	0.0	
822	JUNCTION	4932.00	10.00	0.0	
823	JUNCTION	4908.00	10.00	0.0	
834	JUNCTION	4932.00	15.00	0.0	
838	JUNCTION	4949.00	15.00	0.0	
831	JUNCTION	4928.50	15.00	0.0	
808	JUNCTION	4885.00	15.00	0.0	
O_803	OUTFALL	4865.00	0.00	0.0	
O_708	OUTFALL	4828.00	10.00	0.0	
O_620	OUTFALL	4817.00	0.00	0.0	
O_714	OUTFALL	4838.00	0.00	0.0	
836	DIVIDER	4945.00	15.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
DL_620	620	O_620	CONDUIT	400.0	26.6486	0.0100
DL_714	714	O_714	CONDUIT	400.0	6.5138	0.0100
DL_803	803	O_803	CONDUIT	400.0	0.2500	0.0100
DL_804	804	803	CONDUIT	400.0	4.0032	0.0100
DL_810	810	809	CONDUIT	400.0	8.7837	0.0100
DL_820	820	819	CONDUIT	400.0	11.0672	0.0100
DL_830	830	829	CONDUIT	400.0	13.6247	0.0100
DL_840	840	839	CONDUIT	400.0	6.2622	0.0100
DL_842	842	841	CONDUIT	400.0	8.2782	0.0100
DL_844	844	843	CONDUIT	400.0	9.0367	0.0100
L_808	808	803	CONDUIT	1197.0	1.5875	0.0700
L_823	823	819	CONDUIT	943.0	0.7423	0.0400
L_839	839	843	CONDUIT	541.0	1.1091	0.0480
L_841	841	839	CONDUIT	190.0	1.0527	0.0440
L_850	850	841	CONDUIT	1740.0	1.3220	0.0440
L_708	708	O_708	CONDUIT	202.0	11.4607	0.0350
L_709	709	708	CONDUIT	560.2	2.6786	0.0300
L_710	710	709	CONDUIT	154.3	3.2421	0.0400
L_711	711	710	CONDUIT	615.3	2.9267	0.0400
L_713	713	711	CONDUIT	338.1	2.6629	0.0700
L_712	712	713	CONDUIT	485.4	3.5044	0.0400
L_838	838	836	CONDUIT	314.9	1.2704	0.0480
L_811	811	809	CONDUIT	183.0	1.6396	0.0450
L_843	843	838	CONDUIT	304.0	3.2913	0.0350
L_819	819	811	CONDUIT	761.0	1.0513	0.0700
L_824	824	822	CONDUIT	1270.0	2.2841	0.0350
L_822	822	819	CONDUIT	671.0	4.6249	0.0400
L_829	829	823	CONDUIT	290.0	3.4503	0.0350
L_836	836	834	CONDUIT	442.0	2.9424	0.0130
OV_836	836	834	CONDUIT	442.0	2.9424	0.0350
L_831	831	829	CONDUIT	105.0	10.0504	0.0400
L_834	834	831	CONDUIT	1040.0	0.3365	0.0400
L_809	809	808	CONDUIT	90.0	5.5641	0.0130

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
DL_620	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_714	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_803	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_804	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_820	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_830	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_840	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_842	DUMMY	0.00	0.00	0.00	0.00	1	0.00

DL_844	DUMMY	0.00	0.00	0.00	0.00	1	0.00
L_808	TRAPEZOIDAL	10.00	950.00	7.41	125.00	1	9655.82
L_823	TRAPEZOIDAL	10.00	2850.00	8.46	335.00	1	37867.18
L_839	TRAPEZOIDAL	15.00	5662.50	8.63	655.00	1	77684.49
L_841	TRIANGULAR	10.00	1000.00	4.98	200.00	1	10098.48
L_850	TRAPEZOIDAL	10.00	1400.00	5.37	260.00	1	16665.33
L_708	TRAPEZOIDAL	10.00	420.00	6.29	62.00	1	20580.76
L_709	TRAPEZOIDAL	10.00	900.00	6.79	130.00	1	26173.35
L_710	TRAPEZOIDAL	10.00	900.00	7.85	110.00	1	23769.29
L_711	TRAPEZOIDAL	10.00	1130.00	7.27	153.00	1	26947.94
L_713	TRAPEZOIDAL	10.00	1550.00	6.05	255.00	1	17837.15
L_712	TRAPEZOIDAL	10.00	2560.00	6.30	406.00	1	60698.05
L_838	TRAPEZOIDAL	15.00	3735.00	7.86	474.00	1	51535.74
L_811	TRAPEZOIDAL	10.00	1670.00	7.30	227.00	1	26581.36
L_843	CIRCULAR	15.00	176.71	3.75	15.00	1	3285.42
L_819	TRAPEZOIDAL	10.00	1450.00	8.13	175.00	1	12765.94
L_824	TRAPEZOIDAL	10.00	9570.00	7.61	1257.00	1	237606.05
L_822	TRAPEZOIDAL	10.00	2850.00	8.46	335.00	1	94518.19
L_829	TRAPEZOIDAL	10.00	1250.00	7.06	175.00	1	36264.24
L_836	CIRCULAR	4.00	12.57	1.00	4.00	1	246.40
OV_836	TRAPEZOIDAL	15.00	3975.00	8.10	490.00	1	116720.41
L_831	TRAPEZOIDAL	15.00	2325.00	9.39	245.00	1	121915.29
L_834	TRAPEZOIDAL	15.00	2310.00	9.37	244.00	1	22129.56
L_809	RECT_CLOSED	15.00	75.00	1.88	5.00	1	3074.94

****
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	135.719	44.226
External Outflow	136.848	44.594
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	0.021	0.007
Continuity Error (%)	-0.847	

****
Highest Flow Instability Indexes
****
Link L_829 (1)
Link L_831 (1)
Link L_819 (1)
Link L_823 (1)
Link L_834 (1)

****
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: Thu Jun 13 09:57:02 2024
Analysis ended on: Thu Jun 13 09:57:02 2024
Total elapsed time: < 1 sec

"R:\23.1447.001 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221 Models\CUHP_SWMM\SWMM\Alternatives\Fut_100yr_GO_Do_Nothing.inp"

```
[TITLE]
;;Project Title/Notes
City of Greeley
Storm Drainage Master Plan
Oklahoma Baseline Alternatives
Additional Basins 700-800
Matrix Design Group, Inc. 2024
Scenario ID = Fut_100yr_GO_Do_Nothing

[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:\23.1447.001 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221
Models\CUHP_SWMM\CUHP\15_Fut_100yr_0mi^2_Greeley_7.8.txt"

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

[JUNCTIONS]

;;Name	Elevation	MaxDepth	InitDepth	SurDepth	Aponded
620	4920	10	0	0	0
712	4915	10	0	0	0
714	4864	10	0	0	0
803	4866	10	0	0	0
804	4882	10	0	0	0
809	4890	25	0	0	0
810	4925	10	0	0	0
819	4901	10	0	0	0
820	4945	10	0	0	0
824	4961	10	0	0	0
829	4918	15	0	0	0
830	4972	10	0	0	0
839	4965	15	0	0	0
840	4990	10	0	0	0
841	4967	10	0	0	0
842	5000	10	0	0	0
843	4959	15	0	0	0
844	4995	10	0	0	0
850	4990	10	0	0	0
711	4889	10	0	0	0
710	4871	10	0	0	0
709	4866	10	0	0	0
708	4851	10	0	0	0
713	4898	10	0	0	0
811	4893	10	0	0	0
822	4932	10	0	0	0
823	4908	10	0	0	0
834	4932	15	0	0	0
838	4949	15	0	0	0
831	4928.5	15	0	0	0
808	4885	0	0	0	0

[OUTFALLS]

;;Name	Elevation	Type	Stage Data	Gated	Route To
O_803	4865	FREE		NO	
O_708	4828	FREE		NO	
O_620	4817	FREE		NO	
O_714	4838	FREE		NO	

[DIVIDERS]

;;Name	Elevation	Diverted Link	Type	Parameters
836	4945	OV_836	OVERFLOW	15 0 0 0

[CONDUITS]

;;Name	From Node	To Node	Length	Roughness	InOffset	OutOffset	InitFlow	MaxFlow
DL_620	620	O_620	400	0.01	0	0	0	0
DL_714	714	O_714	400	0.01	0	0	0	0
DL_803	803	O_803	400	0.01	0	0	0	0
DL_804	804	803	400	0.01	0	0	0	0
DL_810	810	809	400	0.01	0	0	0	0

```
DL_820          820             819             400         0.01        0           0           0           0
DL_830          830             829             400         0.01        0           0           0           0
DL_840          840             839             400         0.01        0           0           0           0
DL_842          842             841             400         0.01        0           0           0           0
DL_844          844             843             400         0.01        0           0           0           0
L_808           808             803             1197        0.07        0           0           0           0
L_823           823             819             943         0.04        0           0           0           0
L_839           839             843             541         0.048       0           0           0           0
L_841           841             839             190         .044        0           0           0           0
L_850           850             841             1740        0.044       0           0           0           0
L_708           708             O_708           202         0.035       0           0           0           0
L_709           709             708             560.2       0.03        0           0           0           0
L_710           710             709             154.3       0.04        0           0           0           0
L_711           711             710             615.3       0.04        0           0           0           0
L_713           713             711             338.1       0.07        0           0           0           0
L_712           712             713             485.4       .04         0           0           0           0
L_838           838             836             314.88      0.048       0           0           0           0
L_811           811             809             183         0.045       0           0           0           0
L_843           843             838             304         0.035       0           0           0           0
L_819           819             811             761         0.07        0           0           0           0
L_824           824             822             1270        0.035       0           0           0           0
L_822           822             819             671         0.04        0           0           0           0
L_829           829             823             290         0.035       0           0           0           0
L_836           836             834             442         0.013       0           0           0           0
OV_836          836             834             442         .035        0           0           0           0
L_831           831             829             105         0.04        0           0           0           0
L_834           834             831             1040        0.04        0           0           0           0
L_809           809             808             90          0.013       0           0           0           0

[XSECTIONS]
;;Link           Shape           Geom1           Geom2       Geom3       Geom4       Barrels     Culvert
;;-------------- ------------ ---------------- ---------- ---------- ---------- ---------- ----------
DL_620          DUMMY           0               0           0           0           1
DL_714          DUMMY           0               0           0           0           1
DL_803          DUMMY           0               0           0           0           1
DL_804          DUMMY           0               0           0           0           1
DL_810          DUMMY           0               0           0           0           1
DL_820          DUMMY           0               0           0           0           1
DL_830          DUMMY           0               0           0           0           1
DL_840          DUMMY           0               0           0           0           1
DL_842          DUMMY           0               0           0           0           1
DL_844          DUMMY           0               0           0           0           1
L_808           TRAPEZOIDAL     10              65          3           3           1
L_823           TRAPEZOIDAL     10              235         5           5           1
L_839           TRAPEZOIDAL     15              100         27          10          1
L_841           TRIANGULAR      10              200         0           0           1
L_850           TRAPEZOIDAL     10              20          12          12          1
L_708           TRAPEZOIDAL     10              22          2           2           1
L_709           TRAPEZOIDAL     10              50          4           4           1
L_710           TRAPEZOIDAL     10              70          2           2           1
L_711           TRAPEZOIDAL     10              73          4           4           1
L_713           TRAPEZOIDAL     10              55          10          10          1
L_712           TRAPEZOIDAL     10              106         15          15          1
L_838           TRAPEZOIDAL     15              24          15          15          1
L_811           TRAPEZOIDAL     10              107         6           6           1
L_843           CIRCULAR        15              0           0           0           1
L_819           TRAPEZOIDAL     10              115         3           3           1
L_824           TRAPEZOIDAL     10              657         30          30          1
L_822           TRAPEZOIDAL     10              235         5           5           1
L_829           TRAPEZOIDAL     10              75          3.5         6.5         1
L_836           CIRCULAR        4               0           0           0           1
OV_836          TRAPEZOIDAL     15              40          15          15          1
L_831           TRAPEZOIDAL     15              65          6           6           1
L_834           TRAPEZOIDAL     15              64          6           6           1
L_809           RECT_CLOSED     15              5           0           0           1

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

[TAGS]

[MAP]
DIMENSIONS 0.000 0.000 8882.267 8132.154
Units      None

[COORDINATES]
;;Node           X-Coord         Y-Coord
;;-------------- ---------------- ----------------
620             3176.446        5603.079
712             2895.562        4845.602
714             2396.597        5524.935
803             2046.787        5306.170
804             2224.496        5288.834
809             2304.222        4931.686
810             2221.307        4534.501
819             2458.581        4607.362
820             2858.872        4455.858
824             3212.781        4053.026
829             2531.995        4090.155
830             2310.615        3639.827
839             3222.537        3474.569
840             4296.625        2946.685
841             3225.328        3393.633
842             4116.415        2195.542
843             3098.576        3589.753
844             3175.492        2589.454
850             3628.528        2902.994
711             2728.325        5128.419
710             2635.627        5340.281
709             2645.107        5386.630
708             2650.374        5598.361
713             2796.803        5016.287
811             2326.424        4882.578
822             2779.481        4253.460
823             2482.561        4170.492
834             2793.200        3771.985
838             3041.708        3648.672
831             2539.570        4080.449
808             2290.503        4963.697
```

```
O_803           2037.522         5457.441
O_708           2644.492         5672.936
O_620           3155.399         5761.408
O_714           2402.976         5620.622
836            2952.697         3687.647

[VERTICES]
;;Link           X-Coord          Y-Coord
;;-------------- ---------------- ----------------
DL_803          2026.861         5357.978
DL_803          2038.817         5412.975
DL_810          2232.974         4619.614
DL_810          2245.732         4810.989
DL_830          2525.911         4040.117
DL_840          4169.043         3071.079
DL_840          4092.493         3157.197
DL_840          3953.747         3410.768
DL_840          3583.757         3433.095
DL_840          3315.833         3429.905
DL_842          3580.567         2554.368
DL_842          3454.075         2733.989
DL_842          3356.793         2914.200
DL_842          3278.649         3199.666
DL_844          3186.655         2742.553
DL_844          3202.603         2914.790
DL_844          3193.034         3211.420
DL_844          3164.328         3249.694
DL_844          3183.466         3396.415
L_808           2265.576         5028.444
L_808           2246.438         5036.418
L_808           2206.569         5066.719
L_808           2203.379         5100.210
L_808           2190.621         5159.217
L_808           2137.993         5194.302
L_808           2080.325         5208.102
L_808           2060.399         5283.821
L_823           2485.244         4167.900
L_823           2482.053         4247.674
L_823           2482.053         4378.503
L_850           3608.479         2914.796
L_850           3593.723         2919.982
L_850           3576.180         2921.577
L_850           3539.500         2931.146
L_850           3506.010         2942.309
L_850           3486.872         2971.016
L_850           3467.735         2998.127
L_850           3439.029         3045.970
L_850           3419.891         3090.624
L_850           3389.590         3162.390
L_850           3365.669         3202.259
L_850           3341.747         3250.103
L_850           3308.256         3289.973
L_850           3271.576         3334.626
OV_836          2870.006         3747.691

[Polygons]

[BACKDROP]
FILE       "R:\23.1447.001 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221 Models\CUHP_SWMM\SWMM\Backgrounds\Final
Map.jpg"
DIMENSIONS 735.737 1837.108 8882.267 8132.154

"R:\23.1447.001 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221
Models\CUHP_SWMM\SWMM\Alternatives\Fut_100yr_GO_Do_Nothing.inp"
```

City of Greeley
Storm Drainage Master Plan
Oklahoma Baseline Alternatives

****
Element Count
****
Number of rain gages 0
Number of subcatchments ... 0
Number of nodes 36
Number of links 33
Number of pollutants 0
Number of land uses 0

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
620	JUNCTION	4920.00	10.00	0.0	
712	JUNCTION	4915.00	10.00	0.0	
714	JUNCTION	4864.00	10.00	0.0	
803	JUNCTION	4866.00	10.00	0.0	
804	JUNCTION	4882.00	10.00	0.0	
809	JUNCTION	4890.00	25.00	0.0	
810	JUNCTION	4925.00	10.00	0.0	
819	JUNCTION	4901.00	10.00	0.0	
820	JUNCTION	4945.00	10.00	0.0	
824	JUNCTION	4961.00	10.00	0.0	
829	JUNCTION	4918.00	15.00	0.0	
830	JUNCTION	4972.00	10.00	0.0	
839	JUNCTION	4965.00	15.00	0.0	
840	JUNCTION	4990.00	10.00	0.0	
841	JUNCTION	4967.00	10.00	0.0	
842	JUNCTION	5000.00	10.00	0.0	
843	JUNCTION	4959.00	15.00	0.0	
844	JUNCTION	4995.00	10.00	0.0	
850	JUNCTION	4990.00	10.00	0.0	
711	JUNCTION	4889.00	10.00	0.0	
710	JUNCTION	4871.00	10.00	0.0	
709	JUNCTION	4866.00	10.00	0.0	
708	JUNCTION	4851.00	10.00	0.0	
713	JUNCTION	4898.00	10.00	0.0	
811	JUNCTION	4893.00	10.00	0.0	
822	JUNCTION	4932.00	10.00	0.0	
823	JUNCTION	4908.00	10.00	0.0	
834	JUNCTION	4932.00	15.00	0.0	
838	JUNCTION	4949.00	15.00	0.0	
831	JUNCTION	4928.50	15.00	0.0	
808	JUNCTION	4885.00	15.00	0.0	
O_803	OUTFALL	4865.00	0.00	0.0	
O_708	OUTFALL	4828.00	10.00	0.0	
O_620	OUTFALL	4817.00	0.00	0.0	
O_714	OUTFALL	4838.00	0.00	0.0	
836	DIVIDER	4945.00	15.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
DL_620	620	O_620	CONDUIT	400.0	26.6486	0.0100
DL_714	714	O_714	CONDUIT	400.0	6.5138	0.0100
DL_803	803	O_803	CONDUIT	400.0	0.2500	0.0100
DL_804	804	803	CONDUIT	400.0	4.0032	0.0100
DL_810	810	809	CONDUIT	400.0	8.7837	0.0100
DL_820	820	819	CONDUIT	400.0	11.0672	0.0100
DL_830	830	829	CONDUIT	400.0	13.6247	0.0100
DL_840	840	839	CONDUIT	400.0	6.2622	0.0100
DL_842	842	841	CONDUIT	400.0	8.2782	0.0100
DL_844	844	843	CONDUIT	400.0	9.0367	0.0100
L_808	808	803	CONDUIT	1197.0	1.5875	0.0700
L_823	823	819	CONDUIT	943.0	0.7423	0.0400
L_839	839	843	CONDUIT	541.0	1.1091	0.0480
L_841	841	839	CONDUIT	190.0	1.0527	0.0440
L_850	850	841	CONDUIT	1740.0	1.3220	0.0440
L_708	708	O_708	CONDUIT	202.0	11.4607	0.0350
L_709	709	708	CONDUIT	560.2	2.6786	0.0300
L_710	710	709	CONDUIT	154.3	3.2421	0.0400
L_711	711	710	CONDUIT	615.3	2.9267	0.0400
L_713	713	711	CONDUIT	338.1	2.6629	0.0700
L_712	712	713	CONDUIT	485.4	3.5044	0.0400
L_838	838	836	CONDUIT	314.9	1.2704	0.0480
L_811	811	809	CONDUIT	183.0	1.6396	0.0450
L_843	843	838	CONDUIT	304.0	3.2913	0.0350
L_819	819	811	CONDUIT	761.0	1.0513	0.0700
L_824	824	822	CONDUIT	1270.0	2.2841	0.0350
L_822	822	819	CONDUIT	671.0	4.6249	0.0400
L_829	829	823	CONDUIT	290.0	3.4503	0.0350
L_836	836	834	CONDUIT	442.0	2.9424	0.0130
OV_836	836	834	CONDUIT	442.0	2.9424	0.0350
L_831	831	829	CONDUIT	105.0	10.0504	0.0400
L_834	834	831	CONDUIT	1040.0	0.3365	0.0400
L_809	809	808	CONDUIT	90.0	5.5641	0.0130

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
DL_620	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_714	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_803	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_804	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_820	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_830	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_840	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_842	DUMMY	0.00	0.00	0.00	0.00	1	0.00

DL_844	DUMMY	0.00	0.00	0.00	0.00	1	0.00
L_808	TRAPEZOIDAL	10.00	950.00	7.41	125.00	1	9655.82
L_823	TRAPEZOIDAL	10.00	2850.00	8.46	335.00	1	37867.18
L_839	TRAPEZOIDAL	15.00	5662.50	8.63	655.00	1	77684.49
L_841	TRIANGULAR	10.00	1000.00	4.98	200.00	1	10098.48
L_850	TRAPEZOIDAL	10.00	1400.00	5.37	260.00	1	16665.33
L_708	TRAPEZOIDAL	10.00	420.00	6.29	62.00	1	20580.76
L_709	TRAPEZOIDAL	10.00	900.00	6.79	130.00	1	26173.35
L_710	TRAPEZOIDAL	10.00	900.00	7.85	110.00	1	23769.29
L_711	TRAPEZOIDAL	10.00	1130.00	7.27	153.00	1	26947.94
L_713	TRAPEZOIDAL	10.00	1550.00	6.05	255.00	1	17837.15
L_712	TRAPEZOIDAL	10.00	2560.00	6.30	406.00	1	60698.05
L_838	TRAPEZOIDAL	15.00	3735.00	7.86	474.00	1	51535.74
L_811	TRAPEZOIDAL	10.00	1670.00	7.30	227.00	1	26581.36
L_843	CIRCULAR	15.00	176.71	3.75	15.00	1	3285.42
L_819	TRAPEZOIDAL	10.00	1450.00	8.13	175.00	1	12765.94
L_824	TRAPEZOIDAL	10.00	9570.00	7.61	1257.00	1	237606.05
L_822	TRAPEZOIDAL	10.00	2850.00	8.46	335.00	1	94518.19
L_829	TRAPEZOIDAL	10.00	1250.00	7.06	175.00	1	36264.24
L_836	CIRCULAR	4.00	12.57	1.00	4.00	1	246.40
OV_836	TRAPEZOIDAL	15.00	3975.00	8.10	490.00	1	116720.41
L_831	TRAPEZOIDAL	15.00	2325.00	9.39	245.00	1	121915.29
L_834	TRAPEZOIDAL	15.00	2310.00	9.37	244.00	1	22129.56
L_809	RECT_CLOSED	15.00	75.00	1.88	5.00	1	3074.94

****
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	170.202	55.463
External Outflow	171.109	55.758
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	0.012	0.004
Continuity Error (%)	-0.540	

****
Highest Flow Instability Indexes
****
Link L_831 (1)
Link L_834 (1)
Link L_829 (1)

****
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 : 1.01
% of Steps Not Converging : 0.00

****
Analysis begun on: Thu Jun 13 10:02:06 2024
Analysis ended on: Thu Jun 13 10:02:06 2024
Total elapsed time: < 1 sec

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CUHP Results for Multiple Scenarios

SWMM Run Wait Time (sec)	(Optional) SWMM Time Series Inflow "Modification Type" (LU, RP, or LU&RP)
60	

Subcatchment Name	Existing Landuse % Imperviousness	Future Landuse % Imperviousness
620	23.42	23.48
712	27.31	30.15
714	5.01	12.53
804	9.96	9.98
810	4.67	48.10
820	52.02	69.77
824	13.57	77.95
830	50.62	67.82
840	8.02	76.53
842	2.61	68.58
844	6.68	76.19
850	2.00	60.07

Raingage	Return Period (Years)	1 Hr Depths (in)	6 Hr Depths (in)
Greeley	WQ	0.600	N/A
	2	0.844	1.280
	5	1.120	1.670
	10	1.400	2.080
	25	1.870	2.780
	50	2.310	3.410
	100	2.800	4.130
	500	4.180	6.190

Enter "X" to Run Scenario	Scenario ID	Land Use (E or F)	Return Period (yr)	Correction Area (Sq.Mi.)
X	1	E	WQ	0
X	2	E	2	0
X	3	E	5	0
X	4	E	10	0
X	5	E	25	0
X	6	E	50	0
X	7	E	100	0
X	8	E	500	0
X	9	F	WQ	0
X	10	F	2	0
X	11	F	5	0
X	12	F	10	0
X	13	F	25	0
X	14	F	50	0
X	15	F	100	0
X	16	F	500	0

(Optional) SWMM Time Series Inflow Table "NAME"

"R:\23.1447.001 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221 Models\CUHP_SWMM\CUHP\Greeley_7.8_BaseHydrology.xlsm"

Appendix C – Hydraulic Analysis

Culvert Data: Structure#702

Site Data - Structure#702

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4867.00 ft
Outlet Station: 97.00 ft
Outlet Elevation: 4862.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#702

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: Mitered to Conform to Slope (Ke=0.7)
Inlet Depression: None

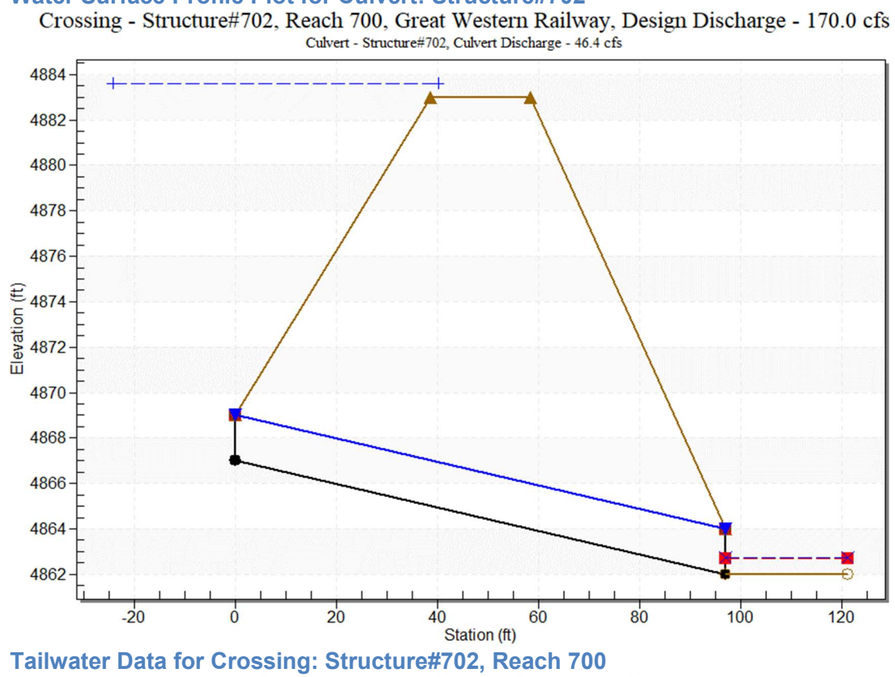
Table 1- Culvert Summary Table: Structure#702

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	24.91 cfs	24.91 cfs	4871.48	4.48	2.530	5-S2n	1.47	1.76	1.47	0.23	10.03	2.12
100 Year	170.02 cfs	46.38 cfs	4883.59	12.46	16.591	6-FFc	2.00	2.00	2.00	0.72	14.76	4.44

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4867.00 ft,
Outlet Elevation (invert): 4862.00 ft
Culvert Length: 97.13 ft,
Culvert Slope: 0.0515

Water Surface Profile Plot for Culvert: Structure#702



Tailwater Data for Crossing: Structure#702, Reach 700

Table 2 - Downstream Channel Rating Curve (Crossing: Structure#702, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4862.23	0.23	2.12	0.43	0.79
172	4862.72	0.72	4.44	1.35	0.94

Tailwater Channel Data - Structure#702, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0300
Channel Manning's n: 0.0450
Channel Invert Elevation: 4862.00 ft

Roadway Data for Crossing: Structure#702, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4883.00 ft
Roadway Surface: Gravel
Roadway Top Width: 20.00 ft

Culvert Data: Structure#703

Site Data - Structure#703,

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4872.00 ft
Outlet Station: 42.00 ft
Outlet Elevation: 4871.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#703,

Barrel Shape: Circular
Barrel Diameter: 0.83 ft
Barrel Material: PVC
Embedment: 0.00 in
Barrel Manning's n: 0.0130
Culvert Type: Straight
Inlet Configuration: Mitered to Conform to Slope (Ke=0.7)
Inlet Depression: None

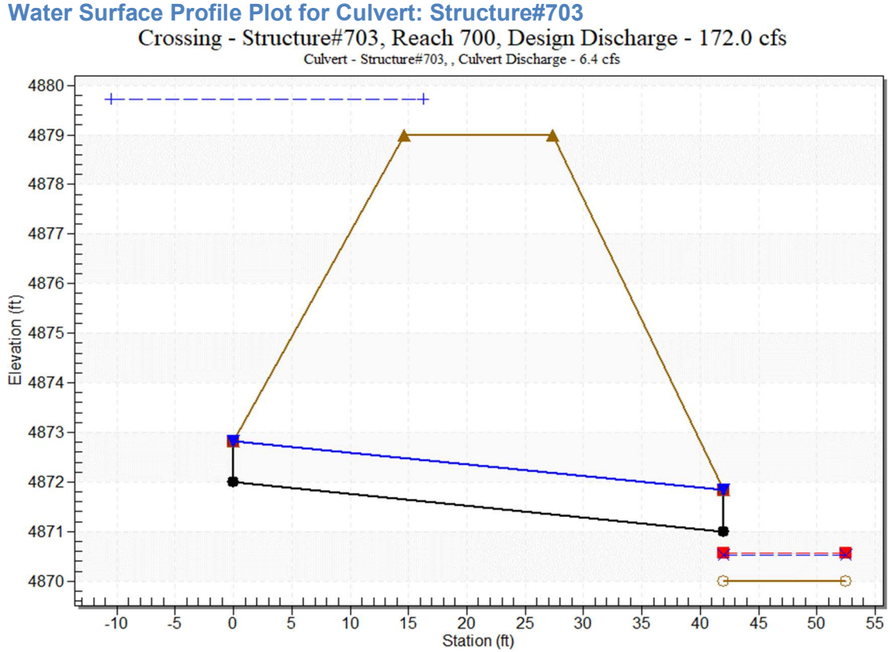
Table 3 - Culvert Summary Table: Structure#703

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	24.91 cfs	6.21 cfs	4879.17	7.17	6.613	6-FFc	0.83	0.83	0.83	0.16	11.39	2.18
100 Year	172.00 cfs	6.45 cfs	4879.71	7.71	7.155	6-FFc	0.83	0.83	0.83	0.52	11.83	4.68

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4872.00 ft,
Outlet Elevation (invert): 4871.00 ft
Culvert Length: 42.01 ft,
Culvert Slope: 0.0238

Water Surface Profile Plot for Culvert: Structure#703



Tailwater Data for Crossing: Structure#703, Reach 700

Table 4 - Downstream Channel Rating Curve (Crossing: Structure#703, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4870.16	0.16	2.18	0.22	0.95
172	4870.52	0.52	4.68	0.71	1.15

Tailwater Channel Data - Structure#703, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 70.00 ft
Side Slope (H:V): 2.00 (_:1)
Channel Slope: 0.0220
Channel Manning's n: 0.0300
Channel Invert Elevation: 4870.00 ft

Roadway Data for Crossing: Structure#703, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4879.00 ft
Roadway Surface: Gravel
Roadway Top Width: 12.76 ft

Culvert Data: Structure#704

Site Data - Structure#704

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4891.00 ft
Outlet Station: 89.00 ft
Outlet Elevation: 4888.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#704

Barrel Shape: Circular
Barrel Diameter: 2.50 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

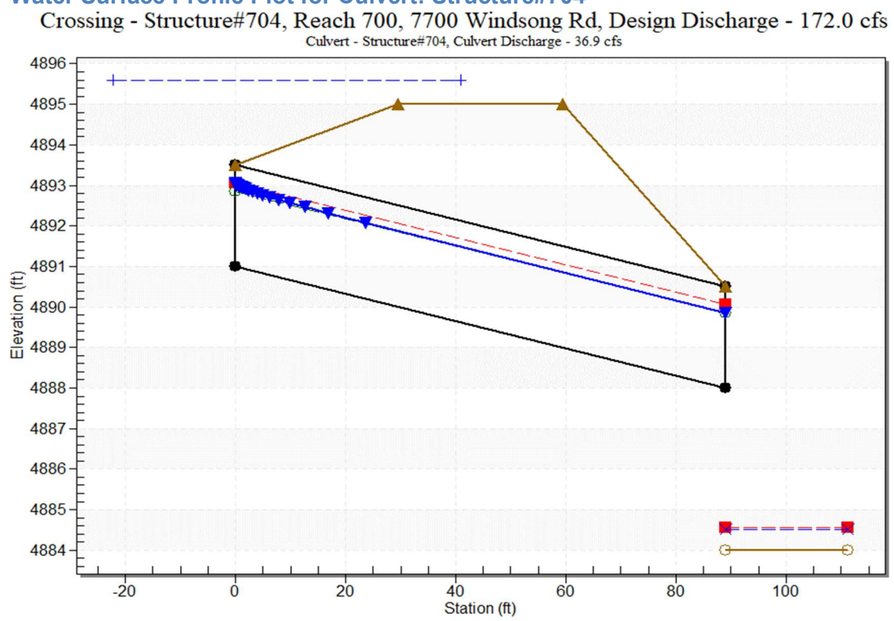
Table 5 - Culvert Summary Table: Structure#704

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	24.91 cfs	24.91 cfs	4893.98	2.98	0.573	5-S2n	1.41	1.70	1.41	0.16	8.73	2.09
100 Year	172.00 cfs	36.92 cfs	4895.58	4.58	3.393	5-S2n	1.86	2.06	1.86	0.51	9.43	4.47

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4891.00 ft,
Outlet Elevation (invert): 4888.00 ft
Culvert Length: 89.05 ft,
Culvert Slope: 0.0337

Water Surface Profile Plot for Culvert: Structure#704



Tailwater Data for Crossing: Structure#704, Reach 700

Table 6 - Downstream Channel Rating Curve (Crossing: Structure#704, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4884.16	0.16	2.09	0.28	0.92
172.00	4884.51	0.51	4.47	0.90	1.11

Tailwater Channel Data - Structure#704, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 73.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0280
Channel Manning's n: 0.0350
Channel Invert Elevation: 4884.00 ft

Roadway Data for Crossing: Structure#704, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4895.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 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: 74.00 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

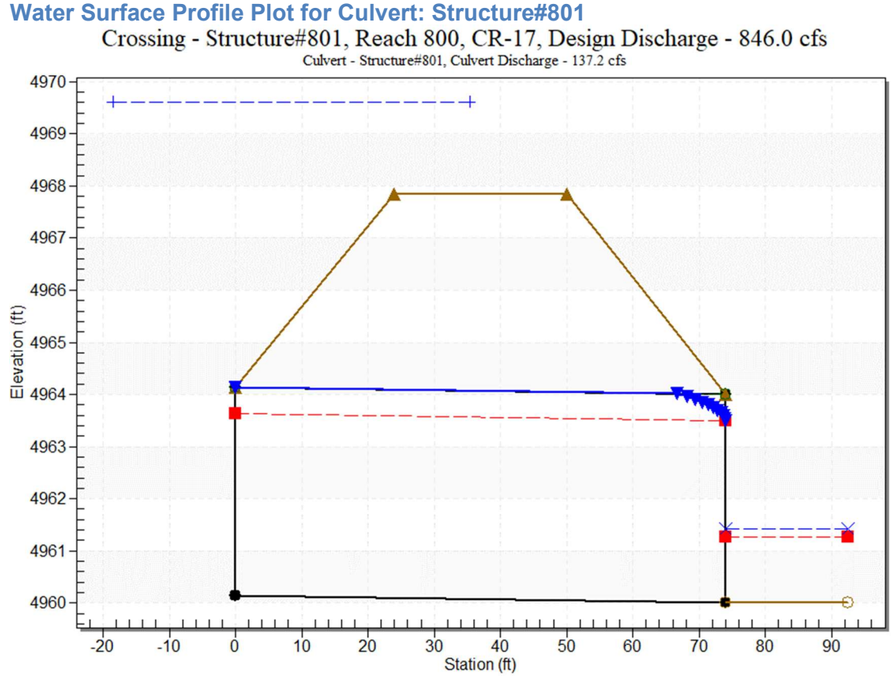
Table 7 - Culvert Summary Table: Structure#801

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	18.94 cfs	18.94 cfs	4962.29	1.90	2.145	2-M2c	2.16	1.28	1.28	0.15	5.47	1.25
100 Year	846.00 cfs	137.19 cfs	4969.60	8.94	9.458	7-M2c	4.00	3.48	3.48	1.42	11.81	5.23

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4960.15 ft,
Outlet Elevation (invert): 4960.01 ft
Culvert Length: 74.00 ft,
Culvert Slope: 0.0018

Water Surface Profile Plot for Culvert: Structure#801



Tailwater Data for Crossing: Structure#802, Reach 800

Table 8 - Downstream Channel Rating Curve (Crossing: Structure#802, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
18.94	4960.16	0.15	1.25	0.17	0.58
846.00	4961.43	1.42	5.23	1.63	0.82

Tailwater Channel Data - Structure#801, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 100.00 ft
Side Slope (H:V): 10.00 (_:1)
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

Culvert Data: Structure#804

Site Data - Structure#804

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4889.00 ft
Outlet Station: 90.00 ft
Outlet Elevation: 4881.00 ft

Culvert Data Summary - Structure#804

Number of Barrels: 1
Barrel Shape: Concrete Box
Barrel Span: 5.00 ft
Barrel Rise: 6.33 ft
Barrel Material: Concrete
Embedment: 60.00 in
Barrel Manning's n: 0.0130 (top and sides)
Manning's n: 0.0130 (bottom)
Culvert Type: Straight
Inlet Configuration: Square Edge (30-75º flare) Wingwall (Ke=0.4)
Inlet Depression: None

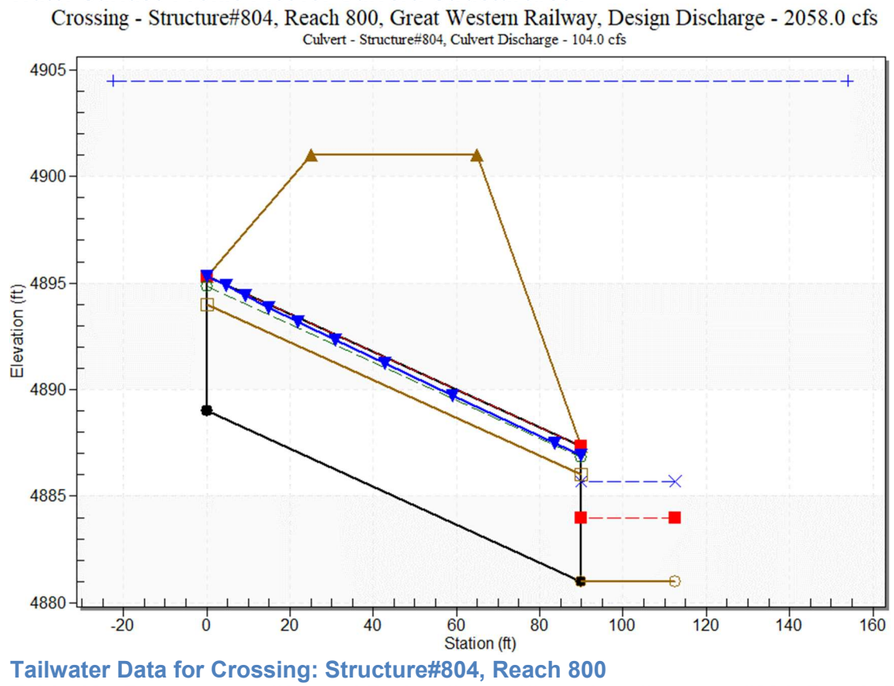
Table 9 - Culvert Summary Table: Structure#804

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	126.99 cfs	85.50 cfs	4901.29	7.29	0.0*	5-S2n	0.73	1.33	0.81	0.92	21.16	2.04
100 Year	2058.00 cfs	103.95 cfs	4904.46	10.46	2.606	5-S2n	0.83	1.33	0.92	4.70	22.52	5.54

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4894.00 ft,
Outlet Elevation (invert): 4886.00 ft
Culvert Length: 90.35 ft,
Culvert Slope: 0.0889

Water Surface Profile Plot for Culvert: Structure#804



Tailwater Data for Crossing: Structure#804, Reach 800

Table 10 - Downstream Channel Rating Curve (Crossing: Structure#804, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
126.99	4881.92	0.92	2.04	0.63	0.38
2058.00	4885.70	4.70	5.54	3.22	0.49

Tailwater Channel Data - Structure#804, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 65.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0110
Channel Manning's n: 0.0700
Channel Invert Elevation: 4881.00 ft

Roadway Data for Crossing: Structure#804, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4901.00 ft
Roadway Surface: Gravel
Roadway Top Width: 40.00 ft

Culvert Data: Structure#805

Site Data - Structure#805

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4893.00 ft
Outlet Station: 62.00 ft
Outlet Elevation: 4892.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#805

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

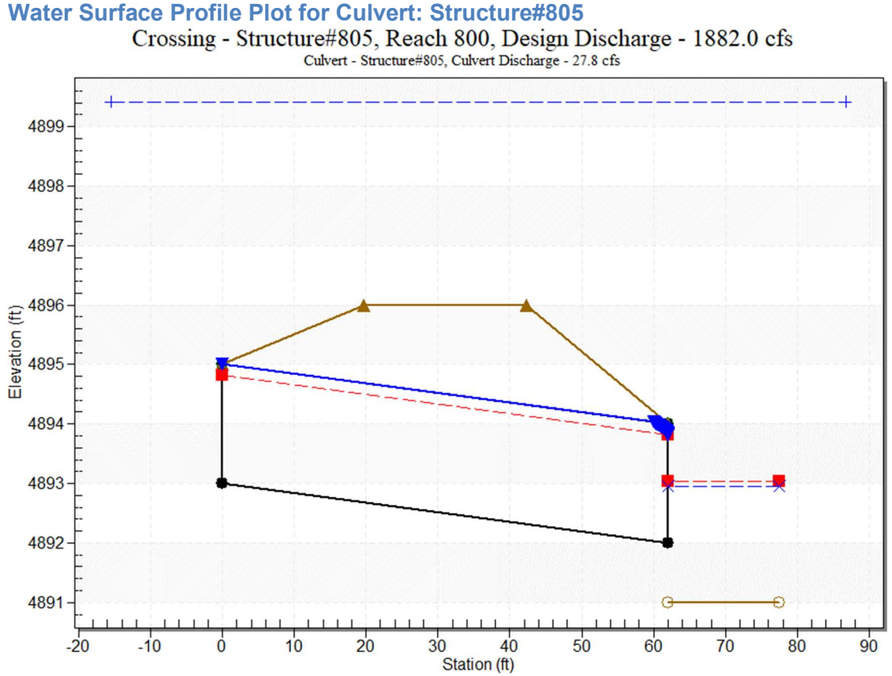
Table 11 - Culvert Summary Table: Structure#805

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	126.99 cfs	19.78 cfs	4896.54	3.39	3.538	7-M2c	2.00	1.60	1.60	0.40	7.35	2.93
100 Year	1882.00 cfs	27.78 cfs	4899.41	5.49	6.405	7-M2c	2.00	1.82	1.82	1.96	9.24	8.10

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4893.00 ft,
Outlet Elevation (invert): 4892.00 ft
Culvert Length: 62.01 ft,
Culvert Slope: 0.0161

Water Surface Profile Plot for Culvert: Structure#805



Tailwater Data for Crossing: Structure#805, Reach 800

Table 12 - Downstream Channel Rating Curve (Crossing: Structure#805, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
126.99	4891.40	0.40	2.93	0.69	0.83
1882.00	4892.96	1.96	8.10	3.42	1.07

Tailwater Channel Data - Structure#805, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 107.00 ft
Side Slope (H:V): 6.00 (_:1)
Channel Slope: 0.0280
Channel Manning's n: 0.0450
Channel Invert Elevation: 4891.00 ft

Roadway Data for Crossing: Structure#805, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4896.00 ft
Roadway Surface: Gravel
Roadway Top Width: 22.60 ft

Culvert Data: Structure#806

Site Data - Structure#806

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4900.00 ft
Outlet Station: 50.00 ft
Outlet Elevation: 4899.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#806

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0130
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

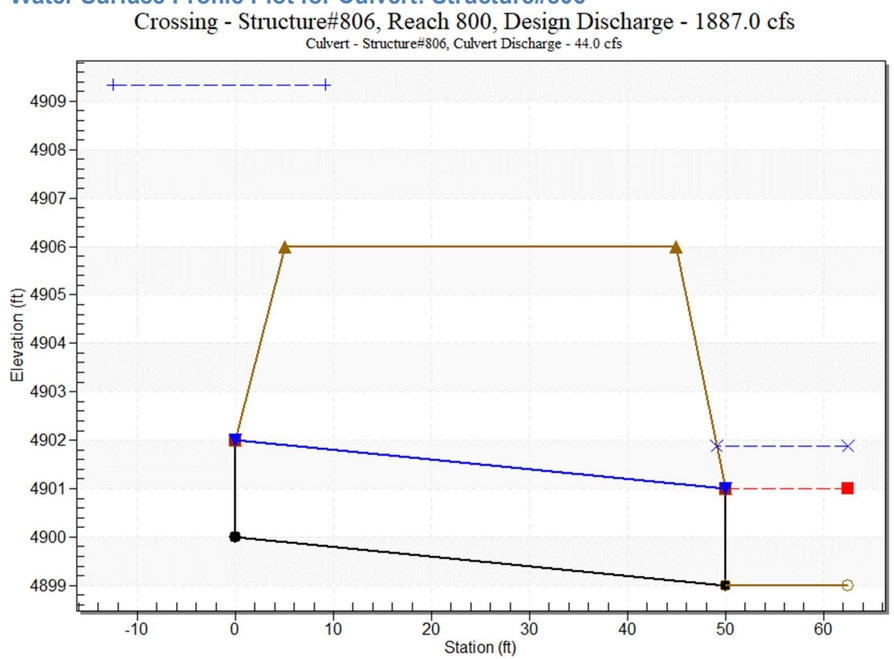
Table 13 - Culvert Summary Table: Structure#806

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	124.66 cfs	35.58 cfs	4906.44	6.44	5.217	7-M2c	2.00	1.82	1.82	0.57	11.85	1.88
100 Year	1887.00 cfs	44.00 cfs	4909.33	9.33	8.320	4-FFf	2.00	2.00	2.00	2.87	14.01	5.32

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4900.00 ft,
Outlet Elevation (invert): 4899.00 ft
Culvert Length: 50.01 ft,
Culvert Slope: 0.0200

Water Surface Profile Plot for Culvert: Structure#806



Tailwater Data for Crossing: Structure#806, Reach 800

Table 14 - Downstream Channel Rating Curve (Crossing: Structure#806, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
124.66	4899.57	0.57	1.88	0.60	0.44
1887.00	4901.87	2.87	5.32	3.04	0.57

Tailwater Channel Data - Structure#806, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 115.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0170
Channel Manning's n: 0.0700
Channel Invert Elevation: 4899.00 ft

Roadway Data for Crossing: Structure#806, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4906.00 ft
Roadway Surface: Paved
Roadway Top Width: 40.00 ft

Culvert Data: Structure#807

Site Data - Structure#807

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4917.00 ft
Outlet Station: 80.00 ft
Outlet Elevation: 4916.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#807

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 (30-75º flare) Wingwall (Ke=0.4)
Inlet Depression: None

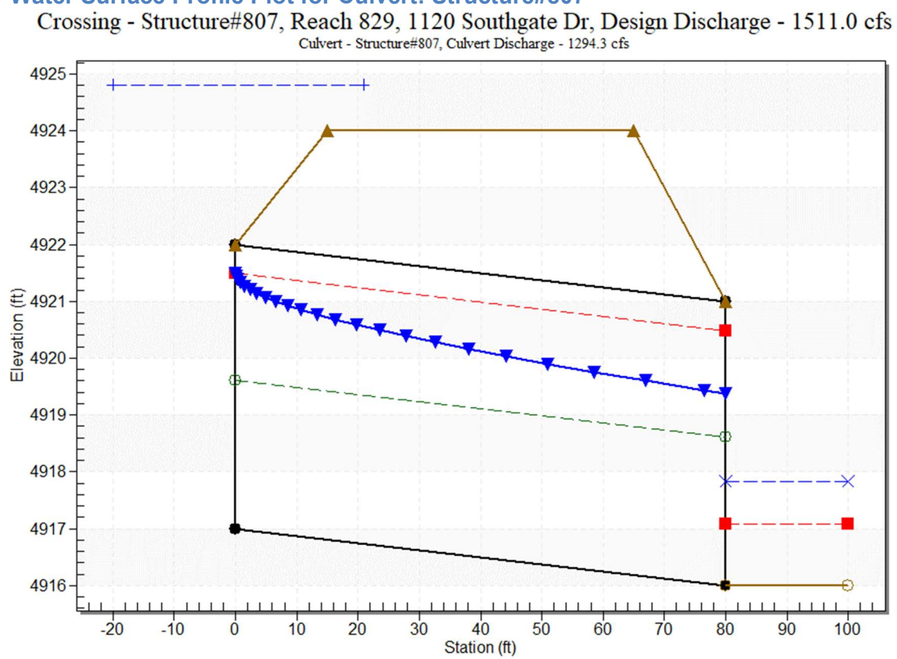
Table 15 - Culvert Summary Table: Structure#807

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	63.00 cfs	63.00 cfs	4917.91	0.91	0.0*	1-S2n	0.38	0.60	0.38	0.27	6.97	0.98
100 Year	1511.00 cfs	1294.26 cfs	4924.80	7.80	6.555	5-S2n	2.61	4.49	3.37	1.82	16.00	3.40

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4917.00 ft,
Outlet Elevation (invert): 4916.00 ft
Culvert Length: 80.01 ft,
Culvert Slope: 0.0125

Water Surface Profile Plot for Culvert: Structure#807



Tailwater Data for Crossing: Structure#807, Reach 829

Table 16 - Downstream Channel Rating Curve (Crossing: Structure#807, Reach 829)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
63.00	4916.27	0.27	0.98	0.09	0.33
1511.00	4917.82	1.82	3.40	0.57	0.45

Tailwater Channel Data - Structure#807, Reach 829

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 235.00 ft
Side Slope (H:V): 5.00 (_:1)
Channel Slope: 0.0050
Channel Manning's n: 0.0450
Channel Invert Elevation: 4916.00 ft

Roadway Data for Crossing: Structure#807, Reach 829

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4924.00 ft
Roadway Surface: Paved
Roadway Top Width: 50.00 ft

Culvert Data: Structure#808

Site Data - Structure#808

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4942.00 ft
Outlet Station: 527.00 ft
Outlet Elevation: 4932.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#808

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0130
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

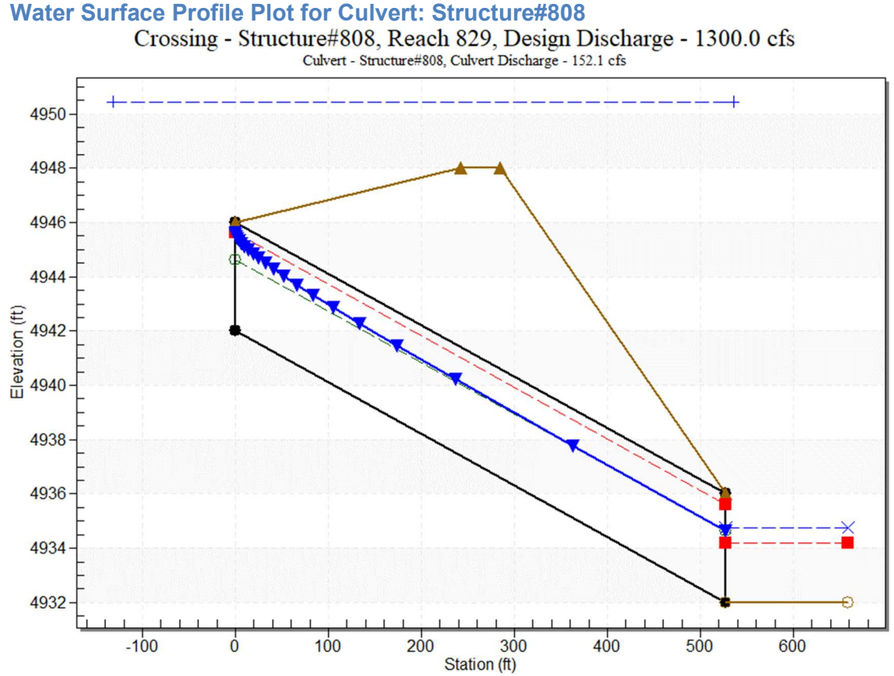
Table 17 - Culvert Summary Table: Structure#808

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	36.03 cfs	36.03 cfs	4944.55	2.55	0.0*	1-S2n	1.15	1.79	1.16	0.33	11.92	1.64
100 Year	1300.00 cfs	152.07 cfs	4950.43	8.43	3.091	5-S2n	2.63	3.61	2.65	2.74	17.18	6.02

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4942.00 ft,
Outlet Elevation (invert): 4932.00 ft
Culvert Length: 527.09 ft,
Culvert Slope: 0.0190

Water Surface Profile Plot for Culvert: Structure#808



Tailwater Data for Crossing: Structure#808, Reach 829

Table 18 - Downstream Channel Rating Curve (Crossing: Structure#808, Reach 829)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
36.03	4932.33	0.33	1.64	0.23	0.51
1300.00	4934.74	2.74	6.02	1.88	0.70

Tailwater Channel Data - Structure#808, Reach 829

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 64.00 ft
Side Slope (H:V): 5.40 (_:1)
Channel Slope: 0.0110
Channel Manning's n: 0.0450
Channel Invert Elevation: 4932.00 ft

Roadway Data for Crossing: Structure#808, Reach 829

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4948.00 ft
Roadway Surface: Paved
Roadway Top Width: 43.00 ft

Culvert Data: Structure#809

Site Data - Structure#809

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4958.00 ft
Outlet Station: 304.00 ft
Outlet Elevation: 4948.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#809

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0110
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall (Ke=0.5)
Inlet Depression: None

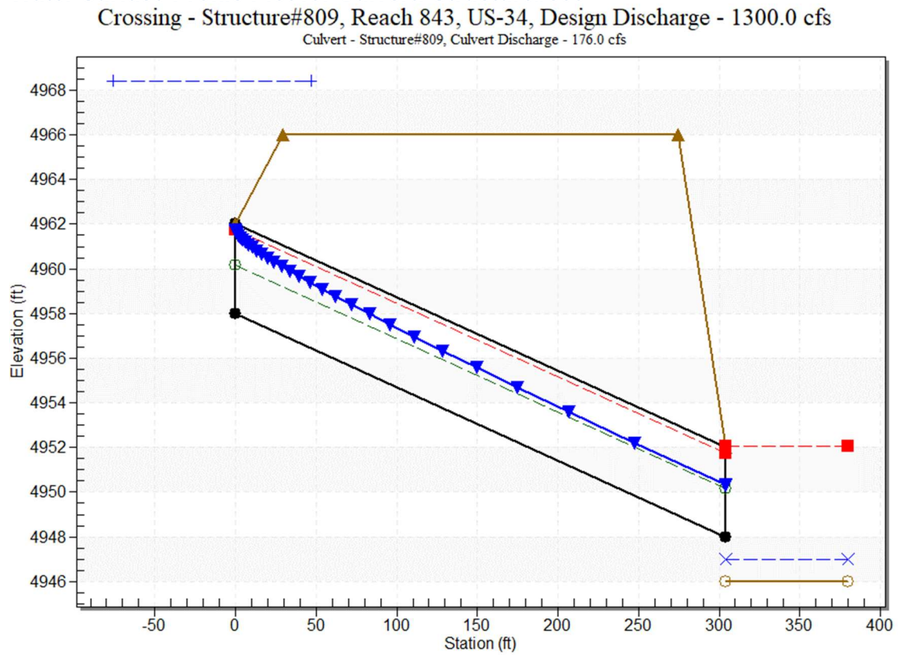
Table 19 - Culvert Summary Table: Structure#809

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	36.03 cfs	36.03 cfs	4960.52	2.52	0.0*	1-S2n	0.92	1.79	0.92	0.11	16.43	21.45
100 Year	1300.00 cfs	175.97 cfs	4968.39	10.39	1.695	5-S2n	2.16	3.76	2.31	0.98	23.45	86.35

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4958.00 ft,
Outlet Elevation (invert): 4948.00 ft
Culvert Length: 304.16 ft,
Culvert Slope: 0.0329

Water Surface Profile Plot for Culvert: Structure#809



Tailwater Data for Crossing: Structure#809, Reach 843

Table 20 - Downstream Channel Rating Curve (Crossing: Structure#809, Reach 843)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
36.03	4946.11	0.11	21.45	34.03	11.45
1300.00	4946.98	0.98	86.35	305.00	15.39

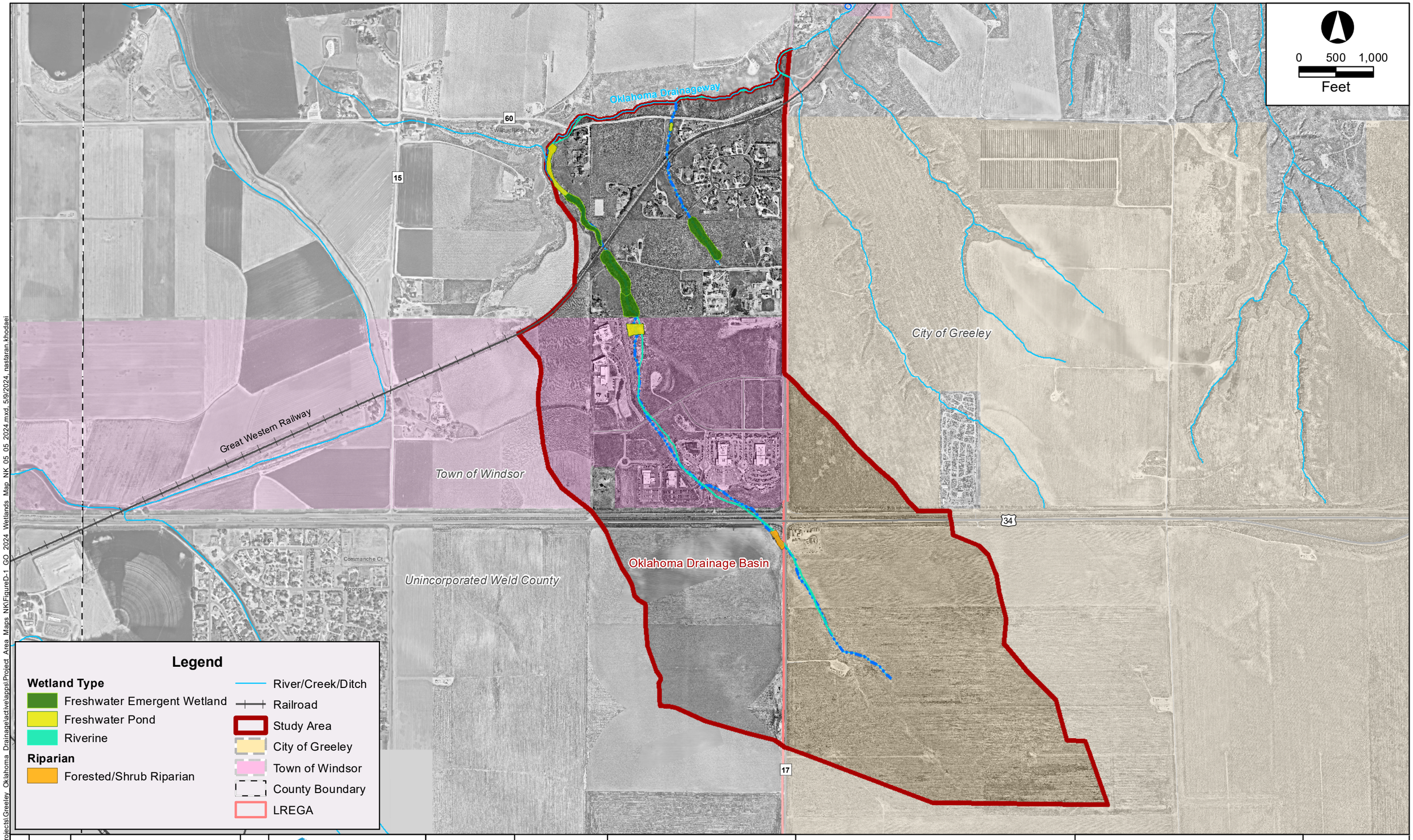
Tailwater Channel Data - Structure#809, Reach 843

Tailwater Channel Option: Rectangular Channel
Bottom Width: 15.40 ft
Channel Slope: 5.0000
Channel Manning's n: 0.0350
Channel Invert Elevation: 4946.00 ft

Roadway Data for Crossing: Structure#809, Reach 843

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4966.00 ft
Roadway Surface: Paved
Roadway Top Width: 245.00 ft

Appendix D – Wetland and Riparian Inventory



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No.	DATE	DESCRIPTION	APPR.

Matrix Excellence by Design

designed by:
drawn by: NK
checked by: BL
project no.: 23.1447.001
date: 02/08/2024

City of Greeley, Colorado

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA DRAINAGE BASINS 700 & 800

POTENTIAL WETLANDS AND RIPARIAN ZONES MAP

FIGURE
D-1

0 500 1,000
Feet

Oklahoma Drainageway

Willow Ridge Dr

60

15

Great Western Railway

Town of Windsor

City of Greeley

Lakota Ct

Commanche Ct

Algonquin Dr

Unincorporated Weld County

Oklahoma Drainage Basin

34

17

Legend

COGCC Well
- Abandoned Location
- Plugged and Abandoned
- Producing

River/Creek/Ditch

Railroad

Study Area

City of Greeley

Town of Windsor

County Boundary

LREGA

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

FILE: G:\gis_projects\Greeley_Oklahoma_Drainage\activelapps\Project_Area_Maps_NK\FigureD-2_GO_2024_Oil_Gas_Map_NK_05_05_2024.mxd 5/9/2024 nastaran.khodaei

No.	DATE	DESCRIPTION	APPR.

Matrix Excellence by Design

designed by:
drawn by: NK
checked by: BL
project no.: 23.1447.001
date: 02/08/2024

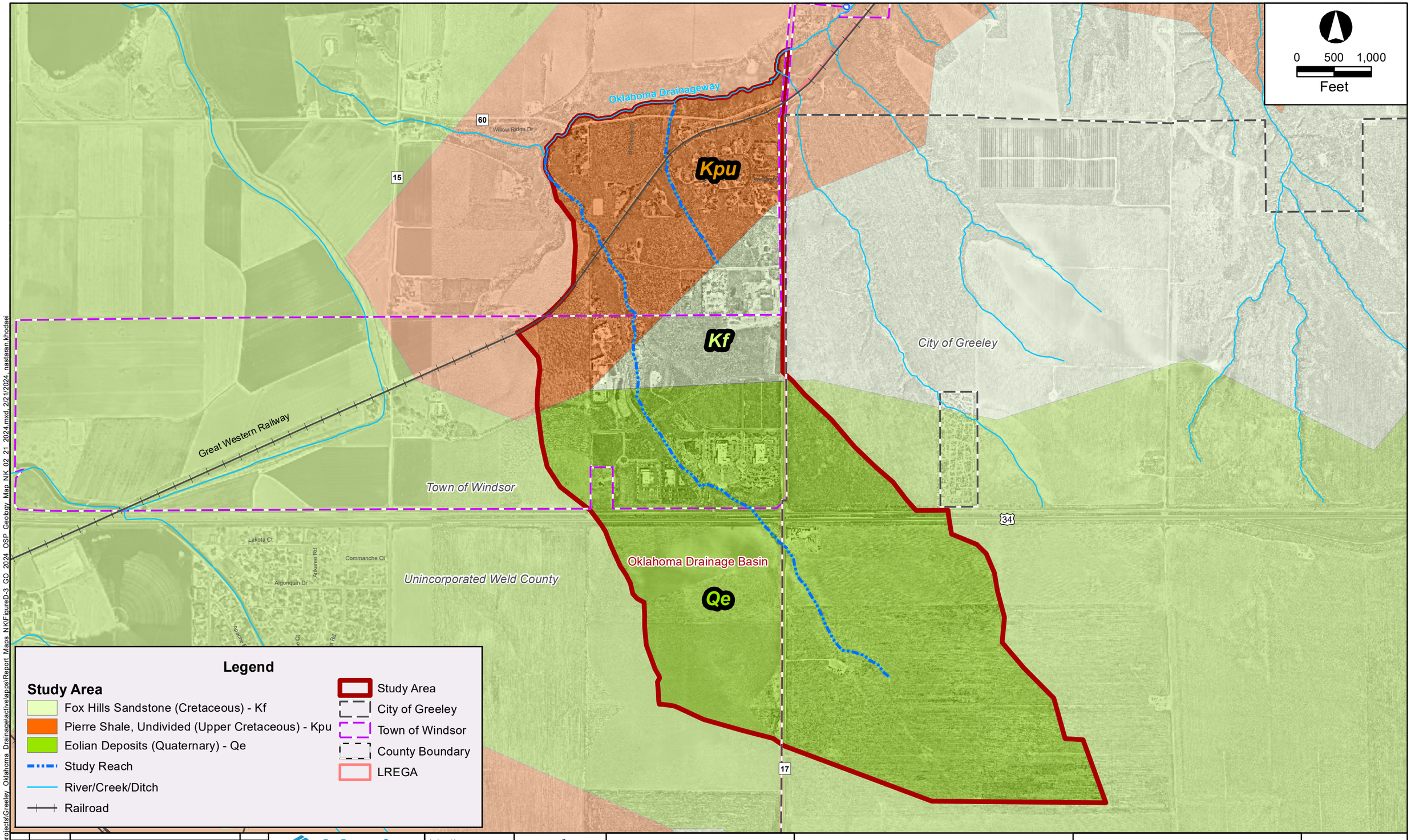
City of Greeley

CITY OF GREELEY

COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA DRAINAGE BASINS 700 & 800

WELLS

FIGURE
D-2



No.	DATE	DESCRIPTION	APPR.

Matrix Excellence by Design

designed by:
drawn by: NK
checked by: BI
project no.: 23.1447.001
date: 02/08/2024

City of Greeley

CITY OF GREELEY

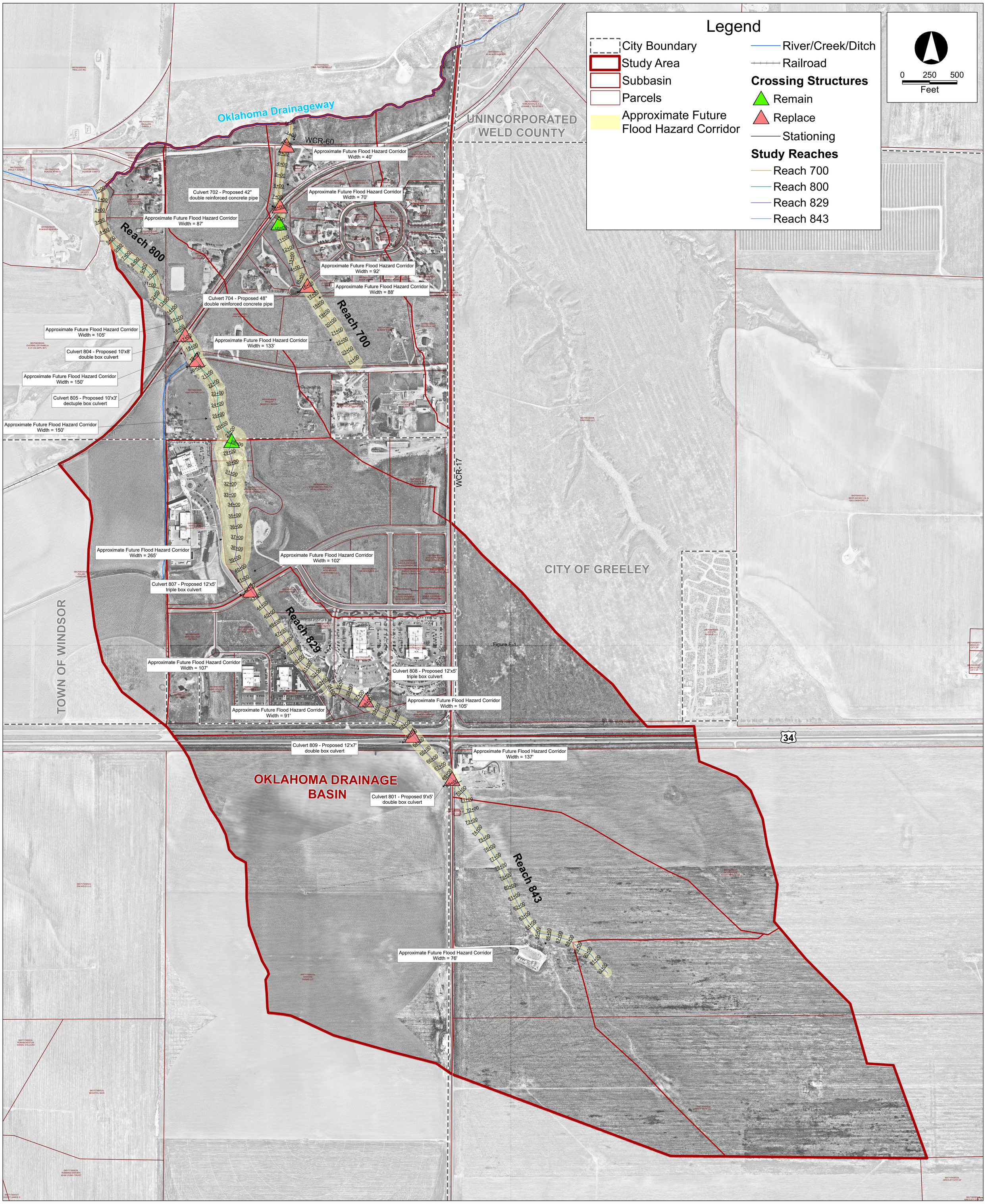
COMPREHENSIVE DRAINAGE PLAN
OKLAHOMA DRAINAGE BASINS 700 & 800

GEOLOGIC MAP

FIGURE
D-3

FILE: G:\gis_projects\Greeley_Oklahoma_Drainage\activeapps\Report_Maps_NK\FigureD-3_GO_2024_OSP_Geology_Map_NK_02_21_2024.mxd, 2/21/2024, nastaran.khodaei

Appendix E – Alternatives Analysis



City of Greeley Colorado

Matrix

Layer Control Instructions

The Map Controls to the right set the visibility of the layers automatically for the selected map. Additional layer control is available through the "Layers" Navigational Panel which can be accessed from the View Menu under Navigational Panels. In the Panel, the visibility of layers and layer groups can be changed by clicking the square left of the layer/group. An eye in the square indicates that the layer is on. An empty square indicates that the layer is off. Layer groups can be expanded and reduced by clicking the +/- symbol left of the layer/group

Interactive Figures (Select from Below)

Option 1: Do Nothing
Option 2: Detention
Option 3: Channel Improvements Only
Option 4: LID

Option 1, Figure E-1
Alternatives Map (July 2024)
Oklahoma Drainage Basins 700 & 800

Appendix E-2
MHFD Detention Workbooks

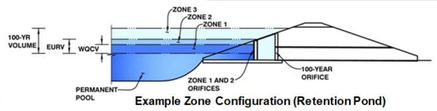
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 24.1447.001 Greeley- Oklahoma Drainage MP

Basin ID: Option 2 Detenetion 711



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	90.00	acres
Watershed Length =	3,900	ft
Watershed Length to Centroid =	1,738	ft
Watershed Slope =	0.031	ft/ft
Watershed Imperviousness =	30.20%	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) =	1.141	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	2.470	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	1.598	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	2.810	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	4.602	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	8.506	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	11.792	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	15.995	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	27.074	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	1.515	acre-feet		
Approximate 5-yr Detention Volume =	2.643	acre-feet		
Approximate 10-yr Detention Volume =	3.285	acre-feet		
Approximate 25-yr Detention Volume =	4.314	acre-feet		
Approximate 50-yr Detention Volume =	4.931	acre-feet		
Approximate 100-yr Detention Volume =	6.534	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	1.141	acre-feet
Zone 2 Volume (EURV - Zone 1)	1.329	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	4.064	acre-feet
Total Detention Basin Volume =	6.534	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}) =	0.003	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}) =	1,752	ft^2
Surcharge Volume Length (L_{ISV}) =	41.9	ft
Surcharge Volume Width (W_{ISV}) =	41.9	ft
Depth of Basin Floor (H_{FLOOR}) =	0.78	ft
Length of Basin Floor (L_{FLOOR}) =	305.0	ft
Width of Basin Floor (W_{FLOOR}) =	171.9	ft
Area of Basin Floor (A_{FLOOR}) =	52,410	ft^2
Volume of Basin Floor (V_{FLOOR}) =	16,573	ft^3
Depth of Main Basin (H_{MAIN}) =	4.39	ft
Length of Main Basin (L_{MAIN}) =	340.1	ft
Width of Main Basin (W_{MAIN}) =	207.0	ft
Area of Main Basin (A_{MAIN}) =	70,389	ft^2
Volume of Main Basin (V_{MAIN}) =	268,575	ft^3
Calculated Total Basin Volume (V_{total}) =	**6.579**	acre-feet

Depth Increment = 0.50 ft

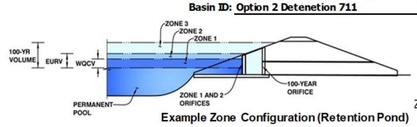
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		41.9	41.9	1,752		0.040		
ISV	0.33		41.9	41.9	1,752		0.040	578	0.013
	0.50		41.9	41.9	1,752		0.040	876	0.020
	1.00		99.2	70.2	6,962		0.160	2,148	0.049
	1.50		267.9	153.5	41,122		0.944	12,998	0.298
Floor	1.61		305.0	171.9	52,410		1.203	18,130	0.416
	2.00		308.1	175.0	53,907		1.238	38,861	0.892
Zone 1 (WQCV)	2.20		309.7	176.6	54,683		1.255	49,720	1.141
	2.50		312.1	179.0	55,855		1.282	66,300	1.522
	3.00		316.1	183.0	57,836		1.328	94,722	2.175
Zone 2 (EURV)	3.23		317.9	184.8	58,757		1.349	108,130	2.482
	3.50		320.1	187.0	59,848		1.374	124,141	2.850
	4.00		324.1	191.0	61,892		1.421	154,575	3.549
	4.50		328.1	195.0	63,968		1.469	186,038	4.271
	5.00		332.1	199.0	66,077		1.517	218,548	5.017
	5.50		336.1	203.0	68,217		1.566	252,120	5.788
Zone 3 (100-year)	5.97		339.9	206.7	70,258		1.613	284,661	6.535
	6.00		340.1	207.0	70,389		1.616	286,770	6.583
	6.50		344.1	211.0	72,593		1.667	322,515	7.404
	7.00		348.1	215.0	74,830		1.718	359,369	8.250
	7.50		352.1	219.0	77,098		1.770	397,350	9.122
	8.00		356.1	223.0	79,398		1.823	436,472	10.020
	8.50		360.1	227.0	81,730		1.876	476,753	10.945
	9.00		364.1	231.0	84,095		1.931	518,208	11.896
	9.50		368.1	235.0	86,491		1.986	560,853	12.875
	10.00		372.1	239.0	88,919		2.041	604,704	13.882
	10.50		376.1	243.0	91,379		2.098	649,777	14.917
	11.00		380.1	247.0	93,872		2.155	696,089	15.980
	11.50		384.1	251.0	96,396		2.213	743,654	17.072
	12.00		388.1	255.0	98,952		2.272	792,490	18.193
	12.50		392.1	259.0	101,540		2.331	842,611	19.344
	13.00		396.1	263.0	104,161		2.391	894,035	20.524
	13.50		400.1	267.0	106,813		2.452	946,777	21.735
	14.00		404.1	271.0	109,497		2.514	1,000,853	22.976
	14.50		408.1	275.0	112,213		2.576	1,056,280	24.249
	15.00		412.1	279.0	114,962		2.639	1,113,072	25.553
	15.50		416.1	283.0	117,742		2.703	1,171,246	26.888
	16.00		420.1	287.0	120,554		2.768	1,230,819	28.256
	16.50		424.1	291.0	123,398		2.833	1,291,806	29.656
	17.00		428.1	295.0	126,275		2.899	1,354,223	31.089
	17.50		432.1	299.0	129,183		2.966	1,418,086	32.555
	18.00		436.1	303.0	132,123		3.033	1,483,411	34.054
	18.50		440.1	307.0	135,095		3.101	1,550,214	35.588
	19.00		444.1	311.0	138,100		3.170	1,618,511	37.156
	19.50		448.1	315.0	141,136		3.240	1,688,319	38.758
	20.00		452.1	319.0	144,204		3.310	1,759,652	40.396
	20.50		456.1	323.0	147,304		3.382	1,832,528	42.069
	21.00		460.1	327.0	150,436		3.454	1,906,962	43.778
	21.50		464.1	331.0	153,601		3.526	1,982,970	45.523
	22.00		468.1	335.0	156,797		3.600	2,060,568	47.304
	22.50		472.1	339.0	160,025		3.674	2,139,772	49.122
	23.00		476.1	343.0	163,285		3.749	2,220,599	50.978
	23.50		480.1	347.0	166,578		3.824	2,303,063	52.871
	24.00		484.1	351.0	169,902		3.900	2,387,182	54.802
	24.50		488.1	355.0	173,258		3.977	2,472,970	56.772
	25.00		492.1	359.0	176,646		4.055	2,560,445	58.780
	25.50		496.1	363.0	180,067		4.134	2,649,622	60.827
	26.00		500.1	367.0	183,519		4.213	2,740,517	62.914

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 24.1447.001 Greeley- Oklahoma Drainage MP

Basin ID: Option 2 Detenetion 711



Example Zone Configuration (Retention Pond)

Clear Input Parameters (Including Tables)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	2.20	1.141	Orifice Plate	Orifice Plate
Zone 2 (EURV)	3.23	1.329	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 3 (100-year)	5.97	4.064	Weir&Pipe (Rect.)	Weir and Pipe (w/ Rectangular Orifice Plate)
	Total (all zones)	6.534		

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 =	2.861E-02	ft^2
Depth at top of Zone using Orifice Plate =	2.20	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	8.80	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	4.12	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	0.73	1.47					
Orifice Area (sq. inches)	4.12	4.12	4.12					

	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 =	2.20	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.26	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	3.23	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 =	18.79		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 =	3.23	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	6.56	N/A	feet
Overflow Weir Front Edge Length =	62.00	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 =	35.44	N/A	
Horiz. Length of Weir Sides =	10.00	N/A	feet	Overflow Grate Open Area w/o Debris =	454.86	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	227.43	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 Rectangula	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Rectangula	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	12.83	N/A	ft^2
Rectangular Orifice Width =	43.90	N/A	inches	Outlet Orifice Centroid =	1.75	N/A	feet
Rectangular Orifice Height =	42.10		inches	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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	5.70	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.96	feet
Spillway Crest Length =	59.00	feet	Stage at Top of Freeboard =	7.66	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.79	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	9.41	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) =	1.141	2.470	1.598	2.810	4.602	8.506	11.792	15.995	27.074
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.598	2.810	4.602	8.506	11.792	15.995	27.074
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.8	8.6	24.1	64.2	93.3	131.2	225.3
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	0.27	0.71	1.04	1.46	2.50
Peak Inflow Q (cfs) =	N/A	N/A	16.2	29.4	48.3	95.8	131.0	176.7	291.6
Peak Outflow Q (cfs) =	0.5	1.9	1.0	2.0	15.3	51.6	82.4	126.6	253.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.6	0.8	0.9	1.0	1.1
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	0.2	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) =	37	49	45	52	50	45	42	37	28
Time to Drain 99% of Inflow Volume (hours) =	**40**	52	48	55	55	53	52	50	45
Maximum Ponding Depth (ft) =	2.20	3.23	2.44	3.25	3.79	4.56	5.05	5.63	6.43
Area at Maximum Ponding Depth (acres) =	1.26	1.35	1.28	1.35	1.40	1.47	1.52	1.58	1.66
Maximum Volume Stored (acre-ft) =	1.141	2.482	1.433	2.509	3.252	4.359	5.078	5.992	7.288

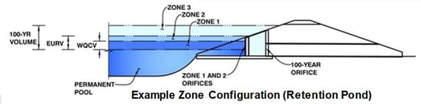
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 2, Detention 823



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	327.00	acres
Watershed Length =	4,753	ft
Watershed Length to Centroid =	2,751	ft
Watershed Slope =	0.012	ft/ft
Watershed Imperviousness =	72.98%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	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) =	7.879	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	23.271	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	16.082	acre-feet	0.85 inches
5-yr Runoff Volume (P1 = 1.12 in.) =	22.795	acre-feet	1.12 inches
10-yr Runoff Volume (P1 = 1.4 in.) =	30.462	acre-feet	1.40 inches
25-yr Runoff Volume (P1 = 1.87 in.) =	44.522	acre-feet	1.87 inches
50-yr Runoff Volume (P1 = 2.3 in.) =	57.083	acre-feet	2.30 inches
100-yr Runoff Volume (P1 = 2.79 in.) =	71.969	acre-feet	2.79 inches
500-yr Runoff Volume (P1 = 4.16 in.) =	112.726	acre-feet	4.16 inches
Approximate 2-yr Detention Volume =	14.974	acre-feet	
Approximate 5-yr Detention Volume =	21.673	acre-feet	
Approximate 10-yr Detention Volume =	26.650	acre-feet	
Approximate 25-yr Detention Volume =	33.089	acre-feet	
Approximate 50-yr Detention Volume =	37.124	acre-feet	
Approximate 100-yr Detention Volume =	43.128	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	7.879	acre-feet
Zone 2 Volume (EURV - Zone 1)	15.391	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	19.857	acre-feet
Total Detention Basin Volume =	43.128	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = 1.00 ft

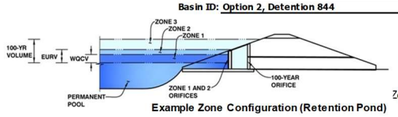
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	37,664	0.865		
	--	1.00	--	--	--	77,436	1.778	57,550	1.321
	--	2.00	--	--	--	133,078	3.055	162,807	3.738
	--	3.00	--	--	--	163,864	3.762	311,278	7.146
	--	4.00	--	--	--	190,605	4.376	488,512	11.215
	--	5.00	--	--	--	204,897	4.704	686,263	15.754
	--	6.00	--	--	--	215,528	4.948	896,476	20.580
	--	7.00	--	--	--	226,286	5.195	1,117,383	25.652
	--	8.00	--	--	--	237,198	5.445	1,349,125	30.972
	--	8.49	--	--	--	273,603	6.281	1,474,271	33.845
	--	9.00	--	--	--	273,603	6.281	1,613,808	37.048
	--	10.00	--	--	--	273,603	6.281	1,887,411	43.329
	--		--	--	--				
	--		--	--	--				
	--		--	--	--			

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 2, Detention 844



Example Zone Configuration (Retention Pond)

Clear Input Parameters (Including Tables)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.63	3.229	Orifice Plate
Zone 2 (EURV)	4.18	6.211	Rectangular Orifice
Zone 3 (100-year)	6.00	7.827	Weir&Pipe (Restrict)
Total (all zones)		17.267	

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	ft²
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 =	3.55	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	14.20	inches
Orifice Plate: Orifice Area per Row =	12.28	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	8.528E-02	ft²
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft²

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	1.18	2.37					
Orifice Area (sq. inches)	12.28	12.28	12.28					

	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)

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	2.63	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	4.18	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	2.00	N/A	inches
Vertical Orifice Width =	99.87		inches

Calculated Parameters for Vertical Orifice

	Zone 2 Rectangular	Not Selected	
Vertical Orifice Area =	1.39	N/A	ft²
Vertical Orifice Centroid =	0.08	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 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.83	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	263.00	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V
Horiz. Length of Weir Sides =	10.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	8.16	N/A	feet
Overflow Weir Slope Length =	10.54	N/A	feet
Grate Open Area / 100-yr Orifice Area =	94.15	N/A	
Overflow Grate Open Area w/o Debris =	1929.50	N/A	ft²
Overflow Grate Open Area w/ Debris =	964.75	N/A	ft²

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	72.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	49.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	20.49	N/A	ft²
Outlet Orifice Centroid =	2.29	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.94	N/A	radians

Size Outlet Plate to match 90% of Predevelopment 100-year Peak Runoff Rate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.10	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	174.00	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=	0.98 feet
Stage at Top of Freeboard =	8.08 feet
Basin Area at Top of Freeboard =	4.80 acres
Basin Volume at Top of Freeboard =	26.87 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) =	3.229	9.439	6.502	9.158	12.151	17.573	22.433	28.164	43.897
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.502	9.158	12.151	17.573	22.433	28.164	43.897
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.4	14.7	41.1	106.6	155.2	216.5	372.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.12	0.32	0.84	1.23	1.71	2.94
Peak Inflow Q (cfs) =	N/A	N/A	119.6	166.5	218.6	325.1	413.4	522.6	803.0
Peak Outflow Q (cfs) =	1.4	10.1	6.7	9.0	11.1	46.8	107.7	198.6	478.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.3	0.4	0.7	0.9	1.3
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 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	N/A	N/A	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	48	47	49	51	51	49	46	41
Time to Drain 99% of Inflow Volume (hours) =	**40**	52	50	53	55	56	56	55	52
Maximum Ponding Depth (ft) =	2.63	4.18	3.26	3.83	4.48	5.24	5.64	6.09	6.73
Area at Maximum Ponding Depth (acres) =	3.89	4.14	3.99	4.08	4.19	4.31	4.38	4.45	4.56
Maximum Volume Stored (acre-ft) =	3.246	9.465	5.688	7.986	10.672	13.900	15.638	17.625	20.509

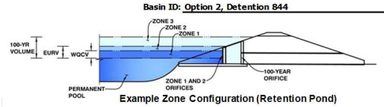
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 2, Detention 844



Example Zone Configuration (Retention Pond)

Watershed Information

	EDB	
Watershed Area =	126.60	acres
Watershed Length =	3,111	ft
Watershed Length to Centroid =	1,437	ft
Watershed Slope =	0.019	ft/ft
Watershed Imperviousness =	76.20%	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) =	3.229	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	9.439	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	6.502	acre-feet	0.85 inches
5-yr Runoff Volume (P1 = 1.12 in.) =	9.158	acre-feet	1.12 inches
10-yr Runoff Volume (P1 = 1.4 in.) =	12.151	acre-feet	1.40 inches
25-yr Runoff Volume (P1 = 1.87 in.) =	17.573	acre-feet	1.87 inches
50-yr Runoff Volume (P1 = 2.3 in.) =	22.433	acre-feet	2.30 inches
100-yr Runoff Volume (P1 = 2.79 in.) =	28.164	acre-feet	2.79 inches
500-yr Runoff Volume (P1 = 4.16 in.) =	43.897	acre-feet	4.16 inches
Approximate 2-yr Detention Volume =	6.088	acre-feet	
Approximate 5-yr Detention Volume =	8.743	acre-feet	
Approximate 10-yr Detention Volume =	10.768	acre-feet	
Approximate 25-yr Detention Volume =	13.353	acre-feet	
Approximate 50-yr Detention Volume =	14.966	acre-feet	
Approximate 100-yr Detention Volume =	17.267	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	3.229	acre-feet
Zone 2 Volume (EURV - Zone 1)	6.211	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	7.827	acre-feet
Total Detention Basin Volume =	17.267	acre-feet
Initial Surcharge Volume (ISV) =	578	ft^3
Initial Surcharge Depth (ISD) =	0.33	ft
Total Available Detention Depth (H_{tota}) =	6.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.003	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}) =	1,752	ft^2
Surcharge Volume Length (L_{ISV}) =	41.9	ft
Surcharge Volume Width (W_{ISV}) =	41.9	ft
Depth of Basin Floor (H_{FLOOR}) =	1.54	ft
Length of Basin Floor (L_{FLOOR}) =	561.3	ft
Width of Basin Floor (W_{FLOOR}) =	298.5	ft
Area of Basin Floor (A_{FLOOR}) =	167,571	ft^2
Volume of Basin Floor (V_{FLOOR}) =	95,713	ft^3
Depth of Main Basin (H_{MAIN}) =	3.63	ft
Length of Main Basin (L_{MAIN}) =	590.4	ft
Width of Main Basin (W_{MAIN}) =	327.6	ft
Area of Main Basin (A_{MAIN}) =	193,385	ft^2
Volume of Main Basin (V_{MAIN}) =	654,577	ft^3
Calculated Total Basin Volume (V_{total}) =	**17.258**	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	1,752		0.040		
ISV	0.33		41.9	41.9	1,752		0.040	578	0.013
	0.50		41.9	41.9	1,752		0.040	876	0.020
	1.00		99.2	70.2	6,962		0.160	2,148	0.049
	1.50		267.9	153.5	41,122		0.944	12,998	0.298
	2.00		436.5	236.9	103,393		2.374	47,956	1.101
Floor	2.37		561.3	298.5	167,571		3.847	97,609	2.241
	2.50		562.4	299.6	168,467		3.867	119,452	2.742
Zone 1 (WQCV)	2.63		563.4	300.6	169,364		3.888	141,411	3.246
	3.00		566.4	303.6	171,930		3.947	204,550	4.696
	3.50		570.4	307.6	175,426		4.027	291,387	6.689
	4.00		574.4	311.6	178,954		4.108	379,981	8.723
Zone 2 (EURV)	4.18		575.8	313.0	180,232		4.138	412,308	9.465
	4.50		578.4	315.6	182,514		4.190	470,347	10.798
	5.00		582.4	319.6	186,105		4.272	562,500	12.913
	5.50		586.4	323.6	189,729		4.356	656,457	15.070
Zone 3 (100-year)	6.00		590.4	327.6	193,385		4.440	752,235	17.269
	6.50		594.4	331.6	197,073		4.524	849,848	19.510
	7.00		598.4	335.6	200,793		4.610	949,313	21.793
	7.50		602.4	339.6	204,544		4.696	1,050,646	24.120
	8.00		606.4	343.6	208,328		4.783	1,153,862	26.489
	8.50		610.4	347.6	212,144		4.870	1,258,979	28.902
	9.00		614.4	351.6	215,992		4.958	1,366,012	31.359
	9.50		618.4	355.6	219,871		5.048	1,474,976	33.861
	10.00		622.4	359.6	223,783		5.137	1,585,888	36.407
	10.50		626.4	363.6	227,727		5.228	1,698,765	38.998
	11.00		630.4	367.6	231,703		5.319	1,813,621	41.635
	11.50		634.4	371.6	235,710		5.411	1,930,473	44.318
	12.00		638.4	375.6	239,750		5.504	2,049,336	47.046
	12.50		642.4	379.6	243,822		5.597	2,170,228	49.822
	13.00		646.4	383.6	247,926		5.692	2,293,164	52.644
	13.50		650.4	387.6	252,062		5.787	2,418,159	55.513
	14.00		654.4	391.6	256,229		5.882	2,545,231	58.430
	14.50		658.4	395.6	260,429		5.979	2,674,394	61.396
	15.00		662.4	399.6	264,661		6.076	2,805,665	64.409
	15.50		666.4	403.6	268,925		6.174	2,939,060	67.472
	16.00		670.4	407.6	273,220		6.272	3,074,595	70.583
	16.50		674.4	411.6	277,548		6.372	3,212,286	73.744
	17.00		678.4	415.6	281,908		6.472	3,352,149	76.955
	17.50		682.4	419.6	286,300		6.573	3,494,199	80.216
	18.00		686.4	423.6	290,723		6.674	3,638,454	83.527
	18.50		690.4	427.6	295,179		6.776	3,784,928	86.890
	19.00		694.4	431.6	299,667		6.879	3,933,638	90.304
	19.50		698.4	435.6	304,187		6.983	4,084,600	93.770
	20.00		702.4	439.6	308,739		7.088	4,237,830	97.287
	20.50		706.4	443.6	313,322		7.193	4,393,344	100.857
	21.00		710.4	447.6	317,938		7.299	4,551,158	104.480
	21.50		714.4	451.6	322,586		7.406	4,711,288	108.156
	22.00		718.4	455.6	327,266		7.513	4,873,749	111.886
	22.50		722.4	459.6	331,977		7.621	5,038,558	115.669
	23.00		726.4	463.6	336,721		7.730	5,205,732	119.507
	23.50		730.4	467.6	341,497		7.840	5,375,285	123.400
	24.00		734.4	471.6	346,305		7.950	5,547,234	127.347
	24.50		738.4	475.6	351,144		8.061	5,721,595	131.350
	25.00		742.4	479.6	356,016		8.173	5,898,384	135.408
	25.50		746.4	483.6	360,920		8.286	6,077,617	139.523
	26.00		750.4	487.6	365,856		8.399	6,259,309	143.694
	26.50		754.4	491.6	370,824		8.513	6,443,478	147.922
	27.00		758.4	495.6	375,823		8.628	6,630,138	152.207
	27.50		762.4	499.6	380,855		8.743	6,819,306	156.550
	28.00		766.4	503.6	385,919		8.859	7,010,998	160.950
	28.50		770.4	507.6	391,015		8.976	7,205,230	165.409
	29.00		774.4	511.6	396,142		9.094	7,402,018	169.927
	29.50		778.4	515.6	401,302		9.213	7,601,378	174.504
	30.00		782.4	519.6	406,494		9.332	7,803,326	179.140

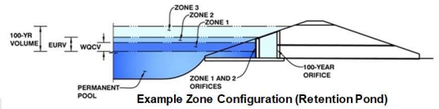
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greely - Oklahoma Basin

Basin ID: Detention_841



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

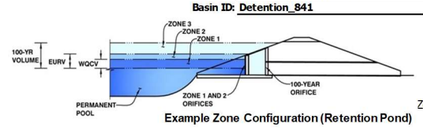
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Overr	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		41.9	41.9	1,753		0.040		
ISV	0.33		41.9	41.9	1,753		0.040	578	0.013
	0.50		41.9	41.9	1,753		0.040	876	0.020
	1.00		76.5	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

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greely - Oklahoma Basin

Basin ID: Detention_841



Example Zone Configuration (Retention Pond)

Clear Input Parameters (Including Tables)

	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		

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 =	7.00	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	10.33	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=	9.00	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 =	12.45	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	14.14	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	110.39	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	4.3	4.9	5.4	40.8	282.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.1	0.0	0.0	0.1	0.6
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.0	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	81	101	117	>120	119
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	60	73	86	108	>120	>120	>120
Maximum Ponding Depth (ft) =	3.57	4.90	4.30	4.82	5.30	6.05	6.70	7.31	8.20
Area at Maximum Ponding Depth (acres) =	4.36	8.99	6.69	8.62	10.70	12.26	12.44	12.62	12.88
Maximum Volume Stored (acre-ft) =	4.452	13.142	8.455	12.349	17.075	25.981	33.886	41.530	53.004

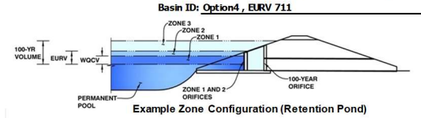
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option4 , EURV 711



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	90.00	acres
Watershed Length =	3,900	ft
Watershed Length to Centroid =	1,738	ft
Watershed Slope =	0.031	ft/ft
Watershed Imperviousness =	30.20%	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) =	1.141	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	2.470	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	1.598	acre-feet	0.85 inches
5-yr Runoff Volume (P1 = 1.12 in.) =	2.010	acre-feet	1.12 inches
10-yr Runoff Volume (P1 = 1.4 in.) =	4.602	acre-feet	1.40 inches
25-yr Runoff Volume (P1 = 1.87 in.) =	8.506	acre-feet	1.87 inches
50-yr Runoff Volume (P1 = 2.3 in.) =	11.792	acre-feet	2.30 inches
100-yr Runoff Volume (P1 = 2.79 in.) =	15.995	acre-feet	2.79 inches
500-yr Runoff Volume (P1 = 4.16 in.) =	27.074	acre-feet	4.16 inches
Approximate 2-yr Detention Volume =	1.515	acre-feet	
Approximate 5-yr Detention Volume =	2.643	acre-feet	
Approximate 10-yr Detention Volume =	3.285	acre-feet	
Approximate 25-yr Detention Volume =	4.314	acre-feet	
Approximate 50-yr Detention Volume =	4.931	acre-feet	
Approximate 100-yr Detention Volume =	6.534	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	1.141	acre-feet
Zone 2 Volume (EURV - Zone 1)	1.329	acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	2.470	acre-feet
Initial Surcharge Volume (ISV) =	578	ft³
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}) =	0.003	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}) =	1,752	ft²
Surcharge Volume Length (L_{ISV}) =	41.9	ft
Surcharge Volume Width (W_{ISV}) =	41.9	ft
Depth of Basin Floor (H_{FLOOR}) =	0.35	ft
Length of Basin Floor (L_{FLOOR}) =	159.9	ft
Width of Basin Floor (W_{FLOOR}) =	100.2	ft
Area of Basin Floor (A_{FLOOR}) =	16,021	ft²
Volume of Basin Floor (V_{FLOOR}) =	2,692	ft³
Depth of Main Basin (H_{MAIN}) =	4.82	ft
Length of Main Basin (L_{MAIN}) =	198.5	ft
Width of Main Basin (W_{MAIN}) =	138.7	ft
Area of Main Basin (A_{MAIN}) =	27,538	ft²
Volume of Main Basin (V_{MAIN}) =	103,732	ft³
Calculated Total Basin Volume (V_{total}) =	**2.477**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 0.50 ft

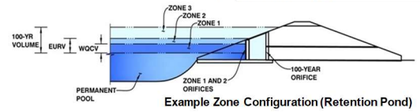
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft²)	Optional Override Area (ft²)	Area (acre)	Volume (ft³)	Volume (ac-ft)
Top of Micropool	0.00		41.9	41.9	1,752		0.040		
ISV	0.33		41.9	41.9	1,752		0.040	578	0.013
	0.50		41.9	41.9	1,752		0.040	876	0.020
	1.00		99.2	70.2	6,962		0.160	2,148	0.049
Floor	1.18		159.9	100.2	16,021		0.368	4,162	0.096
	1.50		162.5	102.7	16,694		0.383	9,396	0.216
	2.00		166.5	106.7	17,771		0.408	18,011	0.413
	2.50		170.5	110.7	18,879		0.433	27,172	0.624
	3.00		174.5	114.7	20,020		0.460	36,896	0.847
	3.50		178.5	118.7	21,193		0.487	47,198	1.084
Zone 1 (WQCV)	3.62		179.4	119.7	21,479		0.493	49,758	1.142
	4.00		182.5	122.7	22,398		0.514	58,094	1.334
	4.50		186.5	126.7	23,635		0.543	69,601	1.598
	5.00		190.5	130.7	24,904		0.572	81,735	1.876
	5.50		194.5	134.7	26,205		0.602	94,511	2.170
Zone 2 (EURV)	5.99		198.4	138.7	27,511		0.632	107,670	2.472
	6.00		198.5	138.7	27,538		0.632	107,945	2.478
	6.50		202.5	142.7	28,903		0.664	122,054	2.802
	7.00		206.5	146.7	30,299		0.696	136,853	3.142
	7.50		210.5	150.7	31,728		0.728	152,358	3.498
	8.00		214.5	154.7	33,189		0.762	168,586	3.870
	8.50		218.5	158.7	34,682		0.796	185,553	4.260
	9.00		222.5	162.7	36,207		0.831	203,274	4.667
	9.50		226.5	166.7	37,764		0.867	221,765	5.091
	10.00		230.5	170.7	39,353		0.903	241,043	5.534
	10.50		234.5	174.7	40,974		0.941	261,123	5.995
	11.00		238.5	178.7	42,627		0.979	282,022	6.474
	11.50		242.5	182.7	44,311		1.017	303,755	6.973
	12.00		246.5	186.7	46,028		1.057	326,339	7.492
	12.50		250.5	190.7	47,777		1.097	349,789	8.030
	13.00		254.5	194.7	49,558		1.138	374,122	8.589
	13.50		258.5	198.7	51,371		1.179	399,353	9.168
	14.00		262.5	202.7	53,216		1.222	425,498	9.768
	14.50		266.5	206.7	55,093		1.265	452,574	10.390
	15.00		270.5	210.7	57,002		1.309	480,596	11.033
	15.50		274.5	214.7	58,943		1.353	509,581	11.698
	16.00		278.5	218.7	60,915		1.398	539,544	12.386
	16.50		282.5	222.7	62,920		1.444	570,502	13.097
	17.00		286.5	226.7	64,957		1.491	602,470	13.831
	17.50		290.5	230.7	67,026		1.539	635,464	14.588
	18.00		294.5	234.7	69,127		1.587	669,501	15.370
	18.50		298.5	238.7	71,260		1.636	704,597	16.175
	19.00		302.5	242.7	73,425		1.686	740,766	17.006
	19.50		306.5	246.7	75,622		1.736	778,027	17.861
	20.00		310.5	250.7	77,851		1.787	816,393	18.742
	20.50		314.5	254.7	80,111		1.839	855,883	19.648
	21.00		318.5	258.7	82,404		1.892	896,510	20.581
	21.50		322.5	262.7	84,729		1.945	938,292	21.540
	22.00		326.5	266.7	87,086		1.999	981,245	22.526
	22.50		330.5	270.7	89,475		2.054	1,025,384	23.540
	23.00		334.5	274.7	91,896		2.110	1,070,725	24.580
	23.50		338.5	278.7	94,349		2.166	1,117,285	25.649
	24.00		342.5	282.7	96,834		2.223	1,165,079	26.747
	24.50		346.5	286.7	99,351		2.281	1,214,124	27.872
	25.00		350.5	290.7	101,899		2.339	1,264,435	29.027
	25.50		354.5	294.7	104,480		2.399	1,316,029	30.212
	26.00		358.5	298.7	107,093		2.459	1,368,921	31.426
	26.50		362.5	302.7	109,738		2.519	1,423,127	32.671
	27.00		366.5	306.7	112,415		2.581	1,478,664	33.945
	27.50		370.5	310.7	115,124		2.643	1,535,548	35.251
	28.00		374.5	314.7	117,865		2.706	1,593,794	36.588
	28.50		378.5	318.7	120,638		2.769	1,653,418	37.957
	29.00		382.5	322.7	123,443		2.834	1,714,437	39.358
	29.50		386.5	326.7	126,279		2.899	1,776,866	40.791
	30.00		390.5	330.7	129,148		2.965	1,840,721	42.257

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option4 , EURV 711



Example Zone Configuration (Retention Pond)

Clear Input Parameters (Including Tables)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.62	1.141	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.99	1.329	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3			Not Utilized	Zone 3 Not Utilized
Total (all zones)		2.470		

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	ft²
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 =	3.62	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	14.50	inches
Orifice Plate: Orifice Area per Row =	4.41	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	3.063E-02	ft²
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft²

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	1.21	2.41					
Orifice Area (sq. inches)	4.41	4.41	4.41					

	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	ft²
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 =	4.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	800.00	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V
Horiz. Length of Weir Sides =	10.00	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 =	7.33	N/A	feet
Overflow Weir Slope Length =	10.54	N/A	feet
Grate Open Area / 100-yr Orifice Area =	11382.38	N/A	
Overflow Grate Open Area w/o Debris =	5869.19	N/A	ft²
Overflow Grate Open Area w/ Debris =	2934.59	N/A	ft²

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.52	N/A	ft²
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=	9.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	59.00	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=	0.96	feet
Stage at Top of Freeboard =	10.96	feet
Basin Area at Top of Freeboard =	0.98	acres
Basin Volume at Top of Freeboard =	6.44	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) =	1.141	2.470	1.598	2.810	4.602	8.506	11.792	15.995	27.074
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.598	2.810	4.602	8.506	11.792	15.995	27.074
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.8	8.6	24.1	64.2	93.3	131.2	225.3
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	0.27	0.71	1.04	1.46	2.50
Peak Inflow Q (cfs) =	N/A	N/A	16.2	29.4	48.3	95.8	131.0	176.7	291.6
Peak Outflow Q (cfs) =	0.7	7.1	4.1	6.7	7.7	52.8	98.6	157.8	291.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.3	0.8	1.1	1.2	1.3
Structure Controlling Flow =	Plate	Outlet Plate 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.00	0.00	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) =	38	40	43	41	40	36	32	27	19
Time to Drain 99% of Inflow Volume (hours) =	**40**	44	46	45	46	45	43	40	35
Maximum Ponding Depth (ft) =	3.62	5.99	4.04	5.15	7.43	9.39	9.62	9.87	10.31
Area at Maximum Ponding Depth (acres) =	0.49	0.63	0.52	0.58	0.72	0.86	0.88	0.89	0.93
Maximum Volume Stored (acre-ft) =	1.142	2.472	1.354	1.963	3.447	4.996	5.196	5.408	5.808

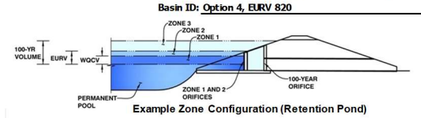
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, EURV 820



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	81.00	acres
Watershed Length =	2,600	ft
Watershed Length to Centroid =	720	ft
Watershed Slope =	0.022	ft/ft
Watershed Imperviousness =	69.80%	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) =	1.850	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	5.493	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.) =	5.323	acre-feet	1.12 inches
10-yr Runoff Volume (P1 = 1.4 in.) =	7.165	acre-feet	1.40 inches
25-yr Runoff Volume (P1 = 1.87 in.) =	10.587	acre-feet	1.87 inches
50-yr Runoff Volume (P1 = 2.3 in.) =	13.634	acre-feet	2.30 inches
100-yr Runoff Volume (P1 = 2.79 in.) =	17.263	acre-feet	2.79 inches
500-yr Runoff Volume (P1 = 4.16 in.) =	27.180	acre-feet	4.16 inches
Approximate 2-yr Detention Volume =	3.526	acre-feet	
Approximate 5-yr Detention Volume =	5.146	acre-feet	
Approximate 10-yr Detention Volume =	6.318	acre-feet	
Approximate 25-yr Detention Volume =	7.856	acre-feet	
Approximate 50-yr Detention Volume =	8.825	acre-feet	
Approximate 100-yr Detention Volume =	10.325	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	1.850	acre-feet
Zone 2 Volume (EURV - Zone 1)	3.643	acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	5.493	acre-feet
Initial Surcharge Volume (ISV) =	578	ft³
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}) =	0.003	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}) =	1,752	ft²
Surcharge Volume Length (L_{ISV}) =	41.9	ft
Surcharge Volume Width (W_{ISV}) =	41.9	ft
Depth of Basin Floor (H_{FLOOR}) =	0.68	ft
Length of Basin Floor (L_{FLOOR}) =	271.2	ft
Width of Basin Floor (W_{FLOOR}) =	155.2	ft
Area of Basin Floor (A_{FLOOR}) =	42,092	ft²
Volume of Basin Floor (V_{FLOOR}) =	11,884	ft³
Depth of Main Basin (H_{MAIN}) =	4.49	ft
Length of Main Basin (L_{MAIN}) =	307.2	ft
Width of Main Basin (W_{MAIN}) =	191.1	ft
Area of Main Basin (A_{MAIN}) =	58,699	ft²
Volume of Main Basin (V_{MAIN}) =	225,245	ft³
Calculated Total Basin Volume (V_{total}) =	**5.477**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 0.50 ft

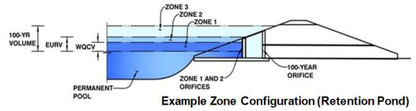
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft²)	Optional Override Area (ft²)	Area (acre)	Volume (ft³)	Volume (ac-ft)
Top of Micropool	0.00		41.9	41.9	1,752		0.040		
ISV	0.33		41.9	41.9	1,752		0.040	578	0.013
	0.50		41.9	41.9	1,752		0.040	876	0.020
	1.00		99.2	70.2	6,962		0.160	2,148	0.049
	1.50		267.9	153.5	41,122		0.944	12,998	0.298
Floor	1.51		271.2	155.2	42,092		0.966	13,414	0.308
	2.00		275.2	159.1	43,779		1.005	34,451	0.791
	2.50		279.2	163.1	45,532		1.045	56,778	1.303
	3.00		283.2	167.1	47,317		1.086	79,988	1.836
Zone 1 (WQCV)	3.02		283.3	167.3	47,389		1.088	80,935	1.858
	3.50		287.2	171.1	49,134		1.128	104,100	2.390
	4.00		291.2	175.1	50,983		1.170	129,128	2.964
	4.50		295.2	179.1	52,864		1.214	155,088	3.560
	5.00		299.2	183.1	54,777		1.258	181,997	4.178
	5.50		303.2	187.1	56,722		1.302	209,871	4.818
	6.00		307.2	191.1	58,699		1.348	238,725	5.480
Zone 2 (EURV)	6.01		307.2	191.2	58,739		1.348	239,312	5.494
	6.50		311.2	195.1	60,708		1.394	268,575	6.166
	7.00		315.2	199.1	62,749		1.441	299,430	6.874
	7.50		319.2	203.1	64,822		1.488	331,330	7.606
	8.00		323.2	207.1	66,927		1.536	364,266	8.362
	8.50		327.2	211.1	69,064		1.586	398,263	9.143
	9.00		331.2	215.1	71,234		1.635	433,336	9.948
	9.50		335.2	219.1	73,435		1.686	469,501	10.778
	10.00		339.2	223.1	75,668		1.737	506,776	11.634
	10.50		343.2	227.1	77,933		1.789	545,174	12.515
	11.00		347.2	231.1	80,230		1.842	584,714	13.423
	11.50		351.2	235.1	82,559		1.895	625,409	14.357
	12.00		355.2	239.1	84,920		1.949	667,278	15.319
	12.50		359.2	243.1	87,313		2.004	710,335	16.307
	13.00		363.2	247.1	89,738		2.060	754,596	17.323
	13.50		367.2	251.1	92,195		2.117	800,078	18.367
	14.00		371.2	255.1	94,684		2.174	846,796	19.440
	14.50		375.2	259.1	97,205		2.232	894,767	20.541
	15.00		379.2	263.1	99,758		2.290	944,007	21.671
	15.50		383.2	267.1	102,343		2.349	994,530	22.831
	16.00		387.2	271.1	104,960		2.410	1,046,355	24.021
	16.50		391.2	275.1	107,609		2.470	1,099,496	25.241
	17.00		395.2	279.1	110,290		2.532	1,153,970	26.491
	17.50		399.2	283.1	113,003		2.594	1,209,792	27.773
	18.00		403.2	287.1	115,748		2.657	1,266,978	29.086
	18.50		407.2	291.1	118,525		2.721	1,325,545	30.430
	19.00		411.2	295.1	121,334		2.785	1,385,509	31.807
	19.50		415.2	299.1	124,176		2.851	1,446,885	33.216
	20.00		419.2	303.1	127,049		2.917	1,509,690	34.658
	20.50		423.2	307.1	129,954		2.983	1,573,939	36.133
	21.00		427.2	311.1	132,891		3.051	1,639,649	37.641
	21.50		431.2	315.1	135,860		3.119	1,706,835	39.184
	22.00		435.2	319.1	138,861		3.188	1,775,514	40.760
	22.50		439.2	323.1	141,894		3.257	1,845,701	42.371
	23.00		443.2	327.1	144,959		3.328	1,917,413	44.018
	23.50		447.2	331.1	148,056		3.399	1,990,665	45.699
	24.00		451.2	335.1	151,185		3.471	2,065,474	47.417
	24.50		455.2	339.1	154,346		3.543	2,141,856	49.170
	25.00		459.2	343.1	157,539		3.617	2,219,826	50.960
	25.50		463.2	347.1	160,764		3.691	2,299,400	52.787
	26.00		467.2	351.1	164,021		3.765	2,380,595	54.651
	26.50		471.2	355.1	167,310		3.841	2,463,427	56.552
	27.00		475.2	359.1	170,631		3.917	2,547,911	58.492
	27.50		479.2	363.1	173,984		3.994	2,634,063	60.470
	28.00		483.2	367.1	177,369		4.072	2,721,900	62.486
	28.50		487.2	371.1	180,786		4.150	2,811,438	64.542
	29.00		491.2	375.1	184,235		4.229	2,902,692	66.637
	29.50		495.2	379.1	187,717		4.309	2,995,679	68.771
	30.00		499.2	383.1	191,230		4.390	3,090,414	70.946

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, EURV 820



Example Zone Configuration (Retention Pond)

Clear Input Parameters (Including Tables)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.02	1.850	Orifice Plate	Orifice Plate
Zone 2 (EURV)	6.01	3.643	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3			Not Utilized	Zone 3 Not Utilized
Total (all zones)		5.493		

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	ft²
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 =	3.60	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	14.40	inches
Orifice Plate: Orifice Area per Row =	7.34	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	5.097E-02	ft²
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft²

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

Size Plate to match WQCV Drain Time

	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	1.20	2.40					
Orifice Area (sq. inches)	7.34	7.34	7.34					

	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	ft²
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 =	3.02	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	800.00	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V
Horiz. Length of Weir Sides =	10.00	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 =	6.35	N/A	feet
Overflow Weir Slope Length =	10.54	N/A	feet
Grate Open Area / 100-yr Orifice Area =	11382.38	N/A	
Overflow Grate Open Area w/o Debris =	5869.19	N/A	ft²
Overflow Grate Open Area w/ Debris =	2934.59	N/A	ft²

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 =	3.00	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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.52	N/A	ft²
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=	6.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	72.00	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=	0.97	feet
Stage at Top of Freeboard =	7.97	feet
Basin Area at Top of Freeboard =	1.53	acres
Basin Volume at Top of Freeboard =	8.32	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) =	1.850	5.493	3.732	5.323	7.165	10.587	13.634	17.263	27.180
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.732	5.323	7.165	10.587	13.634	17.263	27.180
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.1	11.7	32.5	82.7	120.4	166.0	285.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.14	0.40	1.02	1.49	2.05	3.52
Peak Inflow Q (cfs) =	N/A	N/A	76.5	108.0	143.4	215.3	277.2	355.1	547.6
Peak Outflow Q (cfs) =	0.9	7.3	6.4	7.0	17.3	102.6	169.8	269.5	507.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.5	1.2	1.4	1.6	1.8
Structure Controlling Flow =	Overflow Weir 1	Spillway	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.00	0.00	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) =	38	40	40	41	41	38	36	33	27
Time to Drain 99% of Inflow Volume (hours) =	**40**	45	43	45	46	45	44	43	40
Maximum Ponding Depth (ft) =	3.02	6.01	3.98	5.16	6.13	6.57	6.81	7.10	7.67
Area at Maximum Ponding Depth (acres) =	1.09	1.35	1.17	1.27	1.36	1.40	1.42	1.45	1.50
Maximum Volume Stored (acre-ft) =	1.858	5.494	2.941	4.368	5.643	6.249	6.588	7.019	7.846

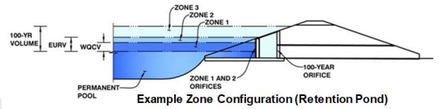
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 842, EURV



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	**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

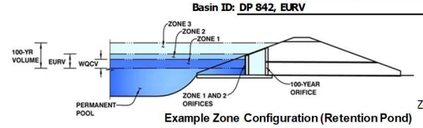
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		26.3	26.3	694		0.016		
ISV	0.50		26.3	26.3	694		0.016	347	0.008
	0.75		26.3	26.3	694		0.016	521	0.012
	1.00		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

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 842, EURV



Example Zone Configuration (Retention Pond)

Clear Input Parameters (Including Tables)

	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)

			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 =	4.924E-02	ft^2
Depth at top of Zone using Orifice Plate =	3.38	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	21.20	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	7.09	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	2.25					
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		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 =	3.38	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.38	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 =	19.36	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 =	0.58	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.32	N/A	feet
Restrictor Plate Height Above Pipe Invert =	6.50		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.29	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	6.51	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.36	feet
Spillway Crest Length =	1000.00	feet	Stage at Top of Freeboard =	7.87	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	10.41	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	40.08	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
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

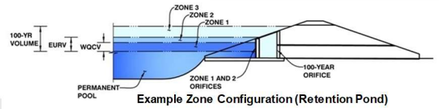
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 840, 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) =	0.986 acre-feet	0.986	acre-feet
Excess Urban Runoff Volume (EURV) =	5.367 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	3.261 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	4.496 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	5.952 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	8.664 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	11.063 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	13.930 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	21.754 acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	3.057 acre-feet		
Approximate 5-yr Detention Volume =	4.250 acre-feet		
Approximate 10-yr Detention Volume =	5.588 acre-feet		
Approximate 25-yr Detention Volume =	7.033 acre-feet		
Approximate 50-yr Detention Volume =	7.997 acre-feet		
Approximate 100-yr Detention Volume =	9.192 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

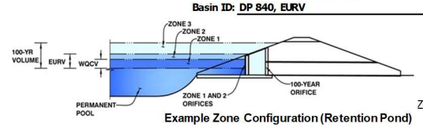
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		16.1	16.1	258		0.006		
ISV	0.50		16.1	16.1	258		0.006	129	0.003
	0.75		16.1	16.1	258		0.006	193	0.004
	1.00		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

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 840, EURV



Example Zone Configuration (Retention Pond)

Clear Input Parameters (Including Tables)

	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

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

Size Plate to match WQCV Drain Time

	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

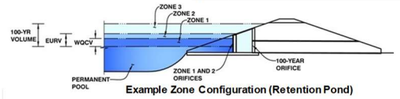
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oldahoma Drainage MP

Basin ID: Option 4, EURV 830



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	90.00	acres
Watershed Length =	2,406	ft
Watershed Length to Centroid =	1,738	ft
Watershed Slope =	0.031	ft/ft
Watershed Imperviousness =	67.80%	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) =	1.991 acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	5.915 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	4.073 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	5.035 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	7.895 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	11.755 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	15.181 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	19.277 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	30.442 acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	3.791 acre-feet		
Approximate 5-yr Detention Volume =	5.563 acre-feet		
Approximate 10-yr Detention Volume =	6.823 acre-feet		
Approximate 25-yr Detention Volume =	8.494 acre-feet		
Approximate 50-yr Detention Volume =	9.547 acre-feet		
Approximate 100-yr Detention Volume =	11.222 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	1.991	acre-feet
Zone 2 Volume (EURV - Zone 1)	3.924	acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	5.915	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}) =	0.003	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}) =	1,752	ft^2
Surcharge Volume Length (L_{ISV}) =	41.9	ft
Surcharge Volume Width (W_{ISV}) =	41.9	ft
Depth of Basin Floor (H_{FLOOR}) =	0.72	ft
Length of Basin Floor (L_{FLOOR}) =	284.7	ft
Width of Basin Floor (W_{FLOOR}) =	161.9	ft
Area of Basin Floor (A_{FLOOR}) =	46,084	ft^2
Volume of Basin Floor (V_{FLOOR}) =	13,637	ft^3
Depth of Main Basin (H_{MAIN}) =	4.45	ft
Length of Main Basin (L_{MAIN}) =	320.3	ft
Width of Main Basin (W_{MAIN}) =	197.5	ft
Area of Main Basin (A_{MAIN}) =	63,250	ft^2
Volume of Main Basin (V_{MAIN}) =	242,262	ft^3
Calculated Total Basin Volume (V_{total}) =	**5.908**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 0.50 ft

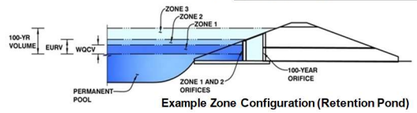
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		41.9	41.9	1,752		0.040		
ISV	0.33		41.9	41.9	1,752		0.040	578	0.013
	0.50		41.9	41.9	1,752		0.040	876	0.020
	1.00		99.2	70.2	6,962		0.160	2,148	0.049
	1.50		267.9	153.5	41,122		0.944	12,998	0.298
Floor	1.55		284.7	161.9	46,084		1.058	15,177	0.348
	2.00		288.3	165.5	47,705		1.095	36,279	0.833
	2.50		292.3	169.5	49,536		1.137	60,587	1.391
	3.00		296.3	173.5	51,399		1.180	85,820	1.970
Zone 1 (WQCV)	3.02		296.5	173.6	51,474		1.182	86,848	1.994
	3.50		300.3	177.5	53,294		1.223	111,992	2.571
	4.00		304.3	181.5	55,221		1.268	139,119	3.194
	4.50		308.3	185.5	57,180		1.313	167,218	3.839
	5.00		312.3	189.5	59,171		1.358	196,305	4.507
	5.50		316.3	193.5	61,195		1.405	226,395	5.197
	6.00		320.3	197.5	63,250		1.452	257,505	5.911
Zone 2 (EURV)	6.01		320.4	197.5	63,291		1.453	258,137	5.926
	6.50		324.3	201.5	65,337		1.500	289,650	6.649
	7.00		328.3	205.5	67,456		1.549	322,047	7.412
	7.50		332.3	209.5	69,607		1.598	357,111	8.198
	8.00		336.3	213.5	71,790		1.648	392,459	9.010
	8.50		340.3	217.5	74,005		1.699	428,907	9.846
	9.00		344.3	221.5	76,253		1.751	466,470	10.709
	9.50		348.3	225.5	78,532		1.803	505,165	11.597
	10.00		352.3	229.5	80,843		1.856	545,007	12.512
	10.50		356.3	233.5	83,186		1.910	586,013	13.453
	11.00		360.3	237.5	85,561		1.964	628,198	14.421
	11.50		364.3	241.5	87,968		2.019	671,579	15.417
	12.00		368.3	245.5	90,407		2.075	716,172	16.441
	12.50		372.3	249.5	92,878		2.132	761,992	17.493
	13.00		376.3	253.5	95,382		2.190	809,056	18.573
	13.50		380.3	257.5	97,917		2.248	857,379	19.683
	14.00		384.3	261.5	100,484		2.307	906,978	20.821
	14.50		388.3	265.5	103,083		2.366	957,868	21.990
	15.00		392.3	269.5	105,714		2.427	1,010,066	23.188
	15.50		396.3	273.5	108,377		2.488	1,063,587	24.417
	16.00		400.3	277.5	111,072		2.550	1,118,448	25.676
	16.50		404.3	281.5	113,799		2.612	1,174,665	26.967
	17.00		408.3	285.5	116,559		2.676	1,232,253	28.289
	17.50		412.3	289.5	119,350		2.740	1,291,229	29.643
	18.00		416.3	293.5	122,173		2.805	1,351,608	31.029
	18.50		420.3	297.5	125,028		2.870	1,413,407	32.447
	19.00		424.3	301.5	127,915		2.937	1,476,641	33.899
	19.50		428.3	305.5	130,834		3.004	1,541,327	35.384
	20.00		432.3	309.5	133,785		3.071	1,607,481	36.903
	20.50		436.3	313.5	136,768		3.140	1,675,118	38.455
	21.00		440.3	317.5	139,784		3.209	1,744,255	40.043
	21.50		444.3	321.5	142,831		3.279	1,814,907	41.665
	22.00		448.3	325.5	145,910		3.350	1,887,091	43.322
	22.50		452.3	329.5	149,021		3.421	1,960,822	45.014
	23.00		456.3	333.5	152,164		3.493	2,036,117	46.743
	23.50		460.3	337.5	155,339		3.566	2,112,992	48.508
	24.00		464.3	341.5	158,546		3.640	2,191,462	50.309
	24.50		468.3	345.5	161,785		3.714	2,271,543	52.147
	25.00		472.3	349.5	165,057		3.789	2,353,253	54.023
	25.50		476.3	353.5	168,360		3.865	2,436,605	55.937
	26.00		480.3	357.5	171,695		3.942	2,521,618	57.888
	26.50		484.3	361.5	175,062		4.019	2,608,305	59.878
	27.00		488.3	365.5	178,461		4.097	2,696,685	61.907
	27.50		492.3	369.5	181,892		4.176	2,786,772	63.975
	28.00		496.3	373.5	185,355		4.255	2,878,583	66.083
	28.50		500.3	377.5	188,851		4.335	2,972,133	68.231
	29.00		504.3	381.5	192,378		4.416	3,067,438	70.419
	29.50		508.3	385.5	195,937		4.498	3,164,516	72.647
	30.00		512.3	389.5	199,528		4.581	3,263,381	74.917

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oldahoma Drainage MP

Basin ID: Option 4, EURV 830



Example Zone Configuration (Retention Pond)

Clear Input Parameters (Including Tables)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.02	1.991	Orifice Plate	Orifice Plate
Zone 2 (EURV)	6.01	3.924	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3			Not Utilized	Zone 3 Not Utilized
Total (all zones)		5.915		

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 =	3.02	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	12.10	inches
Orifice Plate: Orifice Area per Row =	6.97	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	4.840E-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	1.01	2.01					
Orifice Area (sq. inches)	6.97	6.97	6.97					

	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 =	3.02	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	800.00	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V
Horiz. Length of Weir Sides =	10.00	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 =	6.35	N/A	feet
Overflow Weir Slope Length =	10.54	N/A	feet
Grate Open Area / 100-yr Orifice Area =	12272.31	N/A	
Overflow Grate Open Area w/o Debris =	5869.19	N/A	ft^2
Overflow Grate Open Area w/ Debris =	2934.59	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 =	16.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	6.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.48	N/A	ft^2
Outlet Orifice Centroid =	0.29	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.32	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.10	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	117.00	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=	0.98	feet
Stage at Top of Freeboard =	8.08	feet
Basin Area at Top of Freeboard =	1.66	acres
Basin Volume at Top of Freeboard =	9.14	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) =	1.991	5.915	4.073	5.835	7.895	11.755	15.181	19.277	30.442
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	4.073	5.835	7.895	11.755	15.181	19.277	30.442
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.0	10.6	29.5	76.5	111.1	155.2	266.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.12	0.33	0.85	1.23	1.72	2.96
Peak Inflow Q (cfs) =	N/A	N/A	72.5	103.5	139.7	214.5	275.9	352.0	546.5
Peak Outflow Q (cfs) =	1.0	6.6	5.8	6.3	21.4	114.7	194.4	298.5	552.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.7	1.5	1.7	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	0.00	0.00	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) =	38	42	41	43	43	40	37	34	27
Time to Drain 99% of Inflow Volume (hours) =	**40**	46	44	47	48	47	46	44	41
Maximum Ponding Depth (ft) =	3.02	6.01	4.10	5.33	6.22	6.55	6.75	6.97	7.41
Area at Maximum Ponding Depth (acres) =	1.18	1.45	1.28	1.39	1.47	1.50	1.52	1.54	1.59
Maximum Volume Stored (acre-ft) =	1.994	5.926	3.308	4.946	6.233	6.725	7.027	7.350	8.055

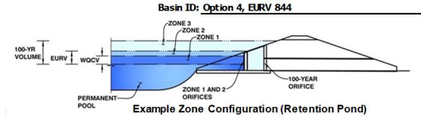
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, EURV 844



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	126.50	acres
Watershed Length =	2,939	ft
Watershed Length to Centroid =	1,428	ft
Watershed Slope =	0.031	ft/ft
Watershed Imperviousness =	76.20%	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) =	3.226	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	9.432	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	6.396	acre-feet	0.85 inches
5-yr Runoff Volume (P1 = 1.12 in.) =	9.013	acre-feet	1.12 inches
10-yr Runoff Volume (P1 = 1.4 in.) =	11.961	acre-feet	1.40 inches
25-yr Runoff Volume (P1 = 1.87 in.) =	17.299	acre-feet	1.87 inches
50-yr Runoff Volume (P1 = 2.3 in.) =	22.084	acre-feet	2.30 inches
100-yr Runoff Volume (P1 = 2.79 in.) =	27.727	acre-feet	2.79 inches
500-yr Runoff Volume (P1 = 4.16 in.) =	43.218	acre-feet	4.16 inches
Approximate 2-yr Detention Volume =	6.083	acre-feet	
Approximate 5-yr Detention Volume =	8.736	acre-feet	
Approximate 10-yr Detention Volume =	10.760	acre-feet	
Approximate 25-yr Detention Volume =	13.343	acre-feet	
Approximate 50-yr Detention Volume =	14.954	acre-feet	
Approximate 100-yr Detention Volume =	17.253	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	3.226	acre-feet
Zone 2 Volume (EURV - Zone 1)	6.206	acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	9.432	acre-feet
Initial Surcharge Volume (ISV) =	578	ft³
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}) =	0.003	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}) =	1,752	ft²
Surcharge Volume Length (L_{ISV}) =	41.9	ft
Surcharge Volume Width (W_{ISV}) =	41.9	ft
Depth of Basin Floor (H_{FLOOR}) =	1.01	ft
Length of Basin Floor (L_{FLOOR}) =	382.6	ft
Width of Basin Floor (W_{FLOOR}) =	210.2	ft
Area of Basin Floor (A_{FLOOR}) =	80,408	ft²
Volume of Basin Floor (V_{FLOOR}) =	31,656	ft³
Depth of Main Basin (H_{MAIN}) =	4.16	ft
Length of Main Basin (L_{MAIN}) =	415.8	ft
Width of Main Basin (W_{MAIN}) =	243.5	ft
Area of Main Basin (A_{MAIN}) =	101,242	ft²
Volume of Main Basin (V_{MAIN}) =	377,000	ft³
Calculated Total Basin Volume (V_{total}) =	**9.415**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 0.50 ft

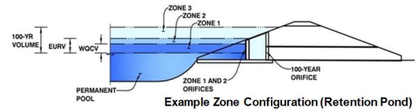
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft²)	Optional Override Area (ft²)	Area (acre)	Volume (ft³)	Volume (ac-ft)
Top of Micropool	0.00		41.9	41.9	1,752		0.040		
ISV	0.33		41.9	41.9	1,752		0.040	578	0.013
	0.50		41.9	41.9	1,752		0.040	876	0.020
	1.00		99.2	70.2	6,962		0.160	2,148	0.049
	1.50		267.9	153.5	41,122		0.944	12,998	0.298
Floor	1.84		382.6	210.2	80,408		1.846	33,290	0.764
	2.00		383.8	211.5	81,168		1.863	46,216	1.061
	2.50		387.8	215.5	83,565		1.918	87,398	2.006
	3.00		391.8	219.5	85,994		1.974	129,786	2.979
Zone 1 (WQCV)	3.13		392.9	220.5	86,631		1.989	141,007	3.237
	3.50		395.8	223.5	88,456		2.031	173,398	3.981
	4.00		399.8	227.5	90,949		2.088	218,247	5.010
	4.50		403.8	231.5	93,474		2.146	264,352	6.069
	5.00		407.8	235.5	96,031		2.205	311,727	7.156
	5.50		411.8	239.5	98,621		2.264	360,388	8.273
	6.00		415.8	243.5	101,242		2.324	410,353	9.420
Zone 2 (EURV)	6.01		415.9	243.5	101,294		2.325	411,365	9.444
	6.50		419.8	247.5	103,895		2.385	461,636	10.598
	7.00		423.0	251.5	106,500		2.447	514,253	11.806
	7.50		427.8	255.5	109,297		2.509	568,221	13.045
	8.00		431.8	259.5	112,047		2.572	623,556	14.315
	8.50		435.8	263.5	114,828		2.636	680,273	15.617
	9.00		439.8	267.5	117,641		2.701	738,389	16.951
	9.50		443.8	271.5	120,486		2.766	797,919	18.318
	10.00		447.8	275.5	123,363		2.832	858,880	19.717
	10.50		451.8	279.5	126,273		2.899	921,288	21.150
	11.00		455.8	283.5	129,214		2.966	985,158	22.616
	11.50		459.8	287.5	132,187		3.035	1,050,507	24.116
	12.00		463.8	291.5	135,192		3.104	1,117,350	25.651
	12.50		467.8	295.5	138,229		3.173	1,185,705	27.220
	13.00		471.8	299.5	141,299		3.244	1,255,585	28.824
	13.50		475.8	303.5	144,400		3.315	1,327,009	30.464
	14.00		479.8	307.5	147,533		3.387	1,399,990	32.139
	14.50		483.8	311.5	150,698		3.460	1,474,547	33.851
	15.00		487.8	315.5	153,895		3.533	1,550,694	35.599
	15.50		491.8	319.5	157,125		3.607	1,628,448	37.384
	16.00		495.8	323.5	160,386		3.682	1,707,824	39.206
	16.50		499.8	327.5	163,679		3.758	1,788,839	41.066
	17.00		503.8	331.5	167,004		3.834	1,871,508	42.964
	17.50		507.8	335.5	170,362		3.911	1,955,849	44.900
	18.00		511.8	339.5	173,751		3.989	2,041,875	46.875
	18.50		515.8	343.5	177,172		4.067	2,129,605	48.889
	19.00		519.8	347.5	180,625		4.147	2,219,053	50.942
	19.50		523.8	351.5	184,110		4.227	2,310,235	53.036
	20.00		527.8	355.5	187,628		4.307	2,403,168	55.169
	20.50		531.8	359.5	191,177		4.389	2,497,868	57.343
	21.00		535.8	363.5	194,758		4.471	2,594,350	59.558
	21.50		539.8	367.5	198,371		4.554	2,692,631	61.814
	22.00		543.8	371.5	202,016		4.638	2,792,727	64.112
	22.50		547.8	375.5	205,694		4.722	2,894,653	66.452
	23.00		551.8	379.5	209,403		4.807	2,998,426	68.834
	23.50		555.8	383.5	213,144		4.893	3,104,061	71.259
	24.00		559.8	387.5	216,917		4.980	3,211,575	73.728
	24.50		563.8	391.5	220,722		5.067	3,320,984	76.239
	25.00		567.8	395.5	224,560		5.155	3,432,303	78.795
	25.50		571.8	399.5	228,429		5.244	3,545,549	81.395
	26.00		575.8	403.5	232,330		5.334	3,660,737	84.039
	26.50		579.8	407.5	236,263		5.424	3,777,884	86.728
	27.00		583.8	411.5	240,228		5.515	3,897,006	89.463
	27.50		587.8	415.5	244,226		5.607	4,018,118	92.243
	28.00		591.8	419.5	248,255		5.699	4,141,237	95.070
	28.50		595.8	423.5	252,316		5.792	4,266,378	97.943
	29.00		599.8	427.5	256,409		5.886	4,393,558	100.862
	29.50		603.8	431.5	260,535		5.981	4,522,793	103.829
	30.00		607.8	435.5	264,692		6.076	4,654,098	106.843

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, EURV 844



Example Zone Configuration (Retention Pond)

Clear Input Parameters (Including Tables)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.13	3.226	Orifice Plate	Orifice Plate
Zone 2 (EURV)	6.01	6.206	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3			Not Utilized	Zone 3 Not Utilized
Total (all zones)		9.432		

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	ft²
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 =	3.63	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	14.50	inches
Orifice Plate: Orifice Area per Row =	11.60	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	8.056E-02	ft²
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft²

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

Size Plate to match WQCV Drain Time

	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	1.21	2.42					
Orifice Area (sq. inches)	11.60	11.60	11.60					

	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	ft²
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 =	3.13	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	800.00	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V
Horiz. Length of Weir Sides =	10.00	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 =	6.46	N/A	feet
Overflow Weir Slope Length =	10.54	N/A	feet
Grate Open Area / 100-yr Orifice Area =	11382.38	N/A	
Overflow Grate Open Area w/o Debris =	5869.19	N/A	ft²
Overflow Grate Open Area w/ Debris =	2934.59	N/A	ft²

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 =	3.00	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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.52	N/A	ft²
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=	6.10	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	183.00	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=	0.98	feet
Stage at Top of Freeboard =	8.08	feet
Basin Area at Top of Freeboard =	2.58	acres
Basin Volume at Top of Freeboard =	14.52	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) =	3.226	9.432	6.396	9.013	11.961	17.299	22.084	27.727	43.218
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.396	9.013	11.961	17.299	22.084	27.727	43.218
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.6	16.9	46.2	119.1	172.4	241.0	412.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.13	0.36	0.94	1.36	1.90	3.26
Peak Inflow Q (cfs) =	N/A	N/A	126.7	175.8	229.8	339.1	430.4	547.8	840.3
Peak Outflow Q (cfs) =	1.5	7.3	6.5	7.1	28.9	156.4	272.4	435.5	823.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.6	1.3	1.6	1.8	2.0
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	0.00	0.00	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) =	38	46	43	46	47	45	42	40	34
Time to Drain 99% of Inflow Volume (hours) =	**40**	50	46	50	52	51	50	49	46
Maximum Ponding Depth (ft) =	3.13	6.01	4.25	5.38	6.21	6.52	6.71	6.94	7.38
Area at Maximum Ponding Depth (acres) =	1.99	2.33	2.12	2.25	2.35	2.39	2.41	2.44	2.49
Maximum Volume Stored (acre-ft) =	3.237	9.444	5.515	7.980	9.911	10.622	11.101	11.635	12.744

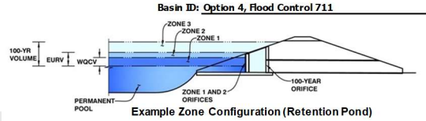
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, Flood Control 711



Example Zone Configuration (Retention Pond)

Watershed Information — **Flood Control Only**

Flood Control Only	**No BMP**	
Watershed Area =	90.00	acres
Watershed Length =	3,900	ft
Watershed Length to Centroid =	1,738	ft
Watershed Slope =	0.031	ft/ft
Watershed Imperviousness =	30.20%	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 =	N/A	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) =	1.141	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	2.470	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	1.598	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	2.810	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	4.602	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	8.506	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	11.792	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	15.995	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	27.074	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	1.515	acre-feet		
Approximate 5-yr Detention Volume =	2.643	acre-feet		
Approximate 10-yr Detention Volume =	3.285	acre-feet		
Approximate 25-yr Detention Volume =	4.314	acre-feet		
Approximate 50-yr Detention Volume =	4.931	acre-feet		
Approximate 100-yr Detention Volume =	6.534	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (100-year)	6.534	acre-feet
Select Zone 2 Storage Volume (Optional)		acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	6.534	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	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}) =	0.003	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}) =	271.7	ft
Width of Basin Floor (W_{FLOOR}) =	135.9	ft
Area of Basin Floor (A_{FLOOR}) =	36,922	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{MAIN}) =	6.00	ft
Length of Main Basin (L_{MAIN}) =	319.7	ft
Width of Main Basin (W_{MAIN}) =	183.9	ft
Area of Main Basin (A_{MAIN}) =	58,791	ft^2
Volume of Main Basin (V_{MAIN}) =	284,607	ft^3
Calculated Total Basin Volume (V_{total}) =	**6.534**	acre-feet

Depth Increment = 0.50 ft

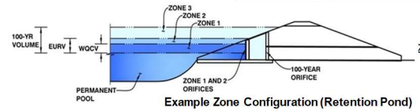
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		271.7	135.9	36,922		0.848		
	0.50		275.7	139.9	38,568		0.885	18,871	0.433
	1.00		279.7	143.9	40,247		0.924	38,574	0.886
	1.50		283.7	147.9	41,957		0.963	59,123	1.357
	2.00		287.7	151.9	43,700		1.003	80,536	1.849
	2.50		291.7	155.9	45,474		1.044	102,828	2.361
	3.00		295.7	159.9	47,280		1.085	126,015	2.893
	3.50		299.7	163.9	49,119		1.128	150,114	3.446
	4.00		303.7	167.9	50,989		1.171	175,139	4.021
	4.50		307.7	171.9	52,892		1.214	201,108	4.617
	5.00		311.7	175.9	54,826		1.259	228,036	5.235
	5.50		315.7	179.9	56,793		1.304	255,940	5.876
Zone 1 (100-year)	6.00		319.7	183.9	58,791		1.350	284,834	6.539
	6.50		323.7	187.9	60,822		1.396	314,736	7.225
	7.00		327.7	191.9	62,884		1.444	345,661	7.935
	7.50		331.7	195.9	64,978		1.492	377,626	8.669
	8.00		335.7	199.9	67,105		1.541	410,645	9.427
	8.50		339.7	203.9	69,263		1.590	444,736	10.210
	9.00		343.7	207.9	71,454		1.640	479,914	11.017
	9.50		347.7	211.9	73,676		1.691	516,195	11.850
	10.00		351.7	215.9	75,931		1.743	553,595	12.709
	10.50		355.7	219.9	78,217		1.796	592,131	13.593
	11.00		359.7	223.9	80,536		1.849	631,818	14.505
	11.50		363.7	227.9	82,886		1.903	672,672	15.442
	12.00		367.7	231.9	85,268		1.957	714,709	16.407
	12.50		371.7	235.9	87,683		2.013	757,946	17.400
	13.00		375.7	239.9	90,129		2.069	802,398	18.421
	13.50		379.7	243.9	92,608		2.126	848,081	19.469
	14.00		383.7	247.9	95,118		2.184	895,011	20.547
	14.50		387.7	251.9	97,661		2.242	943,204	21.653
	15.00		391.7	255.9	100,235		2.301	992,677	22.789
	15.50		395.7	259.9	102,842		2.361	1,043,445	23.954
	16.00		399.7	263.9	105,480		2.421	1,095,524	25.150
	16.50		403.7	267.9	108,151		2.483	1,148,930	26.376
	17.00		407.7	271.9	110,853		2.545	1,203,680	27.633
	17.50		411.7	275.9	113,587		2.608	1,259,788	28.921
	18.00		415.7	279.9	116,354		2.671	1,317,272	30.240
	18.50		419.7	283.9	119,152		2.735	1,376,148	31.592
	19.00		423.7	287.9	121,983		2.800	1,436,430	32.976
	19.50		427.7	291.9	124,845		2.866	1,498,136	34.392
	20.00		431.7	295.9	127,740		2.932	1,561,281	35.842
	20.50		435.7	299.9	130,666		3.000	1,625,881	37.325
	21.00		439.7	303.9	133,625		3.068	1,691,952	38.842
	21.50		443.7	307.9	136,615		3.136	1,759,511	40.393
	22.00		447.7	311.9	139,637		3.206	1,828,573	41.978
	22.50		451.7	315.9	142,692		3.276	1,899,154	43.599
	23.00		455.7	319.9	145,778		3.347	1,971,270	45.254
	23.50		459.7	323.9	148,897		3.418	2,044,937	46.945
	24.00		463.7	327.9	152,047		3.491	2,120,172	48.672
	24.50		467.7	331.9	155,230		3.564	2,196,990	50.436
	25.00		471.7	335.9	158,444		3.637	2,275,407	52.236
	25.50		475.7	339.9	161,691		3.712	2,355,439	54.073
	26.00		479.7	343.9	164,969		3.787	2,437,103	55.948
	26.50		483.7	347.9	168,280		3.863	2,520,414	57.861
	27.00		487.7	351.9	171,622		3.940	2,605,388	59.811
	27.50		491.7	355.9	174,996		4.017	2,692,041	61.801
	28.00		495.7	359.9	178,403		4.096	2,780,390	63.829
	28.50		499.7	363.9	181,841		4.175	2,870,449	65.896
	29.00		503.7	367.9	185,312		4.254	2,962,236	68.004
	29.50		507.7	371.9	188,814		4.335	3,055,766	70.151
	30.00		511.7	375.9	192,349		4.416	3,151,056	72.338

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, Flood Control 711



Example Zone Configuration (Retention Pond)

Clear Input Parameters (Including Tables)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (100-year)	6.00	6.534	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 2				Select Zone 2 Outlet Type
Zone 3				Select Zone 3 Outlet Type
Total (all zones)		6.534		

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 =	6.00		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	Size Emergency Spillway to pass Developed 100-yr Peak Runoff Rate	Basin Area at Top of Freeboard =	acres
Freeboard above Max Water Surface =		feet		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) =	1.141	2.470	1.598	2.810	4.602	8.506	11.792	15.995	27.074
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.598	2.810	4.602	8.506	11.792	16.052	27.074
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.8	8.6	24.1	64.2	93.3	131.2	225.3
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	0.27	0.71	1.04	1.46	2.50
Peak Inflow Q (cfs) =	N/A	N/A	16.2	29.4	48.3	95.8	131.0	172.2	291.6
Peak Outflow Q (cfs) =	17.5	60.7	8.1	17.0	30.7	69.9	100.5	138.0	241.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.0	1.3	1.1	1.1	1.1	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	ertical 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) =	14	8	12	8	6	5	4	4	3
Time to Drain 99% of Inflow Volume (hours) =	**34**	19	27	18	13	9	7	7	5
Maximum Ponding Depth (ft) =	1.28	2.61	0.79	1.19	1.65	2.60	3.18	3.78	5.29
Area at Maximum Ponding Depth (acres) =	0.95	1.05	0.91	0.94	0.98	1.05	1.10	1.15	1.28
Maximum Volume Stored (acre-ft) =	1.147	2.476	0.693	1.053	1.503	2.455	3.079	3.765	5.604

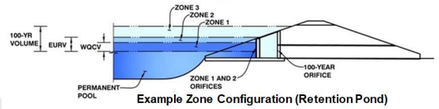
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, Flood Control 823



Example Zone Configuration (Retention Pond)

Watershed Information — Flood Control Only

Flood Control Only	No BMP	
Watershed Area =	327.00	acres
Watershed Length =	4,753	ft
Watershed Length to Centroid =	2,751	ft
Watershed Slope =	0.012	ft/ft
Watershed Imperviousness =	72.98%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	N/A	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) =	7.879	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	23.271	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	16.082	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	22.795	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	30.462	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	44.522	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	57.083	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	71.969	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	112.726	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	14.974	acre-feet		
Approximate 5-yr Detention Volume =	21.673	acre-feet		
Approximate 10-yr Detention Volume =	26.650	acre-feet		
Approximate 25-yr Detention Volume =	33.089	acre-feet		
Approximate 50-yr Detention Volume =	37.124	acre-feet		
Approximate 100-yr Detention Volume =	43.128	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (100-year)	43.128	acre-feet
Select Zone 2 Storage Volume (Optional)		acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	43.128	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = 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)
Media Surface	--	0.00	--	--	--	37,664	0.865		
	--	1.00	--	--	--	77,436	1.778	57,550	1.321
	--	2.00	--	--	--	133,078	3.055	162,807	3.738
	--	3.00	--	--	--	163,864	3.762	311,278	7.146
	--	4.00	--	--	--	190,605	4.376	488,512	11.215
	--	5.00	--	--	--	204,897	4.704	686,263	15.754
	--	6.00	--	--	--	215,528	4.948	896,476	20.580
	--	7.00	--	--	--	226,286	5.195	1,117,383	25.652
	--	8.00	--	--	--	237,198	5.445	1,349,125	30.972
	--	8.49	--	--	--	273,603	6.281	1,474,271	33.845
	--	9.00	--	--	--	273,603	6.281	1,613,808	37.048
	--	10.00	--	--	--	273,603	6.281	1,887,411	43.329
	--		--	--	--				
	--		--	--	--				
	--		--	--	--			

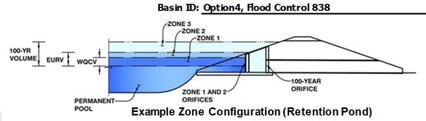
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option4, Flood Control 838



Example Zone Configuration (Retention Pond)

Watershed Information — **Flood Control Only**

Flood Control Only	**No BMP**	
Watershed Area =	126.50	acres
Watershed Length =	2,939	ft
Watershed Length to Centroid =	1,428	ft
Watershed Slope =	0.031	ft/ft
Watershed Imperviousness =	76.20%	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 =	N/A	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) =	3.226	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	9.432	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	6.396	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	9.013	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	11.961	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	17.299	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	22.084	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	27.727	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	43.218	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	6.083	acre-feet		
Approximate 5-yr Detention Volume =	8.736	acre-feet		
Approximate 10-yr Detention Volume =	10.760	acre-feet		
Approximate 25-yr Detention Volume =	13.343	acre-feet		
Approximate 50-yr Detention Volume =	14.954	acre-feet		
Approximate 100-yr Detention Volume =	17.253	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (100-year)	17.253	acre-feet
Select Zone 2 Storage Volume (Optional)		acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	17.253	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	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}) =	0.003	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}) =	464.4	ft
Width of Basin Floor (W_{FLOOR}) =	232.2	ft
Area of Basin Floor (A_{FLOOR}) =	107,813	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{MAIN}) =	6.00	ft
Length of Main Basin (L_{MAIN}) =	512.4	ft
Width of Main Basin (W_{MAIN}) =	280.2	ft
Area of Main Basin (A_{MAIN}) =	143,551	ft^2
Volume of Main Basin (V_{MAIN}) =	751,538	ft^3
Calculated Total Basin Volume (V_{total}) =	**17.253**	acre-feet

Depth Increment = 0.50 ft

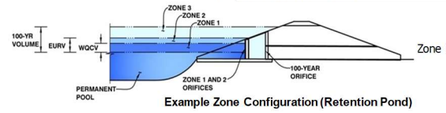
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		464.4	232.2	107,813		2.475		
	0.50		468.4	236.2	110,615		2.539	54,606	1.254
	1.00		472.4	240.2	113,449		2.604	110,621	2.539
	1.50		476.4	244.2	116,315		2.670	168,060	3.858
	2.00		480.4	248.2	119,214		2.737	226,941	5.210
	2.50		484.4	252.2	122,144		2.804	287,279	6.595
	3.00		488.4	256.2	125,106		2.872	349,090	8.014
	3.50		492.4	260.2	128,100		2.941	412,391	9.467
	4.00		496.4	264.2	131,126		3.010	477,196	10.955
	4.50		500.4	268.2	134,184		3.080	543,522	12.478
	5.00		504.4	272.2	137,274		3.151	611,385	14.035
	5.50		508.4	276.2	140,397		3.223	680,802	15.629
Zone 1 (100-year)	6.00		512.4	280.2	143,551		3.295	751,787	17.259
	6.50		516.4	284.2	146,737		3.369	824,358	18.925
	7.00		520.4	288.2	149,955		3.442	898,529	20.627
	7.50		524.4	292.2	153,205		3.517	974,318	22.367
	8.00		528.4	296.2	156,487		3.592	1,051,740	24.145
	8.50		532.4	300.2	159,801		3.669	1,130,811	25.960
	9.00		536.4	304.2	163,147		3.745	1,211,546	27.813
	9.50		540.4	308.2	166,526		3.823	1,293,963	29.705
	10.00		544.4	312.2	169,936		3.901	1,378,077	31.636
	10.50		548.4	316.2	173,378		3.980	1,463,904	33.607
	11.00		552.4	320.2	176,852		4.060	1,551,461	35.617
	11.50		556.4	324.2	180,358		4.140	1,640,762	37.667
	12.00		560.4	328.2	183,896		4.222	1,731,824	39.757
	12.50		564.4	332.2	187,466		4.304	1,824,663	41.889
	13.00		568.4	336.2	191,069		4.386	1,919,296	44.061
	13.50		572.4	340.2	194,703		4.470	2,015,737	46.275
	14.00		576.4	344.2	198,369		4.554	2,114,004	48.531
	14.50		580.4	348.2	202,067		4.639	2,214,111	50.829
	15.00		584.4	352.2	205,797		4.724	2,316,076	53.170
	15.50		588.4	356.2	209,559		4.811	2,419,914	55.554
	16.00		592.4	360.2	213,353		4.898	2,525,641	57.981
	16.50		596.4	364.2	217,179		4.986	2,633,272	60.452
	17.00		600.4	368.2	221,038		5.074	2,742,825	62.967
	17.50		604.4	372.2	224,928		5.164	2,854,315	65.526
	18.00		608.4	376.2	228,850		5.254	2,967,758	68.130
	18.50		612.4	380.2	232,804		5.344	3,083,171	70.780
	19.00		616.4	384.2	236,790		5.436	3,200,568	73.475
	19.50		620.4	388.2	240,808		5.528	3,319,966	76.216
	20.00		624.4	392.2	244,858		5.621	3,441,381	79.003
	20.50		628.4	396.2	248,941		5.715	3,564,830	81.837
	21.00		632.4	400.2	253,055		5.809	3,690,327	84.718
	21.50		636.4	404.2	257,201		5.905	3,817,890	87.647
	22.00		640.4	408.2	261,379		6.000	3,947,533	90.623
	22.50		644.4	412.2	265,589		6.097	4,079,274	93.647
	23.00		648.4	416.2	269,831		6.194	4,213,128	96.720
	23.50		652.4	420.2	274,105		6.293	4,349,111	99.842
	24.00		656.4	424.2	278,411		6.391	4,487,238	103.013
	24.50		660.4	428.2	282,750		6.491	4,627,527	106.233
	25.00		664.4	432.2	287,120		6.591	4,769,993	109.504
	25.50		668.4	436.2	291,522		6.692	4,914,652	112.825
	26.00		672.4	440.2	295,956		6.794	5,061,521	116.197
	26.50		676.4	444.2	300,422		6.897	5,210,614	119.619
	27.00		680.4	448.2	304,920		7.000	5,361,948	123.093
	27.50		684.4	452.2	309,450		7.104	5,515,539	126.619
	28.00		688.4	456.2	314,013		7.209	5,671,404	130.198
	28.50		692.4	460.2	318,607		7.314	5,829,557	133.828
	29.00		696.4	464.2	323,233		7.420	5,990,016	137.512
	29.50		700.4	468.2	327,891		7.527	6,152,795	141.249
	30.00		704.4	472.2	332,581		7.635	6,317,912	145.039

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option4, Flood Control 838



Example Zone Configuration (Retention Pond)

Clear Input Parameters (Including Tables)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (100-year)	6.00	17.253	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 2				Select Zone 2 Outlet Type
Zone 3				Select Zone 3 Outlet Type
Total (all zones)		17.253		

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 =	29.17		ft^2
Depth at top of Zone using Vertical Orifice =	6.00		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	2.50		feet
Vertical Orifice Height =	60.00		inches				
Vertical Orifice Width =	70.00		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 =	0.00		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) =	3.226	9.432	6.396	9.013	11.961	17.299	22.084	27.727	43.218
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.396	9.013	11.961	17.299	22.084	49.811	43.218
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.6	16.9	46.2	119.1	172.4	241.0	412.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.13	0.36	0.94	1.36	1.90	3.26
Peak Inflow Q (cfs) =	N/A	N/A	126.7	175.8	229.8	339.1	430.4	511.0	840.3
Peak Outflow Q (cfs) =	17.8	108.2	25.5	41.5	60.6	116.5	161.5	293.9	308.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.5	1.3	1.0	0.9	1.2	0.7
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	ertical 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) =	41	18	24	19	15	12	10	8	7
Time to Drain 99% of Inflow Volume (hours) =	**100**	44	59	45	36	27	23	15	14
Maximum Ponding Depth (ft) =	1.27	3.49	1.51	1.98	2.44	3.50	4.19	6.88	7.34
Area at Maximum Ponding Depth (acres) =	2.64	2.94	2.67	2.73	2.80	2.94	3.04	3.42	3.49
Maximum Volume Stored (acre-ft) =	3.247	9.438	3.885	5.155	6.427	9.467	11.529	20.181	21.772

Appendix E-3
HY8 Culvert Sizing

Culvert Data: Structure#702

Site Data - Structure#702

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4867.00 ft
Outlet Station: 97.00 ft
Outlet Elevation: 4862.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#702

Barrel Shape: Circular
Barrel Diameter: 3.50 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

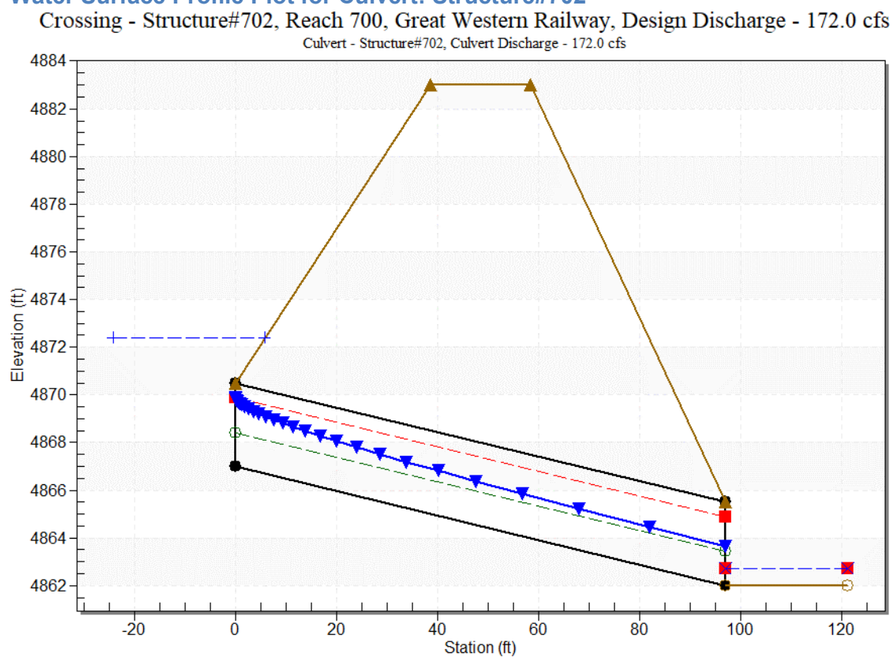
Table 1 - Culvert Summary Table: Structure#702

Names	Discharge (cfs)	Discharge (cfs)	Elevation (ft)	Control Depth (ft)	Control Depth (ft)	Type	Depth (ft)	Depth (ft)	Depth (ft)	Depth (ft)	Velocity (ft/s)	Velocity (ft/s)
5 Year	24.91 cfs	24.91 cfs	4868.42	1.42	0.0*	1-S2n	0.53	1.07	0.56	0.23	12.54	2.12
100 Year	172.00 cfs	172.00 cfs	4872.41	5.41	0.655	5-S2n	1.42	2.89	1.64	0.73	19.36	4.46

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4867.00 ft,
Outlet Elevation (invert): 4862.00 ft
Culvert Length: 97.13 ft,
Culvert Slope: 0.0515

Water Surface Profile Plot for Culvert: Structure#702



Tailwater Data for Crossing: Structure#702, Reach 700

Table 2 - Downstream Channel Rating Curve (Crossing: Structure#702, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4862.23	0.23	2.12	0.43	0.79
172.00	4862.73	0.73	4.46	1.36	0.95

Tailwater Channel Data - Structure#702, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0300
Channel Manning's n: 0.0450

Roadway Data for Crossing: Structure#702, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4883.00 ft
Roadway Surface: Gravel
Roadway Top Width: 20.00 ft

Culvert Data: Structure#703

Site Data - Structure#703,

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4872.00 ft
Outlet Station: 42.00 ft
Outlet Elevation: 4871.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#703,

Barrel Shape: Circular
Barrel Diameter: 3.50 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

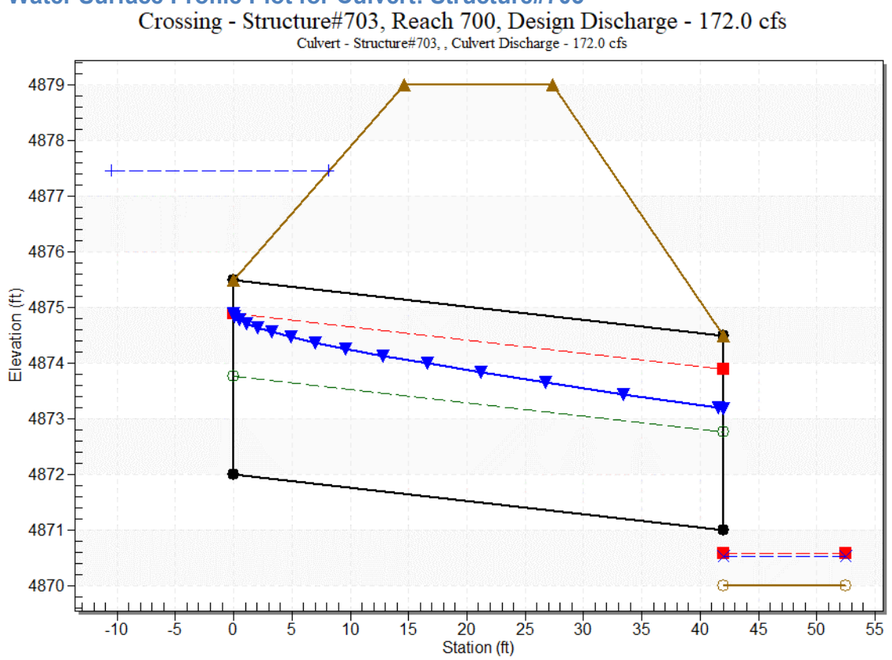
Table 3 - Culvert Summary Table: Structure#703

Names	Discharge (cfs)	Discharge (cfs)	Elevation (ft)	Control Depth (ft)	Control Depth (ft)	Type	Depth (ft)	Depth (ft)	Depth (ft)	Depth (ft)	Velocity (ft/s)	Velocity (ft/s)
5 Year	24.91 cfs	24.91 cfs	4873.45	1.45	0.116	1-S2n	0.64	1.07	0.70	0.16	9.01	2.18
100 Year	172.00 cfs	172.00 cfs	4877.46	5.46	4.314	5-S2n	1.77	2.89	2.18	0.52	13.62	4.68

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4872.00 ft,
Outlet Elevation (invert): 4871.00 ft
Culvert Length: 42.01 ft,
Culvert Slope: 0.0238

Water Surface Profile Plot for Culvert: Structure#703



Tailwater Data for Crossing: Structure#703, Reach 700

Table 4 - Downstream Channel Rating Curve (Crossing: Structure#703, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4870.16	0.16	2.18	0.22	0.95
172.00	4870.52	0.52	4.68	0.71	1.15

Tailwater Channel Data - Structure#703, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 70.00 ft
Side Slope (H:V): 2.00 (_:1)
Channel Slope: 0.0220
Channel Manning's n: 0.0300
Channel Invert Elevation: 4870.00 ft

Roadway Data for Crossing: Structure#703, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4879.00 ft
Roadway Surface: Gravel
Roadway Top Width: 12.76 ft

Culvert Data: Structure#704

Site Data - Structure#704

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4890.00 ft
Outlet Station: 89.00 ft
Outlet Elevation: 4888.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#704

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
Inlet Depression: None

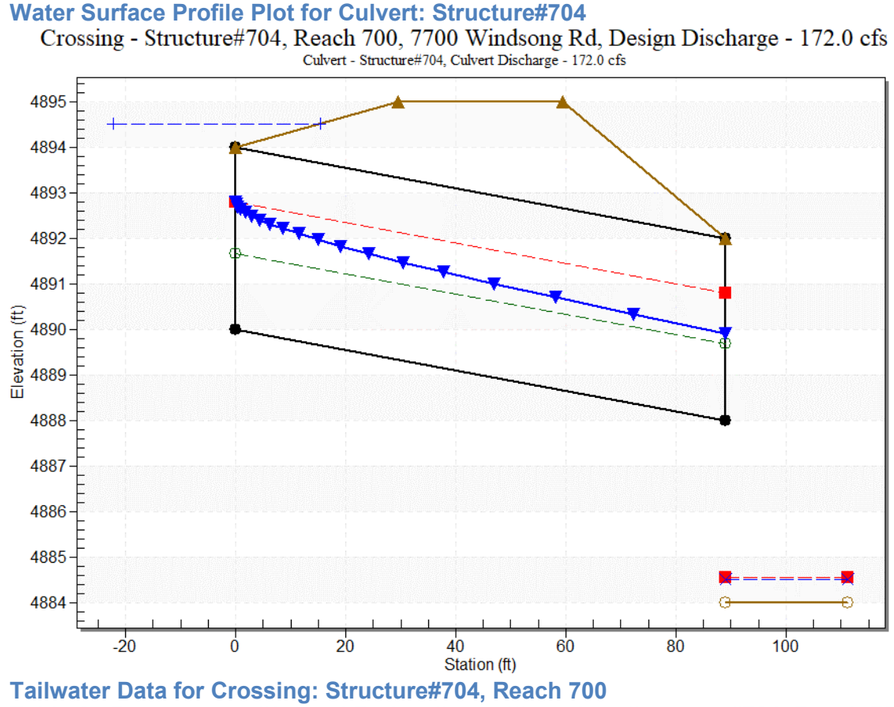
Table 5 - Culvert Summary Table: Structure#704

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	24.91 cfs	24.91 cfs	4891.39	1.39	0.0*	1-S2n	0.63	1.03	0.64	0.16	9.50	2.09
100 Year	172.00 cfs	172.00 cfs	4894.52	4.52	2.172	5-S2n	1.68	2.81	1.91	0.51	14.47	4.47

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4890.00 ft,
Outlet Elevation (invert): 4888.00 ft
Culvert Length: 89.02 ft,
Culvert Slope: 0.0225

Water Surface Profile Plot for Culvert: Structure#704



Tailwater Data for Crossing: Structure#704, Reach 700

Table 6 - Downstream Channel Rating Curve (Crossing: Structure#704, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4884.16	0.16	2.09	0.28	0.92
172.00	4884.51	0.51	4.47	0.90	1.11

Tailwater Channel Data - Structure#704, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 73.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0280
Channel Manning's n: 0.0350
Channel Invert Elevation: 4884.00 ft

Roadway Data for Crossing: Structure#704, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4895.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 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: 74.00 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
Inlet Depression: None

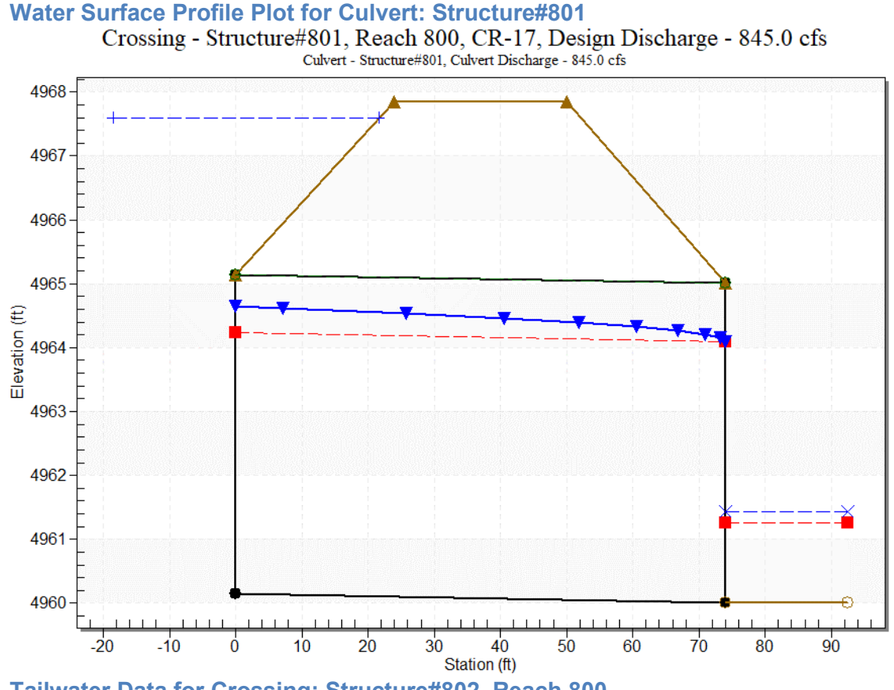
Table 7 - Culvert Summary Table: Structure#801

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	18.94 cfs	18.94 cfs	4960.71	0.56	0.560	2-M2c	0.39	0.33	0.33	0.15	3.24	1.25
100 Year	845.00 cfs	845.00 cfs	4967.59	7.44	7.036	7-M2c	5.00	4.09	4.09	1.41	11.48	5.23

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4960.15 ft,
Outlet Elevation (invert): 4960.01 ft
Culvert Length: 74.00 ft,
Culvert Slope: 0.0018

Water Surface Profile Plot for Culvert: Structure#801



Tailwater Data for Crossing: Structure#802, Reach 800

Table 8 - Downstream Channel Rating Curve (Crossing: Structure#802, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
18.94	4960.16	0.15	1.25	0.17	0.58
845.00	4961.42	1.41	5.23	1.63	0.82

Tailwater Channel Data - Structure#801, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 100.00 ft
Side Slope (H:V): 10.00 (_:1)
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

Culvert Data: Structure#804

Site Data - Structure#804

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4889.00 ft
Outlet Station: 90.00 ft
Outlet Elevation: 4881.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#804

Barrel Shape: Concrete Box
Barrel Span: 10.00 ft
Barrel Rise: 8.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0130
Culvert Type: Straight
Inlet Configuration: Square Edge (30-75º flare) Wingwall
Inlet Depression: None

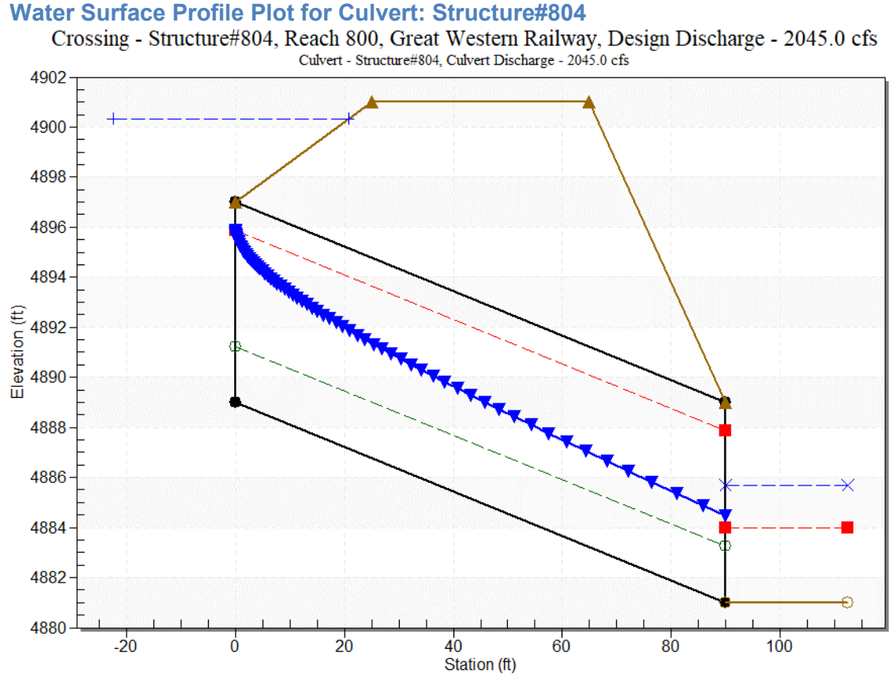
Table 9 - Culvert Summary Table: Structure#804

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	126.99 cfs	126.99 cfs	4890.53	1.53	0.0*	1-S2n	0.37	1.08	0.38	0.92	16.52	2.04
100 Year	2045.00 cfs	2045.00 cfs	4900.34	11.34	3.375	5-S2n	2.24	6.87	3.48	4.68	29.35	5.53

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4889.00 ft,
Outlet Elevation (invert): 4881.00 ft
Culvert Length: 90.35 ft,
Culvert Slope: 0.0889

Water Surface Profile Plot for Culvert: Structure#804



Tailwater Data for Crossing: Structure#804, Reach 800

Table 10 - Downstream Channel Rating Curve (Crossing: Structure#804, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
126.99	4881.92	0.92	2.04	0.63	0.38
2045.00	4885.68	4.68	5.53	3.21	0.49

Tailwater Channel Data - Structure#804, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 65.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0110
Channel Manning's n: 0.0700
Channel Invert Elevation: 4881.00 ft

Roadway Data for Crossing: Structure#804, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4901.00 ft
Roadway Surface: Gravel
Roadway Top Width: 40.00 ft

Culvert Data: Structure#805

Site Data - Structure#805

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4892.00 ft
Outlet Station: 62.00 ft
Outlet Elevation: 4890.00 ft
Number of Barrels: 6

Culvert Data Summary - Structure#805

Barrel Shape: Concrete Box
Barrel Span: 16.00 ft
Barrel Rise: 3.50 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

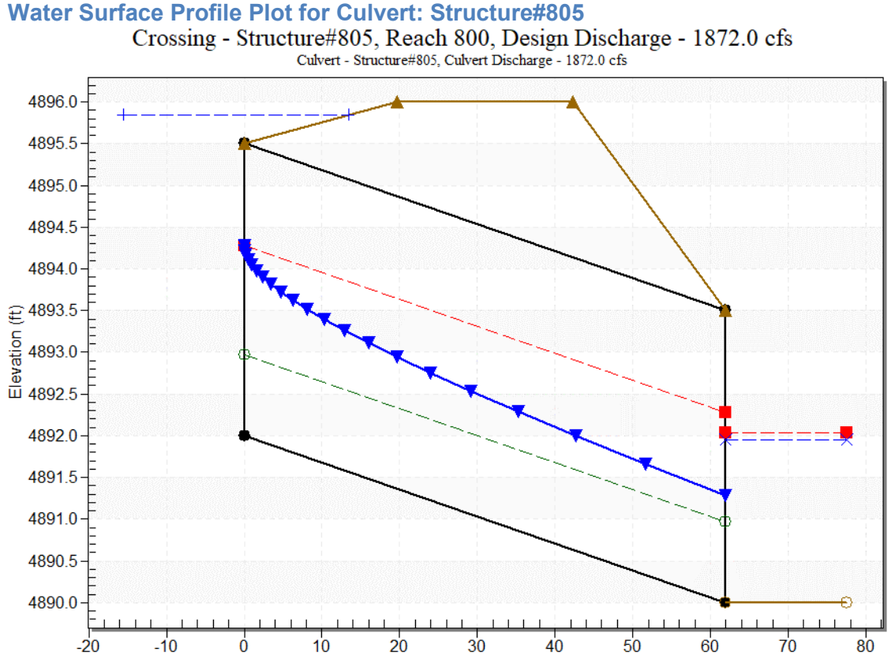
Table 11 - Culvert Summary Table: Structure#805

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	126.99 cfs	126.99 cfs	4892.63	0.63	0.0*	1-S2n	0.18	0.38	0.18	0.40	7.16	2.93
100 Year	1872.00 cfs	1872.00 cfs	4895.84	3.84	1.077	5-S2n	0.97	2.28	1.28	1.95	15.23	8.09

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4892.00 ft,
Outlet Elevation (invert): 4890.00 ft
Culvert Length: 62.03 ft,
Culvert Slope: 0.0323

Water Surface Profile Plot for Culvert: Structure#805



Tailwater Data for Crossing: Structure#805, Reach 800

Table 12 - Downstream Channel Rating Curve (Crossing: Structure#805, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
126.99	4890.40	0.40	2.93	0.69	0.83
1872.00	4891.95	1.95	8.09	3.41	1.07

Tailwater Channel Data - Structure#805, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 107.00 ft
Side Slope (H:V): 6.00 (_:1)
Channel Slope: 0.0280
Channel Manning's n: 0.0450
Channel Invert Elevation: 4890.00 ft

Roadway Data for Crossing: Structure#805, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4896.00 ft
Roadway Surface: Gravel
Roadway Top Width: 22.60 ft

Culvert Data: Structure#806

Site Data - Structure#806

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4900.00 ft
Outlet Station: 50.00 ft
Outlet Elevation: 4899.00 ft
Number of Barrels: 5

Culvert Data Summary - Structure#806

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

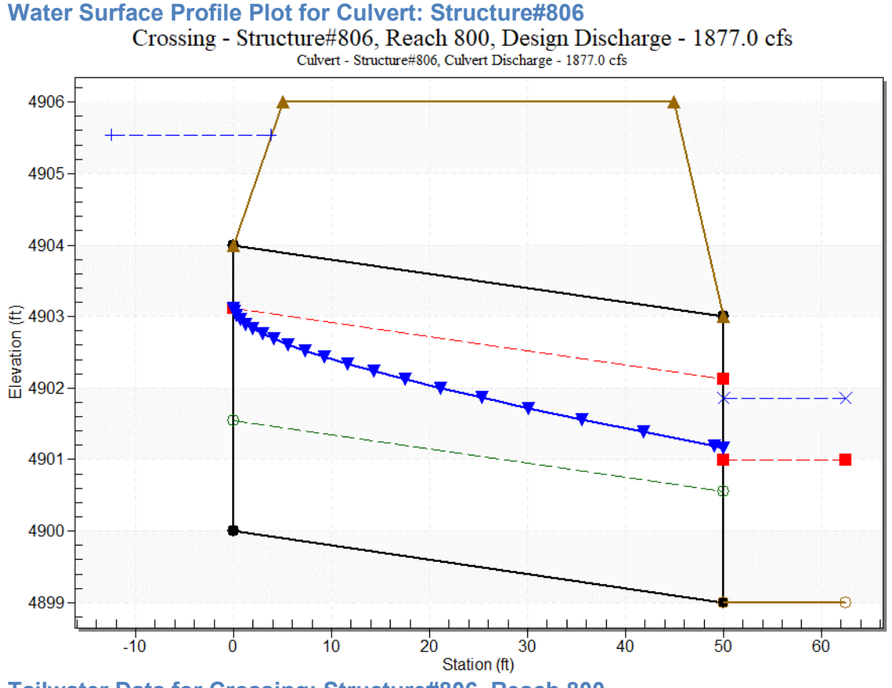
Table 13 - Culvert Summary Table: Structure#806

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	124.66 cfs	124.66 cfs	4900.86	0.86	0.0*	1-S2n	0.28	0.51	0.29	0.57	7.11	1.88
100 Year	1877.00 cfs	1877.00 cfs	4905.53	5.53	4.101	5-S2n	1.55	3.12	2.17	2.86	14.45	5.31

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4900.00 ft,
Outlet Elevation (invert): 4899.00 ft
Culvert Length: 50.01 ft,
Culvert Slope: 0.0200

Water Surface Profile Plot for Culvert: Structure#806



Tailwater Data for Crossing: Structure#806, Reach 800

Table 14 - Downstream Channel Rating Curve (Crossing: Structure#806, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
124.66	4899.57	0.57	1.88	0.60	0.44
1877.00	4901.86	2.86	5.31	3.03	0.57

Tailwater Channel Data - Structure#806, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 115.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0170
Channel Manning's n: 0.0700
Channel Invert Elevation: 4899.00 ft

Roadway Data for Crossing: Structure#806, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4906.00 ft
Roadway Surface: Paved
Roadway Top Width: 40.00 ft

Culvert Data: Structure#807

Site Data - Structure#807

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4917.00 ft
Outlet Station: 80.00 ft
Outlet Elevation: 4916.00 ft
Number of Barrels: 3

Culvert Data Summary - Structure#807

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 (30-75º flare) Wingwall
Inlet Depression: None

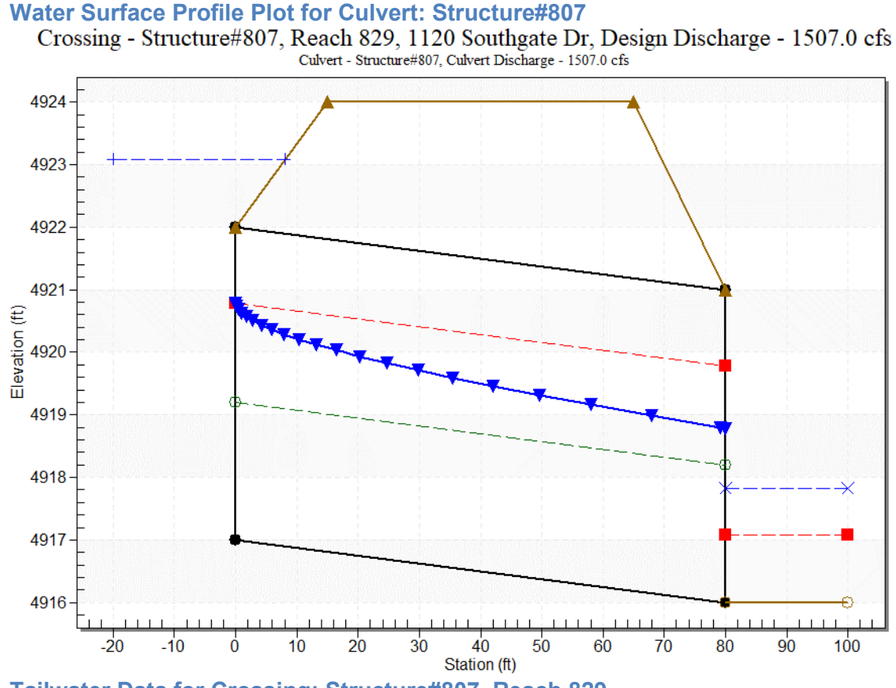
Table 15 - Culvert Summary Table: Structure#807

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	63.00 cfs	63.00 cfs	4917.69	0.69	0.0*	1-S2n	0.29	0.46	0.29	0.27	6.01	0.98
100 Year	1507.00 cfs	1507.00 cfs	4923.08	6.08	5.089	5-S2n	2.20	3.79	2.79	1.82	15.02	3.39

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4917.00 ft,
Outlet Elevation (invert): 4916.00 ft
Culvert Length: 80.01 ft,
Culvert Slope: 0.0125

Water Surface Profile Plot for Culvert: Structure#807



Tailwater Data for Crossing: Structure#807, Reach 829

Table 16 - Downstream Channel Rating Curve (Crossing: Structure#807, Reach 829)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
63.00	4916.27	0.27	0.98	0.09	0.33
1507.00	4917.82	1.82	3.39	0.57	0.45

Tailwater Channel Data - Structure#807, Reach 829

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 235.00 ft
Side Slope (H:V): 5.00 (_:1)
Channel Slope: 0.0050
Channel Manning's n: 0.0450
Channel Invert Elevation: 4916.00 ft

Roadway Data for Crossing: Structure#807, Reach 829

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4924.00 ft
Roadway Surface: Paved
Roadway Top Width: 50.00 ft

Culvert Data: Structure#808

Site Data - Structure#808

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4942.00 ft
Outlet Station: 527.00 ft
Outlet Elevation: 4932.00 ft
Number of Barrels: 3

Culvert Data Summary - Structure#808

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
Inlet Depression: None

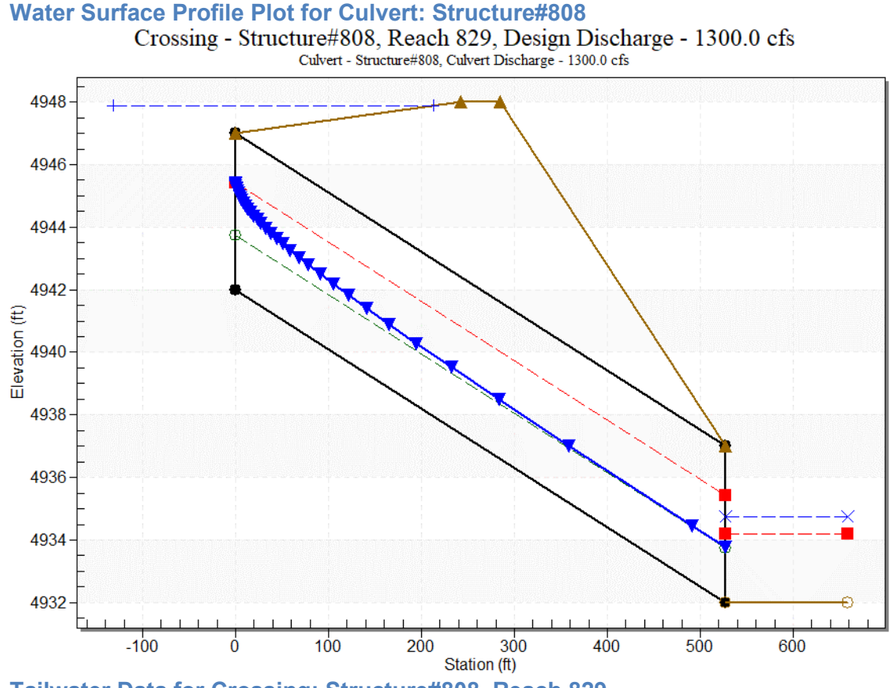
Table 17 - Culvert Summary Table: Structure#808

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	36.03 cfs	36.03 cfs	4942.53	0.53	0.0*	1-S2n	0.18	0.31	0.18	0.33	5.63	1.64
100 Year	1300.00 cfs	1300.00 cfs	4947.88	5.88	0.0*	5-S2n	1.73	3.43	1.78	2.74	20.29	6.02

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4942.00 ft,
Outlet Elevation (invert): 4932.00 ft
Culvert Length: 527.09 ft,
Culvert Slope: 0.0190

Water Surface Profile Plot for Culvert: Structure#808



Tailwater Data for Crossing: Structure#808, Reach 829

Table 18 - Downstream Channel Rating Curve (Crossing: Structure#808, Reach 829)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
36.03	4932.33	0.33	1.64	0.23	0.51
1300.00	4934.74	2.74	6.02	1.88	0.70

Tailwater Channel Data - Structure#808, Reach 829

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 64.00 ft
Side Slope (H:V): 5.40 (_:1)
Channel Slope: 0.0110
Channel Manning's n: 0.0450
Channel Invert Elevation: 4932.00 ft

Roadway Data for Crossing: Structure#808, Reach 829

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4948.00 ft
Roadway Surface: Paved
Roadway Top Width: 43.00 ft

Culvert Data: Structure#809

Site Data - Structure#809

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4958.00 ft
Outlet Station: 304.00 ft
Outlet Elevation: 4948.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#809

Barrel Shape: Concrete Box
Barrel Span: 12.00 ft
Barrel Rise: 7.00 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

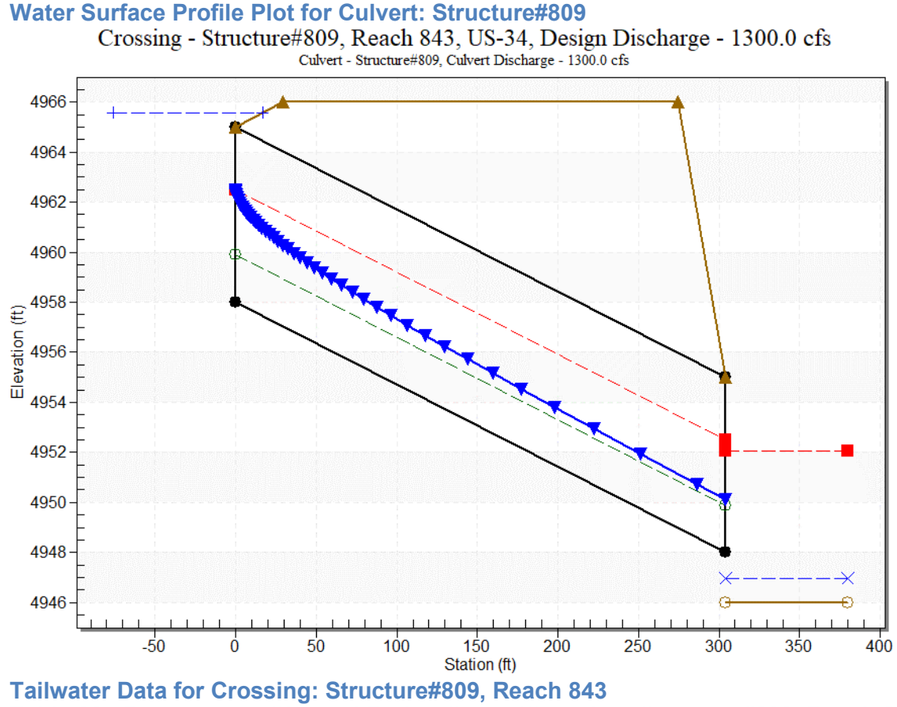
Table 19 - Culvert Summary Table: Structure#809

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	36.03 cfs	36.03 cfs	4958.68	0.68	0.0*	1-S2n	0.20	0.41	0.20	0.11	7.67	21.45
100 Year	1300.00 cfs	1300.00 cfs	4965.58	7.58	0.0*	5-S2n	1.89	4.50	2.13	0.98	25.43	86.35

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4958.00 ft,
Outlet Elevation (invert): 4948.00 ft
Culvert Length: 304.16 ft,
Culvert Slope: 0.0329

Water Surface Profile Plot for Culvert: Structure#809



Tailwater Data for Crossing: Structure#809, Reach 843

Table 20 - Downstream Channel Rating Curve (Crossing: Structure#809, Reach 843)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
36.03	4946.11	0.11	21.45	34.03	11.45
1300.00	4946.98	0.98	86.35	305.00	15.39

Tailwater Channel Data - Structure#809, Reach 843

Tailwater Channel Option: Rectangular Channel
Bottom Width: 15.40 ft
Channel Slope: 5.0000
Channel Manning's n: 0.0350
Channel Invert Elevation: 4946.00 ft

Roadway Data for Crossing: Structure#809, Reach 843

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4966.00 ft
Roadway Surface: Paved
Roadway Top Width: 245.00 ft

Culvert Data: Structure#702

Site Data - Structure#702

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4867.00 ft
Outlet Station: 97.00 ft
Outlet Elevation: 4862.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#702

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
Inlet Depression: None

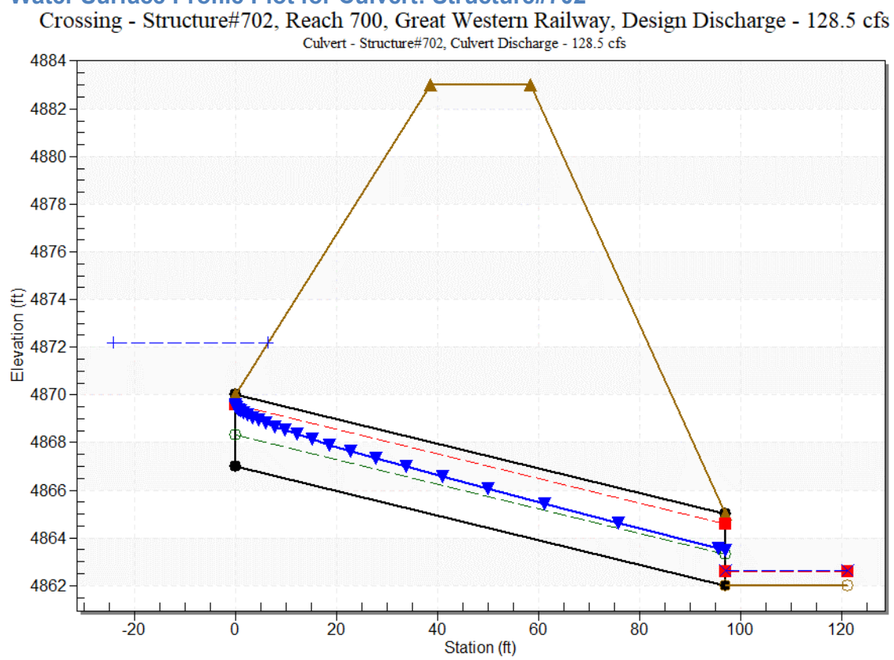
Table 1 - Culvert Summary Table: Structure#702

Names	Discharge (cfs)	Discharge (cfs)	Elevation (ft)	Control Depth (ft)	Control Depth (ft)	Type	Depth (ft)	Depth (ft)	Depth (ft)	Depth (ft)	Velocity (ft/s)	Velocity (ft/s)
5 Year	24.91 cfs	24.91 cfs	4868.49	1.49	0.0*	1-S2n	0.56	1.12	0.56	0.23	13.73	2.12
100 Year	128.47 cfs	128.47 cfs	4872.19	5.19	0.473	5-S2n	1.30	2.57	1.47	0.61	18.64	4.00

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4867.00 ft,
Outlet Elevation (invert): 4862.00 ft
Culvert Length: 97.13 ft,
Culvert Slope: 0.0515

Water Surface Profile Plot for Culvert: Structure#702



Tailwater Data for Crossing: Structure#702, Reach 700

Table 2 - Downstream Channel Rating Curve (Crossing: Structure#702, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4862.23	0.23	2.12	0.43	0.79
128.47	4862.61	0.61	4.00	1.15	0.92

Tailwater Channel Data - Structure#702, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0300
Channel Manning's n: 0.0450
Channel Invert Elevation: 4862.00 ft

Roadway Data for Crossing: Structure#702, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4883.00 ft
Roadway Surface: Gravel
Roadway Top Width: 20.00 ft

Culvert Data: Structure#703

Site Data - Structure#703,

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4872.00 ft
Outlet Station: 42.00 ft
Outlet Elevation: 4871.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#703,

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
Inlet Depression: None

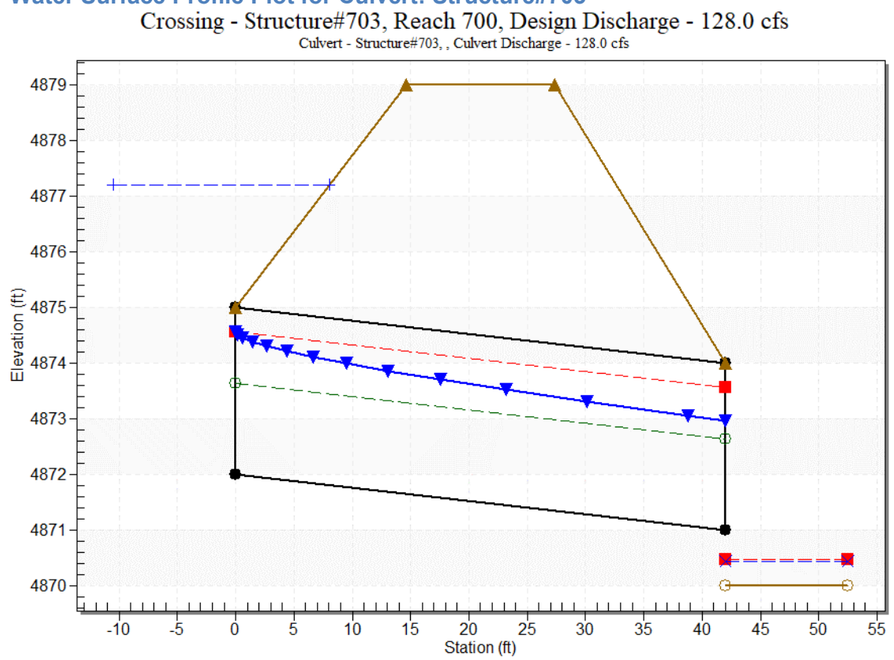
Table 3 - Culvert Summary Table: Structure#703

Names	Discharge (cfs)	Discharge (cfs)	Elevation (ft)	Control Depth (ft)	Control Depth (ft)	Type	Depth (ft)	Depth (ft)	Depth (ft)	Depth (ft)	Velocity (ft/s)	Velocity (ft/s)
5 Year	24.91 cfs	24.91 cfs	4873.53	1.53	0.206	1-S2n	0.68	1.12	0.74	0.16	9.15	2.18
100 Year	128.00 cfs	128.00 cfs	4877.21	5.21	4.022	5-S2n	1.63	2.57	1.95	0.43	13.12	4.17

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4872.00 ft,
Outlet Elevation (invert): 4871.00 ft
Culvert Length: 42.01 ft,
Culvert Slope: 0.0238

Water Surface Profile Plot for Culvert: Structure#703



Tailwater Data for Crossing: Structure#703, Reach 700

Table 4 - Downstream Channel Rating Curve (Crossing: Structure#703, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4870.16	0.16	2.18	0.22	0.95
128.00	4870.43	0.43	4.17	0.60	1.12

Tailwater Channel Data - Structure#703, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 70.00 ft
Side Slope (H:V): 2.00 (_:1)
Channel Slope: 0.0220
Channel Manning's n: 0.0300
Channel Invert Elevation: 4870.00 ft

Roadway Data for Crossing: Structure#703, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4879.00 ft
Roadway Surface: Gravel
Roadway Top Width: 12.76 ft

Culvert Data: Structure#704

Site Data - Structure#704

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4890.00 ft
Outlet Station: 89.00 ft
Outlet Elevation: 4888.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#704

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
Inlet Depression: None

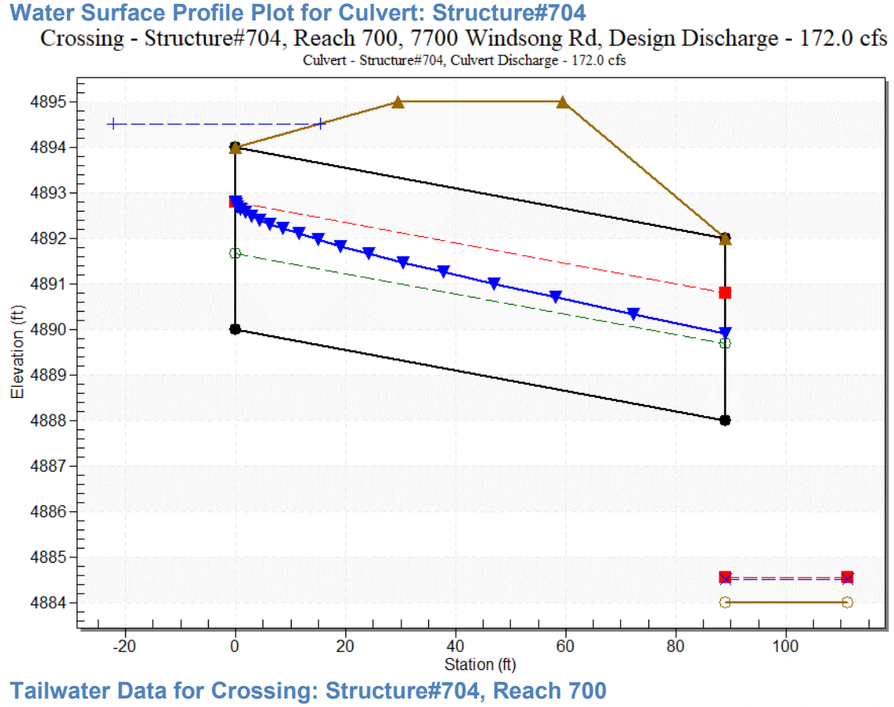
Table 5 - Culvert Summary Table: Structure#704

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	24.91 cfs	24.91 cfs	4891.39	1.39	0.0*	1-S2n	0.63	1.03	0.64	0.16	9.50	2.09
100 Year	172.00 cfs	172.00 cfs	4894.52	4.52	2.172	5-S2n	1.68	2.81	1.91	0.51	14.47	4.47

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4890.00 ft,
Outlet Elevation (invert): 4888.00 ft
Culvert Length: 89.02 ft,
Culvert Slope: 0.0225

Water Surface Profile Plot for Culvert: Structure#704



Tailwater Data for Crossing: Structure#704, Reach 700

Table 6 - Downstream Channel Rating Curve (Crossing: Structure#704, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4884.16	0.16	2.09	0.28	0.92
172.00	4884.51	0.51	4.47	0.90	1.11

Tailwater Channel Data - Structure#704, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 73.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0280
Channel Manning's n: 0.0350
Channel Invert Elevation: 4884.00 ft

Roadway Data for Crossing: Structure#704, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4895.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 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: 74.00 ft
Outlet Elevation: 4960.01 ft
Number of Barrels: 1

Culvert Data Summary - Structure#801

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
Inlet Depression: None

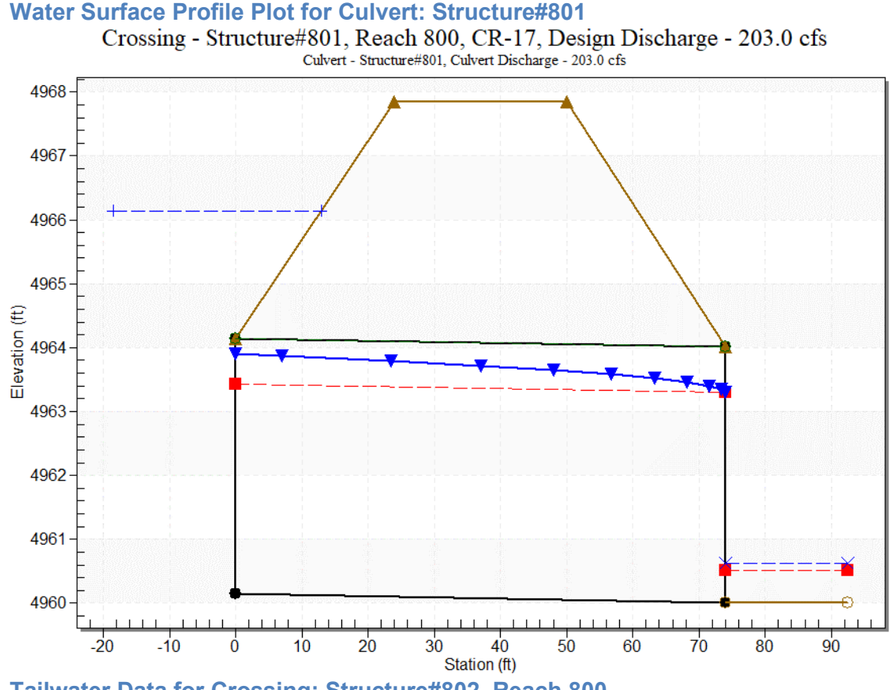
Table 7 - Culvert Summary Table: Structure#801

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	18.94 cfs	18.94 cfs	4961.31	1.16	1.162	2-M2c	0.80	0.68	0.68	0.15	4.67	1.25
100 Year	203.00 cfs	203.00 cfs	4966.14	5.99	5.647	7-M2c	4.00	3.29	3.29	0.61	10.29	3.12

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4960.15 ft,
Outlet Elevation (invert): 4960.01 ft
Culvert Length: 74.00 ft,
Culvert Slope: 0.0018

Water Surface Profile Plot for Culvert: Structure#801



Tailwater Data for Crossing: Structure#802, Reach 800

Table 8 - Downstream Channel Rating Curve (Crossing: Structure#802, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
18.94	4960.16	0.15	1.25	0.17	0.58
203.00	4960.62	0.61	3.12	0.71	0.72

Tailwater Channel Data - Structure#801, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 100.00 ft
Side Slope (H:V): 10.00 (_:1)
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

Culvert Data: Structure#804

Site Data - Structure#804

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4889.00 ft
Outlet Station: 90.00 ft
Outlet Elevation: 4881.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#804

Barrel Shape: Concrete Box
Barrel Span: 6.00 ft
Barrel Rise: 7.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0130
Culvert Type: Straight
Inlet Configuration: Square Edge (30-75º flare) Wingwall
Inlet Depression: None

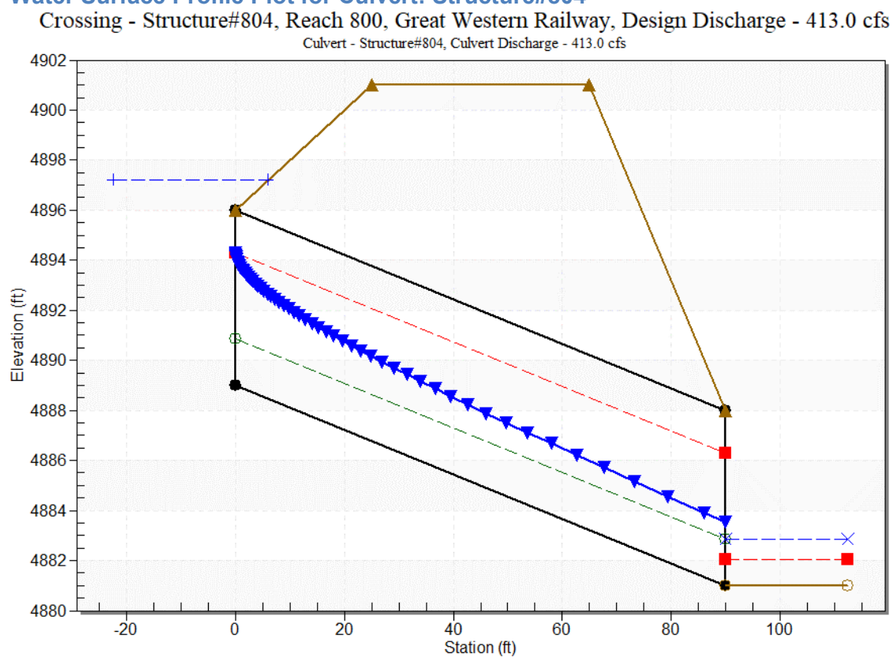
Table 9 - Culvert Summary Table: Structure#804

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	126.99 cfs	126.99 cfs	4892.40	3.40	0.0*	1-S2n	0.83	2.41	0.96	0.92	22.06	2.04
100 Year	413.00 cfs	413.00 cfs	4897.20	8.20	0.593	5-S2n	1.84	5.28	2.55	1.85	26.95	3.17

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4889.00 ft,
Outlet Elevation (invert): 4881.00 ft
Culvert Length: 90.35 ft,
Culvert Slope: 0.0889

Water Surface Profile Plot for Culvert: Structure#804



Tailwater Data for Crossing: Structure#804, Reach 800

Table 10 - Downstream Channel Rating Curve (Crossing: Structure#804, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
126.99	4881.92	0.92	2.04	0.63	0.38
413.00	4882.85	1.85	3.17	1.27	0.43

Tailwater Channel Data - Structure#804, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 65.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0110
Channel Manning's n: 0.0700
Channel Invert Elevation: 4881.00 ft

Roadway Data for Crossing: Structure#804, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4901.00 ft
Roadway Surface: Gravel
Roadway Top Width: 40.00 ft

Culvert Data: Structure#805

Site Data - Structure#805

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4892.00 ft
Outlet Station: 62.00 ft
Outlet Elevation: 4890.00 ft
Number of Barrels: 3

Culvert Data Summary - Structure#805

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
Inlet Depression: None

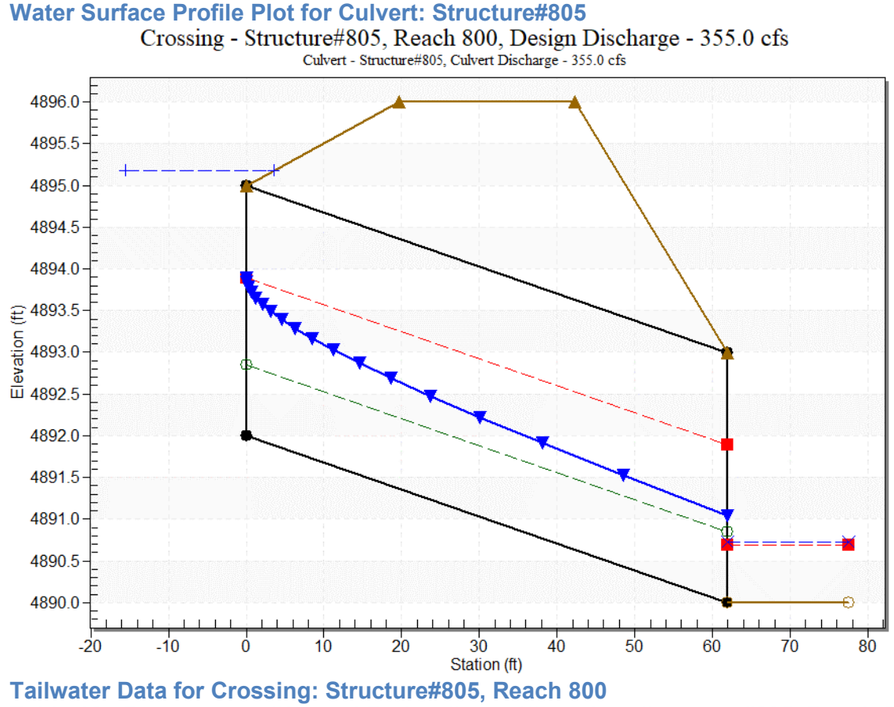
Table 11 - Culvert Summary Table: Structure#805

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	126.99 cfs	126.99 cfs	4893.59	1.59	0.0*	1-S2n	0.44	0.95	0.48	0.40	10.94	2.93
100 Year	355.00 cfs	355.00 cfs	4895.18	3.18	0.547	5-S2n	0.84	1.89	1.05	0.73	14.15	4.36

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4892.00 ft,
Outlet Elevation (invert): 4890.00 ft
Culvert Length: 62.03 ft,
Culvert Slope: 0.0323

Water Surface Profile Plot for Culvert: Structure#805



Tailwater Data for Crossing: Structure#805, Reach 800

Table 12 - Downstream Channel Rating Curve (Crossing: Structure#805, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
126.99	4890.40	0.40	2.93	0.69	0.83
355.00	4890.73	0.73	4.36	1.28	0.92

Tailwater Channel Data - Structure#805, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 107.00 ft
Side Slope (H:V): 6.00 (_:1)
Channel Slope: 0.0280
Channel Manning's n: 0.0450
Channel Invert Elevation: 4890.00 ft

Roadway Data for Crossing: Structure#805, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4896.00 ft
Roadway Surface: Gravel
Roadway Top Width: 22.60 ft

Culvert Data: Structure#806

Site Data - Structure#806

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4900.00 ft
Outlet Station: 50.00 ft
Outlet Elevation: 4899.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#806

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

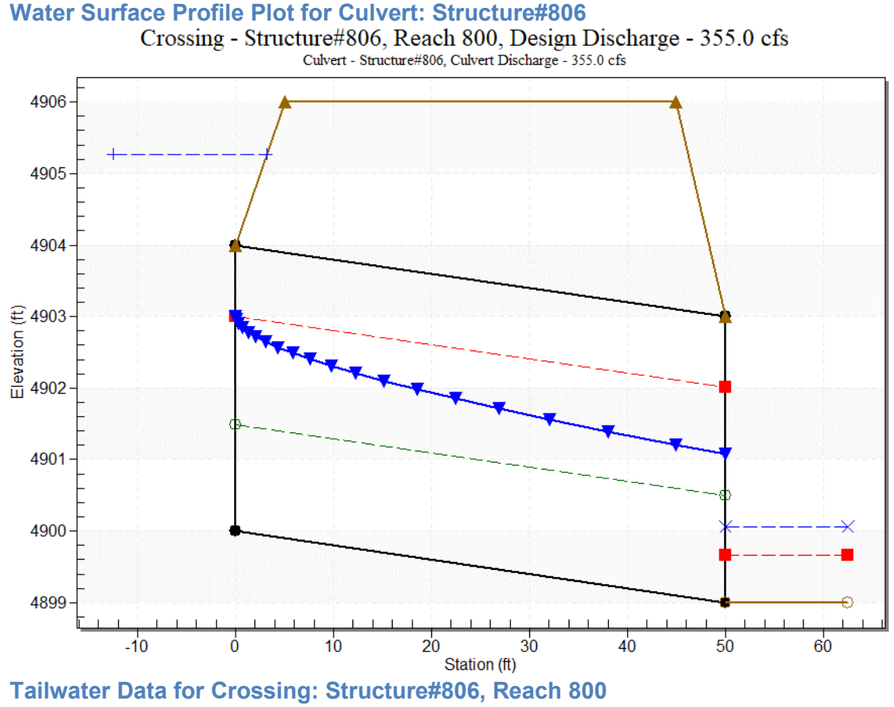
Table 13 - Culvert Summary Table: Structure#806

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	124.66 cfs	124.66 cfs	4902.51	2.51	0.666	1-S2n	0.77	1.50	0.93	0.57	11.14	1.88
100 Year	355.00 cfs	355.00 cfs	4905.26	5.26	3.881	5-S2n	1.49	3.01	2.07	1.06	14.26	2.83

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4900.00 ft,
Outlet Elevation (invert): 4899.00 ft
Culvert Length: 50.01 ft,
Culvert Slope: 0.0200

Water Surface Profile Plot for Culvert: Structure#806



Tailwater Data for Crossing: Structure#806, Reach 800

Table 14 - Downstream Channel Rating Curve (Crossing: Structure#806, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
124.66	4899.57	0.57	1.88	0.60	0.44
355.00	4900.06	1.06	2.83	1.13	0.49

Tailwater Channel Data - Structure#806, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 115.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0170
Channel Manning's n: 0.0700
Channel Invert Elevation: 4899.00 ft

Roadway Data for Crossing: Structure#806, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4906.00 ft
Roadway Surface: Paved
Roadway Top Width: 40.00 ft

Culvert Data: Structure#807

Site Data - Structure#807

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4917.00 ft
Outlet Station: 80.00 ft
Outlet Elevation: 4916.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#807

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 (30-75º flare) Wingwall
Inlet Depression: None

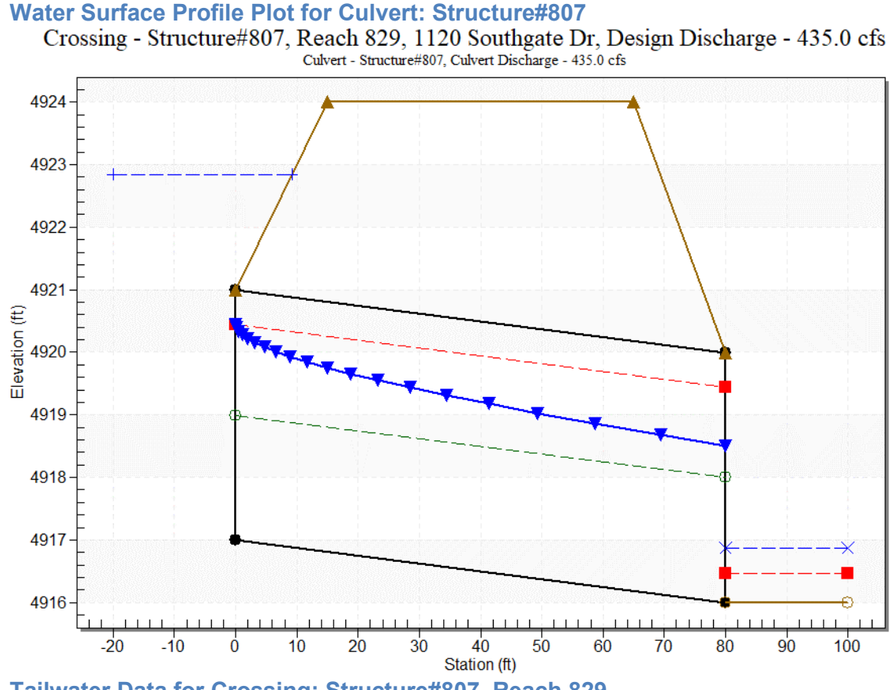
Table 15 - Culvert Summary Table: Structure#807

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	63.00 cfs	63.00 cfs	4918.44	1.44	0.0*	1-S2n	0.58	0.95	0.61	0.27	8.64	0.98
100 Year	435.00 cfs	435.00 cfs	4922.84	5.84	4.755	5-S2n	2.00	3.44	2.50	0.87	14.49	2.10

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4917.00 ft,
Outlet Elevation (invert): 4916.00 ft
Culvert Length: 80.01 ft,
Culvert Slope: 0.0125

Water Surface Profile Plot for Culvert: Structure#807



Tailwater Data for Crossing: Structure#807, Reach 829

Table 16 - Downstream Channel Rating Curve (Crossing: Structure#807, Reach 829)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
63.00	4916.27	0.27	0.98	0.09	0.33
435.00	4916.87	0.87	2.10	0.27	0.40

Tailwater Channel Data - Structure#807, Reach 829

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 235.00 ft
Side Slope (H:V): 5.00 (_:1)
Channel Slope: 0.0050
Channel Manning's n: 0.0450
Channel Invert Elevation: 4916.00 ft

Roadway Data for Crossing: Structure#807, Reach 829

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4924.00 ft
Roadway Surface: Paved
Roadway Top Width: 50.00 ft

Culvert Data: Structure#808

Site Data - Structure#808

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4942.00 ft
Outlet Station: 527.00 ft
Outlet Elevation: 4932.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#808

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

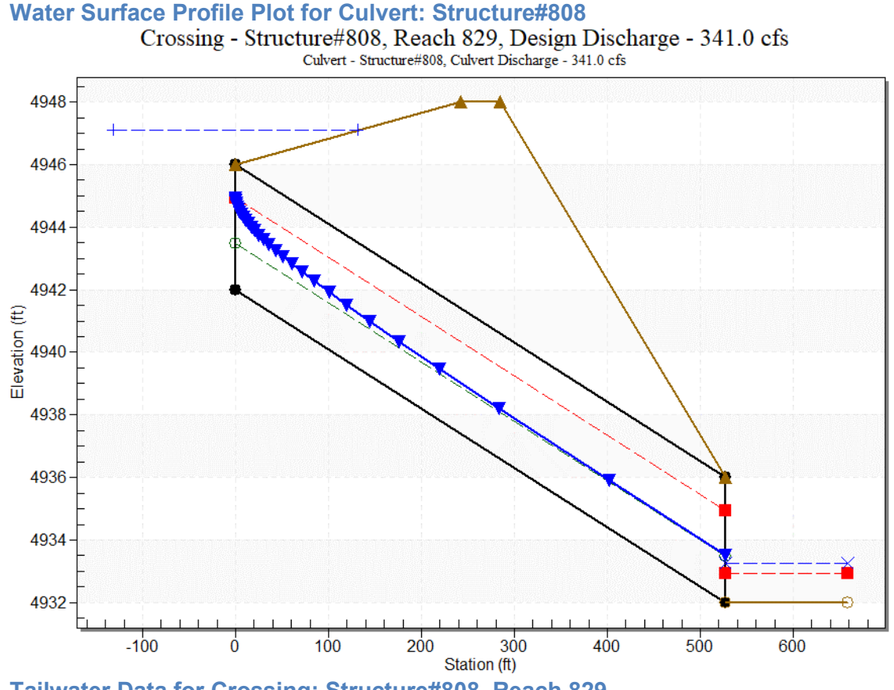
Table 17 - Culvert Summary Table: Structure#808

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	36.03 cfs	36.03 cfs	4943.10	1.10	0.0*	1-S2n	0.36	0.65	0.36	0.33	8.38	1.64
100 Year	341.00 cfs	341.00 cfs	4947.09	5.09	0.0*	5-S2n	1.48	2.93	1.51	1.27	18.77	3.80

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4942.00 ft,
Outlet Elevation (invert): 4932.00 ft
Culvert Length: 527.09 ft,
Culvert Slope: 0.0190

Water Surface Profile Plot for Culvert: Structure#808



Tailwater Data for Crossing: Structure#808, Reach 829

Table 18 - Downstream Channel Rating Curve (Crossing: Structure#808, Reach 829)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
36.03	4932.33	0.33	1.64	0.23	0.51
341.00	4933.27	1.27	3.80	0.87	0.62

Tailwater Channel Data - Structure#808, Reach 829

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 64.00 ft
Side Slope (H:V): 5.40 (_:1)
Channel Slope: 0.0110
Channel Manning's n: 0.0450
Channel Invert Elevation: 4932.00 ft

Roadway Data for Crossing: Structure#808, Reach 829

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4948.00 ft
Roadway Surface: Paved
Roadway Top Width: 43.00 ft

Culvert Data: Structure#809

Site Data - Structure#809

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4958.00 ft
Outlet Station: 304.00 ft
Outlet Elevation: 4948.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#809

Barrel Shape: Concrete Box
Barrel Span: 10.00 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

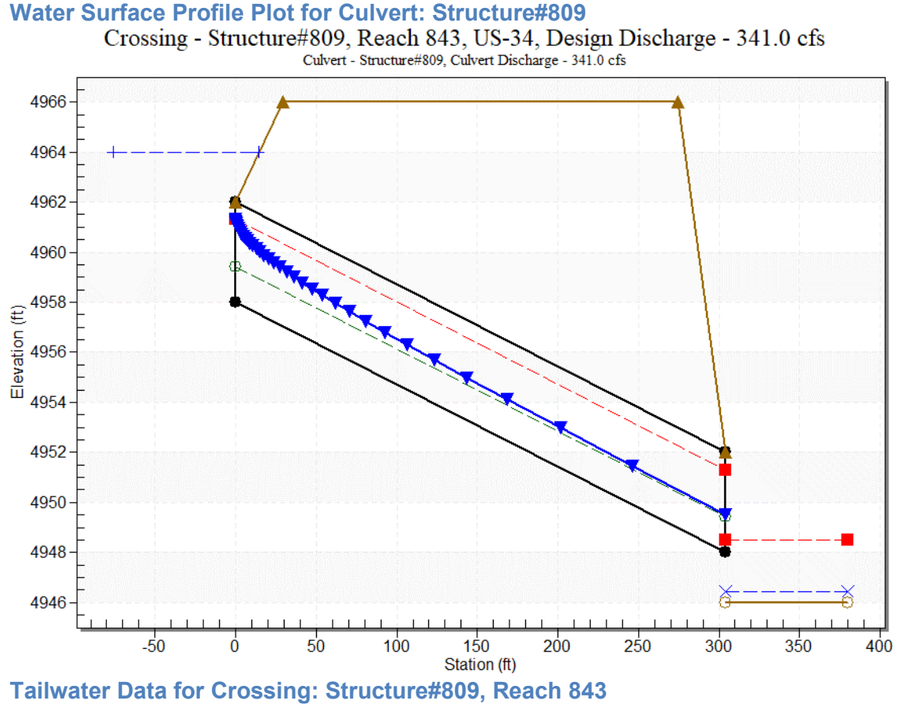
Table 19 - Culvert Summary Table: Structure#809

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	36.03 cfs	36.03 cfs	4959.23	1.23	0.0*	1-S2n	0.34	0.74	0.34	0.11	10.59	21.45
100 Year	341.00 cfs	341.00 cfs	4963.98	5.98	0.0*	5-S2n	1.42	3.31	1.51	0.43	22.53	51.90

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4958.00 ft,
Outlet Elevation (invert): 4948.00 ft
Culvert Length: 304.16 ft,
Culvert Slope: 0.0329

Water Surface Profile Plot for Culvert: Structure#809



Tailwater Data for Crossing: Structure#809, Reach 843

Table 20 - Downstream Channel Rating Curve (Crossing: Structure#809, Reach 843)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
36.03	4946.11	0.11	21.45	34.03	11.45
341.00	4946.43	0.43	51.90	133.12	14.00

Tailwater Channel Data - Structure#809, Reach 843

Tailwater Channel Option: Rectangular Channel
Bottom Width: 15.40 ft
Channel Slope: 5.0000
Channel Manning's n: 0.0350
Channel Invert Elevation: 4946.00 ft

Roadway Data for Crossing: Structure#809, Reach 843

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4966.00 ft
Roadway Surface: Paved
Roadway Top Width: 245.00 ft

Culvert Data: Structure#702

Site Data - Structure#702

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4867.00 ft
Outlet Station: 97.00 ft
Outlet Elevation: 4862.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#702

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
Inlet Depression: None

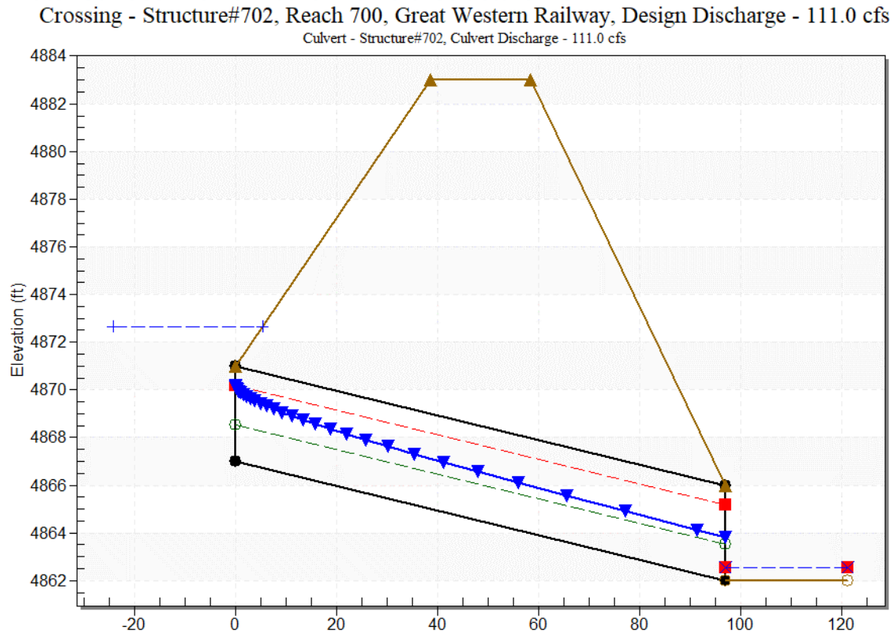
Table 1 - Culvert Summary Table: Structure#702

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	24.91 cfs	24.91 cfs	4868.96	1.96	0.0*	1-S2n	0.72	1.47	0.76	0.23	14.91	2.12
100 Year	111.00 cfs	111.00 cfs	4872.67	5.67	0.901	5-S2n	1.54	3.18	1.82	0.56	19.98	3.78

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4867.00 ft,
Outlet Elevation (invert): 4862.00 ft
Culvert Length: 97.13 ft,
Culvert Slope: 0.0515

Water Surface Profile Plot for Culvert: Structure#702



Tailwater Data for Crossing: Structure#702, Reach 700

Table 2 - Downstream Channel Rating Curve (Crossing: Structure#702, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4862.23	0.23	2.12	0.43	0.79
111.00	4862.56	0.56	3.78	1.05	0.91

Tailwater Channel Data - Structure#702, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0300
Channel Manning's n: 0.0450
Channel Invert Elevation: 4862.00 ft

Roadway Data for Crossing: Structure#702, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4883.00 ft
Roadway Surface: Gravel
Roadway Top Width: 20.00 ft

Culvert Data: Structure#703

Site Data - Structure#703,

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4872.00 ft
Outlet Station: 42.00 ft
Outlet Elevation: 4871.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#703,

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
Inlet Depression: None

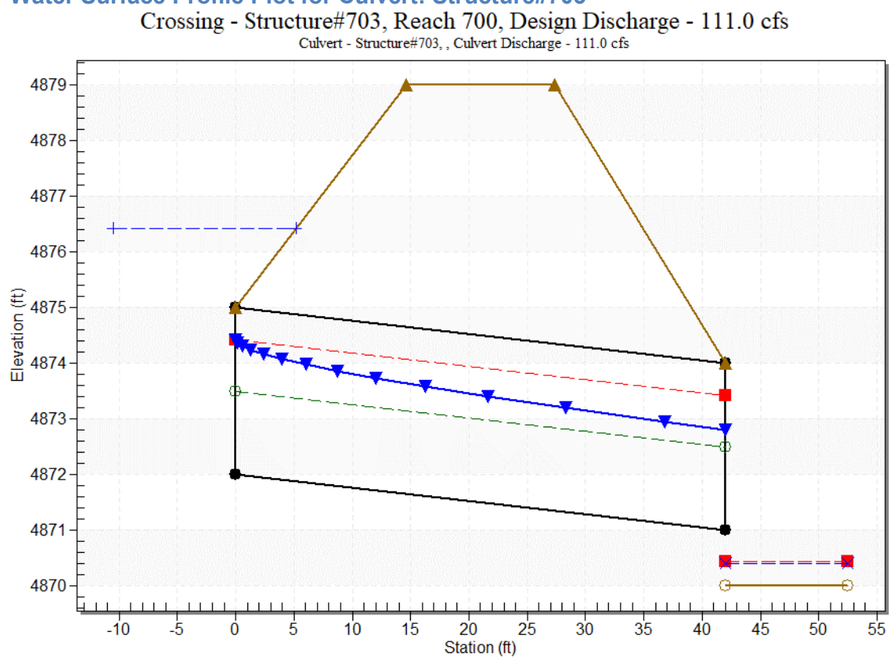
Table 3 - Culvert Summary Table: Structure#703

Names	Discharge (cfs)	Discharge (cfs)	Elevation (ft)	Control Depth (ft)	Control Depth (ft)	Type	Depth (ft)	Depth (ft)	Depth (ft)	Depth (ft)	Velocity (ft/s)	Velocity (ft/s)
5 Year	24.91 cfs	24.91 cfs	4873.53	1.53	0.206	1-S2n	0.68	1.12	0.74	0.16	9.15	2.18
100 Year	111.00 cfs	111.00 cfs	4876.41	4.41	3.391	5-S2n	1.49	2.42	1.79	0.40	12.59	3.94

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4872.00 ft,
Outlet Elevation (invert): 4871.00 ft
Culvert Length: 42.01 ft,
Culvert Slope: 0.0238

Water Surface Profile Plot for Culvert: Structure#703



Tailwater Data for Crossing: Structure#703, Reach 700

Table 4 - Downstream Channel Rating Curve (Crossing: Structure#703, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4870.16	0.16	2.18	0.22	0.95
111.00	4870.40	0.40	3.94	0.55	1.11

Tailwater Channel Data - Structure#703, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 70.00 ft
Side Slope (H:V): 2.00 (_:1)
Channel Slope: 0.0220
Channel Manning's n: 0.0300
Channel Invert Elevation: 4870.00 ft

Roadway Data for Crossing: Structure#703, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4879.00 ft
Roadway Surface: Gravel
Roadway Top Width: 12.76 ft

Culvert Data: Structure#704

Site Data - Structure#704

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4890.00 ft
Outlet Station: 89.00 ft
Outlet Elevation: 4888.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#704

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
Inlet Depression: None

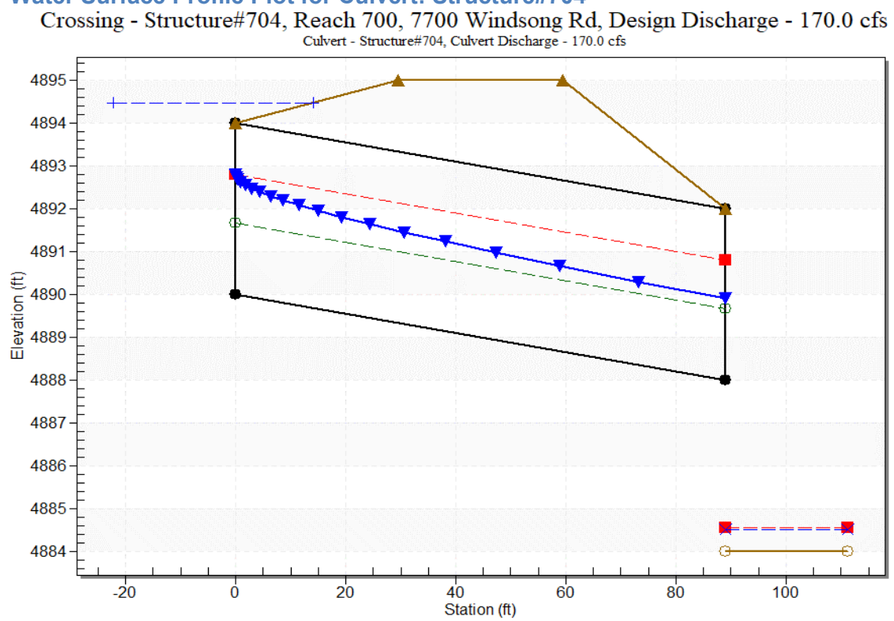
Table 5 - Culvert Summary Table: Structure#704

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	24.91 cfs	24.91 cfs	4891.39	1.39	0.0*	1-S2n	0.63	1.03	0.64	0.16	9.50	2.09
100 Year	170.00 cfs	170.00 cfs	4894.48	4.48	2.124	5-S2n	1.67	2.79	1.90	0.51	14.43	4.45

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4890.00 ft,
Outlet Elevation (invert): 4888.00 ft
Culvert Length: 89.02 ft,
Culvert Slope: 0.0225

Water Surface Profile Plot for Culvert: Structure#704



Tailwater Data for Crossing: Structure#704, Reach 700

Table 6 - Downstream Channel Rating Curve (Crossing: Structure#704, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4884.16	0.16	2.09	0.28	0.92
170.00	4884.51	0.51	4.45	0.89	1.11

Tailwater Channel Data - Structure#704, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 73.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0280
Channel Manning's n: 0.0350
Channel Invert Elevation: 4884.00 ft

Roadway Data for Crossing: Structure#704, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4897.00 ft
Roadway Surface: Paved
Roadway Top Width: 25.30 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: 74.00 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: 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

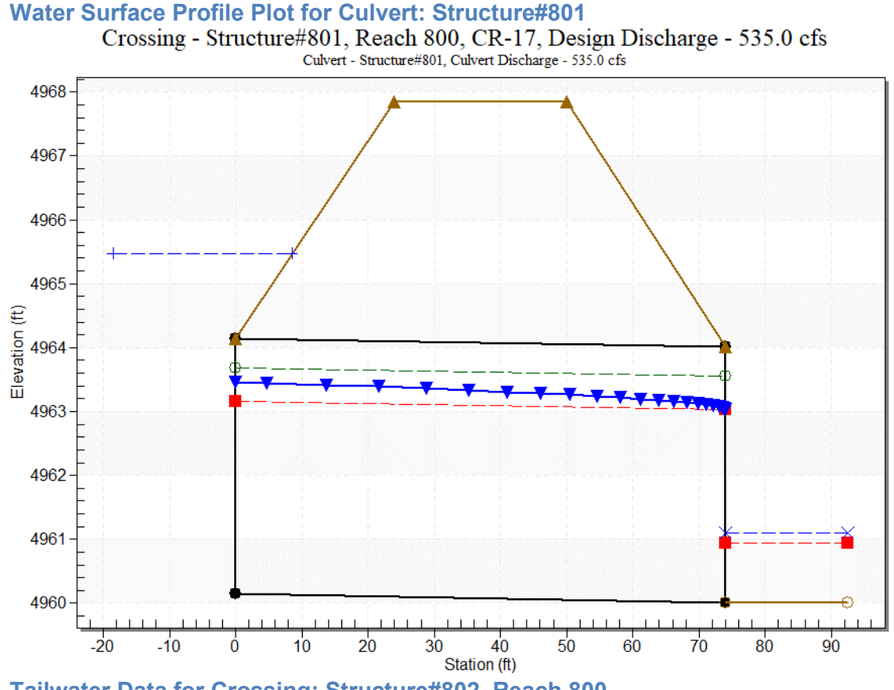
Table 7 - Culvert Summary Table: Structure#801

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	18.94 cfs	18.94 cfs	4960.71	0.56	0.560	2-M2c	0.39	0.33	0.33	0.15	3.24	1.25
100 Year	535.00 cfs	535.00 cfs	4965.47	5.32	5.188	7-M2c	3.54	3.02	3.02	1.08	9.85	4.45

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4960.15 ft,
Outlet Elevation (invert): 4960.01 ft
Culvert Length: 74.00 ft,
Culvert Slope: 0.0018

Water Surface Profile Plot for Culvert: Structure#801



Tailwater Data for Crossing: Structure#802, Reach 800

Table 8 - Downstream Channel Rating Curve (Crossing: Structure#802, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
18.94	4960.16	0.15	1.25	0.17	0.58
535.00	4961.09	1.08	4.45	1.25	0.79

Tailwater Channel Data - Structure#801, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 100.00 ft
Side Slope (H:V): 10.00 (_:1)
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

Culvert Data: Structure#804

Site Data - Structure#804

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4889.00 ft
Outlet Station: 90.00 ft
Outlet Elevation: 4881.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#804

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: 0.0130
Culvert Type: Straight
Inlet Configuration: Square Edge (30-75º flare) Wingwall
Inlet Depression: None

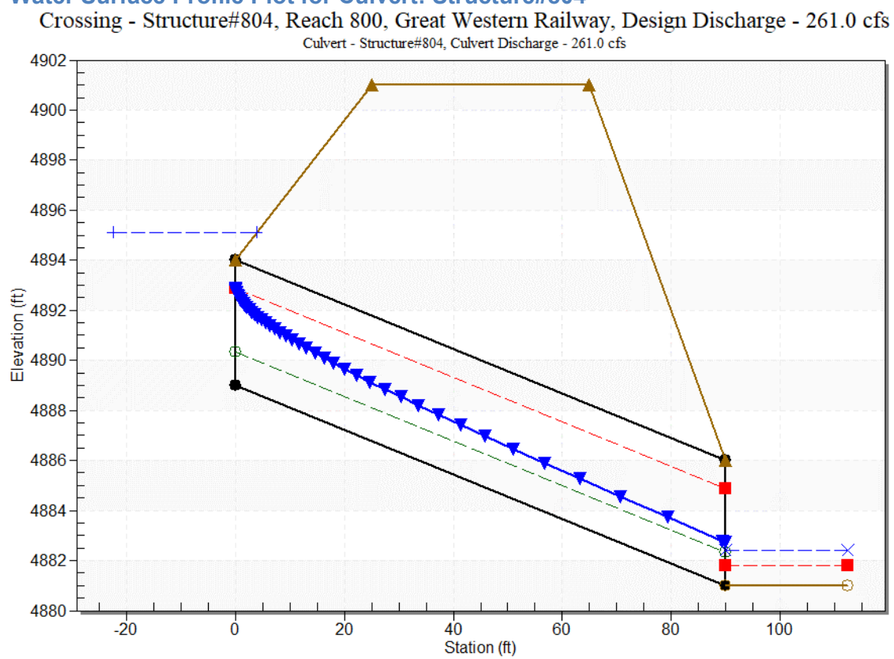
Table 9 - Culvert Summary Table: Structure#804

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	126.99 cfs	126.99 cfs	4892.50	3.50	0.0*	1-S2n	0.83	2.41	0.96	0.92	22.06	2.04
100 Year	261.00 cfs	261.00 cfs	4895.10	6.10	0.0*	5-S2n	1.34	3.89	1.74	1.41	25.06	2.68

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4889.00 ft,
Outlet Elevation (invert): 4881.00 ft
Culvert Length: 90.35 ft,
Culvert Slope: 0.0889

Water Surface Profile Plot for Culvert: Structure#804



Tailwater Data for Crossing: Structure#804, Reach 800

Table 10 - Downstream Channel Rating Curve (Crossing: Structure#804, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
126.99	4881.92	0.92	2.04	0.63	0.38
261.00	4882.41	1.41	2.68	0.97	0.41

Tailwater Channel Data - Structure#804, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 65.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0110
Channel Manning's n: 0.0700
Channel Invert Elevation: 4881.00 ft

Roadway Data for Crossing: Structure#804, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4901.00 ft
Roadway Surface: Gravel
Roadway Top Width: 40.00 ft

Culvert Data: Structure#805

Site Data - Structure#805

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4892.00 ft
Outlet Station: 62.00 ft
Outlet Elevation: 4890.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#805

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
Inlet Depression: None

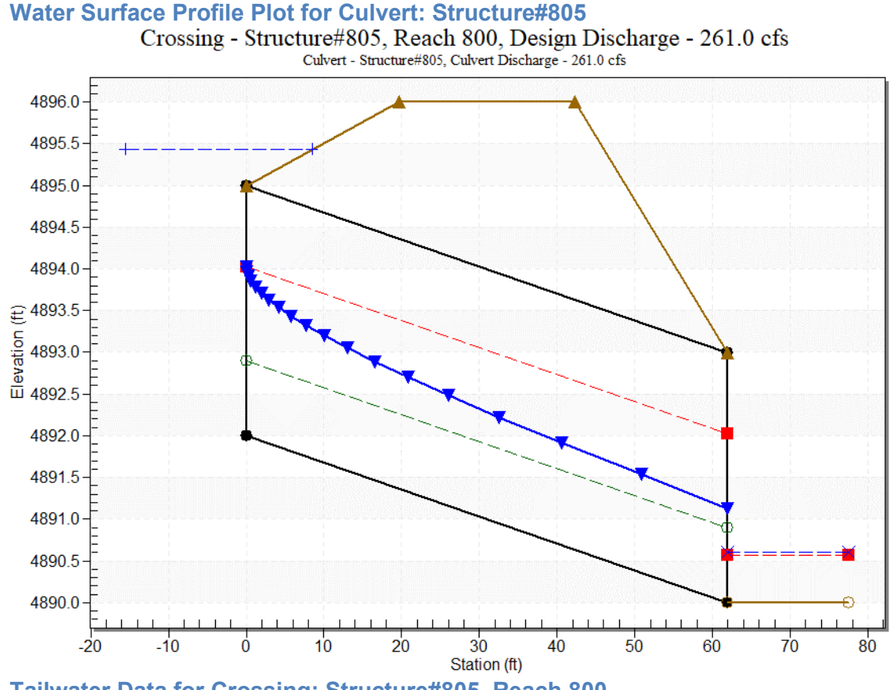
Table 11 - Culvert Summary Table: Structure#805

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	126.99 cfs	126.99 cfs	4894.07	2.07	0.0*	1-S2n	0.57	1.25	0.65	0.40	12.28	2.93
100 Year	261.00 cfs	261.00 cfs	4895.43	3.43	0.816	5-S2n	0.90	2.02	1.13	0.61	14.44	3.88

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4892.00 ft,
Outlet Elevation (invert): 4890.00 ft
Culvert Length: 62.03 ft,
Culvert Slope: 0.0323

Water Surface Profile Plot for Culvert: Structure#805



Tailwater Data for Crossing: Structure#805, Reach 800

Table 12 - Downstream Channel Rating Curve (Crossing: Structure#805, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
126.99	4890.40	0.40	2.93	0.69	0.83
261.00	4890.61	0.61	3.88	1.06	0.89

Tailwater Channel Data - Structure#805, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 107.00 ft
Side Slope (H:V): 6.00 (_:1)
Channel Slope: 0.0280
Channel Manning's n: 0.0450
Channel Invert Elevation: 4890.00 ft

Roadway Data for Crossing: Structure#805, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4896.00 ft
Roadway Surface: Gravel
Roadway Top Width: 22.60 ft

Culvert Data: Structure#806

Site Data - Structure#806

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4900.00 ft
Outlet Station: 50.00 ft
Outlet Elevation: 4899.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#806

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

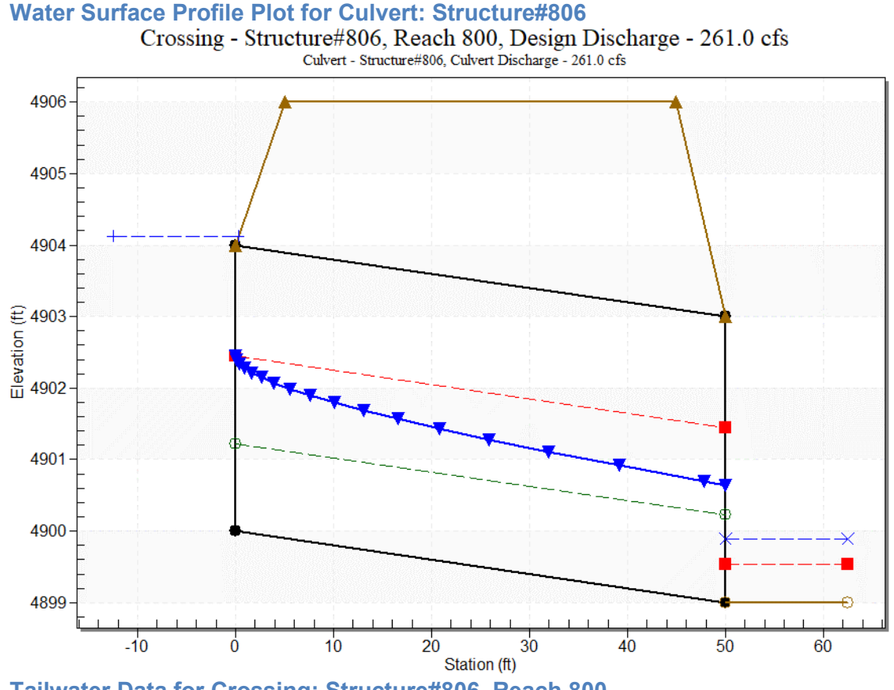
Table 13 - Culvert Summary Table: Structure#806

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	124.66 cfs	124.66 cfs	4902.51	2.51	0.666	1-S2n	0.77	1.50	0.93	0.57	11.14	1.88
100 Year	261.00 cfs	261.00 cfs	4904.13	4.13	2.194	5-S2n	1.23	2.45	1.64	0.88	13.27	2.51

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4900.00 ft,
Outlet Elevation (invert): 4899.00 ft
Culvert Length: 50.01 ft,
Culvert Slope: 0.0200

Water Surface Profile Plot for Culvert: Structure#806



Tailwater Data for Crossing: Structure#806, Reach 800

Table 14 - Downstream Channel Rating Curve (Crossing: Structure#806, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
124.66	4899.57	0.57	1.88	0.60	0.44
261.00	4899.88	0.88	2.51	0.94	0.48

Tailwater Channel Data - Structure#806, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 115.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0170
Channel Manning's n: 0.0700
Channel Invert Elevation: 4899.00 ft

Roadway Data for Crossing: Structure#806, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4906.00 ft
Roadway Surface: Paved
Roadway Top Width: 40.00 ft

Culvert Data: Structure#807

Site Data - Structure#807

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4917.00 ft
Outlet Station: 80.00 ft
Outlet Elevation: 4916.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#807

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 (30-75º flare) Wingwall
Inlet Depression: None

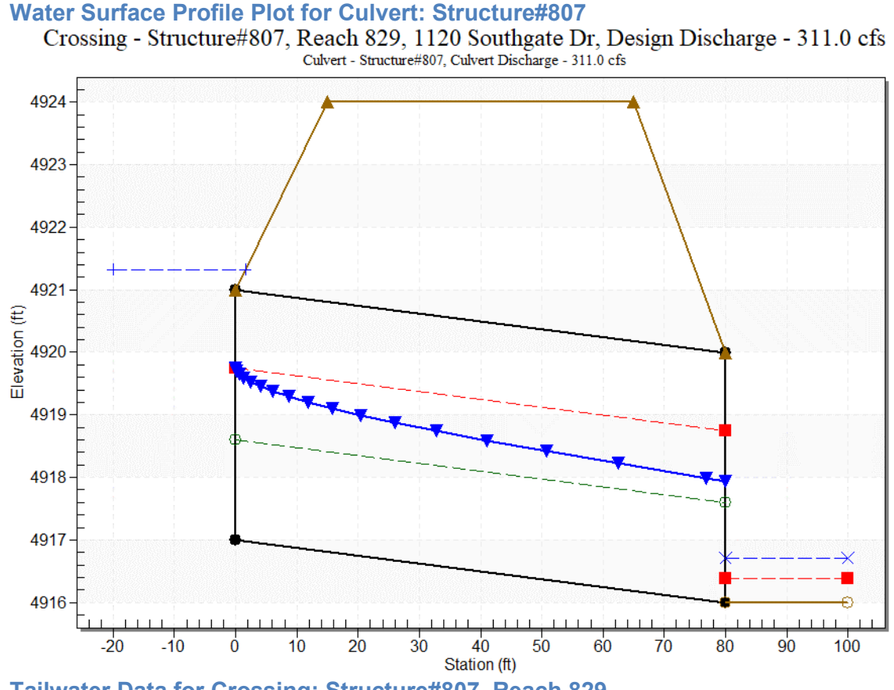
Table 15 - Culvert Summary Table: Structure#807

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	63.00 cfs	63.00 cfs	4918.44	1.44	0.0*	1-S2n	0.58	0.95	0.61	0.27	8.64	0.98
100 Year	311.00 cfs	311.00 cfs	4921.32	4.32	2.792	5-S2n	1.60	2.75	1.94	0.71	13.33	1.84

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4917.00 ft,
Outlet Elevation (invert): 4916.00 ft
Culvert Length: 80.01 ft,
Culvert Slope: 0.0125

Water Surface Profile Plot for Culvert: Structure#807



Tailwater Data for Crossing: Structure#807, Reach 829

Table 16 - Downstream Channel Rating Curve (Crossing: Structure#807, Reach 829)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
63.00	4916.27	0.27	0.98	0.09	0.33
311.00	4916.71	0.71	1.84	0.22	0.39

Tailwater Channel Data - Structure#807, Reach 829

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 235.00 ft
Side Slope (H:V): 5.00 (_:1)
Channel Slope: 0.0050
Channel Manning's n: 0.0450
Channel Invert Elevation: 4916.00 ft

Roadway Data for Crossing: Structure#807, Reach 829

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4924.00 ft
Roadway Surface: Paved
Roadway Top Width: 50.00 ft

Culvert Data: Structure#808

Site Data - Structure#808

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4942.00 ft
Outlet Station: 527.00 ft
Outlet Elevation: 4932.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#808

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

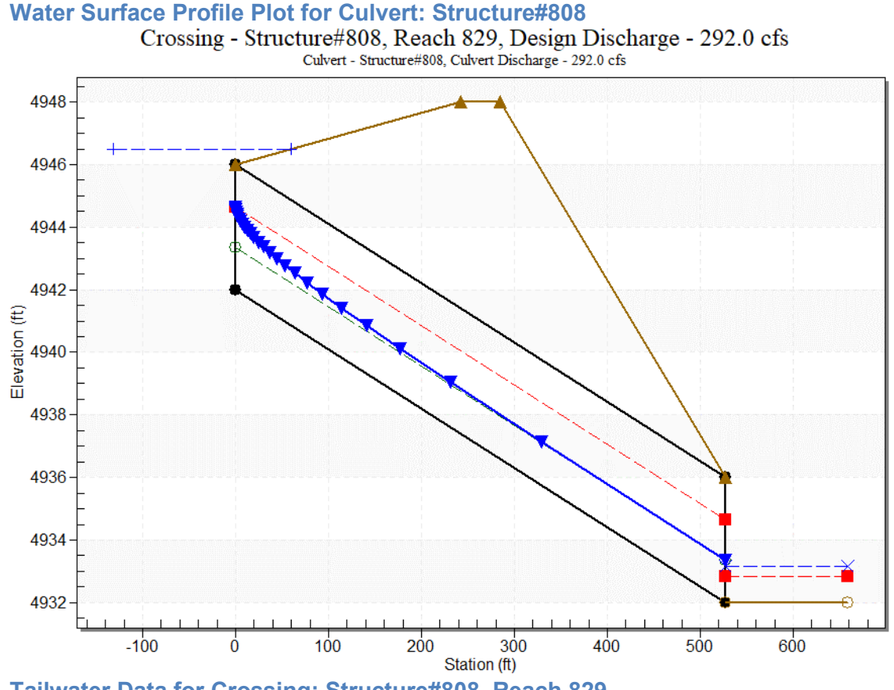
Table 17 - Culvert Summary Table: Structure#808

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	36.03 cfs	36.03 cfs	4943.10	1.10	0.0*	1-S2n	0.36	0.65	0.36	0.33	8.38	1.64
100 Year	292.00 cfs	292.00 cfs	4946.49	4.49	0.0*	5-S2n	1.34	2.64	1.36	1.16	17.89	3.60

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4942.00 ft,
Outlet Elevation (invert): 4932.00 ft
Culvert Length: 527.09 ft,
Culvert Slope: 0.0190

Water Surface Profile Plot for Culvert: Structure#808



Tailwater Data for Crossing: Structure#808, Reach 829

Table 18 - Downstream Channel Rating Curve (Crossing: Structure#808, Reach 829)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
36.03	4932.33	0.33	1.64	0.23	0.51
292.00	4933.16	1.16	3.60	0.79	0.62

Tailwater Channel Data - Structure#808, Reach 829

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 64.00 ft
Side Slope (H:V): 5.40 (_:1)
Channel Slope: 0.0110
Channel Manning's n: 0.0450
Channel Invert Elevation: 4932.00 ft

Roadway Data for Crossing: Structure#808, Reach 829

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4948.00 ft
Roadway Surface: Paved
Roadway Top Width: 43.00 ft

Culvert Data: Structure#809

Site Data - Structure#809

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4958.00 ft
Outlet Station: 304.00 ft
Outlet Elevation: 4948.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#809

Barrel Shape: Concrete Box
Barrel Span: 10.00 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 19 - Culvert Summary Table: Structure#809

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	36.03 cfs	36.03 cfs	4958.77	0.77	0.0*	1-S2n	0.22	0.47	0.22	0.11	8.12	21.45
100 Year	528.00 cfs	528.00 cfs	4962.76	4.76	0.0*	5-S2n	1.20	2.79	1.26	0.56	21.01	61.42

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4958.00 ft,
Outlet Elevation (invert): 4948.00 ft
Culvert Length: 304.16 ft,
Culvert Slope: 0.0329

Water Surface Profile Plot for Culvert: Structure#809

Tailwater Data for Crossing: Structure#809, Reach 843

Table 20 - Downstream Channel Rating Curve (Crossing: Structure#809, Reach 843)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
36.03	4946.11	0.11	21.45	34.03	11.45
528.00	4946.56	0.56	61.42	174.16	14.49

Tailwater Channel Data - Structure#809, Reach 843

Tailwater Channel Option: Rectangular Channel
Bottom Width: 15.40 ft
Channel Slope: 5.0000
Channel Manning's n: 0.0350
Channel Invert Elevation: 4946.00 ft

Roadway Data for Crossing: Structure#809, Reach 843

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4966.00 ft
Roadway Surface: Paved
Roadway Top Width: 245.00 ft

Appendix E-4
SWMM Inputs/Outputs
Option 1: Do Nothing

```
[TITLE]
;;Project Title/Notes
City of Greeley
Storm Drainage Master Plan
Oklahoma Baseline Alternatives
Additional Basins 700-800
Matrix Design Group, Inc. 2024
Scenario ID = Fut_100yr_GO_Do_Nothin  g

[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:\23.1447.001 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221
Models\CUHP_SWMM\CUHP\15_Fut_100yr_0mi^2_Greeley_7.8.txt"

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

[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
620              4920       10         0          0          0
712              4915       10         0          0          0
714              4864       10         0          0          0
803              4866       10         0          0          0
804              4882       10         0          0          0
809              4890       25         0          0          0
810              4925       10         0          0          0
819              4901       10         0          0          0
820              4945       10         0          0          0
824              4961       10         0          0          0
829              4918       15         0          0          0
830              4972       10         0          0          0
839              4965       15         0          0          0
840              4990       10         0          0          0
841              4967       10         0          0          0
842              5000       10         0          0          0
843              4959       15         0          0          0
844              4995       10         0          0          0
850              4990       10         0          0          0
711              4889       10         0          0          0
710              4871       10         0          0          0
709              4866       10         0          0          0
708              4851       10         0          0          0
713              4898       10         0          0          0
811              4893       10         0          0          0
822              4932       10         0          0          0
823              4908       10         0          0          0
834              4932       15         0          0          0
838              4949       15         0          0          0
831              4928.5     15         0          0          0
808              4885       0          0          0          0

[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
O_803            4865       FREE                        NO
O_708            4828       FREE                        NO
O_620            4817       FREE                        NO
O_714            4838       FREE                        NO

[DIVIDERS]
;;Name           Elevation  Diverted Link    Type       Parameters
;;-------------- ---------- ---------------- ---------- ----------
836              4945       OV_836           OVERFLOW   15         0          0          0
```

```
[CONDUITS]
;;Name           From Node       To Node         Length     Roughness  InOffset   OutOffset  InitFlow   MaxFlow
;;-------------- --------------- --------------- ---------- ---------- ---------- ---------- ---------- ----------
DL_620           620             O_620           400        0.01       0          0          0          0
DL_714           714             O_714           400        0.01       0          0          0          0
DL_803           803             O_803           400        0.01       0          0          0          0
DL_804           804             803             400        0.01       0          0          0          0
DL_810           810             809             400        0.01       0          0          0          0
DL_820           820             819             400        0.01       0          0          0          0
DL_830           830             829             400        0.01       0          0          0          0
DL_840           840             839             400        0.01       0          0          0          0
DL_842           842             841             400        0.01       0          0          0          0
DL_844           844             843             400        0.01       0          0          0          0
L_808            808             803             1197       0.07       0          0          0          0
L_823            823             819             943        0.04       0          0          0          0
L_839            839             843             541        0.048      0          0          0          0
L_841            841             839             190        .044       0          0          0          0
L_850            850             841             1740       0.044      0          0          0          0
L_708            708             O_708           202        0.035      0          0          0          0
L_709            709             708             560.2      0.03       0          0          0          0
L_710            710             709             154.3      0.04       0          0          0          0
L_711            711             710             615.3      0.04       0          0          0          0
L_713            713             711             338.1      0.07       0          0          0          0
L_712            712             713             485.4      .04        0          0          0          0
L_838            838             836             314.88     0.048      0          0          0          0
L_811            811             809             183        0.045      0          0          0          0
L_843            843             838             304        0.035      0          0          0          0
L_819            819             811             761        0.07       0          0          0          0
L_824            824             822             1270       0.035      0          0          0          0
L_822            822             819             671        0.04       0          0          0          0
L_829            829             823             290        0.035      0          0          0          0
L_836            836             834             442        0.013      0          0          0          0
OV_836           836             834             442        .035       0          0          0          0
L_831            831             829             105        0.04       0          0          0          0
L_834            834             831             1040       0.04       0          0          0          0
L_809            809             808             90         0.013      0          0          0          0

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels    Culvert
;;-------------- ------------ ---------------- ---------- ---------- ---------- ---------- ----------
DL_620           DUMMY        0                0          0          0          1
DL_714           DUMMY        0                0          0          0          1
DL_803           DUMMY        0                0          0          0          1
DL_804           DUMMY        0                0          0          0          1
DL_810           DUMMY        0                0          0          0          1
DL_820           DUMMY        0                0          0          0          1
DL_830           DUMMY        0                0          0          0          1
DL_840           DUMMY        0                0          0          0          1
DL_842           DUMMY        0                0          0          0          1
DL_844           DUMMY        0                0          0          0          1
L_808            TRAPEZOIDAL  10               65         3          3          1
L_823            TRAPEZOIDAL  10               235        5          5          1
L_839            TRAPEZOIDAL  15               100        27         10         1
L_841            TRIANGULAR   10               200        0          0          1
L_850            TRAPEZOIDAL  10               20         12         12         1
L_708            TRAPEZOIDAL  10               22         2          2          1
L_709            TRAPEZOIDAL  10               50         4          4          1
L_710            TRAPEZOIDAL  10               70         2          2          1
L_711            TRAPEZOIDAL  10               73         4          4          1
L_713            TRAPEZOIDAL  10               55         10         10         1
L_712            TRAPEZOIDAL  10               106        15         15         1
L_838            TRAPEZOIDAL  15               24         15         15         1
L_811            TRAPEZOIDAL  10               107        6          6          1
L_843            CIRCULAR     15               0          0          0          1
L_819            TRAPEZOIDAL  10               115        3          3          1
L_824            TRAPEZOIDAL  10               657        30         30         1
L_822            TRAPEZOIDAL  10               235        5          5          1
L_829            TRAPEZOIDAL  10               75         3.5        6.5        1
L_836            CIRCULAR     4                0          0          0          1
OV_836           TRAPEZOIDAL  15               40         15         15         1
L_831            TRAPEZOIDAL  15               65         6          6          1
L_834            TRAPEZOIDAL  15               64         6          6          1
L_809            RECT_CLOSED  15               5          0          0          1

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

[TAGS]

[MAP]
DIMENSIONS 0.000 0.000 8882.267 8132.154
Units      None

[COORDINATES]
;;Node           X-Coord          Y-Coord
;;-------------- ---------------- ----------------
620              3176.446         5603.079
712              2895.562         4845.602
714              2396.597         5524.935
803              2046.787         5306.170
804              2224.496         5288.834
809              2304.222         4931.686
810              2221.307         4534.501
819              2458.581         4607.362
820              2858.872         4455.858
824              3212.781         4053.026
829              2531.995         4090.155
830              2310.615         3639.827
839              3222.537         3474.569
840              4296.625         2946.685
841              3225.328         3393.633
```

```
842             4116.415        2195.542
843             3098.576        3589.753
844             3175.492        2589.454
850             3628.528        2902.994
711             2728.325        5128.419
710             2635.627        5340.281
709             2645.107        5386.630
708             2650.374        5598.361
713             2796.803        5016.287
811             2326.424        4882.578
822             2779.481        4253.460
823             2482.561        4170.492
834             2793.200        3771.985
838             3041.708        3648.672
831             2539.570        4080.449
808             2290.503        4963.697
O_803             2037.522          5457.441
O_708             2644.492          5672.936
O_620             3155.399          5761.408
O_714             2402.976          5620.622
836             2952.697        3687.647

[VERTICES]
;;Link           X-Coord           Y-Coord
;;-------------- ----------------- -----------------
DL_803            2026.861          5357.978
DL_803            2038.817          5412.975
DL_810            2232.974          4619.614
DL_810            2245.732          4810.989
DL_830            2525.911          4040.117
DL_840            4169.043          3071.079
DL_840            4092.493          3157.197
DL_840            3953.747          3410.768
DL_840            3583.757          3433.095
DL_840            3315.833          3429.905
DL_842            3580.567          2554.368
DL_842            3454.075          2733.989
DL_842            3356.793          2914.200
DL_842            3278.649          3199.666
DL_844            3186.655          2742.553
DL_844            3202.603          2914.790
DL_844            3193.034          3211.420
DL_844            3164.328          3249.694
DL_844            3183.466          3396.415
L_808             2265.576          5028.444
L_808             2246.438          5036.418
L_808             2206.569          5066.719
L_808             2203.379          5100.210
L_808             2190.621          5159.217
L_808             2137.993          5194.302
L_808             2080.325          5208.102
L_808             2060.399          5283.821
L_823             2485.244          4167.900
L_823             2482.053          4247.674
L_823             2482.053          4378.503
L_850             3608.479          2914.796
L_850             3593.723          2919.982
L_850             3576.180          2921.577
L_850             3539.500          2931.146
L_850             3506.010          2942.309
L_850             3486.872          2971.016
L_850             3467.735          2998.127
L_850             3439.029          3045.970
L_850             3419.891          3090.624
L_850             3389.590          3162.390
L_850             3365.669          3202.259
L_850             3341.747          3250.103
L_850             3308.256          3289.973
L_850             3271.576          3334.626
OV_836            2870.006          3747.691

[Polygons]

[BACKDROP]
FILE       "R:\23.1447.001 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221
Models\CUHP_SWMM\SWMM\Backgrounds\Final Map.jpg"
DIMENSIONS 735.737 1837.108 8882.267 8132.154"
```

City of Greeley
Storm Drainage Master Plan
Oklahoma Baseline Alternatives

****
Element Count
****
Number of rain gages 0
Number of subcatchments ... 0
Number of nodes 36
Number of links 33
Number of pollutants 0
Number of land uses 0

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
620	JUNCTION	4920.00	10.00	0.0	
712	JUNCTION	4915.00	10.00	0.0	
714	JUNCTION	4864.00	10.00	0.0	
803	JUNCTION	4866.00	10.00	0.0	
804	JUNCTION	4882.00	10.00	0.0	
809	JUNCTION	4890.00	25.00	0.0	
810	JUNCTION	4925.00	10.00	0.0	
819	JUNCTION	4901.00	10.00	0.0	
820	JUNCTION	4945.00	10.00	0.0	
824	JUNCTION	4961.00	10.00	0.0	
829	JUNCTION	4918.00	15.00	0.0	
830	JUNCTION	4972.00	10.00	0.0	
839	JUNCTION	4965.00	15.00	0.0	
840	JUNCTION	4990.00	10.00	0.0	
841	JUNCTION	4967.00	10.00	0.0	
842	JUNCTION	5000.00	10.00	0.0	
843	JUNCTION	4959.00	15.00	0.0	
844	JUNCTION	4995.00	10.00	0.0	
850	JUNCTION	4990.00	10.00	0.0	
711	JUNCTION	4889.00	10.00	0.0	
710	JUNCTION	4871.00	10.00	0.0	
709	JUNCTION	4866.00	10.00	0.0	
708	JUNCTION	4851.00	10.00	0.0	
713	JUNCTION	4898.00	10.00	0.0	
811	JUNCTION	4893.00	10.00	0.0	
822	JUNCTION	4932.00	10.00	0.0	
823	JUNCTION	4908.00	10.00	0.0	
834	JUNCTION	4932.00	15.00	0.0	
838	JUNCTION	4949.00	15.00	0.0	
831	JUNCTION	4928.50	15.00	0.0	
808	JUNCTION	4885.00	15.00	0.0	
O_803	OUTFALL	4865.00	0.00	0.0	
O_708	OUTFALL	4828.00	10.00	0.0	
O_620	OUTFALL	4817.00	0.00	0.0	
O_714	OUTFALL	4838.00	0.00	0.0	
836	DIVIDER	4945.00	15.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
DL_620	620	O_620	CONDUIT	400.0	26.6486	0.0100
DL_714	714	O_714	CONDUIT	400.0	6.5138	0.0100
DL_803	803	O_803	CONDUIT	400.0	0.2500	0.0100
DL_804	804	803	CONDUIT	400.0	4.0032	0.0100
DL_810	810	809	CONDUIT	400.0	8.7837	0.0100
DL_820	820	819	CONDUIT	400.0	11.0672	0.0100
DL_830	830	829	CONDUIT	400.0	13.6247	0.0100
DL_840	840	839	CONDUIT	400.0	6.2622	0.0100
DL_842	842	841	CONDUIT	400.0	8.2782	0.0100
DL_844	844	843	CONDUIT	400.0	9.0367	0.0100
L_808	808	803	CONDUIT	1197.0	1.5875	0.0700
L_823	823	819	CONDUIT	943.0	0.7423	0.0400
L_839	839	843	CONDUIT	541.0	1.1091	0.0480
L_841	841	839	CONDUIT	190.0	1.0527	0.0440
L_850	850	841	CONDUIT	1740.0	1.3220	0.0440
L_708	708	O_708	CONDUIT	202.0	11.4607	0.0350
L_709	709	708	CONDUIT	560.2	2.6786	0.0300
L_710	710	709	CONDUIT	154.3	3.2421	0.0400
L_711	711	710	CONDUIT	615.3	2.9267	0.0400
L_713	713	711	CONDUIT	338.1	2.6629	0.0700
L_712	712	713	CONDUIT	485.4	3.5044	0.0400
L_838	838	836	CONDUIT	314.9	1.2704	0.0480
L_811	811	809	CONDUIT	183.0	1.6396	0.0450
L_843	843	838	CONDUIT	304.0	3.2913	0.0350
L_819	819	811	CONDUIT	761.0	1.0513	0.0700
L_824	824	822	CONDUIT	1270.0	2.2841	0.0350
L_822	822	819	CONDUIT	671.0	4.6249	0.0400
L_829	829	823	CONDUIT	290.0	3.4503	0.0350
L_836	836	834	CONDUIT	442.0	2.9424	0.0130
OV_836	836	834	CONDUIT	442.0	2.9424	0.0350
L_831	831	829	CONDUIT	105.0	10.0504	0.0400
L_834	834	831	CONDUIT	1040.0	0.3365	0.0400
L_809	809	808	CONDUIT	90.0	5.5641	0.0130

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
DL_620	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_714	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_803	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_804	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_820	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_830	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_840	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_842	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_844	DUMMY	0.00	0.00	0.00	0.00	1	0.00
L_808	TRAPEZOIDAL	10.00	950.00	7.41	125.00	1	9655.82
L_823	TRAPEZOIDAL	10.00	2850.00	8.46	335.00	1	37867.18
L_839	TRAPEZOIDAL	15.00	5662.50	8.63	655.00	1	77684.49
L_841	TRIANGULAR	10.00	1000.00	4.98	200.00	1	10098.48
L_850	TRAPEZOIDAL	10.00	1400.00	5.37	260.00	1	16665.33
L_708	TRAPEZOIDAL	10.00	420.00	6.29	62.00	1	20580.76
L_709	TRAPEZOIDAL	10.00	900.00	6.79	130.00	1	26173.35
L_710	TRAPEZOIDAL	10.00	900.00	7.85	110.00	1	23769.29
L_711	TRAPEZOIDAL	10.00	1130.00	7.27	153.00	1	26947.94
L_713	TRAPEZOIDAL	10.00	1550.00	6.05	255.00	1	17837.15
L_712	TRAPEZOIDAL	10.00	2560.00	6.30	406.00	1	60698.05
L_838	TRAPEZOIDAL	15.00	3735.00	7.86	474.00	1	51535.74
L_811	TRAPEZOIDAL	10.00	1670.00	7.30	227.00	1	26581.36
L_843	CIRCULAR	15.00	176.71	3.75	15.00	1	3285.42
L_819	TRAPEZOIDAL	10.00	1450.00	8.13	175.00	1	12765.94
L_824	TRAPEZOIDAL	10.00	9570.00	7.61	1257.00	1	237606.05
L_822	TRAPEZOIDAL	10.00	2850.00	8.46	335.00	1	94518.19
L_829	TRAPEZOIDAL	10.00	1250.00	7.06	175.00	1	36264.24
L_836	CIRCULAR	4.00	12.57	1.00	4.00	1	246.40
OV_836	TRAPEZOIDAL	15.00	3975.00	8.10	490.00	1	116720.41
L_831	TRAPEZOIDAL	15.00	2325.00	9.39	245.00	1	121915.29
L_834	TRAPEZOIDAL	15.00	2310.00	9.37	244.00	1	22129.56
L_809	RECT_CLOSED	15.00	75.00	1.88	5.00	1	3074.94

****
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	170.202	55.463
External Outflow	171.109	55.758
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	0.012	0.004
Continuity Error (%)	-0.540	

****
Highest Flow Instability Indexes
****
Link L_831 (1)
Link L_834 (1)
Link L_829 (1)

****
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 : 1.01
% of Steps Not Converging : 0.00

****
Analysis begun on: Wed Jun 12 15:04:07 2024
Analysis ended on: Wed Jun 12 15:04:07 2024
Total elapsed time: < 1 sec

Appendix E-5
Alternatives Results Summary

Channel Results Reach 700							
Options	**Link**	**W_{bot}**	**Side S**	**Q_{100}**	**V_{100}**	**Depth**	**W_{top}**
Option 1 Do Nothing	L_708	22	2	172.3	10.7	0.7	39.8
	L_709	50	4	172.3	5.55	0.6	69.8
	L_710	70	2	172.4	4.42	0.5	87
	L_711	73	4	172.4	4.18	0.5	92
	L_712	106	15	172.8	3.73	0.4	133
	L_713	55	10	172.6	2.97	0.9	88
Detention	L_708	22	2	128.5	9.59	0.6	39.4
	L_709	50	4	128.5	4.96	0.5	69.0
	L_710	70	2	128.5	3.94	0.5	87
	L_711	73	4	172.4	4.11	0.6	92.8
	L_712	106	15	172.8	3.73	0.4	133
	L_713	55	10	172.6	2.97	0.9	88
Channel Improvements	L_708	170	5	172.2	4.95	0.2	187
	L_709	75	4	172.2	4.8	0.5	94
	L_710	70	2	172.4	4.42	0.5	87
	L_711	73	4	172.4	4.18	0.5	92
	L_712	106	15	172.8	3.73	0.4	133
	L_713	55	10	172.6	2.97	0.9	88
LID	L_708	22	2	110.8	9.07	0.5	39
	L_709	50	4	110.8	4.69	0.5	69
	L_710	70	2	110.8	3.72	0.4	86.6
	L_711	73	4	169.7	3.36	0.7	93.6
	L_712	106	15	170.3	3.71	0.4	133
	L_713	55	10	170.1	2.96	0.9	88

Vol. - Volume, acre-ft

Side S - Channel side slopes, H:V

Q_{in} - Inflow, cfs

V_{100} - Average channel velocity, ft/sec

Q_{out} - Outflow, cfs

Q_{100} - Maximum flow in channel, ft/sec

W_{bot} - Bottom width, ft

Depth - 100-yr flow depth, ft

W_{top} - Top width, Area - acres

Channel Results Reach 800							
Options	**Link**	**W_{bot}**	**Side S**	**Q_{100}**	**V_{100}**	**Depth**	**W_{top}**
Do Nothing	L_808	65	3	2049.2	6.29	4.2	105.2
	L_811	107	6	1882.0	6.82	2.3	149.6
	L_819	115	3	1882.2	4.58	3.3	149.8
Detention	L_808	65	3	412.2	3.57	1.7	90.2
	L_811	107	6	355.3	3.7	0.9	132.8
	L_819	115	3	355.3	2.44	1.2	137.2
Channel Improvements	L_808	130	6	2031.6	4.97	2.8	178.6
	L_811	130	6	1871.3	4.85	2.6	176.2
	L_819	115	3	1871.6	4.57	3.3	149.8
LID	L_808	65	3	277.6	3.08	1.3	87.8
	L_811	107	6	260.9	3.29	0.7	130.4
	L_819	115	3	260.9	2.17	1	136

Vol. - Volume, acre-ft

Side S - Channel side slopes, H:V

Q_{in} - Inflow, cfs

V_{100} - Average channel velocity, ft/sec

Q_{out} - Outflow, cfs

Q_{100} - Maximum flow in channel, ft/sec

W_{bot} - Bottom width, ft

Depth - 100-yr flow depth, ft

W_{top} - Top width, Area - acres

Channel Results Reach 829							
Options	**Link**	**W_{bot}**	**Side S**	**Q_{100}**	**V_{100}**	**Depth**	**W_{top}**
Do Nothing	L_823	235	5	1503.6	4.14	1.5	265
	L_829	75	3.5	1511.3	10.56	1.7	101.9
	L_834	64	6	1290.1	4.33	2.3	106.6
	OV_836	40	15	1052.9	8.64	1.2	91
	L_838	24	15	1299.7	5.46	2.2	105
Detention	L_823	235	5	433.6	2.55	0.7	257
	L_829	75	3.5	434.4	6.43	0.9	96.3
	L_834	64	6	339.7	2.8	1.1	92.2
	OV_836	40	15	94.6	4.43	0.3	64
	L_838	24	15	341.1	3.84	1.2	75
Channel Improvements	L_823	235	5	1498.3	4.13	1.5	265
	L_825	75	7	1506.3	8.8	1.3	108.2
	L_829	80	5	1506.3	4.94	3.2	127
	L_834	64	6	1289.5	4.33	2.3	106.6
	OV_836	90	20	805.8	5	0.9	141
	L_838	50	20	1299.7	4.99	1.7	133
LID	L_823	235	5	310.9	1.73	0.8	258
	L_829	75	3.5	311.3	5.89	0.7	94.9
	L_834	64	6	291.5	2.63	1	91
	OV_836	40	15	45.5	3.35	0.2	61
	L_838	24	15	524.4	2.6	2	99

Vol. - Volume, acre-ft

Side S - Channel side slopes, H:V

Q_{in} - Inflow, cfs

V_{100} - Average channel velocity, ft/sec

Q_{out} - Outflow, cfs

Q_{100} - Maximum flow in channel, ft/sec

W_{bot} - Bottom width, ft

Depth - 100-yr flow depth, ft

W_{top} - Top width, Area - acres

Channel Results Reach 843							
Options	**Link**	**W_{bot}**	**Side S**	**Q_{100}**	**V_{100}**	**Depth**	**W_{top}**
Do Nothing	L_839	100	10	843.9	3.95	1.1	137
	L_850	20	12	306.1	4.37	1.7	75.8
Detention	L_839	100	10	202.8	2.46	0.5	125
	L_850	20	12	304.9	4.15	1.8	78.2
Channel Improvements	L_839	100	10	843.9	3.95	1.1	137
	L_850	20	12	306.1	4.37	1.7	75.8
Lid	L_839	100	10	528.3	3.42	0.8	131
	L_850	20	12	303.9	4.36	1.7	75.8

Vol. - Volume, acre-ft

Side S - Channel side slopes, H:V

Q_{in} - Inflow, cfs

V_{100} - Average channel velocity, ft/sec

Q_{out} - Outflow, cfs

Q_{100} - Maximum flow in channel, ft/sec

W_{bot} - Bottom width, ft

Depth - 100-yr flow depth, ft

W_{top} - Top width, Area - acres

Detention Results						
Options	**Reach**	**ID**	**Vol.**	**Area**	**Q_{in}**	**Q_{out}**
Do Nothing	-	-	-	-	-	-
Detention	700	D_711	6.5	1.6	172.39	128.51
	829	D_823	43	6.3	793.39	355.81
	843	D_841	25	12.2	646.8	41.02
		D_844	17	4.4	523.46	205.44
Channel Improvement	-	-	-	-	-	-
LID	700	D_EURV_711	2.4	0.6	169.72	155.18
	829	D_EURV_820	5.5	1.3	331.54	239.67
	843	D_EURV_830	5.6	1.5	293.46	192.74
	843	D_EURV_840	5.4	3.1	199.75	164.78
	843	D_EURV_842	14.3	9.5	646.49	328.28
	829	D_EURV_844	9.4	2.3	523.28	382.8
	700	D_FC_711	6.5	1.3	155.18	110.83
	829	D_FC_823	20	5	474.73	260.99
	829	D_FC_838	17.3	3.3	524.38	291.98
	843	D_FC__842	2.4	0.6	328.28	283.97

Vol. - Volume, acre-ft

Side S - Channel side slopes, H:V

Q_{in} - Inflow, cfs

V_{100} - Average channel velocity, ft/sec

Q_{out} - Outflow, cfs

Q_{100} - Maximum flow in channel, ft/sec

W_{bot} - Bottom width, ft

Depth - 100-yr flow depth, ft

W_{top} - Top width, Area - acres

Appendix E-6
MHFD Cost Estimate Workbooks

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alterative Analysis			
DRAINAGEWAY :	Reach 700			
REACH :	700			
JURISDICTION :	Greeley			
REACH ID:	Option 1 -Reach700	Sabastian Ortega	DATE :	6/11/2024

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	**Length (ft)**	**No. of Barrels**				
42-inch	97	2	194	L.F.	$210.00	$40,740.00
48-inch	89	2	178	L.F.	$240.00	$42,720.00
Removals						
Removal of culvert pipe (D<48")			186	L.F.	$33.00	$6,138.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$83,460.00
Concrete Box Culverts			$0.00
Hydraulic Structures			$0.00
Channel Improvements			$0.00
Detention/Water Quality Facilities			$0.00
Removals			$6,138.00
Landscaping and Maintenance Improvements			$0.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$89,598.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$4,480.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$4,480.00
Subtotal Additional Capital Improvement Costs			**$8,960.00**

Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$14,784.00
Legal/Administrative	5%		$4,928.00
Contract Admin/Construction Management	10%		$9,856.00
Contingency	25%		$24,640.00
Subtotal Other Costs			**$54,208.00**
Total Capital Improvement Costs			**$152,766.00**

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, etc.)	372	L.F.	$2.00	$744.00	
Total Annual Operation and Maintenance Cost				**$744.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$37,200.00**	

Summary for Tabulation (Does Not Print)

Capital Improvement Costs	$98,558.00
ROW/Easements	$0.00
Engineering	$14,784.00
Legal/Administrative	$4,928.00
Contract Admin/Construction Management	$9,856.00
Contingency	$24,640.00
Total Capital Improvement Costs	$152,766.00
Total Annual Operation and Maintenance Cost	$744.00
Total Operation and Maintenance Costs Over 50 Years	$37,200.00

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 700			
REACH :	700			
JURISDICTION :	Greeley			
REACH ID:	Option 2-Reach700	Sabastian Ortega	DATE :	6/11/2024

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	Length (ft)	No. of Barrels				
36-inch	97	2	194	L.F.	$180.00	$34,920.00
48-inch	89	2	178	L.F.	$240.00	$42,720.00
Channel Improvements						
Soil Riprap, Type M			295	C.Y.	$117.00	$34,515.00
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)			7	AC-FT	$76,152.00	$494,988.00
Removals						
Removal of culvert pipe (D<48")			186	L.F.	$33.00	$6,138.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			2	ACRE	$1,670.00	$2,672.00
Land Acquisition						
Easement/ROW Acquisition			1.60	ACRE	$11,228.00	$17,965.00

Master Plan Capital Improvement Cost Summary	
Capital Improvement Costs	
Pipe Culverts and Storm Drains	$77,640.00
Concrete Box Culverts	$0.00
Hydraulic Structures	$0.00
Channel Improvements	$34,515.00
Detention/Water Quality Facilities	$494,988.00
Removals	$6,138.00
Landscaping and Maintenance Improvements	$2,672.00
Special Items (User Defined)	$0.00

Subtotal Capital Improvement Costs			**$615,953.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$30,798.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$30,798.00
Subtotal Additional Capital Improvement Costs			**$61,596.00**
Land Acquisition Costs			
ROW/Easements			$17,965.00
Subtotal Land Acquisition Costs			**$17,965.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$101,632.00
Legal/Administrative	5%		$33,877.00
Contract Admin/Construction Management	10%		$67,755.00
Contingency	25%		$169,387.00
Subtotal Other Costs			**$372,651.00**
Total Capital Improvement Costs			**$1,068,165.00**

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, etc.)	372	L.F.	$2.00	$744.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	1.6	ACRE	$2,505.00	$4,008.00	
Total Annual Operation and Maintenance Cost				**$4,752.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$237,600.00**	

Summary for Tabulation (Does Not Print)

Capital Improvement Costs	$677,549.00
ROW/Easements	$17,965.00
Engineering	$101,632.00
Legal/Administrative	$33,877.00
Contract Admin/Construction Management	$67,755.00
Contingency	$169,387.00
Total Capital Improvement Costs	$1,068,165.00
Total Annual Operation and Maintenance Cost	$4,752.00
Total Operation and Maintenance Costs Over 50 Years	$237,600.00

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 700			
REACH :	700			
JURISDICTION :	Greeley			
REACH ID:	Option 3-Reach700	Sabastian Ortega	DATE :	6/11/2024

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	Length (ft)	No. of Barrels				
42-inch	97	2	194	L.F.	$210.00	$40,740.00
48-inch	89	2	178	L.F.	$240.00	$42,720.00
Channel Improvements						
Excavation, Mid Range			12378	C.Y.	$40.00	$495,109.00
Removals						
Removal of culvert pipe (D<48")			186	L.F.	$33.00	$6,138.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			6	ACRE	$1,670.00	$9,770.00
Land Acquisition						
Easement/ROW Acquisition			5.85	ACRE	$11,228.00	$65,684.00

Master Plan Capital Improvement Cost Summary	
Capital Improvement Costs	
Pipe Culverts and Storm Drains	$83,460.00
Concrete Box Culverts	$0.00
Hydraulic Structures	$0.00
Channel Improvements	$495,109.00
Detention/Water Quality Facilities	$0.00
Removals	$6,138.00
Landscaping and Maintenance Improvements	$9,770.00
Special Items (User Defined)	$0.00
Subtotal Capital Improvement Costs	**$594,477.00**
Additional Capital Improvement Costs	
Dewatering	$0.00

Mobilization	5%		$29,724.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$29,724.00
Subtotal Additional Capital Improvement Costs			**$59,448.00**
Land Acquisition Costs			
ROW/Easements			$65,684.00
Subtotal Land Acquisition Costs			**$65,684.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$98,089.00
Legal/Administrative	5%		$32,696.00
Contract Admin/Construction Management	10%		$65,393.00
Contingency	25%		$163,481.00
Subtotal Other Costs			**$359,659.00**
Total Capital Improvement Costs			**$1,079,268.00**

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, etc.)	372	L.F.	$2.00	$744.00	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	2400	L.F.	$3.00	$7,200.00	
Total Annual Operation and Maintenance Cost				**$7,944.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$397,200.00**	

Summary for Tabulation (Does Not Print)

Capital Improvement Costs	$653,925.00
ROW/Easements	$65,684.00
Engineering	$98,089.00
Legal/Administrative	$32,696.00
Contract Admin/Construction Management	$65,393.00
Contingency	$163,481.00
Total Capital Improvement Costs	$1,079,268.00
Total Annual Operation and Maintenance Cost	$7,944.00
Total Operation and Maintenance Costs Over 50 Years	$397,200.00

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 700			
REACH :	700			
JURISDICTION :	Greeley			
REACH ID:	Option 4-Reach700	Sabastian Ortega	DATE :	6/11/2024

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	Length (ft)	No. of Barrels				
48-inch	97	1	97	L.F.	$240.00	$23,280.00
48-inch	89	2	178	L.F.	$240.00	$42,720.00
Channel Improvements						
Soil Riprap, Type M			291	C.Y.	$117.00	$34,047.00
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)			6.5	AC-FT	$76,152.00	$494,988.00
Removals						
Removal of culvert pipe (D<48")			186	L.F.	$33.00	$6,138.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			1.3	ACRE	$1,670.00	$2,171.00
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	$66,000.00
Concrete Box Culverts	$0.00
Hydraulic Structures	$0.00
Channel Improvements	$34,047.00
Detention/Water Quality Facilities	$494,988.00
Removals	$6,138.00
Landscaping and Maintenance Improvements	$2,171.00
Special Items (User Defined)	$0.00
Subtotal Capital Improvement Costs	**$603,344.00**

Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$30,167.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$30,167.00
Subtotal Additional Capital Improvement Costs			**$60,334.00**
Land Acquisition Costs			
ROW/Easements			$14,596.00
Subtotal Land Acquisition Costs			**$14,596.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$99,552.00
Legal/Administrative	5%		$33,184.00
Contract Admin/Construction Management	10%		$66,368.00
Contingency	25%		$165,920.00
Subtotal Other Costs			**$365,024.00**
Total Capital Improvement Costs			**$1,043,298.00**

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, etc.)	359	L.F.	$2.00	$718.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	1.3	ACRE	$2,505.00	$3,257.00	
Total Annual Operation and Maintenance Cost				**$3,975.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$198,750.00**	

Summary for Tabulation (Does Not Print)

Capital Improvement Costs	$663,678.00
ROW/Easements	$14,596.00
Engineering	$99,552.00
Legal/Administrative	$33,184.00
Contract Admin/Construction Management	$66,368.00
Contingency	$165,920.00
Total Capital Improvement Costs	$1,043,298.00
Total Annual Operation and Maintenance Cost	$3,975.00
Total Operation and Maintenance Costs Over 50 Years	$198,750.00

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 800			
REACH :	800			
JURISDICTION :	Greeley			
REACH ID:	Option 1 -Reach800	Sabastian Ortega	DATE :	6/11/2024

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)			
10	8	2	90	L.F.	$3,677.22	$330,949.00
10	3	10	62	L.F.	$12,688.10	$786,662.00
Removals						
Removal of culvert pipe (D<48")			62	L.F.	$33.00	$2,046.00
Concrete Box Culvert			90	L.F./CELL	$167.00	$15,030.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$1,117,611.00
Hydraulic Structures			$0.00
Channel Improvements			$0.00
Detention/Water Quality Facilities			$0.00
Removals			$17,076.00
Landscaping and Maintenance Improvements			$0.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$1,134,687.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$56,734.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$56,734.00

Subtotal Additional Capital Improvement Costs			**$113,468.00**
Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$187,223.00
Legal/Administrative	5%		$62,408.00
Contract Admin/Construction Management	10%		$124,816.00
Contingency	25%		$312,039.00
Subtotal Other Costs			**$686,486.00**
Total Capital Improvement Costs			**$1,934,641.00**

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, etc.)	800	L.F.	$2.00	$1,600.00	
Total Annual Operation and Maintenance Cost				**$1,600.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$80,000.00**	

Summary for Tabulation (Does Not Print)

Capital Improvement Costs	$1,248,155.00
ROW/Easements	$0.00
Engineering	$187,223.00
Legal/Administrative	$62,408.00
Contract Admin/Construction Management	$124,816.00
Contingency	$312,039.00
Total Capital Improvement Costs	$1,934,641.00
Total Annual Operation and Maintenance Cost	$1,600.00
Total Operation and Maintenance Costs Over 50 Years	$80,000.00

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 800			
REACH :	800			
JURISDICTION :	Greeley			
REACH ID:	Option 2-Reach800	Sabastian Ortega	DATE :	6/11/2024

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)			
6	7	1	90	L.F.	$1,141.67	$102,750.00
8	3	3	62	L.F.	$3,286.69	$203,775.00
				L.F.	$0.00	$0.00
Removals						
Removal of culvert pipe (48"<D<84")			62	L.F.	$84.00	$5,208.00
Concrete Box Culvert			90	L.F./CELL	$167.00	$15,030.00

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$306,525.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$0.00
Removals				$20,238.00
Landscaping and Maintenance Improvements				$0.00
Special Items (User Defined)				$0.00
Subtotal Capital Improvement Costs				**$326,763.00**
Additional Capital Improvement Costs				
Dewatering			L.S.	$0.00
Mobilization	5%			$16,338.00
Traffic Control			L.S.	$0.00

Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$16,338.00
Subtotal Additional Capital Improvement Costs			**$32,676.00**
Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$53,916.00
Legal/Administrative	5%		$17,972.00
Contract Admin/Construction Management	10%		$35,944.00
Contingency	25%		$89,860.00
Subtotal Other Costs			**$197,692.00**
Total Capital Improvement Costs			**$557,131.00**

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, etc.)	276	L.F.	$2.00	$552.00	
Total Annual Operation and Maintenance Cost				**$552.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$27,600.00**	

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MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 800			
REACH :	800			
JURISDICTION :	Greeley			
REACH ID:	Option 3-Reach800	Sabastian Ortega	DATE :	6/11/2024

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)		
10	8	2	90	L.F.	$3,677.22	$330,949.00
10	3	10	62	L.F.	$12,688.10	$786,662.00
Channel Improvements					
Excavation, Mid Range		36879	C.Y.	$40.00	$1,475,141.00
Removals					
Removal of culvert pipe (48"<D<84")		62	L.F.	$84.00	$5,208.00
Concrete Box Culvert		90	L.F./CELL	$167.00	$15,030.00
Landscaping and Maintenance Improvements					
Reclamation & seeding (native grasses)		8	ACRE	$1,670.00	$13,811.00
Land Acquisition					
Easement/ROW Acquisition		8.27	ACRE	$11,228.00	$92,856.00

Master Plan Capital Improvement Cost Summary	
Capital Improvement Costs	
Pipe Culverts and Storm Drains	$0.00
Concrete Box Culverts	$1,117,611.00
Hydraulic Structures	$0.00
Channel Improvements	$1,475,141.00
Detention/Water Quality Facilities	$0.00
Removals	$20,238.00
Landscaping and Maintenance Improvements	$13,811.00
Special Items (User Defined)	$0.00

Subtotal Capital Improvement Costs			**$2,626,801.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$131,340.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$131,340.00
Subtotal Additional Capital Improvement Costs			**$262,680.00**
Land Acquisition Costs			
ROW/Easements			$92,856.00
Subtotal Land Acquisition Costs			**$92,856.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$433,422.00
Legal/Administrative	5%		$144,474.00
Contract Admin/Construction Management	10%		$288,948.00
Contingency	25%		$722,370.00
Subtotal Other Costs			**$1,589,214.00**
Total Capital Improvement Costs			**$4,571,551.00**

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, etc.)		800	L.F.	$2.00	$1,600.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	2141	L.F.	$3.00	$6,423.00	
Total Annual Operation and Maintenance Cost				**$8,023.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$401,150.00**	

Summary for Tabulation (Does Not Print)

Capital Improvement Costs	$2,889,481.00
ROW/Easements	$92,856.00
Engineering	$433,422.00
Legal/Administrative	$144,474.00
Contract Admin/Construction Management	$288,948.00
Contingency	$722,370.00
Total Capital Improvement Costs	$4,571,551.00
Total Annual Operation and Maintenance Cost	$8,023.00
Total Operation and Maintenance Costs Over 50 Years	$401,150.00

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 800			
REACH :	800			
JURISDICTION :	Greeley			
REACH ID:	Option 4-Reach800	Sabastian Ortega	DATE :	6/11/2024

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)			
6	5	1	90	L.F.	$1,095.56	$98,601.00
8	3	2	62	L.F.	$2,191.13	$135,850.00
				L.F.	$0.00	$0.00
Removals						
Removal of culvert pipe (D<48")			62	L.F.	$33.00	$2,046.00
Concrete Box Culvert			90	L.F./CELL	$167.00	$15,030.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$234,451.00
Hydraulic Structures			$0.00
Channel Improvements			$0.00
Detention/Water Quality Facilities			$0.00
Removals			$17,076.00
Landscaping and Maintenance Improvements			$0.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$251,527.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$12,576.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00

Stormwater Management/Erosion Control	5%		$12,576.00
Subtotal Additional Capital Improvement Costs			**$25,152.00**
Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$41,502.00
Legal/Administrative	5%		$13,834.00
Contract Admin/Construction Management	10%		$27,668.00
Contingency	25%		$69,170.00
Subtotal Other Costs			**$152,174.00**
Total Capital Improvement Costs			**$428,853.00**

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, etc.)	214	L.F.	$2.00	$428.00	
Total Annual Operation and Maintenance Cost				**$428.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$21,400.00**	

Summary for Tabulation (Does Not Print)

Capital Improvement Costs	$276,679.00
ROW/Easements	$0.00
Engineering	$41,502.00
Legal/Administrative	$13,834.00
Contract Admin/Construction Management	$27,668.00
Contingency	$69,170.00
Total Capital Improvement Costs	$428,853.00
Total Annual Operation and Maintenance Cost	$428.00
Total Operation and Maintenance Costs Over 50 Years	$21,400.00

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 829			
REACH :	829			
JURISDICTION :	Greeley			
REACH ID:	Option 1 -Reach829	Sabastian Ortega	DATE :	6/11/2024

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	5	3	80	L.F.	$5,227.30	$418,184.00
12	5	3	527	L.F.	$5,227.30	$2,754,785.00
Removals						
Removal of culvert pipe (48"<D<84")			527	L.F.	$84.00	$44,268.00
Concrete Box Culvert			80	L.F./CELL	$167.00	$13,360.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$3,172,969.00
Hydraulic Structures			$0.00
Channel Improvements			$0.00
Detention/Water Quality Facilities			$0.00
Removals			$57,628.00
Landscaping and Maintenance Improvements			$0.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$3,230,597.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$161,530.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$161,530.00
Subtotal Additional Capital Improvement Costs			**$323,060.00**

Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$533,049.00
Legal/Administrative	5%		$177,683.00
Contract Admin/Construction Management	10%		$355,366.00
Contingency	25%		$888,414.00
Subtotal Other Costs			**$1,954,512.00**
Total Capital Improvement Costs			**$5,508,169.00**

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, etc.)	1821	L.F.	$2.00	$3,642.00	
Total Annual Operation and Maintenance Cost				**$3,642.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$182,100.00**	

Summary for Tabulation (Does Not Print)

Capital Improvement Costs	$3,553,657.00
ROW/Easements	$0.00
Engineering	$533,049.00
Legal/Administrative	$177,683.00
Contract Admin/Construction Management	$355,366.00
Contingency	$888,414.00
Total Capital Improvement Costs	$5,508,169.00
Total Annual Operation and Maintenance Cost	$3,642.00
Total Operation and Maintenance Costs Over 50 Years	$182,100.00

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 829			
REACH :	829			
JURISDICTION :	Greeley			
REACH ID:	Option 2-Reach829	Sabastian Ortega	DATE :	6/11/2024

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	1	80	L.F.	$1,529.18	$122,335.00
12	4	1	527	L.F.	$1,529.18	$805,879.00
Channel Improvements						
Soil Riprap, Type M			561	C.Y.	$117.00	$65,637.00
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)			43	AC-FT	$76,152.00	$3,274,536.00
Removals						
Removal of culvert pipe (48"<D<84")			527	L.F.	$84.00	$44,268.00
Concrete Box Culvert			80	L.F./CELL	$167.00	$13,360.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			6	ACRE	$1,670.00	$10,521.00
Land Acquisition						
Easement/ROW Acquisition			6.30	ACRE	$11,228.00	$70,736.00

Master Plan Capital Improvement Cost Summary	
Capital Improvement Costs	
Pipe Culverts and Storm Drains	$0.00
Concrete Box Culverts	$928,214.00
Hydraulic Structures	$0.00
Channel Improvements	$65,637.00
Detention/Water Quality Facilities	$3,274,536.00
Removals	$57,628.00
Landscaping and Maintenance Improvements	$10,521.00
Special Items (User Defined)	$0.00

Subtotal Capital Improvement Costs			**$4,336,536.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$216,827.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$216,827.00
Subtotal Additional Capital Improvement Costs			**$433,654.00**
Land Acquisition Costs			
ROW/Easements			$70,736.00
Subtotal Land Acquisition Costs			**$70,736.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$715,529.00
Legal/Administrative	5%		$238,510.00
Contract Admin/Construction Management	10%		$477,019.00
Contingency	25%		$1,192,548.00
Subtotal Other Costs			**$2,623,606.00**
Total Capital Improvement Costs			**$7,464,532.00**

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, etc.)	607	L.F.	$2.00	$1,214.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	6.3	ACRE	$2,505.00	$15,782.00	
Total Annual Operation and Maintenance Cost				**$16,996.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$849,800.00**	

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MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 829			
REACH :	829			
JURISDICTION :	Greeley			
REACH ID:	Option 3-Reach829	Sabastian Ortega	DATE :	6/11/2024

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	5	3	80	L.F.	$5,227.30	$418,184.00
12	5	3	527	L.F.	$5,227.30	$2,754,785.00
Channel Improvements						
Soil Riprap, Type M			561	C.Y.	$117.00	$65,637.00
Excavation, Mid Range			38190	C.Y.	$40.00	$1,527,600.00
Removals						
Removal of culvert pipe (48"<D<84")			527	L.F.	$84.00	$44,268.00
Concrete Box Culvert			80	L.F./CELL	$167.00	$13,360.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			11	ACRE	$1,670.00	$19,138.00
Land Acquisition						
Easement/ROW Acquisition			11.46	ACRE	$11,228.00	$128,673.00

Master Plan Capital Improvement Cost Summary	
Capital Improvement Costs	
Pipe Culverts and Storm Drains	$0.00
Concrete Box Culverts	$3,172,969.00
Hydraulic Structures	$0.00
Channel Improvements	$1,593,237.00
Detention/Water Quality Facilities	$0.00
Removals	$57,628.00
Landscaping and Maintenance Improvements	$19,138.00
Special Items (User Defined)	$0.00
Subtotal Capital Improvement Costs	**$4,842,972.00**
Additional Capital Improvement Costs	

Dewatering		L.S.	$0.00
Mobilization	5%		$242,149.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$242,149.00
Subtotal Additional Capital Improvement Costs			**$484,298.00**
Land Acquisition Costs			
ROW/Easements			$128,673.00
Subtotal Land Acquisition Costs			**$128,673.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$799,091.00
Legal/Administrative	5%		$266,364.00
Contract Admin/Construction Management	10%		$532,727.00
Contingency	25%		$1,331,818.00
Subtotal Other Costs			**$2,930,000.00**
Total Capital Improvement Costs			**$8,385,943.00**

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, etc.)	1821	L.F.	$2.00	$3,642.00	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	3030	L.F.	$3.00	$9,090.00	
Total Annual Operation and Maintenance Cost				**$12,732.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$636,600.00**	

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MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 829			
REACH :	829			
JURISDICTION :	Greeley			
REACH ID:	Option 4-Reach829	Sabastian Ortega	DATE :	6/11/2024

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 / 1 / 80		L.F.	$1,529.18	$122,335.00
12	4 / 1 / 527		L.F.	$1,529.18	$805,879.00
Channel Improvements					
Soil Riprap, Type M		561	C.Y.	$117.00	$65,637.00
Detention/Water Quality Facilities					
Detention (Complete-in-Place)					
Detention Facility 1 (Complete-in-Place)		20	AC-FT	$76,152.00	$1,523,040.00
Detention Facility 2 (Complete-in-Place)		17	AC-FT	$76,152.00	$1,317,430.00
Removals					
Removal of culvert pipe (48"<D<84")		527	L.F.	$84.00	$44,268.00
Concrete Box Culvert		80	L.F./CELL	$167.00	$13,360.00
Landscaping and Maintenance Improvements					
Reclamation & seeding (native grasses)		8	ACRE	$1,670.00	$13,861.00
Land Acquisition					
Easement/ROW Acquisition		8.30	ACRE	$11,228.00	$93,192.00

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs	
Pipe Culverts and Storm Drains	$0.00
Concrete Box Culverts	$928,214.00
Hydraulic Structures	$0.00
Channel Improvements	$65,637.00
Detention/Water Quality Facilities	$2,840,470.00
Removals	$57,628.00

Landscaping and Maintenance Improvements			$13,861.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$3,905,810.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$195,291.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$195,291.00
Subtotal Additional Capital Improvement Costs			**$390,582.00**
Land Acquisition Costs			
ROW/Easements			$93,192.00
Subtotal Land Acquisition Costs			**$93,192.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$644,459.00
Legal/Administrative	5%		$214,820.00
Contract Admin/Construction Management	10%		$429,639.00
Contingency	25%		$1,074,098.00
Subtotal Other Costs			**$2,363,016.00**
Total Capital Improvement Costs			**$6,752,600.00**

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, etc.)	607	L.F.	$2.00	$1,214.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	8.3	ACRE	$2,505.00	$20,792.00	
Total Annual Operation and Maintenance Cost				**$22,006.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$1,100,300.00**	

Summary for Tabulation (Does Not Print)

Capital Improvement Costs	$4,296,392.00
ROW/Easements	$93,192.00
Engineering	$644,459.00
Legal/Administrative	$214,820.00
Contract Admin/Construction Management	$429,639.00
Contingency	$1,074,098.00
Total Capital Improvement Costs	$6,752,600.00
Total Annual Operation and Maintenance Cost	$22,006.00
Total Operation and Maintenance Costs Over 50 Years	$1,100,300.00

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 843			
REACH :	843			
JURISDICTION :	Greeley			
REACH ID:	Option 1 -Reach843	Sabastian Ortega	DATE :	6/11/2024

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	2	74	L.F.	$2,764.44	$204,569.00
12	7	2	304	L.F.	$4,124.61	$1,253,881.00
Removals						
Removal of culvert pipe (48"<D<84")			378	L.F.	$84.00	$31,752.00

Master Plan Capital Improvement Cost Summary			
Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$1,458,450.00
Hydraulic Structures			$0.00
Channel Improvements			$0.00
Detention/Water Quality Facilities			$0.00
Removals			$31,752.00
Landscaping and Maintenance Improvements			$0.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$1,490,202.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$74,510.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$74,510.00
Subtotal Additional Capital Improvement Costs			**$149,020.00**

Land Acquisition Costs			
ROW/Easements			$0.00
Subtotal Land Acquisition Costs			**$0.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$245,883.00
Legal/Administrative	5%		$81,961.00
Contract Admin/Construction Management	10%		$163,922.00
Contingency	25%		$409,806.00
Subtotal Other Costs			**$901,572.00**
Total Capital Improvement Costs			**$2,540,794.00**

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, etc.)	756	L.F.	$2.00	$1,512.00	
Total Annual Operation and Maintenance Cost				**$1,512.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$75,600.00**	

Summary for Tabulation (Does Not Print)

Capital Improvement Costs	$1,639,222.00
ROW/Easements	$0.00
Engineering	$245,883.00
Legal/Administrative	$81,961.00
Contract Admin/Construction Management	$163,922.00
Contingency	$409,806.00
Total Capital Improvement Costs	$2,540,794.00
Total Annual Operation and Maintenance Cost	$1,512.00
Total Operation and Maintenance Costs Over 50 Years	$75,600.00

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 843			
REACH :	843			
JURISDICTION :	Greeley			
REACH ID:	Option 2-Reach843	Sabastian Ortega	DATE :	6/11/2024

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)			
6	4	1	74	L.F.	$1,009.44	$74,699.00
10	4	1	304	L.F.	$1,354.93	$411,900.00
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)			25	AC-FT	$76,152.00	$1,903,800.00
Detention Facility 2 (Complete-in-Place)			17	AC-FT	$76,152.00	$1,294,584.00
Removals						
Removal of culvert pipe (48"<D<84")			378	L.F.	$84.00	$31,752.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			16.60	ACRE	$1,670.00	$27,722.00
Land Acquisition						
Easement/ROW Acquisition			16.60	ACRE	$11,228.00	$186,385.00

Master Plan Capital Improvement Cost Summary	
Capital Improvement Costs	
Pipe Culverts and Storm Drains	$0.00
Concrete Box Culverts	$486,599.00
Hydraulic Structures	$0.00
Channel Improvements	$0.00
Detention/Water Quality Facilities	$3,198,384.00
Removals	$31,752.00
Landscaping and Maintenance Improvements	$27,722.00
Special Items (User Defined)	$0.00
Subtotal Capital Improvement Costs	**$3,744,457.00**
Additional Capital Improvement Costs	

Dewatering		L.S.	$0.00
Mobilization	5%		$187,223.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$187,223.00
Subtotal Additional Capital Improvement Costs			**$374,446.00**
Land Acquisition Costs			
ROW/Easements			$186,385.00
Subtotal Land Acquisition Costs			**$186,385.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$617,835.00
Legal/Administrative	5%		$205,945.00
Contract Admin/Construction Management	10%		$411,890.00
Contingency	25%		$1,029,726.00
Subtotal Other Costs			**$2,265,396.00**
Total Capital Improvement Costs			**$6,570,684.00**

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, etc.)	378	L.F.	$2.00	$756.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	16.6	ACRE	$2,505.00	$41,583.00	
Total Annual Operation and Maintenance Cost				**$42,339.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$2,116,950.00**	

Summary for Tabulation (Does Not Print)

Capital Improvement Costs	$4,118,903.00
ROW/Easements	$186,385.00
Engineering	$617,835.00
Legal/Administrative	$205,945.00
Contract Admin/Construction Management	$411,890.00
Contingency	$1,029,726.00
Total Capital Improvement Costs	$6,570,684.00
Total Annual Operation and Maintenance Cost	$42,339.00
Total Operation and Maintenance Costs Over 50 Years	$2,116,950.00

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 843			
REACH :	843			
JURISDICTION :	Greeley			
REACH ID:	Option 3-Reach843	Sabastian Ortega	DATE :	6/11/2024

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 / 2 / 74		L.F.	$2,764.44	$204,569.00
12 / 7 / 2 / 304		L.F.	$4,124.61	$1,253,881.00
Channel Improvements				
Excavation, Mid Range	8828	C.Y.	$40.00	$353,120.00
Removals				
Removal of culvert pipe (48"<D<84")	378	L.F.	$84.00	$31,752.00
Landscaping and Maintenance Improvements				
Reclamation & seeding (native grasses)	5	ACRE	$1,670.00	$7,899.00
Land Acquisition				
Easement/ROW Acquisition	4.73	ACRE	$11,228.00	$53,108.00

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs	
Pipe Culverts and Storm Drains	$0.00
Concrete Box Culverts	$1,458,450.00
Hydraulic Structures	$0.00
Channel Improvements	$353,120.00
Detention/Water Quality Facilities	$0.00
Removals	$31,752.00
Landscaping and Maintenance Improvements	$7,899.00
Special Items (User Defined)	$0.00
Subtotal Capital Improvement Costs	**$1,851,221.00**
Additional Capital Improvement Costs	

Dewatering		L.S.	$0.00
Mobilization	5%		$92,561.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$92,561.00
Subtotal Additional Capital Improvement Costs			**$185,122.00**
Land Acquisition Costs			
ROW/Easements			$53,108.00
Subtotal Land Acquisition Costs			**$53,108.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$305,451.00
Legal/Administrative	5%		$101,817.00
Contract Admin/Construction Management	10%		$203,634.00
Contingency	25%		$509,086.00
Subtotal Other Costs			**$1,119,988.00**
Total Capital Improvement Costs			**$3,209,439.00**

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, etc.)	756	L.F.	$2.00	$1,512.00	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	2471	L.F.	$3.00	$7,413.00	
Total Annual Operation and Maintenance Cost				**$8,925.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$446,250.00**	

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MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Alteratives Analysis			
DRAINAGEWAY :	Reach 843			
REACH :	843			
JURISDICTION :	Greeley			
REACH ID:	Option 4-Reach843	Sabastian Ortega	DATE :	6/11/2024

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	4	2	74	L.F.	$2,537.62	$187,784.00
10	4	1	304	L.F.	$1,354.93	$411,900.00
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)			2	AC-FT	$76,152.00	$182,765.00
Removals						
Removal of culvert pipe (48"<D<84")			378	L.F.	$84.00	$31,752.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			1	ACRE	$1,670.00	$1,002.00
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	$599,684.00
Hydraulic Structures	$0.00
Channel Improvements	$0.00
Detention/Water Quality Facilities	$182,765.00
Removals	$31,752.00
Landscaping and Maintenance Improvements	$1,002.00
Special Items (User Defined)	$0.00
Subtotal Capital Improvement Costs	**$815,203.00**
Additional Capital Improvement Costs	

Dewatering		L.S.	$0.00
Mobilization	5%		$40,760.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$40,760.00
Subtotal Additional Capital Improvement Costs			**$81,520.00**
Land Acquisition Costs			
ROW/Easements			$6,737.00
Subtotal Land Acquisition Costs			**$6,737.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$134,508.00
Legal/Administrative	5%		$44,836.00
Contract Admin/Construction Management	10%		$89,672.00
Contingency	25%		$224,181.00
Subtotal Other Costs			**$493,197.00**
Total Capital Improvement Costs			**$1,396,657.00**

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, etc.)	452	L.F.	$2.00	$904.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	0.6	ACRE	$2,505.00	$1,503.00	
Total Annual Operation and Maintenance Cost				**$2,407.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$120,350.00**	

Summary for Tabulation (Does Not Print)

Capital Improvement Costs	$896,723.00
ROW/Easements	$6,737.00
Engineering	$134,508.00
Legal/Administrative	$44,836.00
Contract Admin/Construction Management	$89,672.00
Contingency	$224,181.00
Total Capital Improvement Costs	$1,396,657.00
Total Annual Operation and Maintenance Cost	$2,407.00
Total Operation and Maintenance Costs Over 50 Years	$120,350.00

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
620	620	Greeley	0.0526652	0.271836742	0.5979167	0.007773202	23.47804331	0.35	0.1	3	0.0018	0.5	1
712	712	Greeley	0.1399709	0.346194886	0.7643939	0.032943508	30.15040126	0.35	0.1	3	0.0018	0.5	1
714	714	Greeley	0.0354436	0.090906439	0.2119318	0.03002681	12.53367488	0.35	0.1	3	0.0018	0.5	1
804	804	Greeley	0.0400141	0.084873939	0.38125	0.018132141	9.980909512	0.35	0.1	5	0.0007	1	1
810	810	Greeley	0.1150293	0.241703788	0.5992424	0.01062579	48.09703793	0.35	0.1	3	0.0018	0.5	1
820	820	Greeley	0.1271955	0.170171383	0.5369318	0.021358025	69.77	0.35	0.1	3	0.0018	0.5	1
824	824	Greeley	0.0678322	0.192091856	0.4208333	0.017484248	77.95	0.35	0.1	3	0.0018	0.5	1
830	830	Greeley	0.1105492	0.120804545	0.5405303	0.018826209	67.82	0.35	0.1	3	0.0018	0.5	1
840	840	Greeley	0.099614	0.338775	0.6744318	0.023139568	76.53	0.35	0.1	3	0.0018	0.5	1
842	842	Greeley	0.1731909	0.312127273	0.8337121	0.016110859	68.58	0.35	0.1	3	0.0018	0.5	1
844	844	Greeley	0.1982611	0.278277273	0.5422348	0.016028641	76.19	0.35	0.1	3	0.0018	0.5	1
850	850	Greeley	0.156178	0.361078598	0.5691288	0.02344426	60.07	0.35	0.1	4.5	0.0018	0.6	1

RUN MULTIPLE CUHP AND SWMM SCENARIOS

Columns with this color heading are for required user-input
Columns with this color heading are for program-calculated values

SWMM Run Wait Time (sec)	(Optional) SWMM Time Series Inflow "Modification Type" (LU, RP, or LU&RP)
60	

Subcatchment Name	Existing Landuse % Imperviousness	Future Landuse % Imperviousness
620	23.42	23.48
712	27.31	30.15
714	5.01	12.53
804	9.96	9.98
810	4.67	48.10
820	52.02	69.77
824	13.57	77.95
830	50.62	67.82
840	8.02	76.53
842	2.61	68.58
844	6.68	76.19
850	2.00	60.07

Raingage	Return Period (Years)	1 Hr Depths (in)	6 Hr Depths (in)
Greeley	WQ	0.600	N/A
	2	0.844	1.280
	5	1.120	1.670
	10	1.400	2.080
	25	1.870	2.780
	50	2.310	3.410
	100	2.800	4.130
	500	4.180	6.190

Enter "X" to Run Scenario	Scenario ID	Land Use (E or F)	Return Period (yr)	Correction Area (Sq.Mi.)	(Optional) SWMM Time Series Inflow Table "NAME"
X	1	E	WQ	0	
X	2	E	2	0	
X	3	E	5	0	
X	4	E	10	0	
X	5	E	25	0	
X	6	E	50	0	
X	7	E	100	0	
X	8	E	500	0	
X	9	F	WQ	0	
X	10	F	2	0	
X	11	F	5	0	
X	12	F	10	0	
X	13	F	25	0	
X	14	F	50	0	
X	15	F	100	0	
X	16	F	500	0	

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)
620		0.108	0.097	70.4	6.72	36.6	4.75	11.2	22	122,352	2.06	251,828	60.0	37	251,875	1.10
712		0.101	0.162	35.0	5.86	18.2	4.14	9.8	120	325,181	2.14	694,753	45.0	171	694,138	1.91
714		0.124	0.085	23.8	3.05	12.4	2.16	5.1	45	82,342	1.93	158,953	40.0	52	156,881	2.27
804		0.135	0.096	33.2	3.95	17.2	2.79	6.6	36	92,961	0.86	79,978	40.0	25	79,718	0.99
810		0.090	0.198	25.1	5.32	13.0	3.76	8.9	138	267,236	2.35	627,887	40.0	188	626,375	2.55
820		0.081	0.243	12.4	3.82	6.5	2.70	6.4	307	295,500	2.61	771,295	35.0	332	753,111	4.07
824		0.078	0.189	15.2	3.72	7.9	2.63	6.2	133	157,588	2.71	426,988	35.0	165	424,631	3.80
830		0.081	0.226	11.8	3.55	6.1	2.51	5.9	281	256,828	2.59	664,304	35.0	293	647,959	4.15
840		0.078	0.224	20.0	4.93	10.4	3.48	8.2	150	231,423	2.69	623,051	40.0	200	618,472	3.13
842		0.081	0.278	19.3	5.62	10.0	3.97	9.4	269	402,357	2.60	1,044,424	40.0	353	1,040,010	3.18
844		0.079	0.299	13.4	4.57	7.0	3.23	7.6	444	460,600	2.69	1,238,160	35.0	523	1,234,651	4.12
850		0.085	0.252	18.2	5.01	9.4	3.54	8.4	258	362,833	2.41	874,190	35.0	313	869,553	3.13

Summary of CUHP Input Parameters (Version 2.0.1)

								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.
620	620	GREELEY	0.053	0.272	0.598	0.008	23.5	0.35	0.10	3.00	0.50	0.0018	1.00	0.28	0.26	21.74
712	712	GREELEY	0.140	0.346	0.764	0.033	30.2	0.35	0.10	3.00	0.50	0.0018	1.00	0.37	0.29	28.27
714	714	GREELEY	0.035	0.091	0.212	0.030	12.5	0.35	0.10	3.00	0.50	0.0018	1.00	0.14	0.21	11.27
804	804	GREELEY	0.040	0.085	0.381	0.018	10.0	0.35	0.10	5.00	1.00	0.0007	1.00	0.11	0.20	7.52
810	810	GREELEY	0.115	0.242	0.599	0.011	48.1	0.35	0.10	3.00	0.50	0.0018	1.00	0.59	0.37	46.22
820	820	GREELEY	0.127	0.170	0.537	0.021	69.8	0.35	0.10	3.00	0.50	0.0018	1.00	0.77	0.47	68.30
824	824	GREELEY	0.068	0.192	0.421	0.017	78.0	0.35	0.10	3.00	0.50	0.0018	1.00	0.83	0.50	76.78
830	830	GREELEY	0.111	0.121	0.541	0.019	67.8	0.35	0.10	3.00	0.50	0.0018	1.00	0.75	0.46	66.30
840	840	GREELEY	0.100	0.339	0.674	0.023	76.5	0.35	0.10	3.00	0.50	0.0018	1.00	0.82	0.50	75.31
842	842	GREELEY	0.173	0.312	0.834	0.016	68.6	0.35	0.10	3.00	0.50	0.0018	1.00	0.76	0.46	67.08
844	844	GREELEY	0.198	0.278	0.542	0.016	76.2	0.35	0.10	3.00	0.50	0.0018	1.00	0.82	0.49	74.96
850	850	GREELEY	0.156	0.361	0.569	0.023	60.1	0.35	0.10	4.50	0.60	0.0018	1.00	0.70	0.42	57.88

Appendix F-2
Master Plan Detention

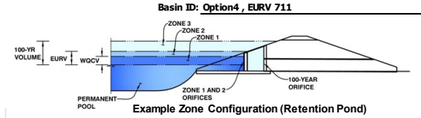
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option4 , EURV 711



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	90.00	acres
Watershed Length =	3,900	ft
Watershed Length to Centroid =	1,738	ft
Watershed Slope =	0.031	ft/ft
Watershed Imperviousness =	30.20%	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) =	1.141	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	2.470	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	1.598	acre-feet	0.85 inches
5-yr Runoff Volume (P1 = 1.12 in.) =	2.810	acre-feet	1.12 inches
10-yr Runoff Volume (P1 = 1.4 in.) =	4.602	acre-feet	1.40 inches
25-yr Runoff Volume (P1 = 1.87 in.) =	8.506	acre-feet	1.87 inches
50-yr Runoff Volume (P1 = 2.3 in.) =	11.792	acre-feet	2.30 inches
100-yr Runoff Volume (P1 = 2.79 in.) =	15.995	acre-feet	2.79 inches
500-yr Runoff Volume (P1 = 4.16 in.) =	27.074	acre-feet	4.16 inches
Approximate 2-yr Detention Volume =	1.515	acre-feet	
Approximate 5-yr Detention Volume =	2.643	acre-feet	
Approximate 10-yr Detention Volume =	3.285	acre-feet	
Approximate 25-yr Detention Volume =	4.314	acre-feet	
Approximate 50-yr Detention Volume =	4.931	acre-feet	
Approximate 100-yr Detention Volume =	6.534	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	1.141	acre-feet
Zone 2 Volume (EURV - Zone 1)	1.329	acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	2.470	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}) =	0.003	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}) =	1,752	ft^2
Surcharge Volume Length (L_{ISV}) =	41.9	ft
Surcharge Volume Width (W_{ISV}) =	41.9	ft
Depth of Basin Floor (H_{FLOOR}) =	0.35	ft
Length of Basin Floor (L_{FLOOR}) =	159.9	ft
Width of Basin Floor (W_{FLOOR}) =	100.2	ft
Area of Basin Floor (A_{FLOOR}) =	16,021	ft^2
Volume of Basin Floor (V_{FLOOR}) =	2,692	ft^3
Depth of Main Basin (H_{MAIN}) =	4.82	ft
Length of Main Basin (L_{MAIN}) =	198.5	ft
Width of Main Basin (W_{MAIN}) =	138.7	ft
Area of Main Basin (A_{MAIN}) =	27,538	ft^2
Volume of Main Basin (V_{MAIN}) =	103,732	ft^3
Calculated Total Basin Volume (V_{total}) =	**2.477**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 0.50 ft

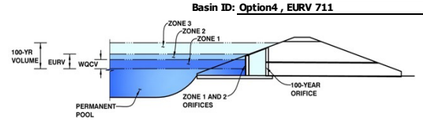
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		41.9	41.9	1,752		0.040		
ISV	0.33		41.9	41.9	1,752		0.040	578	0.013
	0.50		41.9	41.9	1,752		0.040	876	0.020
	1.00		99.2	70.2	6,962		0.160	2,148	0.049
Floor	1.18		159.9	100.2	16,021		0.368	4,162	0.096
	1.50		162.5	102.7	16,694		0.383	9,396	0.216
	2.00		166.5	106.7	17,771		0.408	18,011	0.413
	2.50		170.5	110.7	18,879		0.433	27,172	0.624
	3.00		174.5	114.7	20,020		0.460	36,896	0.847
	3.50		178.5	118.7	21,193		0.487	47,198	1.084
Zone 1 (WQCV)	3.62		179.4	119.7	21,479		0.493	49,758	1.142
	4.00		182.5	122.7	22,398		0.514	58,094	1.334
	4.50		186.5	126.7	23,635		0.543	69,601	1.598
	5.00		190.5	130.7	24,904		0.572	81,735	1.876
	5.50		194.5	134.7	26,205		0.602	94,511	2.170
Zone 2 (EURV)	5.99		198.4	138.7	27,511		0.632	107,670	2.472
	6.00		198.5	138.7	27,538		0.632	107,945	2.478
	6.50		202.5	142.7	28,903		0.664	122,054	2.802
	7.00		206.5	146.7	30,299		0.696	136,853	3.142
	7.50		210.5	150.7	31,728		0.728	152,358	3.498
	8.00		214.5	154.7	33,189		0.762	168,586	3.870
	8.50		218.5	158.7	34,682		0.796	185,553	4.260
	9.00		222.5	162.7	36,207		0.831	203,274	4.667
	9.50		226.5	166.7	37,764		0.867	221,765	5.091
	10.00		230.5	170.7	39,353		0.903	241,043	5.534
	10.50		234.5	174.7	40,974		0.941	261,123	5.995
	11.00		238.5	178.7	42,627		0.979	282,022	6.474
	11.50		242.5	182.7	44,311		1.017	303,755	6.973
	12.00		246.5	186.7	46,028		1.057	326,339	7.492
	12.50		250.5	190.7	47,777		1.097	349,789	8.030
	13.00		254.5	194.7	49,558		1.138	374,122	8.589
	13.50		258.5	198.7	51,371		1.179	399,353	9.168
	14.00		262.5	202.7	53,216		1.222	425,498	9.768
	14.50		266.5	206.7	55,093		1.265	452,574	10.390
	15.00		270.5	210.7	57,002		1.309	480,596	11.033
	15.50		274.5	214.7	58,943		1.353	509,581	11.698
	16.00		278.5	218.7	60,915		1.398	539,544	12.386
	16.50		282.5	222.7	62,920		1.444	570,502	13.097
	17.00		286.5	226.7	64,957		1.491	602,470	13.831
	17.50		290.5	230.7	67,026		1.539	635,464	14.588
	18.00		294.5	234.7	69,127		1.587	669,501	15.370
	18.50		298.5	238.7	71,260		1.636	704,597	16.175
	19.00		302.5	242.7	73,425		1.686	740,766	17.006
	19.50		306.5	246.7	75,622		1.736	778,027	17.861
	20.00		310.5	250.7	77,851		1.787	816,393	18.742
	20.50		314.5	254.7	80,111		1.839	855,883	19.648
	21.00		318.5	258.7	82,404		1.892	896,510	20.581
	21.50		322.5	262.7	84,729		1.945	938,292	21.540
	22.00		326.5	266.7	87,086		1.999	981,245	22.526
	22.50		330.5	270.7	89,475		2.054	1,025,384	23.540
	23.00		334.5	274.7	91,896		2.110	1,070,725	24.580
	23.50		338.5	278.7	94,349		2.166	1,117,285	25.649
	24.00		342.5	282.7	96,834		2.223	1,165,079	26.747
	24.50		346.5	286.7	99,351		2.281	1,214,124	27.872
	25.00		350.5	290.7	101,899		2.339	1,264,435	29.027
	25.50		354.5	294.7	104,480		2.399	1,316,029	30.212
	26.00		358.5	298.7	107,093		2.459	1,368,921	31.426
	26.50		362.5	302.7	109,738		2.519	1,423,127	32.671
	27.00		366.5	306.7	112,415		2.581	1,478,664	33.945
	27.50		370.5	310.7	115,124		2.643	1,535,548	35.251
	28.00		374.5	314.7	117,865		2.706	1,593,794	36.588
	28.50		378.5	318.7	120,638		2.769	1,653,418	37.957
	29.00		382.5	322.7	123,443		2.834	1,714,437	39.358
	29.50		386.5	326.7	126,279		2.899	1,776,866	40.791
	30.00		390.5	330.7	129,148		2.965	1,840,721	42.257

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option4 , EURV 711



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.62	1.141	Orifice Plate	Orifice Plate
Zone 2 (EURV)	5.99	1.329	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3			Not Utilized	Zone 3 Not Utilized
Total (all zones)		2.470		

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 =	3.62	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	14.50	inches
Orifice Plate: Orifice Area per Row =	4.41	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	3.063E-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	1.21	2.41					
Orifice Area (sq. inches)	4.41	4.41	4.41					

	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 =	4.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	800.00	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V
Horiz. Length of Weir Sides =	10.00	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 =	7.33	N/A	feet
Overflow Weir Slope Length =	10.54	N/A	feet
Grate Open Area / 100-yr Orifice Area =	11382.38	N/A	
Overflow Grate Open Area w/o Debris =	5869.19	N/A	ft^2
Overflow Grate Open Area w/ Debris =	2934.59	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

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=	9.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	59.00	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=	0.96	feet
Stage at Top of Freeboard =	10.96	feet
Basin Area at Top of Freeboard =	0.98	acres
Basin Volume at Top of Freeboard =	6.44	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) =	1.141	2.470	1.598	2.810	4.602	8.506	11.792	15.995	27.074
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.598	2.810	4.602	8.506	11.792	15.995	27.074
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.8	8.6	24.1	64.2	93.3	131.2	225.3
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	0.27	0.71	1.04	1.46	2.50
Peak Inflow Q (cfs) =	N/A	N/A	16.2	29.4	48.3	95.8	131.0	176.7	291.6
Peak Outflow Q (cfs) =	0.7	7.1	4.1	6.7	7.7	52.8	98.6	157.8	291.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.3	0.8	1.1	1.2	1.3
Structure Controlling Flow =	Plate	Outlet Plate 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.00	0.00	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) =	38	40	43	41	40	36	32	27	19
Time to Drain 99% of Inflow Volume (hours) =	**40**	44	46	45	46	45	43	40	35
Maximum Ponding Depth (ft) =	3.62	5.99	4.04	5.15	7.43	9.39	9.62	9.87	10.31
Area at Maximum Ponding Depth (acres) =	0.49	0.63	0.52	0.58	0.72	0.86	0.88	0.89	0.93
Maximum Volume Stored (acre-ft) =	1.142	2.472	1.354	1.963	3.447	4.996	5.196	5.408	5.808

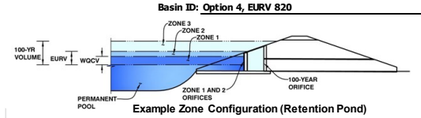
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, EURV 820



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	81.00	acres
Watershed Length =	2,600	ft
Watershed Length to Centroid =	720	ft
Watershed Slope =	0.022	ft/ft
Watershed Imperviousness =	69.80%	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) =	1.850	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	5.493	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.) =	5.323	acre-feet	1.12 inches
10-yr Runoff Volume (P1 = 1.4 in.) =	7.165	acre-feet	1.40 inches
25-yr Runoff Volume (P1 = 1.87 in.) =	10.587	acre-feet	1.87 inches
50-yr Runoff Volume (P1 = 2.3 in.) =	13.634	acre-feet	2.30 inches
100-yr Runoff Volume (P1 = 2.79 in.) =	17.263	acre-feet	2.79 inches
500-yr Runoff Volume (P1 = 4.16 in.) =	27.180	acre-feet	4.16 inches
Approximate 2-yr Detention Volume =	3.526	acre-feet	
Approximate 5-yr Detention Volume =	5.146	acre-feet	
Approximate 10-yr Detention Volume =	6.318	acre-feet	
Approximate 25-yr Detention Volume =	7.856	acre-feet	
Approximate 50-yr Detention Volume =	8.825	acre-feet	
Approximate 100-yr Detention Volume =	10.325	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	1.850	acre-feet
Zone 2 Volume (EURV - Zone 1)	3.643	acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	5.493	acre-feet
Initial Surcharge Volume (ISV) =	578	ft³
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}) =	0.003	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}) =	1,752	ft²
Surcharge Volume Length (L_{ISV}) =	41.9	ft
Surcharge Volume Width (W_{ISV}) =	41.9	ft
Depth of Basin Floor (H_{FLOOR}) =	0.68	ft
Length of Basin Floor (L_{FLOOR}) =	271.2	ft
Width of Basin Floor (W_{FLOOR}) =	155.2	ft
Area of Basin Floor (A_{FLOOR}) =	42,092	ft²
Volume of Basin Floor (V_{FLOOR}) =	11,884	ft³
Depth of Main Basin (H_{MAIN}) =	4.49	ft
Length of Main Basin (L_{MAIN}) =	307.2	ft
Width of Main Basin (W_{MAIN}) =	191.1	ft
Area of Main Basin (A_{MAIN}) =	58,699	ft²
Volume of Main Basin (V_{MAIN}) =	225,245	ft³
Calculated Total Basin Volume (V_{total}) =	**5.477**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 0.50 ft

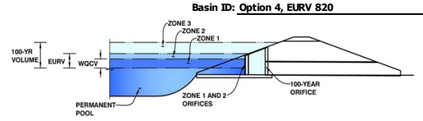
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft²)	Optional Override Area (ft²)	Area (acre)	Volume (ft³)	Volume (ac-ft)
Top of Micropool	0.00		41.9	41.9	1,752		0.040		
ISV	0.33		41.9	41.9	1,752		0.040	578	0.013
	0.50		41.9	41.9	1,752		0.040	876	0.020
	1.00		99.2	70.2	6,962		0.160	2,148	0.049
	1.50		267.9	153.5	41,122		0.944	12,998	0.298
Floor	1.51		271.2	155.2	42,092		0.966	13,414	0.308
	2.00		275.2	159.1	43,779		1.005	34,451	0.791
	2.50		279.2	163.1	45,532		1.045	56,778	1.303
	3.00		283.2	167.1	47,317		1.086	79,988	1.836
Zone 1 (WQCV)	3.02		283.3	167.3	47,389		1.088	80,935	1.858
	3.50		287.2	171.1	49,134		1.128	104,100	2.390
	4.00		291.2	175.1	50,983		1.170	129,128	2.964
	4.50		295.2	179.1	52,864		1.214	155,088	3.560
	5.00		299.2	183.1	54,777		1.258	181,997	4.178
	5.50		303.2	187.1	56,722		1.302	209,871	4.818
	6.00		307.2	191.1	58,699		1.348	238,725	5.480
Zone 2 (EURV)	6.01		307.2	191.2	58,739		1.348	239,312	5.494
	6.50		311.2	195.1	60,708		1.394	268,575	6.166
	7.00		315.2	199.1	62,749		1.441	299,438	6.874
	7.50		319.2	203.1	64,822		1.488	331,330	7.606
	8.00		323.2	207.1	66,927		1.536	364,266	8.362
	8.50		327.2	211.1	69,064		1.586	398,263	9.143
	9.00		331.2	215.1	71,234		1.635	433,336	9.948
	9.50		335.2	219.1	73,435		1.686	469,501	10.778
	10.00		339.2	223.1	75,668		1.737	506,776	11.634
	10.50		343.2	227.1	77,933		1.789	545,174	12.515
	11.00		347.2	231.1	80,230		1.842	584,714	13.423
	11.50		351.2	235.1	82,559		1.895	625,409	14.357
	12.00		355.2	239.1	84,920		1.949	667,278	15.319
	12.50		359.2	243.1	87,313		2.004	710,335	16.307
	13.00		363.2	247.1	89,738		2.060	754,596	17.323
	13.50		367.2	251.1	92,195		2.117	800,078	18.367
	14.00		371.2	255.1	94,684		2.174	846,796	19.440
	14.50		375.2	259.1	97,205		2.232	894,767	20.541
	15.00		379.2	263.1	99,758		2.290	944,007	21.671
	15.50		383.2	267.1	102,343		2.349	994,530	22.831
	16.00		387.2	271.1	104,960		2.410	1,046,355	24.021
	16.50		391.2	275.1	107,609		2.470	1,099,496	25.241
	17.00		395.2	279.1	110,290		2.532	1,153,970	26.491
	17.50		399.2	283.1	113,003		2.594	1,209,792	27.773
	18.00		403.2	287.1	115,748		2.657	1,266,978	29.086
	18.50		407.2	291.1	118,525		2.721	1,325,545	30.430
	19.00		411.2	295.1	121,334		2.785	1,385,509	31.807
	19.50		415.2	299.1	124,176		2.851	1,446,885	33.216
	20.00		419.2	303.1	127,049		2.917	1,509,690	34.658
	20.50		423.2	307.1	129,954		2.983	1,573,939	36.133
	21.00		427.2	311.1	132,891		3.051	1,639,649	37.641
	21.50		431.2	315.1	135,860		3.119	1,706,835	39.184
	22.00		435.2	319.1	138,861		3.188	1,775,514	40.760
	22.50		439.2	323.1	141,894		3.257	1,845,701	42.371
	23.00		443.2	327.1	144,959		3.328	1,917,413	44.018
	23.50		447.2	331.1	148,056		3.399	1,990,665	45.699
	24.00		451.2	335.1	151,185		3.471	2,065,474	47.417
	24.50		455.2	339.1	154,346		3.543	2,141,856	49.170
	25.00		459.2	343.1	157,539		3.617	2,219,826	50.960
	25.50		463.2	347.1	160,764		3.691	2,299,400	52.787
	26.00		467.2	351.1	164,021		3.765	2,380,595	54.651
	26.50		471.2	355.1	167,310		3.841	2,463,427	56.552
	27.00		475.2	359.1	170,631		3.917	2,547,911	58.492
	27.50		479.2	363.1	173,984		3.994	2,634,063	60.470
	28.00		483.2	367.1	177,369		4.072	2,721,900	62.486
	28.50		487.2	371.1	180,786		4.150	2,811,438	64.542
	29.00		491.2	375.1	184,235		4.229	2,902,692	66.637
	29.50		495.2	379.1	187,717		4.309	2,995,679	68.771
	30.00		499.2	383.1	191,230		4.390	3,090,414	70.946

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, EURV 820



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.02	1.850	Orifice Plate	Orifice Plate
Zone 2 (EURV)	6.01	3.643	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3			Not Utilized	Zone 3 Not Utilized
Total (all zones)		5.493		

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	ft²
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 =	3.60	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	14.40	inches
Orifice Plate: Orifice Area per Row =	7.34	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	5.097E-02	ft²
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft²

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	1.20	2.40					
Orifice Area (sq. inches)	7.34	7.34	7.34					

	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	ft²
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 =	3.02	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	800.00	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V
Horiz. Length of Weir Sides =	10.00	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 =	6.35	N/A	feet
Overflow Weir Slope Length =	10.54	N/A	feet
Grate Open Area / 100-yr Orifice Area =	11382.38	N/A	
Overflow Grate Open Area w/o Debris =	5869.19	N/A	ft²
Overflow Grate Open Area w/ Debris =	2934.59	N/A	ft²

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 =	3.00	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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.52	N/A	ft²
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=	6.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	72.00	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=	0.97	feet
Stage at Top of Freeboard =	7.97	feet
Basin Area at Top of Freeboard =	1.53	acres
Basin Volume at Top of Freeboard =	8.32	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) =	1.850	5.493	3.732	5.323	7.165	10.587	13.634	17.263	27.180
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.732	5.323	7.165	10.587	13.634	17.263	27.180
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.1	11.7	32.5	82.7	120.4	166.0	285.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.14	0.40	1.02	1.49	2.05	3.52
Peak Inflow Q (cfs) =	N/A	N/A	76.5	108.0	143.4	215.3	277.2	355.1	547.6
Peak Outflow Q (cfs) =	0.9	7.3	6.4	7.0	17.3	102.6	169.8	269.5	507.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.5	1.2	1.4	1.6	1.8
Structure Controlling Flow =	Overflow Weir 1	Spillway	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.00	0.00	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) =	38	40	40	41	41	38	36	33	27
Time to Drain 99% of Inflow Volume (hours) =	**40**	45	43	45	46	45	44	43	40
Maximum Ponding Depth (ft) =	3.02	6.01	3.98	5.16	6.13	6.57	6.81	7.10	7.67
Area at Maximum Ponding Depth (acres) =	1.09	1.35	1.17	1.27	1.36	1.40	1.42	1.45	1.50
Maximum Volume Stored (acre-ft) =	1.858	5.494	2.941	4.368	5.643	6.249	6.588	7.019	7.846

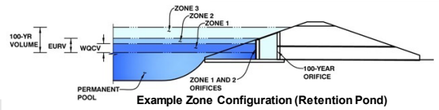
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 842, EURV



Example Zone Configuration (Retention Pond)

Watershed Information

	EDB	
Extended Detention Basin (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

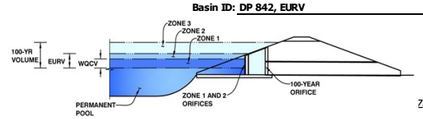
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		26.3	26.3	694		0.016		
ISV	0.50		26.3	26.3	694		0.016	347	0.008
	0.75		26.3	26.3	694		0.016	521	0.012
	1.00		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

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 842, 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	

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

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

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	%

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

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	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=	0.36	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

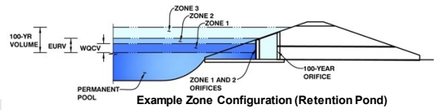
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: Greeley Oklahoma South

Basin ID: DP 840, EURV



Example Zone Configuration (Retention Pond)

Watershed Information

	EDB	
Extended Detention Basin (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) =	0.986 acre-feet	0.986	acre-feet
Excess Urban Runoff Volume (EURV) =	5.367 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	3.261 acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	4.496 acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	5.952 acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	8.664 acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	11.063 acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	13.930 acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	21.754 acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	3.057 acre-feet		
Approximate 5-yr Detention Volume =	4.250 acre-feet		
Approximate 10-yr Detention Volume =	5.588 acre-feet		
Approximate 25-yr Detention Volume =	7.033 acre-feet		
Approximate 50-yr Detention Volume =	7.997 acre-feet		
Approximate 100-yr Detention Volume =	9.192 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

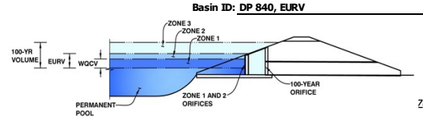
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		16.1	16.1	258		0.006		
ISV	0.50		16.1	16.1	258		0.006	129	0.003
	0.75		16.1	16.1	258		0.006	193	0.004
	1.00		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

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Greeley Oklahoma South

Basin ID: DP 840, 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)

			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 =	1.840E-02	ft^2
Depth at top of Zone using Orifice Plate =	3.33	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	13.30	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	2.65	sq. inches (diameter = 1-13/16 inches)	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		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 =	3.33	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.33	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 =	54.86	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 =	0.20	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 =	3.10		inches	Half-Central Angle of Restrictor Plate on Pipe =	0.86	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway	
Spillway Invert Stage=	5.29	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.16 feet
Spillway Crest Length =	1000.00	feet	Stage at Top of Freeboard =	6.45 feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	3.22 acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	9.04 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) =	0.986	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

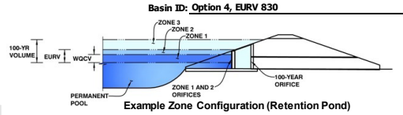
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, EURV 830



Example Zone Configuration (Retention Pond)

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	90.00	acres
Watershed Length =	2,406	ft
Watershed Length to Centroid =	1,738	ft
Watershed Slope =	0.031	ft/ft
Watershed Imperviousness =	67.80%	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) =	1.991	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	5.915	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	4.073	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	5.835	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	7.895	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	11.755	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	15.181	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	19.277	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	30.442	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	3.791	acre-feet		
Approximate 5-yr Detention Volume =	5.563	acre-feet		
Approximate 10-yr Detention Volume =	6.823	acre-feet		
Approximate 25-yr Detention Volume =	8.494	acre-feet		
Approximate 50-yr Detention Volume =	9.547	acre-feet		
Approximate 100-yr Detention Volume =	11.222	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	1.991	acre-feet
Zone 2 Volume (EURV - Zone 1)	3.924	acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	5.915	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}) =	0.003	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}) =	1,752	ft^2
Surcharge Volume Length (L_{ISV}) =	41.9	ft
Surcharge Volume Width (W_{ISV}) =	41.9	ft
Depth of Basin Floor (H_{FLOOR}) =	0.72	ft
Length of Basin Floor (L_{FLOOR}) =	284.7	ft
Width of Basin Floor (W_{FLOOR}) =	161.9	ft
Area of Basin Floor (A_{FLOOR}) =	46,084	ft^2
Volume of Basin Floor (V_{FLOOR}) =	13,637	ft^3
Depth of Main Basin (H_{MAIN}) =	4.45	ft
Length of Main Basin (L_{MAIN}) =	320.3	ft
Width of Main Basin (W_{MAIN}) =	197.5	ft
Area of Main Basin (A_{MAIN}) =	63,250	ft^2
Volume of Main Basin (V_{MAIN}) =	242,262	ft^3
Calculated Total Basin Volume (V_{total}) =	**5.908**	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = 0.50 ft

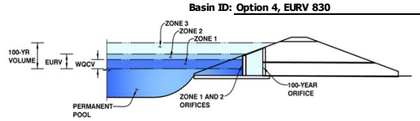
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	0.00		41.9	41.9	1,752		0.040		
ISV	0.33		41.9	41.9	1,752		0.040	578	0.013
	0.50		41.9	41.9	1,752		0.040	876	0.020
	1.00		99.2	70.2	6,962		0.160	2,148	0.049
	1.50		267.9	153.5	41,122		0.944	12,998	0.298
Floor	1.55		284.7	161.9	46,084		1.058	15,177	0.348
	2.00		288.3	165.5	47,705		1.095	36,279	0.833
	2.50		292.3	169.5	49,536		1.137	60,587	1.391
	3.00		296.3	173.5	51,399		1.180	85,820	1.970
Zone 1 (WQCV)	3.02		296.5	173.6	51,474		1.182	86,848	1.994
	3.50		300.3	177.5	53,294		1.223	111,992	2.571
	4.00		304.3	181.5	55,221		1.268	139,119	3.194
	4.50		308.3	185.5	57,180		1.313	167,218	3.839
	5.00		312.3	189.5	59,171		1.358	196,305	4.507
	5.50		316.3	193.5	61,195		1.405	226,395	5.197
	6.00		320.3	197.5	63,250		1.452	257,505	5.911
Zone 2 (EURV)	6.01		320.4	197.5	63,291		1.453	258,137	5.926
	6.50		324.3	201.5	65,337		1.500	289,650	6.649
	7.00		328.3	205.5	67,456		1.549	322,847	7.412
	7.50		332.3	209.5	69,607		1.598	357,111	8.198
	8.00		336.3	213.5	71,790		1.648	392,459	9.010
	8.50		340.3	217.5	74,005		1.699	428,907	9.846
	9.00		344.3	221.5	76,253		1.751	466,470	10.709
	9.50		348.3	225.5	78,532		1.803	505,165	11.597
	10.00		352.3	229.5	80,843		1.856	545,007	12.512
	10.50		356.3	233.5	83,186		1.910	586,013	13.453
	11.00		360.3	237.5	85,561		1.964	628,198	14.421
	11.50		364.3	241.5	87,968		2.019	671,579	15.417
	12.00		368.3	245.5	90,407		2.075	716,172	16.441
	12.50		372.3	249.5	92,878		2.132	761,992	17.493
	13.00		376.3	253.5	95,382		2.190	809,056	18.573
	13.50		380.3	257.5	97,917		2.248	857,379	19.683
	14.00		384.3	261.5	100,484		2.307	906,978	20.821
	14.50		388.3	265.5	103,083		2.366	957,868	21.990
	15.00		392.3	269.5	105,714		2.427	1,010,066	23.188
	15.50		396.3	273.5	108,377		2.488	1,063,587	24.417
	16.00		400.3	277.5	111,072		2.550	1,118,448	25.676
	16.50		404.3	281.5	113,799		2.612	1,174,665	26.967
	17.00		408.3	285.5	116,559		2.676	1,232,253	28.289
	17.50		412.3	289.5	119,350		2.740	1,291,229	29.643
	18.00		416.3	293.5	122,173		2.805	1,351,608	31.029
	18.50		420.3	297.5	125,028		2.870	1,413,407	32.447
	19.00		424.3	301.5	127,915		2.937	1,476,641	33.899
	19.50		428.3	305.5	130,834		3.004	1,541,327	35.384
	20.00		432.3	309.5	133,785		3.071	1,607,481	36.903
	20.50		436.3	313.5	136,768		3.140	1,675,118	38.455
	21.00		440.3	317.5	139,784		3.209	1,744,255	40.043
	21.50		444.3	321.5	142,831		3.279	1,814,907	41.665
	22.00		448.3	325.5	145,910		3.350	1,887,091	43.322
	22.50		452.3	329.5	149,021		3.421	1,960,822	45.014
	23.00		456.3	333.5	152,164		3.493	2,036,117	46.743
	23.50		460.3	337.5	155,339		3.566	2,112,992	48.508
	24.00		464.3	341.5	158,546		3.640	2,191,462	50.309
	24.50		468.3	345.5	161,785		3.714	2,271,543	52.147
	25.00		472.3	349.5	165,057		3.789	2,353,253	54.023
	25.50		476.3	353.5	168,360		3.865	2,436,605	55.937
	26.00		480.3	357.5	171,695		3.942	2,521,618	57.888
	26.50		484.3	361.5	175,062		4.019	2,608,305	59.878
	27.00		488.3	365.5	178,461		4.097	2,696,685	61.907
	27.50		492.3	369.5	181,892		4.176	2,786,772	63.975
	28.00		496.3	373.5	185,355		4.255	2,878,583	66.083
	28.50		500.3	377.5	188,851		4.335	2,972,133	68.231
	29.00		504.3	381.5	192,378		4.416	3,067,438	70.419
	29.50		508.3	385.5	195,937		4.498	3,164,516	72.647
	30.00		512.3	389.5	199,528		4.581	3,263,381	74.917

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, EURV 830



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.02	1.991	Orifice Plate	Orifice Plate
Zone 2 (EURV)	6.01	3.924	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3			Not Utilized	Zone 3 Not Utilized
Total (all zones)		5.915		

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 =	3.02	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	12.10	inches
Orifice Plate: Orifice Area per Row =	6.97	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	4.840E-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	1.01	2.01					
Orifice Area (sq. inches)	6.97	6.97	6.97					

	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 =	3.02	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	800.00	N/A	feet
Overflow Weir Grate Slope =	3.00	N/A	H:V
Horiz. Length of Weir Sides =	10.00	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 =	6.35	N/A	feet
Overflow Weir Slope Length =	10.54	N/A	feet
Grate Open Area / 100-yr Orifice Area =	12272.31	N/A	
Overflow Grate Open Area w/o Debris =	5869.19	N/A	ft^2
Overflow Grate Open Area w/ Debris =	2934.59	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 =	16.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	6.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected	
Outlet Orifice Area =	0.48	N/A	ft^2
Outlet Orifice Centroid =	0.29	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.32	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.10	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	117.00	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=	0.98	feet
Stage at Top of Freeboard =	8.08	feet
Basin Area at Top of Freeboard =	1.66	acres
Basin Volume at Top of Freeboard =	9.14	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) =	1.991	5.915	4.073	5.835	7.895	11.755	15.181	19.277	30.442
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	4.073	5.835	7.895	11.755	15.181	19.277	30.442
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.0	10.6	29.5	76.5	111.1	155.2	266.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.12	0.33	0.85	1.23	1.72	2.96
Peak Inflow Q (cfs) =	N/A	N/A	72.5	103.5	139.7	214.5	275.9	352.0	546.5
Peak Outflow Q (cfs) =	1.0	6.6	5.8	6.3	21.4	114.7	194.4	298.5	552.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.7	1.5	1.7	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	0.00	0.00	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) =	38	42	41	43	43	40	37	34	27
Time to Drain 99% of Inflow Volume (hours) =	**40**	46	44	47	48	47	46	44	41
Maximum Ponding Depth (ft) =	3.02	6.01	4.10	5.33	6.22	6.55	6.75	6.97	7.41
Area at Maximum Ponding Depth (acres) =	1.18	1.45	1.28	1.39	1.47	1.50	1.52	1.54	1.59
Maximum Volume Stored (acre-ft) =	1.994	5.926	3.308	4.946	6.233	6.725	7.027	7.350	8.055

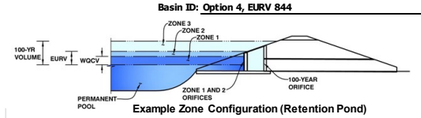
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, EURV 844



Example Zone Configuration (Retention Pond)

Depth Increment = 0.50 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft²)	Optional Override Area (ft²)	Area (acre)	Volume (ft³)	Volume (ac-ft)
Top of Micropool	0.00		41.9	41.9	1,752		0.040		
ISV	0.33		41.9	41.9	1,752		0.040	578	0.013
	0.50		41.9	41.9	1,752		0.040	876	0.020
	1.00		99.2	70.2	6,962		0.160	2,148	0.049
	1.50		267.9	153.5	41,122		0.944	12,998	0.298
Floor	1.84		382.6	210.2	80,408		1.846	33,290	0.764
	2.00		383.8	211.5	81,168		1.863	46,216	1.061
	2.50		387.8	215.5	83,565		1.918	87,398	2.006
	3.00		391.8	219.5	85,994		1.974	129,786	2.979
Zone 1 (WQCV)	3.13		392.9	220.5	86,631		1.989	141,007	3.237
	3.50		395.8	223.5	88,456		2.031	173,398	3.981
	4.00		399.8	227.5	90,949		2.088	218,247	5.010
	4.50		403.8	231.5	93,474		2.146	264,352	6.069
	5.00		407.8	235.5	96,031		2.205	311,727	7.156
	5.50		411.8	239.5	98,621		2.264	360,388	8.273
	6.00		415.8	243.5	101,242		2.324	410,353	9.420
Zone 2 (EURV)	6.01		415.9	243.5	101,294		2.325	411,365	9.444
	6.50		419.8	247.5	103,895		2.385	461,636	10.598
	7.00		423.8	251.5	106,580		2.447	514,253	11.806
	7.50		427.8	255.5	109,297		2.509	568,221	13.045
	8.00		431.8	259.5	112,047		2.572	623,556	14.315
	8.50		435.8	263.5	114,828		2.636	680,273	15.617
	9.00		439.8	267.5	117,641		2.701	738,389	16.951
	9.50		443.8	271.5	120,486		2.766	797,919	18.318
	10.00		447.8	275.5	123,363		2.832	858,880	19.717
	10.50		451.8	279.5	126,273		2.899	921,288	21.150
	11.00		455.8	283.5	129,214		2.966	985,158	22.616
	11.50		459.8	287.5	132,187		3.035	1,050,507	24.116
	12.00		463.8	291.5	135,192		3.104	1,117,350	25.651
	12.50		467.8	295.5	138,229		3.173	1,185,705	27.220
	13.00		471.8	299.5	141,299		3.244	1,255,585	28.824
	13.50		475.8	303.5	144,400		3.315	1,327,009	30.464
	14.00		479.8	307.5	147,533		3.387	1,399,990	32.139
	14.50		483.8	311.5	150,698		3.460	1,474,547	33.851
	15.00		487.8	315.5	153,895		3.533	1,550,694	35.599
	15.50		491.8	319.5	157,125		3.607	1,628,448	37.384
	16.00		495.8	323.5	160,386		3.682	1,707,824	39.206
	16.50		499.8	327.5	163,679		3.758	1,788,839	41.066
	17.00		503.8	331.5	167,004		3.834	1,871,508	42.964
	17.50		507.8	335.5	170,362		3.911	1,955,849	44.900
	18.00		511.8	339.5	173,751		3.989	2,041,875	46.875
	18.50		515.8	343.5	177,172		4.067	2,129,605	48.889
	19.00		519.8	347.5	180,625		4.147	2,219,053	50.942
	19.50		523.8	351.5	184,110		4.227	2,310,235	53.036
	20.00		527.8	355.5	187,628		4.307	2,403,168	55.169
	20.50		531.8	359.5	191,177		4.389	2,497,868	57.343
	21.00		535.8	363.5	194,758		4.471	2,594,350	59.558
	21.50		539.8	367.5	198,371		4.554	2,692,631	61.814
	22.00		543.8	371.5	202,016		4.638	2,792,727	64.112
	22.50		547.8	375.5	205,694		4.722	2,894,653	66.452
	23.00		551.8	379.5	209,403		4.807	2,998,426	68.834
	23.50		555.8	383.5	213,144		4.893	3,104,061	71.259
	24.00		559.8	387.5	216,917		4.980	3,211,575	73.728
	24.50		563.8	391.5	220,722		5.067	3,320,984	76.239
	25.00		567.8	395.5	224,560		5.155	3,432,303	78.795
	25.50		571.8	399.5	228,429		5.244	3,545,549	81.395
	26.00		575.8	403.5	232,330		5.334	3,660,737	84.039
	26.50		579.8	407.5	236,263		5.424	3,777,884	86.728
	27.00		583.8	411.5	240,228		5.515	3,897,006	89.463
	27.50		587.8	415.5	244,226		5.607	4,018,118	92.243
	28.00		591.8	419.5	248,255		5.699	4,141,237	95.070
	28.50		595.8	423.5	252,316		5.792	4,266,378	97.943
	29.00		599.8	427.5	256,409		5.886	4,393,558	100.862
	29.50		603.8	431.5	260,535		5.981	4,522,793	103.829
	30.00		607.8	435.5	264,692		6.076	4,654,098	106.843

Watershed Information

Extended Detention Basin (EDB)	EDB	
Watershed Area =	126.50	acres
Watershed Length =	2,939	ft
Watershed Length to Centroid =	1,428	ft
Watershed Slope =	0.031	ft/ft
Watershed Imperviousness =	76.20%	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) =	3.226	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	9.432	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	6.396	acre-feet	0.85 inches
5-yr Runoff Volume (P1 = 1.12 in.) =	9.013	acre-feet	1.12 inches
10-yr Runoff Volume (P1 = 1.4 in.) =	11.961	acre-feet	1.40 inches
25-yr Runoff Volume (P1 = 1.87 in.) =	17.299	acre-feet	1.87 inches
50-yr Runoff Volume (P1 = 2.3 in.) =	22.084	acre-feet	2.30 inches
100-yr Runoff Volume (P1 = 2.79 in.) =	27.727	acre-feet	2.79 inches
500-yr Runoff Volume (P1 = 4.16 in.) =	43.218	acre-feet	4.16 inches
Approximate 2-yr Detention Volume =	6.083	acre-feet	
Approximate 5-yr Detention Volume =	8.736	acre-feet	
Approximate 10-yr Detention Volume =	10.760	acre-feet	
Approximate 25-yr Detention Volume =	13.343	acre-feet	
Approximate 50-yr Detention Volume =	14.954	acre-feet	
Approximate 100-yr Detention Volume =	17.253	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV)	3.226	acre-feet
Zone 2 Volume (EURV - Zone 1)	6.206	acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	9.432	acre-feet
Initial Surcharge Volume (ISV) =	578	ft³
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}) =	0.003	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	

Total detention volume is less than 100-year volume.

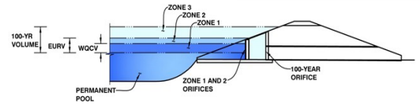
Initial Surcharge Area (A_{ISV}) =	1,752	ft²
Surcharge Volume Length (L_{ISV}) =	41.9	ft
Surcharge Volume Width (W_{ISV}) =	41.9	ft
Depth of Basin Floor (H_{FLOOR}) =	1.01	ft
Length of Basin Floor (L_{FLOOR}) =	382.6	ft
Width of Basin Floor (W_{FLOOR}) =	210.2	ft
Area of Basin Floor (A_{FLOOR}) =	80,408	ft²
Volume of Basin Floor (V_{FLOOR}) =	31,656	ft³
Depth of Main Basin (H_{MAIN}) =	4.16	ft
Length of Main Basin (L_{MAIN}) =	415.8	ft
Width of Main Basin (W_{MAIN}) =	243.5	ft
Area of Main Basin (A_{MAIN}) =	101,242	ft²
Volume of Main Basin (V_{MAIN}) =	377,000	ft³
Calculated Total Basin Volume (V_{total}) =	**9.415**	acre-feet

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, EURV 844



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (WQCV)	3.13	3.226	Orifice Plate	Orifice Plate
Zone 2 (EURV)	6.01	6.206	Weir&Pipe (Restrict)	Weir and Pipe (w/ Restrictor Plate)
Zone 3			Not Utilized	Zone 3 Not Utilized
Total (all zones)		9.432		

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	ft²
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 =	8.056E-02	ft²
Depth at top of Zone using Orifice Plate =	3.63	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	14.50	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	11.60	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft²

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	1.21	2.42					
Orifice Area (sq. inches)	11.60	11.60	11.60					

	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	ft²
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 =	3.13	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	6.46	N/A	feet
Overflow Weir Front Edge Length =	800.00	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 =	11382.38	N/A	
Horiz. Length of Weir Sides =	10.00	N/A	feet	Overflow Grate Open Area w/o Debris =	5869.19	N/A	ft²
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	2934.59	N/A	ft²
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 =	3.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.52	N/A	ft²
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.29	N/A	feet
Restrictor Plate Height Above Pipe Invert =	6.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.23	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway	
Spillway Invert Stage=	6.10	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.98 feet
Spillway Crest Length =	183.00	feet	Stage at Top of Freeboard =	8.08 feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	2.58 acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	14.52 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) =	3.226	9.432	6.396	9.013	11.961	17.299	22.084	27.727	43.218
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.396	9.013	11.961	17.299	22.084	27.727	43.218
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.6	16.9	46.2	119.1	172.4	241.0	412.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.13	0.36	0.94	1.36	1.90	3.26
Peak Inflow Q (cfs) =	N/A	N/A	126.7	175.8	229.8	339.1	430.4	547.8	840.3
Peak Outflow Q (cfs) =	1.5	7.3	6.5	7.1	28.9	156.4	272.4	435.5	823.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.6	1.3	1.6	1.8	2.0
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	0.00	0.00	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) =	38	46	43	46	47	45	42	40	34
Time to Drain 99% of Inflow Volume (hours) =	**40**	50	46	50	52	51	50	49	46
Maximum Ponding Depth (ft) =	3.13	6.01	4.25	5.38	6.21	6.52	6.71	6.94	7.38
Area at Maximum Ponding Depth (acres) =	1.99	2.33	2.12	2.25	2.35	2.39	2.41	2.44	2.49
Maximum Volume Stored (acre-ft) =	3.237	9.444	5.515	7.980	9.911	10.622	11.101	11.635	12.744

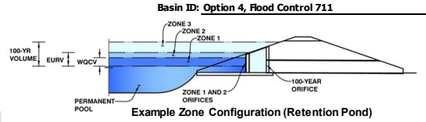
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, Flood Control 711



Example Zone Configuration (Retention Pond)

Watershed Information — Flood Control Only

Flood Control Only	No BMP	
Watershed Area =	90.00	acres
Watershed Length =	3,900	ft
Watershed Length to Centroid =	1,738	ft
Watershed Slope =	0.031	ft/ft
Watershed Imperviousness =	30.20%	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 =	N/A	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) =	1.141	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	2.470	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	1.598	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	2.810	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	4.602	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	8.506	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	11.792	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	15.995	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	27.074	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	1.515	acre-feet		
Approximate 5-yr Detention Volume =	2.643	acre-feet		
Approximate 10-yr Detention Volume =	3.285	acre-feet		
Approximate 25-yr Detention Volume =	4.314	acre-feet		
Approximate 50-yr Detention Volume =	4.931	acre-feet		
Approximate 100-yr Detention Volume =	6.534	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (100-year)	6.534	acre-feet
Select Zone 2 Storage Volume (Optional)		acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	6.534	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	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}) =	0.003	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}) =	271.7	ft
Width of Basin Floor (W_{FLOOR}) =	135.9	ft
Area of Basin Floor (A_{FLOOR}) =	36,922	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{MAIN}) =	6.00	ft
Length of Main Basin (L_{MAIN}) =	319.7	ft
Width of Main Basin (W_{MAIN}) =	183.9	ft
Area of Main Basin (A_{MAIN}) =	58,791	ft^2
Volume of Main Basin (V_{MAIN}) =	284,607	ft^3
Calculated Total Basin Volume (V_{total}) =	**6.534**	acre-feet

Depth Increment = 0.50 ft

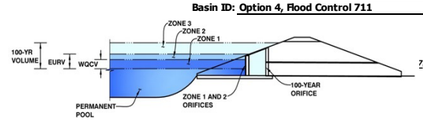
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		271.7	135.9	36,922		0.848		
	0.50		275.7	139.9	38,568		0.885	18,871	0.433
	1.00		279.7	143.9	40,247		0.924	38,574	0.886
	1.50		283.7	147.9	41,957		0.963	59,123	1.357
	2.00		287.7	151.9	43,700		1.003	80,536	1.849
	2.50		291.7	155.9	45,474		1.044	102,828	2.361
	3.00		295.7	159.9	47,280		1.085	126,015	2.893
	3.50		299.7	163.9	49,119		1.128	150,114	3.446
	4.00		303.7	167.9	50,989		1.171	175,139	4.021
	4.50		307.7	171.9	52,892		1.214	201,108	4.617
	5.00		311.7	175.9	54,826		1.259	228,036	5.235
	5.50		315.7	179.9	56,793		1.304	255,940	5.876
Zone 1 (100-year)	6.00		319.7	183.9	58,791		1.350	284,834	6.539
	6.50		323.7	187.9	60,822		1.396	314,736	7.225
	7.00		327.7	191.9	62,884		1.444	345,661	7.935
	7.50		331.7	195.9	64,978		1.492	377,626	8.669
	8.00		335.7	199.9	67,105		1.541	410,645	9.427
	8.50		339.7	203.9	69,263		1.590	444,736	10.210
	9.00		343.7	207.9	71,454		1.640	479,914	11.017
	9.50		347.7	211.9	73,676		1.691	516,195	11.850
	10.00		351.7	215.9	75,931		1.743	553,595	12.709
	10.50		355.7	219.9	78,217		1.796	592,131	13.593
	11.00		359.7	223.9	80,536		1.849	631,818	14.505
	11.50		363.7	227.9	82,886		1.903	672,672	15.442
	12.00		367.7	231.9	85,268		1.957	714,709	16.407
	12.50		371.7	235.9	87,683		2.013	757,946	17.400
	13.00		375.7	239.9	90,129		2.069	802,398	18.421
	13.50		379.7	243.9	92,608		2.126	848,081	19.469
	14.00		383.7	247.9	95,118		2.184	895,011	20.547
	14.50		387.7	251.9	97,661		2.242	943,204	21.653
	15.00		391.7	255.9	100,235		2.301	992,677	22.789
	15.50		395.7	259.9	102,842		2.361	1,043,445	23.954
	16.00		399.7	263.9	105,480		2.421	1,095,524	25.150
	16.50		403.7	267.9	108,151		2.483	1,148,930	26.376
	17.00		407.7	271.9	110,853		2.545	1,203,680	27.633
	17.50		411.7	275.9	113,587		2.608	1,259,788	28.921
	18.00		415.7	279.9	116,354		2.671	1,317,272	30.240
	18.50		419.7	283.9	119,152		2.735	1,376,148	31.592
	19.00		423.7	287.9	121,983		2.800	1,436,430	32.976
	19.50		427.7	291.9	124,845		2.866	1,498,136	34.392
	20.00		431.7	295.9	127,740		2.932	1,561,281	35.842
	20.50		435.7	299.9	130,666		3.000	1,625,881	37.325
	21.00		439.7	303.9	133,625		3.068	1,691,952	38.842
	21.50		443.7	307.9	136,615		3.136	1,759,511	40.393
	22.00		447.7	311.9	139,637		3.206	1,828,573	41.978
	22.50		451.7	315.9	142,692		3.276	1,899,154	43.599
	23.00		455.7	319.9	145,778		3.347	1,971,270	45.254
	23.50		459.7	323.9	148,897		3.418	2,044,937	46.945
	24.00		463.7	327.9	152,047		3.491	2,120,172	48.672
	24.50		467.7	331.9	155,230		3.564	2,196,990	50.436
	25.00		471.7	335.9	158,444		3.637	2,275,407	52.236
	25.50		475.7	339.9	161,691		3.712	2,355,439	54.073
	26.00		479.7	343.9	164,969		3.787	2,437,103	55.948
	26.50		483.7	347.9	168,280		3.863	2,520,414	57.861
	27.00		487.7	351.9	171,622		3.940	2,605,388	59.811
	27.50		491.7	355.9	174,996		4.017	2,692,041	61.801
	28.00		495.7	359.9	178,403		4.096	2,780,390	63.829
	28.50		499.7	363.9	181,841		4.175	2,870,449	65.896
	29.00		503.7	367.9	185,312		4.254	2,962,236	68.004
	29.50		507.7	371.9	188,814		4.335	3,055,766	70.151
	30.00		511.7	375.9	192,349		4.416	3,151,056	72.338

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, Flood Control 711



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (100-year)	6.00	6.534	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 2				Select Zone 2 Outlet Type
Zone 3				Select Zone 3 Outlet Type
Total (all zones)		6.534		

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 =	6.00		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) =	1.141	2.470	1.598	2.810	4.602	8.506	11.792	15.995	27.074
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.598	2.810	4.602	8.506	11.792	16.052	27.074
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.8	8.6	24.1	64.2	93.3	131.2	225.3
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	0.27	0.71	1.04	1.46	2.50
Peak Inflow Q (cfs) =	N/A	N/A	16.2	29.4	48.3	95.8	131.0	172.2	291.6
Peak Outflow Q (cfs) =	17.5	60.7	8.1	17.0	30.7	69.9	100.5	138.0	241.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.0	1.3	1.1	1.1	1.1	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	ertical 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) =	14	8	12	8	6	5	4	4	3
Time to Drain 99% of Inflow Volume (hours) =	**34**	19	27	18	13	9	7	7	5
Maximum Ponding Depth (ft) =	1.28	2.61	0.79	1.19	1.65	2.60	3.18	3.78	5.29
Area at Maximum Ponding Depth (acres) =	0.95	1.05	0.91	0.94	0.98	1.05	1.10	1.15	1.28
Maximum Volume Stored (acre-ft) =	1.147	2.476	0.693	1.053	1.503	2.455	3.079	3.765	5.604

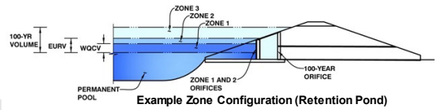
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, Flood Control 823



Example Zone Configuration (Retention Pond)

Watershed Information

Flood Control Only

Flood Control Only	**No BMP**	
Watershed Area =	327.00	acres
Watershed Length =	4,753	ft
Watershed Length to Centroid =	2,751	ft
Watershed Slope =	0.012	ft/ft
Watershed Imperviousness =	72.98%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	N/A	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) =	7.879	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	23.271	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	16.082	acre-feet	0.85	inches
5-yr Runoff Volume (P1 = 1.12 in.) =	22.795	acre-feet	1.12	inches
10-yr Runoff Volume (P1 = 1.4 in.) =	30.462	acre-feet	1.40	inches
25-yr Runoff Volume (P1 = 1.87 in.) =	44.522	acre-feet	1.87	inches
50-yr Runoff Volume (P1 = 2.3 in.) =	57.083	acre-feet	2.30	inches
100-yr Runoff Volume (P1 = 2.79 in.) =	71.969	acre-feet	2.79	inches
500-yr Runoff Volume (P1 = 4.16 in.) =	112.726	acre-feet	4.16	inches
Approximate 2-yr Detention Volume =	14.974	acre-feet		
Approximate 5-yr Detention Volume =	21.673	acre-feet		
Approximate 10-yr Detention Volume =	26.650	acre-feet		
Approximate 25-yr Detention Volume =	33.089	acre-feet		
Approximate 50-yr Detention Volume =	37.124	acre-feet		
Approximate 100-yr Detention Volume =	43.128	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (100-year)	43.128	acre-feet
Select Zone 2 Storage Volume (Optional)		acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	43.128	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 0.50 ft

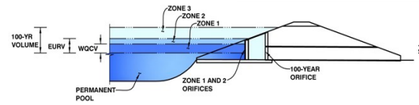
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	--	0.00	--	--	--	37,664	0.865		
	--	1.00	--	--	--	77,436	1.778	57,550	1.321
	--	2.00	--	--	--	133,078	3.055	162,807	3.738
	--	3.00	--	--	--	163,864	3.762	311,278	7.146
	--	4.00	--	--	--	190,605	4.376	488,512	11.215
	--	5.00	--	--	--	204,897	4.704	686,263	15.754
	--	6.00	--	--	--	215,528	4.948	896,476	20.580
	--	7.00	--	--	--	226,286	5.195	1,117,383	25.652
	--	8.00	--	--	--	237,198	5.445	1,349,125	30.972
	--	8.49	--	--	--	273,603	6.281	1,474,271	33.845
	--	9.00	--	--	--	273,603	6.281	1,613,808	37.048
	--	10.00	--	--	--	273,603	6.281	1,887,411	43.329

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option 4, Flood Control 823



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (100-year)	9.97	43.128	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 2				Select Zone 2 Outlet Type
Zone 3				Select Zone 3 Outlet Type
Total (all zones)		43.128		

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 =	29.17		ft^2
Depth at top of Zone using Vertical Orifice =	9.97		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	2.50		feet
Vertical Orifice Height =	60.00		inches				
Vertical Orifice Width =	70.00		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) =	7.879	23.271	16.082	22.795	30.462	44.522	57.083	71.969	112.726
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	16.082	22.795	30.462	44.522	57.083	79.785	112.726
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	2.8	28.0	80.3	215.9	314.9	444.4	766.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.09	0.25	0.66	0.96	1.36	2.34
Peak Inflow Q (cfs) =	N/A	N/A	237.7	333.0	440.1	680.2	868.8	496.2	1700.2
Peak Outflow Q (cfs) =	93.9	275.5	90.8	132.2	179.0	267.8	314.5	284.5	384.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.7	2.2	1.2	1.0	0.6	0.5
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	N/A
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	4	6	5	5	5	5	7	5
Time to Drain 99% of Inflow Volume (hours) =	**11**	7	9	8	7	7	6	8	7
Maximum Ponding Depth (ft) =	3.20	6.54	3.05	3.75	4.44	6.14	7.51	6.60	10.00
Area at Maximum Ponding Depth (acres) =	3.88	5.08	3.79	4.22	4.52	4.98	5.32	5.10	6.28
Maximum Volume Stored (acre-ft) =	7.911	23.288	7.335	10.140	13.127	21.226	28.334	23.593	43.329

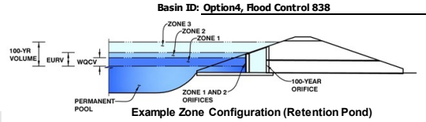
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Clear Workbook

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option4, Flood Control 838



Example Zone Configuration (Retention Pond)

Watershed Information — Flood Control Only

Flood Control Only	No BMP	
Watershed Area =	126.50	acres
Watershed Length =	2,939	ft
Watershed Length to Centroid =	1,428	ft
Watershed Slope =	0.031	ft/ft
Watershed Imperviousness =	76.20%	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 =	N/A	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) =	3.226	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	9.432	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	6.396	acre-feet	0.85 inches
5-yr Runoff Volume (P1 = 1.12 in.) =	9.013	acre-feet	1.12 inches
10-yr Runoff Volume (P1 = 1.4 in.) =	11.961	acre-feet	1.40 inches
25-yr Runoff Volume (P1 = 1.87 in.) =	17.299	acre-feet	1.87 inches
50-yr Runoff Volume (P1 = 2.3 in.) =	22.084	acre-feet	2.30 inches
100-yr Runoff Volume (P1 = 2.79 in.) =	27.727	acre-feet	2.79 inches
500-yr Runoff Volume (P1 = 4.16 in.) =	43.218	acre-feet	4.16 inches
Approximate 2-yr Detention Volume =	6.083	acre-feet	
Approximate 5-yr Detention Volume =	8.736	acre-feet	
Approximate 10-yr Detention Volume =	10.760	acre-feet	
Approximate 25-yr Detention Volume =	13.343	acre-feet	
Approximate 50-yr Detention Volume =	14.955	acre-feet	
Approximate 100-yr Detention Volume =	17.253	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (100-year)	17.253	acre-feet
Select Zone 2 Storage Volume (Optional)		acre-feet
Select Zone 3 Storage Volume (Optional)		acre-feet
Total Detention Basin Volume =	17.253	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	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}) =	0.003	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}) =	464.4	ft
Width of Basin Floor (W_{FLOOR}) =	232.2	ft
Area of Basin Floor (A_{FLOOR}) =	107,813	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{MAIN}) =	6.00	ft
Length of Main Basin (L_{MAIN}) =	512.4	ft
Width of Main Basin (W_{MAIN}) =	280.2	ft
Area of Main Basin (A_{MAIN}) =	143,551	ft^2
Volume of Main Basin (V_{MAIN}) =	751,538	ft^3
Calculated Total Basin Volume (V_{total}) =	**17.253**	acre-feet

Depth Increment = 0.50 ft

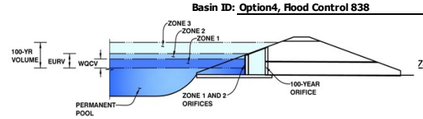
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		464.4	232.2	107,813		2.475		
	0.50		468.4	236.2	110,615		2.539	54,606	1.254
	1.00		472.4	240.2	113,449		2.604	110,621	2.539
	1.50		476.4	244.2	116,315		2.670	168,060	3.858
	2.00		480.4	248.2	119,214		2.737	226,941	5.210
	2.50		484.4	252.2	122,144		2.804	287,279	6.595
	3.00		488.4	256.2	125,106		2.872	349,090	8.014
	3.50		492.4	260.2	128,100		2.941	412,391	9.467
	4.00		496.4	264.2	131,126		3.010	477,196	10.955
	4.50		500.4	268.2	134,184		3.080	543,522	12.478
	5.00		504.4	272.2	137,274		3.151	611,385	14.035
	5.50		508.4	276.2	140,397		3.223	680,802	15.629
Zone 1 (100-year)	6.00		512.4	280.2	143,551		3.295	751,787	17.259
	6.50		516.4	284.2	146,737		3.369	824,358	18.925
	7.00		520.4	288.2	149,955		3.442	898,529	20.627
	7.50		524.4	292.2	153,205		3.517	974,318	22.367
	8.00		528.4	296.2	156,487		3.592	1,051,740	24.145
	8.50		532.4	300.2	159,801		3.669	1,130,811	25.960
	9.00		536.4	304.2	163,147		3.745	1,211,546	27.813
	9.50		540.4	308.2	166,526		3.823	1,293,963	29.705
	10.00		544.4	312.2	169,936		3.901	1,378,077	31.636
	10.50		548.4	316.2	173,378		3.980	1,463,904	33.607
	11.00		552.4	320.2	176,852		4.060	1,551,461	35.617
	11.50		556.4	324.2	180,358		4.140	1,640,762	37.667
	12.00		560.4	328.2	183,896		4.222	1,731,824	39.757
	12.50		564.4	332.2	187,466		4.304	1,824,663	41.889
	13.00		568.4	336.2	191,069		4.386	1,919,296	44.061
	13.50		572.4	340.2	194,703		4.470	2,015,737	46.275
	14.00		576.4	344.2	198,369		4.554	2,114,004	48.531
	14.50		580.4	348.2	202,067		4.639	2,214,111	50.829
	15.00		584.4	352.2	205,797		4.724	2,316,076	53.170
	15.50		588.4	356.2	209,559		4.811	2,419,914	55.554
	16.00		592.4	360.2	213,353		4.898	2,525,641	57.981
	16.50		596.4	364.2	217,179		4.986	2,633,272	60.452
	17.00		600.4	368.2	221,038		5.074	2,742,825	62.967
	17.50		604.4	372.2	224,928		5.164	2,854,315	65.526
	18.00		608.4	376.2	228,850		5.254	2,967,758	68.130
	18.50		612.4	380.2	232,804		5.344	3,083,171	70.780
	19.00		616.4	384.2	236,790		5.436	3,200,568	73.475
	19.50		620.4	388.2	240,808		5.528	3,319,966	76.216
	20.00		624.4	392.2	244,858		5.621	3,441,381	79.003
	20.50		628.4	396.2	248,941		5.715	3,564,830	81.837
	21.00		632.4	400.2	253,055		5.809	3,690,327	84.718
	21.50		636.4	404.2	257,201		5.905	3,817,890	87.647
	22.00		640.4	408.2	261,379		6.000	3,947,533	90.623
	22.50		644.4	412.2	265,589		6.097	4,079,274	93.647
	23.00		648.4	416.2	269,831		6.194	4,213,128	96.720
	23.50		652.4	420.2	274,105		6.293	4,349,111	99.842
	24.00		656.4	424.2	278,411		6.391	4,487,238	103.013
	24.50		660.4	428.2	282,750		6.491	4,627,527	106.233
	25.00		664.4	432.2	287,120		6.591	4,769,993	109.504
	25.50		668.4	436.2	291,522		6.692	4,914,652	112.825
	26.00		672.4	440.2	295,956		6.794	5,061,521	116.197
	26.50		676.4	444.2	300,422		6.897	5,210,614	119.619
	27.00		680.4	448.2	304,920		7.000	5,361,948	123.093
	27.50		684.4	452.2	309,450		7.104	5,515,539	126.619
	28.00		688.4	456.2	314,013		7.209	5,671,404	130.198
	28.50		692.4	460.2	318,607		7.314	5,829,557	133.828
	29.00		696.4	464.2	323,233		7.420	5,990,016	137.512
	29.50		700.4	468.2	327,891		7.527	6,152,795	141.249
	30.00		704.4	472.2	332,581		7.635	6,317,912	145.039

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: 23.1447.001 Greeley - Oklahoma Drainage MP

Basin ID: Option4, Flood Control 838



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type	
Zone 1 (100-year)	6.00	17.253	Rectangular Orifice	Vertical Orifice (Rectangular)
Zone 2				Select Zone 2 Outlet Type
Zone 3				Select Zone 3 Outlet Type
Total (all zones)		17.253		

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 =	29.17		ft^2
Depth at top of Zone using Vertical Orifice =	6.00		ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	2.50		feet
Vertical Orifice Height =	60.00		inches				
Vertical Orifice Width =	70.00		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 =	0.00		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) =	3.226	9.432	6.396	9.013	11.961	17.299	22.084	27.727	43.218
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.396	9.013	11.961	17.299	22.084	49.811	43.218
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.6	16.9	46.2	119.1	172.4	241.0	412.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.13	0.36	0.94	1.36	1.90	3.26
Peak Inflow Q (cfs) =	N/A	N/A	126.7	175.8	229.8	339.1	430.4	511.0	840.3
Peak Outflow Q (cfs) =	17.8	108.2	25.5	41.5	60.6	116.5	161.5	293.9	308.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.5	1.3	1.0	0.9	1.2	0.7
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	ertical 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) =	41	18	24	19	15	12	10	8	7
Time to Drain 99% of Inflow Volume (hours) =	**100**	44	59	45	36	27	23	15	14
Maximum Ponding Depth (ft) =	1.27	3.49	1.51	1.98	2.44	3.50	4.19	6.88	7.34
Area at Maximum Ponding Depth (acres) =	2.64	2.94	2.67	2.73	2.80	2.94	3.04	3.42	3.49
Maximum Volume Stored (acre-ft) =	3.247	9.438	3.885	5.155	6.427	9.467	11.529	20.181	21.772

Appendix F-3
Master Plan SWMM Input

```
[TITLE]
;;Project Title/Notes
City of Greeley
Storm Drainage Master Plan
Master Plan Oklahoma Concept Design
Oklahoma Basins 700-800
Matrix Design Group, Inc. 2024
Scenario ID = Fut_100yr_GO_Option_4_LID

[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:\23.1447.001 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221
Models\CUHP_SWMM\CUHP\Alternative Option
4\15_Fut_100yr_0mi^2_12_Fut_10yr_0mi^2_Greeley_7.8_DCIA1_Output.txt"

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

[JUNCTIONS]
;;Name          Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;------------- ---------- ---------- ---------- ---------- ----------
620             4920       10         0          0          0
712             4915       10         0          0          0
714             4864       10         0          0          0
803             4866       10         0          0          0
804             4882       10         0          0          0
809             4890       25         0          0          0
810             4925       10         0          0          0
819             4901       10         0          0          0
820             4945       10         0          0          0
824             4961       10         0          0          0
829             4918       15         0          0          0
830             4972       10         0          0          0
839             4965       15         0          0          0
840             4990       10         0          0          0
841             4967       10         0          0          0
842             5000       10         0          0          0
843             4959       15         0          0          0
844             4995       10         0          0          0
850             4990       10         0          0          0
711             4889       10         0          0          0
710             4871       10         0          0          0
709             4866       10         0          0          0
708             4851       10         0          0          0
713             4898       10         0          0          0
811             4893       10         0          0          0
822             4932       10         0          0          0
823             4908       10         0          0          0
834             4932       15         0          0          0
838             4949       15         0          0          0
831             4928.5     15         0          0          0
808             4885       0          0          0          0

[OUTFALLS]
;;Name          Elevation  Type       Stage Data       Gated    Route To
;;------------- ---------- ---------- ---------------- -------- ----------------
O_803           4865       FREE                        NO
O_708           4828       FREE                        NO
O_620           4817       FREE                        NO
O_714           4838       FREE                        NO

[DIVIDERS]
;;Name          Elevation  Diverted Link    Type       Parameters
;;------------- ---------- ---------------- ---------- ----------
836             4945       OV_836           OVERFLOW   15         0          0          0
```

[STORAGE]
;;Name Elev. MaxDepth InitDepth Shape Curve Type/Params SurDepth Fevap Psi Ksat IMD
;;-------------- -------- ---------- ---------- ---------- ---------- ---------- -------- -------- --------
D_EURV_842 4967 10 0 TABULAR D_EURV_842 0 0
D_FC__842 4967 10 0 TABULAR D_FC_814 0 0
D_EURV_840 4965 10 0 TABULAR D_EURV_840 0 0
D_EURV_711 4880 10 0 TABULAR D_EURV_711 0 0
D_EURV_830 4935 10 0 TABULAR D_EURV_830 0 0
D_EURV_844 4977 10 0 TABULAR D_EURV_844 0 0
D_EURV_820 4931 10 0 TABULAR D_EURV_820 0 0
D_FC_711 4875 10 0 TABULAR D_FC_711 0 0
D_FC_823 4905 10 0 TABULAR D_FC_811 0 0
D_FC_838 4948 10 0 TABULAR D_FC_838 0 0

[CONDUITS]
;;Name From Node To Node Length Roughness InOffset OutOffset InitFlow MaxFlow
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
DL_620 620 O_620 400 0.01 0 0 0 0
DL_714 714 O_714 400 0.01 0 0 0 0
DL_803 803 O_803 400 0.01 0 0 0 0
DL_804 804 803 400 0.01 0 0 0 0
DL_810 810 809 400 0.01 0 0 0 0
DL_820 820 D_EURV_820 400 0.01 0 0 0 0
DL_830 830 D_EURV_830 400 0.01 0 0 0 0
DL_840 840 D_EURV_840 400 0.01 0 0 0 0
DL_842 842 D_EURV_842 400 0.01 0 0 0 0
DL_844 844 D_EURV_844 400 0.01 0 0 0 0
L_808 808 803 1197 0.07 0 0 0 0
L_823 823 D_FC_823 943 0.04 0 0 0 0
L_839 839 843 541 0.048 0 0 0 0
L_841 841 839 190 .044 0 0 0 0
L_850 850 D_EURV_842 1740 0.044 0 0 0 0
L_708 708 O_708 202 0.035 0 0 0 0
L_709 709 708 560.2 0.03 0 0 0 0
L_710 710 709 154.3 0.04 0 0 0 0
L_711 711 D_EURV_711 615.3 0.04 0 0 0 0
L_713 713 711 338.1 0.07 0 0 0 0
L_712 712 713 485.4 .04 0 0 0 0
L_838 838 D_FC_838 314.88 0.048 0 0 0 0
L_811 811 809 183 0.045 0 0 0 0
L_843 843 838 304 0.035 0 0 0 0
L_819 819 811 761 0.07 0 0 0 0
L_824 824 822 1270 0.035 0 0 0 0
L_822 822 D_FC_823 671 0.04 0 0 0 0
L_829 829 823 290 0.035 0 0 0 0
L_836 836 834 442 0.013 0 0 0 0
OV_836 836 834 442 .035 0 0 0 0
L_831 831 829 105 0.04 0 0 0 0
L_834 834 831 1040 0.04 0 0 0 0
L_809 809 808 90 0.013 0 0 0 0

[OUTLETS]
;;Name From Node To Node Offset Type QTable/Qcoeff Qexpon Gated
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- --------
O_EURV_842 D_EURV_842 D_FC__842 0 TABULAR/DEPTH O_EURV_842 NO
O_FC_842 D_FC__842 841 0 TABULAR/DEPTH O_FC_842 NO
O_EURV_840 D_EURV_840 839 0 TABULAR/DEPTH O_EURV_840 NO
O_EURV_711 D_EURV_711 D_FC_711 0 TABULAR/DEPTH O_EURV_711 NO
O_EURV_844 D_EURV_844 839 0 TABULAR/DEPTH O_EURV_844 NO
O_EURV_830 D_EURV_830 831 0 TABULAR/DEPTH O_EURV_830 NO
O_EURV_820 D_EURV_820 D_FC_823 0 TABULAR/DEPTH O_EURV_820 NO
O_FC_711 D_FC_711 710 0 TABULAR/DEPTH O_FC_711 NO
O_FC_823 D_FC_823 819 0 TABULAR/DEPTH O_FC_823 NO
O_FC_838 D_FC_838 836 0 TABULAR/DEPTH O_FC_838 NO

[XSECTIONS]
;;Link Shape Geom1 Geom2 Geom3 Geom4 Barrels Culvert
;;-------------- ------------ ---------------- ---------- ---------- ---------- ---------- ----------
DL_620 DUMMY 0 0 0 0 1
DL_714 DUMMY 0 0 0 0 1
DL_803 DUMMY 0 0 0 0 1
DL_804 DUMMY 0 0 0 0 1
DL_810 DUMMY 0 0 0 0 1
DL_820 DUMMY 0 0 0 0 1
DL_830 DUMMY 0 0 0 0 1
DL_840 DUMMY 0 0 0 0 1
DL_842 DUMMY 0 0 0 0 1
DL_844 DUMMY 0 0 0 0 1
L_808 TRAPEZOIDAL 10 65 3 3 1
L_823 TRAPEZOIDAL 10 235 5 5 1
L_839 TRAPEZOIDAL 15 100 27 10 1
L_841 TRIANGULAR 10 200 0 0 1
L_850 TRAPEZOIDAL 10 20 12 12 1
L_708 TRAPEZOIDAL 10 22 2 2 1
L_709 TRAPEZOIDAL 10 50 4 4 1
L_710 TRAPEZOIDAL 10 70 2 2 1
L_711 TRAPEZOIDAL 10 73 4 4 1
L_713 TRAPEZOIDAL 10 55 10 10 1
L_712 TRAPEZOIDAL 10 106 15 15 1
L_838 TRAPEZOIDAL 15 24 15 15 1
L_811 TRAPEZOIDAL 10 107 6 6 1
L_843 CIRCULAR 15 0 0 0 1
L_819 TRAPEZOIDAL 10 115 3 3 1
L_824 TRAPEZOIDAL 10 657 30 30 1
L_822 TRAPEZOIDAL 10 235 5 5 1
L_829 TRAPEZOIDAL 10 75 3.5 6.5 1
L_836 CIRCULAR 4 0 0 0 1
OV_836 TRAPEZOIDAL 15 40 15 15 1
L_831 TRAPEZOIDAL 15 65 6 6 1
L_834 TRAPEZOIDAL 15 64 6 6 1
L_809 RECT_CLOSED 15 5 0 0 1

[CURVES]
;;Name Type X-Value Y-Value

```
;;-------------- ---------- ---------- ----------
;60% WQCV, 100% EURV
O_EURV_842      Rating    0        0.00
O_EURV_842                0.5      0.17
O_EURV_842                0.75     0.21
O_EURV_842                1        0.24
O_EURV_842                1.25     0.35
O_EURV_842                1.5      0.43
O_EURV_842                1.75     0.50
O_EURV_842                2        0.56
O_EURV_842                2.25     0.61
O_EURV_842                2.5      0.77
O_EURV_842                2.75     0.86
O_EURV_842                3        0.94
O_EURV_842                3.25     1.01
O_EURV_842                3.38     1.04
O_EURV_842                3.5      2.14
O_EURV_842                3.75     6.75
O_EURV_842                4        6.89
O_EURV_842                4.25     7.02
O_EURV_842                4.5      7.16
O_EURV_842                4.75     7.29
O_EURV_842                5        7.42
O_EURV_842                5.25     7.55
O_EURV_842                5.31     7.58
O_EURV_842                5.37     7.61
O_EURV_842                5.5      7.68
O_EURV_842                5.75     7.80
O_EURV_842                6        7.92
O_EURV_842                6.25     8.04
O_EURV_842                6.5      8.16
O_EURV_842                6.75     361.27
O_EURV_842                7        1039.01
O_EURV_842                7.25     1922.74
O_EURV_842                7.5      2973.09
O_EURV_842                7.75     4167.58
O_EURV_842                8        5491.18
O_EURV_842                8.25     6932.94
O_EURV_842                8.5      8484.40
O_EURV_842                8.75     10138.82
O_EURV_842                9        11890.64
O_EURV_842                9.25     13735.19
O_EURV_842                9.5      15668.45
O_EURV_842                9.75     17686.96
O_EURV_842                10       19787.68
;
;72"x60" 100-yr Flood Control Only
O_FC_842        Rating    0        0.00
O_FC_842                  0.25     1.01
O_FC_842                  0.5      3.54
O_FC_842                  0.75     7.37
O_FC_842                  1        12.40
O_FC_842                  1.25     18.58
O_FC_842                  1.5      25.84
O_FC_842                  1.75     34.15
O_FC_842                  2        43.49
O_FC_842                  2.25     53.83
O_FC_842                  2.5      65.14
O_FC_842                  2.75     77.40
O_FC_842                  3        90.60
O_FC_842                  3.25     104.73
O_FC_842                  3.5      119.76
O_FC_842                  3.75     135.69
O_FC_842                  4        152.50
O_FC_842                  4.25     170.19
O_FC_842                  4.5      188.74
O_FC_842                  4.75     208.14
O_FC_842                  5        228.39
O_FC_842                  5.25     239.54
O_FC_842                  5.5      250.19
O_FC_842                  5.75     260.41
O_FC_842                  6        270.24
O_FC_842                  6.25     279.72
O_FC_842                  6.5      288.90
O_FC_842                  6.75     297.79
O_FC_842                  7        306.42
O_FC_842                  7.25     314.82
O_FC_842                  7.5      323.00
O_FC_842                  7.75     330.97
O_FC_842                  8        338.76
O_FC_842                  8.25     346.38
O_FC_842                  8.5      353.83
O_FC_842                  8.75     361.12
O_FC_842                  9        368.27
O_FC_842                  9.25     375.29
O_FC_842                  9.5      382.18
O_FC_842                  9.75     388.94
O_FC_842                  10       395.59
;
;60% WQCV, 100% EURV
O_EURV_840      Rating    0        0.00
O_EURV_840                0.5      0.06
O_EURV_840                0.75     0.08
O_EURV_840                1        0.09
O_EURV_840                1.25     0.13
O_EURV_840                1.5      0.16
O_EURV_840                1.75     0.19
O_EURV_840                2        0.21
O_EURV_840                2.25     0.24
O_EURV_840                2.5      0.29
O_EURV_840                2.75     0.32
O_EURV_840                3        0.35
O_EURV_840                3.25     0.38
O_EURV_840                3.33     0.39
O_EURV_840                3.5      2.21
O_EURV_840                3.75     2.41
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O_EURV_840      4       2.46
O_EURV_840      4.25    2.51
O_EURV_840      4.5     2.56
O_EURV_840      4.75    2.60
O_EURV_840      4.83    2.62
O_EURV_840      5       2.65
O_EURV_840      5.25    2.69
O_EURV_840      5.28    2.70
O_EURV_840      5.5     291.63
O_EURV_840      5.75    940.12
O_EURV_840      6       1801.67
O_EURV_840      6.25    2833.35
O_EURV_840      6.5     4011.37
O_EURV_840      6.75    5320.05
O_EURV_840      7       6748.04
O_EURV_840      7.25    8286.66
O_EURV_840      7.5     9928.97
O_EURV_840      7.75    11669.30
O_EURV_840      8       13502.88
O_EURV_840      8.25    15425.62
O_EURV_840      8.5     17434.01
O_EURV_840      8.75    19524.95
O_EURV_840      9       21695.70
O_EURV_840      9.25    23943.81
O_EURV_840      9.5     26267.08
O_EURV_840      9.75    28663.52
O_EURV_840      10      31131.31
;
O_EURV_711      Rating  0.00    0.00
O_EURV_711              0.50    0.10
O_EURV_711              1.00    0.15
O_EURV_711              1.50    0.26
O_EURV_711              2.00    0.34
O_EURV_711              2.50    0.44
O_EURV_711              3.00    0.57
O_EURV_711              3.50    0.65
O_EURV_711              3.57    0.73
O_EURV_711              4.00    6.43
O_EURV_711              4.50    6.67
O_EURV_711              4.90    6.89
O_EURV_711              5.00    7.11
O_EURV_711              5.50    7.33
O_EURV_711              5.61    7.53
O_EURV_711              6.00    7.74
O_EURV_711              6.50    7.93
O_EURV_711              7.00    8.12
O_EURV_711              7.50    8.31
O_EURV_711              8.00    72.77
O_EURV_711              8.50    195.27
O_EURV_711              9.00    368.27
O_EURV_711              9.50    382.18
O_EURV_711              10.00   395.59
;
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O_EURV_823      Rating  0.00    0.00
O_EURV_823              0.50    3.44
O_EURV_823              1.00    12.06
O_EURV_823              1.50    25.12
O_EURV_823              2.00    42.28
O_EURV_823              2.50    63.33
O_EURV_823              3.00    88.09
O_EURV_823              3.50    116.43
O_EURV_823              3.57    120.68
O_EURV_823              4.00    148.27
O_EURV_823              4.50    183.50
O_EURV_823              4.90    214.08
O_EURV_823              5.00    222.05
O_EURV_823              5.50    243.24
O_EURV_823              5.61    247.66
O_EURV_823              6.00    262.73
O_EURV_823              6.50    280.87
O_EURV_823              7.00    297.91
O_EURV_823              7.50    314.03
O_EURV_823              8.00    329.35
O_EURV_823              8.50    344.00
O_EURV_823              9.00    358.05
O_EURV_823              9.50    371.56
O_EURV_823              10.00   384.60
;
O_EURV_844      Rating  0.00    0.0
O_EURV_844              0.50    0.3
O_EURV_844              1.00    0.4
O_EURV_844              1.50    0.7
O_EURV_844              2.00    0.9
O_EURV_844              2.50    1.2
O_EURV_844              3.00    1.5
O_EURV_844              3.50    6.2
O_EURV_844              4.00    6.4
O_EURV_844              4.50    6.7
O_EURV_844              5.00    6.9
O_EURV_844              5.50    7.1
O_EURV_844              6.00    7.3
O_EURV_844              6.50    147.4
O_EURV_844              7.00    483.9
O_EURV_844              7.50    939.6
O_EURV_844              8.00    1493.7
O_EURV_844              8.50    2135.2
O_EURV_844              9.00    2857.2
O_EURV_844              9.50    3655.1
O_EURV_844              10.00   4525.5
;
O_EURV_830      Rating  0.00    0.0
O_EURV_830              0.50    0.2
O_EURV_830              1.00    0.2
O_EURV_830              1.50    0.4
O_EURV_830              2.00    0.6
O_EURV_830              2.50    0.8
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O_EURV_830        3.00    1.0
O_EURV_830        3.50    5.5
O_EURV_830        4.00    5.7
O_EURV_830        4.50    6.0
O_EURV_830        5.00    6.2
O_EURV_830        5.50    6.4
O_EURV_830        6.00    6.6
O_EURV_830        6.50    96.6
O_EURV_830        7.00    314.1
O_EURV_830        7.50    610.9
O_EURV_830        8.00    974.4
O_EURV_830        8.50    1398.2
O_EURV_830        9.00    1878.6
O_EURV_830        9.50    2413.0
O_EURV_830        10.00   2999.8
;
O_EURV_810    Rating  0.00    0.0
O_EURV_810        0.50    0.1
O_EURV_810        1.00    0.2
O_EURV_810        1.50    0.3
O_EURV_810        2.00    0.4
O_EURV_810        2.50    0.5
O_EURV_810        3.00    0.6
O_EURV_810        3.50    6.2
O_EURV_810        4.00    6.4
O_EURV_810        4.50    6.7
O_EURV_810        5.00    6.9
O_EURV_810        5.50    7.1
O_EURV_810        6.00    7.3
O_EURV_810        6.50    77.1
O_EURV_810        7.00    209.3
O_EURV_810        7.50    387.1
O_EURV_810        8.00    605.5
O_EURV_810        8.50    862.1
O_EURV_810        9.00    1155.8
O_EURV_810        9.50    1485.9
O_EURV_810        10.00   1852.1
;
O_EURV_820    Rating  0.00    0.0
O_EURV_820        0.50    0.2
O_EURV_820        1.00    0.2
O_EURV_820        1.50    0.4
O_EURV_820        2.00    0.6
O_EURV_820        2.50    0.7
O_EURV_820        3.00    0.9
O_EURV_820        3.50    6.2
O_EURV_820        4.00    6.4
O_EURV_820        4.50    6.7
O_EURV_820        5.00    6.9
O_EURV_820        5.50    7.1
O_EURV_820        6.00    7.3
O_EURV_820        6.50    85.6
O_EURV_820        7.00    233.3
O_EURV_820        7.50    431.2
O_EURV_820        8.00    673.4
O_EURV_820        8.50    957.0
O_EURV_820        9.00    1280.5
O_EURV_820        9.50    1643.0
O_EURV_820        10.00   2044.1
;
O_FC_711      Rating  0.00    0.00
O_FC_711          0.50    3.54
O_FC_711          1.00    12.40
O_FC_711          1.50    25.84
O_FC_711          2.00    43.49
O_FC_711          2.50    65.14
O_FC_711          3.00    90.60
O_FC_711          3.50    119.76
O_FC_711          3.57    124.13
O_FC_711          4.00    152.50
O_FC_711          4.50    188.74
O_FC_711          4.90    220.19
O_FC_711          5.00    228.39
O_FC_711          5.50    250.19
O_FC_711          5.61    254.74
O_FC_711          6.00    270.24
O_FC_711          6.50    288.90
O_FC_711          7.00    306.42
O_FC_711          7.50    323.00
O_FC_711          8.00    338.76
O_FC_711          8.50    353.83
O_FC_711          9.00    368.27
O_FC_711          9.50    382.18
O_FC_711          10.00   395.59
;
O_FC_823      Rating  0.00    0.00
O_FC_823          0.50    3.44
O_FC_823          1.00    12.06
O_FC_823          1.50    25.12
O_FC_823          2.00    42.28
O_FC_823          2.50    63.33
O_FC_823          3.00    88.09
O_FC_823          3.50    116.43
O_FC_823          3.57    120.68
O_FC_823          4.00    148.27
O_FC_823          4.50    183.50
O_FC_823          4.90    214.08
O_FC_823          5.00    222.05
O_FC_823          5.50    243.24
O_FC_823          5.61    247.66
O_FC_823          6.00    262.73
O_FC_823          6.50    280.87
O_FC_823          7.00    297.91
O_FC_823          7.50    314.03
O_FC_823          8.00    329.35
O_FC_823          8.50    344.00
```

```
O_FC_823        9.00    358.05
O_FC_823        9.50    371.56
O_FC_823        10.00   384.60
;
O_FC_844    Rating  0.00    0.00
O_FC_844        0.50    3.44
O_FC_844        1.00    12.06
O_FC_844        1.50    25.12
O_FC_844        2.00    42.28
O_FC_844        2.50    63.33
O_FC_844        3.00    88.09
O_FC_844        3.50    116.43
O_FC_844        4.00    148.27
O_FC_844        4.50    183.50
O_FC_844        5.00    222.05
O_FC_844        5.50    243.24
O_FC_844        6.00    262.73
O_FC_844        6.50    280.87
O_FC_844        7.00    297.91
O_FC_844        7.50    314.03
O_FC_844        8.00    329.35
O_FC_844        8.50    344.00
O_FC_844        9.00    358.05
O_FC_844        9.50    371.56
O_FC_844        10.00   384.60
;
O_FC_838    Rating  0.00    0.00
O_FC_838        0.50    3.44
O_FC_838        1.00    12.06
O_FC_838        1.50    25.12
O_FC_838        2.00    42.28
O_FC_838        2.50    63.33
O_FC_838        3.00    88.09
O_FC_838        3.50    116.43
O_FC_838        3.57    120.68
O_FC_838        4.00    148.27
O_FC_838        4.50    183.50
O_FC_838        4.90    214.08
O_FC_838        5.00    222.05
O_FC_838        5.50    243.24
O_FC_838        5.61    247.66
O_FC_838        6.00    262.73
O_FC_838        6.50    280.87
O_FC_838        7.00    297.91
O_FC_838        7.50    314.03
O_FC_838        8.00    329.35
O_FC_838        8.50    344.00
O_FC_838        9.00    358.05
O_FC_838        9.50    371.56
O_FC_838        10.00   384.60
;
;60% WQCV, 100% EURV
D_EURV_842      Storage 0       694
D_EURV_842      0.5     694
D_EURV_842      0.75    694
D_EURV_842      1       694
D_EURV_842      1.25    3972
D_EURV_842      1.5     9799
D_EURV_842      1.75    18176
D_EURV_842      2       29104
D_EURV_842      2.25    42581
D_EURV_842      2.5     58608
D_EURV_842      2.75    77186
D_EURV_842      3       98313
D_EURV_842      3.25    121991
D_EURV_842      3.38    135311
D_EURV_842      3.5     148218
D_EURV_842      3.75    176995
D_EURV_842      4       208323
D_EURV_842      4.25    242200
D_EURV_842      4.5     278628
D_EURV_842      4.75    317605
D_EURV_842      5       359132
D_EURV_842      5.25    403210
D_EURV_842      5.31    414168
D_EURV_842      5.37    425273
D_EURV_842      5.5     426710
D_EURV_842      5.75    429481
D_EURV_842      6       432259
D_EURV_842      6.25    435046
D_EURV_842      6.5     437840
D_EURV_842      6.75    440643
D_EURV_842      7       443453
D_EURV_842      7.25    446272
D_EURV_842      7.5     449098
D_EURV_842      7.75    451933
D_EURV_842      8       454775
D_EURV_842      8.25    457626
D_EURV_842      8.5     460484
D_EURV_842      8.75    463351
D_EURV_842      9       466225
D_EURV_842      9.25    469108
D_EURV_842      9.5     471998
D_EURV_842      9.75    474897
D_EURV_842      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
D_FC_814        9.75    33590
D_FC_814        10      34341
;
;255'x510'
D_EURV_840      Storage 0       258
D_EURV_840      0.5     258
D_EURV_840      0.75    258
D_EURV_840      1       258
D_EURV_840      1.25    1530
D_EURV_840      1.5     3810
D_EURV_840      1.75    7098
D_EURV_840      2       11394
D_EURV_840      2.25    16698
D_EURV_840      2.5     23010
D_EURV_840      2.75    30329
D_EURV_840      3       38656
D_EURV_840      3.25    47991
D_EURV_840      3.33    51191
D_EURV_840      3.5     58334
D_EURV_840      3.75    69684
D_EURV_840      4       82043
D_EURV_840      4.25    95409
D_EURV_840      4.5     109783
D_EURV_840      4.75    125165
D_EURV_840      4.83    130300
D_EURV_840      5       131343
D_EURV_840      5.25    132883
D_EURV_840      5.28    133069
D_EURV_840      5.5     134432
D_EURV_840      5.75    135988
D_EURV_840      6       137553
D_EURV_840      6.25    139125
D_EURV_840      6.5     140706
D_EURV_840      6.75    142295
D_EURV_840      7       143891
D_EURV_840      7.25    145496
D_EURV_840      7.5     147108
D_EURV_840      7.75    148729
D_EURV_840      8       150357
D_EURV_840      8.25    151994
D_EURV_840      8.5     153638
D_EURV_840      8.75    155291
D_EURV_840      9       156951
D_EURV_840      9.25    158620
D_EURV_840      9.5     160297
D_EURV_840      9.75    161981
D_EURV_840      10      163674
;
D_EURV_711      Storage 0.00    1752
D_EURV_711      0.33    1752
D_EURV_711      0.50    1752
D_EURV_711      1.00    6962
D_EURV_711      1.18    16021
D_EURV_711      1.50    16694
D_EURV_711      2.00    17771
D_EURV_711      2.50    18879
D_EURV_711      3.00    20020
D_EURV_711      3.50    21193
D_EURV_711      3.62    21479
D_EURV_711      4.00    22398
D_EURV_711      4.50    23635
D_EURV_711      5.00    24904
D_EURV_711      5.50    26205
D_EURV_711      5.99    27511
D_EURV_711      6.00    27538
D_EURV_711      6.50    28903
D_EURV_711      7.00    30299
D_EURV_711      7.50    31728
D_EURV_711      8.00    33189
D_EURV_711      8.50    34682
D_EURV_711      9.00    36207
D_EURV_711      9.50    37764
D_EURV_711      10.00   39353
;
D_EURV_823      Storage 0.00    1752
D_EURV_823      0.33    1752
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```
D_EURV_823              0.50      1752
D_EURV_823              1.00      6962
D_EURV_823              1.50      41122
D_EURV_823              2.00      103393
D_EURV_823              2.50      193775
D_EURV_823              2.73      244790
D_EURV_823              3.00      247044
D_EURV_823              3.43      250653
D_EURV_823              3.50      251243
D_EURV_823              4.00      255473
D_EURV_823              4.50      259736
D_EURV_823              5.00      264030
D_EURV_823              5.50      268357
D_EURV_823              5.99      272628
D_EURV_823              6.00      272715
D_EURV_823              6.50      277106
D_EURV_823              7.00      281528
D_EURV_823              7.50      285983
D_EURV_823              8.00      290469
D_EURV_823              8.50      294988
D_EURV_823              9.00      299538
D_EURV_823              9.50      304121
D_EURV_823              10.00     308735
;
D_EURV_844      Storage   0.00      1752
D_EURV_844              0.33      1752
D_EURV_844              0.50      1752
D_EURV_844              1.00      6962
D_EURV_844              1.30      41122
D_EURV_844              1.50      80408
D_EURV_844              2.00      81168
D_EURV_844              2.50      83565
D_EURV_844              3.00      85994
D_EURV_844              3.50      86631
D_EURV_844              3.63      88456
D_EURV_844              4.00      90949
D_EURV_844              4.50      93474
D_EURV_844              5.00      96031
D_EURV_844              5.50      98621
D_EURV_844              6.00      101242
D_EURV_844              6.03      101294
D_EURV_844              6.50      103895
D_EURV_844              7.00      106580
D_EURV_844              7.50      109297
D_EURV_844              8.00      112047
D_EURV_844              8.50      114828
D_EURV_844              9.00      117641
D_EURV_844              9.50      120486
D_EURV_844              10.00     123363
;
D_EURV_830      Storage   0.00      1752
D_EURV_830              0.33      1752
D_EURV_830              0.50      1752
D_EURV_830              1.00      6962
D_EURV_830              1.18      41122
D_EURV_830              1.50      46084
D_EURV_830              2.00      47705
D_EURV_830              2.50      49536
D_EURV_830              3.00      51399
D_EURV_830              3.50      51474
D_EURV_830              3.62      53294
D_EURV_830              4.00      55221
D_EURV_830              4.50      57180
D_EURV_830              5.00      59171
D_EURV_830              5.50      61195
D_EURV_830              5.99      63250
D_EURV_830              6.00      63291
D_EURV_830              6.50      65337
D_EURV_830              7.00      67456
D_EURV_830              7.50      69607
D_EURV_830              8.00      71790
D_EURV_830              8.50      74005
D_EURV_830              9.00      76253
D_EURV_830              9.50      78532
D_EURV_830              10.00     80843
;
D_EURV_810      Storage   0.00      1752
D_EURV_810              0.33      1752
D_EURV_810              0.50      1752
D_EURV_810              1.00      6962
D_EURV_810              1.50      23884
D_EURV_810              2.00      25175
D_EURV_810              2.06      25333
D_EURV_810              2.50      26499
D_EURV_810              2.63      26848
D_EURV_810              3.00      27855
D_EURV_810              3.50      29242
D_EURV_810              4.00      30662
D_EURV_810              4.50      32113
D_EURV_810              5.00      33597
D_EURV_810              5.50      35113
D_EURV_810              6.00      36660
D_EURV_810              6.50      38240
D_EURV_810              7.00      39852
D_EURV_810              7.50      41495
D_EURV_810              8.00      43171
D_EURV_810              8.50      44878
D_EURV_810              9.00      46618
D_EURV_810              9.50      48390
D_EURV_810              10.00     50193
;
D_EURV_820      Storage   0.00      1752
D_EURV_820              0.33      1752
D_EURV_820              0.50      1752
D_EURV_820              1.00      6962
D_EURV_820              1.15      41122
```

```
D_EURV_820              1.50      42092
D_EURV_820              2.00      43779
D_EURV_820              2.50      45532
D_EURV_820              3.00      47317
D_EURV_820              3.50      47389
D_EURV_820              3.60      49134
D_EURV_820              4.00      50983
D_EURV_820              4.50      52864
D_EURV_820              5.00      54777
D_EURV_820              5.50      56722
D_EURV_820              5.94      58699
D_EURV_820              6.00      58739
D_EURV_820              6.50      60708
D_EURV_820              7.00      62749
D_EURV_820              7.50      64822
D_EURV_820              8.00      66927
D_EURV_820              8.50      69064
D_EURV_820              9.00      71234
D_EURV_820              9.50      73435
D_EURV_820              10.00     75668
;
D_FC_823        Storage    1         1
;
D_FC_83         Storage    0.00      37664
D_FC_83                    1.00      77436
D_FC_83                    2.00      133078
D_FC_83                    3.00      163864
D_FC_83                    4.00      190605
D_FC_83                    5.00      204897
D_FC_83                    6.00      215528
D_FC_83                    7.00      226286
D_FC_83                    8.00      237198
D_FC_83                    8.49      273603
;
D_FC_711        Storage    0.00      36922
D_FC_711                   0.50      38568
D_FC_711                   1.00      40247
D_FC_711                   1.50      41957
D_FC_711                   2.00      43700
D_FC_711                   2.50      45474
D_FC_711                   3.00      47280
D_FC_711                   3.50      49119
D_FC_711                   4.00      50989
D_FC_711                   4.50      52892
D_FC_711                   5.00      54826
D_FC_711                   5.50      56793
D_FC_711                   6.00      58791
D_FC_711                   6.50      60822
D_FC_711                   7.00      62884
D_FC_711                   7.50      64978
D_FC_711                   8.00      67105
D_FC_711                   8.50      69263
D_FC_711                   9.00      71454
D_FC_711                   9.50      73676
D_FC_711                   10.00     75931
;
D_FC_811        Storage    0.00      37664
D_FC_811                   1.00      77436
D_FC_811                   2.00      133078
D_FC_811                   3.00      163864
D_FC_811                   4.00      190605
D_FC_811                   5.00      204897
D_FC_811                   6.00      215528
D_FC_811                   7.00      226286
D_FC_811                   8.00      237198
D_FC_811                   8.49      273603
D_FC_811                   9.00      273603
D_FC_811                   10.00     273603
;
D_FC_844        Storage    0.00      107813
D_FC_844                   0.50      110615
D_FC_844                   1.00      113449
D_FC_844                   1.50      116315
D_FC_844                   2.00      119214
D_FC_844                   2.50      122144
D_FC_844                   3.00      125106
D_FC_844                   3.50      128100
D_FC_844                   4.00      131126
D_FC_844                   4.50      134184
D_FC_844                   5.00      137274
D_FC_844                   5.50      140397
D_FC_844                   6.00      143551
D_FC_844                   6.50      146737
D_FC_844                   7.00      149955
D_FC_844                   7.50      153205
D_FC_844                   8.00      156487
D_FC_844                   8.50      159801
D_FC_844                   9.00      163147
D_FC_844                   9.50      166526
D_FC_844                   10.00     169936
;
D_FC_838        Storage    0.00      107813
D_FC_838                   0.50      110615
D_FC_838                   1.00      113449
D_FC_838                   1.50      116315
D_FC_838                   2.00      119214
D_FC_838                   2.50      122144
D_FC_838                   3.00      125106
D_FC_838                   3.50      128100
D_FC_838                   4.00      131126
D_FC_838                   4.50      134184
D_FC_838                   5.00      137274
D_FC_838                   5.50      140397
D_FC_838                   6.00      143551
D_FC_838                   6.50      146737
D_FC_838                   7.00      149955
```

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D_FC_838                7.50      153205
D_FC_838                8.00      156487
D_FC_838                8.50      159801
D_FC_838                9.00      163147
D_FC_838                9.50      166526
D_FC_838                10.00      169936

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

[TAGS]

[MAP]
DIMENSIONS 0.000 0.000 8882.267 8132.154
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
620              3176.446           5603.079
712              2895.562           4845.602
714              2396.597           5524.935
803              2046.787           5306.170
804              2224.496           5288.834
809              2304.222           4931.686
810              2221.307           4534.501
819              2458.581           4607.362
820              2858.872           4455.858
824              3212.781           4053.026
829              2531.995           4090.155
830              2310.615           3639.827
839              3222.537           3474.569
840              4296.625           2946.685
841              3232.367           3448.535
842              4116.415           2195.542
843              3098.576           3589.753
844              3175.492           2589.454
850              3628.528           2902.994
711              2728.325           5128.419
710              2635.627           5340.281
709              2645.107           5386.630
708              2650.374           5598.361
713              2796.803           5016.287
811              2326.424           4882.578
822              2779.481           4253.460
823              2482.561           4170.492
834              2793.200           3771.985
838              3041.708           3648.672
831              2539.570           4080.449
808              2290.503           4963.697
O_803              2037.522           5457.441
O_708              2644.492           5672.936
O_620              3155.399           5761.408
O_714              2402.976           5620.622
836              2952.697           3687.647
D_EURV_842       3387.469           3130.936
D_FC__842        3310.327           3270.126
D_EURV_840       3399.324           3473.799
D_EURV_711       2689.247           5218.198
D_EURV_830       2509.561           4014.873
D_EURV_844       3104.348           3288.010
D_EURV_820       2613.011           4521.636
D_FC_711         2670.611           5308.833
D_FC_823         2475.252           4529.969
D_FC_838         3027.364           3680.041

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
DL_803           2026.861           5357.978
DL_803           2038.817           5412.975
DL_810           2232.974           4619.614
DL_810           2237.218           4666.792
DL_830           2423.812           3865.099
DL_840           4169.043           3071.079
DL_840           4092.493           3157.197
DL_840           3953.747           3410.768
DL_840           3583.757           3433.095
DL_840           3441.035           3473.264
DL_842           3580.567           2554.368
DL_842           3454.075           2733.989
DL_842           3356.793           2914.200
DL_842           3340.070           3019.591
DL_844           3186.655           2742.553
DL_844           3202.603           2914.790
DL_844           3193.034           3211.420
DL_844           3182.258           3223.040
DL_844           3175.394           3235.624
L_808            2265.576           5028.444
L_808            2246.438           5036.418
L_808            2206.569           5066.719
L_808            2203.379           5100.210
L_808            2190.621           5159.217
L_808            2137.993           5194.302
L_808            2080.325           5208.102
L_808            2060.399           5283.821
L_823            2485.244           4167.900
L_823            2482.053           4247.674
L_823            2482.053           4378.503
L_850            3608.479           2914.796
L_850            3593.723           2919.982
```

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L_850           3576.180          2921.577
L_850           3539.500          2931.146
L_850           3506.010          2942.309
L_850           3486.872          2971.016
L_850           3467.735          2998.127
L_850           3448.750          3035.607
L_850           3451.038          3018.447
L_850           3437.310          3036.751
L_850           3429.302          3047.047
L_850           3420.150          3066.495
L_850           3414.430          3080.223
L_850           3405.278          3098.526
OV_836           2870.006          3747.691

[Polygons]
;;Storage Node   X-Coord           Y-Coord
;;--------------- ------------------ ------------------
D_EURV_842       3382.130           3133.605
D_EURV_842       3391.282           3125.597
D_EURV_842       3388.994           3133.605
D_FC__842        3306.134           3266.314
D_FC__842        3311.851           3269.744
D_FC__842        3307.849           3269.172
D_FC__842        3307.849           3265.742
D_EURV_840       3401.419           3474.656
D_EURV_840       3398.277           3474.370
D_EURV_840       3398.277           3472.371
D_EURV_711       2686.959           5219.914
D_EURV_711       2691.535           5216.482
D_EURV_830       2512.421           4009.725
D_EURV_830       2506.701           4020.021
D_EURV_844       3106.064           3284.006
D_EURV_844       3102.632           3292.014
D_EURV_820       2617.587           4525.640
D_EURV_820       2608.435           4517.632
D_FC_711         2680.526           5305.401
D_FC_711         2665.654           5305.401
D_FC_711         2665.654           5315.697
D_FC_823         2477.541           4517.378
D_FC_823         2472.963           4542.561
D_FC_838         3029.651           3677.468
D_FC_838         3025.078           3682.613


[BACKDROP]
FILE       "R:\23.1447.001 Greeley - Oklahoma Drainage MP\200 Design\220 Drainage-WR\221
Models\CUHP_SWMM\SWMM\Backgrounds\Final Map.jpg"
DIMENSIONS 735.737 1837.108 8882.267 8132.154
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Appendix F-4
Master Plan SWMM Output

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)

City of Greeley
Storm Drainage Master Plan
Master Plan Oklahoma Concept Design

****
Element Count
****
Number of rain gages 0
Number of subcatchments ... 0
Number of nodes 46
Number of links 43
Number of pollutants 0
Number of land uses 0

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
620	JUNCTION	4920.00	10.00	0.0	
712	JUNCTION	4915.00	10.00	0.0	
714	JUNCTION	4864.00	10.00	0.0	
803	JUNCTION	4866.00	10.00	0.0	
804	JUNCTION	4882.00	10.00	0.0	
809	JUNCTION	4890.00	25.00	0.0	
810	JUNCTION	4925.00	10.00	0.0	
819	JUNCTION	4901.00	10.00	0.0	
820	JUNCTION	4945.00	10.00	0.0	
824	JUNCTION	4961.00	10.00	0.0	
829	JUNCTION	4918.00	15.00	0.0	
830	JUNCTION	4972.00	10.00	0.0	
839	JUNCTION	4965.00	15.00	0.0	
840	JUNCTION	4990.00	10.00	0.0	
841	JUNCTION	4967.00	10.00	0.0	
842	JUNCTION	5000.00	10.00	0.0	
843	JUNCTION	4959.00	15.00	0.0	
844	JUNCTION	4995.00	10.00	0.0	
850	JUNCTION	4990.00	10.00	0.0	
711	JUNCTION	4889.00	10.00	0.0	
710	JUNCTION	4871.00	10.00	0.0	
709	JUNCTION	4866.00	10.00	0.0	
708	JUNCTION	4851.00	10.00	0.0	
713	JUNCTION	4898.00	10.00	0.0	
811	JUNCTION	4893.00	10.00	0.0	
822	JUNCTION	4932.00	10.00	0.0	
823	JUNCTION	4908.00	10.00	0.0	
834	JUNCTION	4932.00	15.00	0.0	
838	JUNCTION	4949.00	15.00	0.0	
831	JUNCTION	4928.50	15.00	0.0	
808	JUNCTION	4885.00	15.00	0.0	
O_803	OUTFALL	4865.00	0.00	0.0	
O_708	OUTFALL	4828.00	10.00	0.0	
O_620	OUTFALL	4817.00	0.00	0.0	
O_714	OUTFALL	4838.00	0.00	0.0	
836	DIVIDER	4945.00	15.00	0.0	
D_EURV_842	STORAGE	4967.00	10.00	0.0	
D_FC__842	STORAGE	4967.00	10.00	0.0	
D_EURV_840	STORAGE	4965.00	10.00	0.0	
D_EURV_711	STORAGE	4880.00	10.00	0.0	
D_EURV_830	STORAGE	4935.00	10.00	0.0	
D_EURV_844	STORAGE	4977.00	10.00	0.0	
D_EURV_820	STORAGE	4931.00	10.00	0.0	
D_FC_711	STORAGE	4875.00	10.00	0.0	
D_FC_823	STORAGE	4905.00	10.00	0.0	
D_FC_838	STORAGE	4948.00	10.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
DL_620	620	O_620	CONDUIT	400.0	26.6486	0.0100
DL_714	714	O_714	CONDUIT	400.0	6.5138	0.0100
DL_803	803	O_803	CONDUIT	400.0	0.2500	0.0100
DL_804	804	803	CONDUIT	400.0	4.0032	0.0100
DL_810	810	809	CONDUIT	400.0	8.7837	0.0100
DL_820	820	D_EURV_820	CONDUIT	400.0	3.5021	0.0100
DL_830	830	D_EURV_830	CONDUIT	400.0	9.2898	0.0100
DL_840	840	D_EURV_840	CONDUIT	400.0	6.2622	0.0100
DL_842	842	D_EURV_842	CONDUIT	400.0	8.2782	0.0100
DL_844	844	D_EURV_844	CONDUIT	400.0	4.5046	0.0100
L_808	808	803	CONDUIT	1197.0	1.5875	0.0700
L_823	823	D_FC_823	CONDUIT	943.0	0.3181	0.0400
L_839	839	843	CONDUIT	541.0	1.1091	0.0480
L_841	841	839	CONDUIT	190.0	1.0527	0.0440
L_850	850	D_EURV_842	CONDUIT	1740.0	1.3220	0.0440
L_708	708	O_708	CONDUIT	202.0	11.4607	0.0350
L_709	709	708	CONDUIT	560.2	2.6786	0.0300
L_710	710	709	CONDUIT	154.3	3.2421	0.0400
L_711	711	D_EURV_711	CONDUIT	615.3	1.4629	0.0400
L_713	713	711	CONDUIT	338.1	2.6629	0.0700
L_712	712	713	CONDUIT	485.4	3.5044	0.0400
L_838	838	D_FC_838	CONDUIT	314.9	0.3176	0.0480
L_811	811	809	CONDUIT	183.0	1.6396	0.0450
L_843	843	838	CONDUIT	304.0	3.2913	0.0350
L_819	819	811	CONDUIT	761.0	1.0513	0.0700
L_824	824	822	CONDUIT	1270.0	2.2841	0.0350
L_822	822	D_FC_823	CONDUIT	671.0	4.0271	0.0400
L_829	829	823	CONDUIT	290.0	3.4503	0.0350
L_836	836	834	CONDUIT	442.0	2.9424	0.0130

OV_836	836	834	CONDUIT	442.0	2.9424	0.0350
L_831	831	829	CONDUIT	105.0	10.0504	0.0400
L_834	834	831	CONDUIT	1040.0	0.3365	0.0400
L_809	809	808	CONDUIT	90.0	5.5641	0.0130
O_EURV_842	D_EURV_842	D_FC__842	OUTLET			
O_FC_842	D_FC__842	841	OUTLET			
O_EURV_840	D_EURV_840	839	OUTLET			
O_EURV_711	D_EURV_711	D_FC_711	OUTLET			
O_EURV_844	D_EURV_844	839	OUTLET			
O_EURV_830	D_EURV_830	831	OUTLET			
O_EURV_820	D_EURV_820	D_FC_823	OUTLET			
O_FC_711	D_FC_711	710	OUTLET			
O_FC_823	D_FC_823	819	OUTLET			
O_FC_838	D_FC_838	836	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
DL_620	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_714	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_803	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_804	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_820	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_830	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_840	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_842	DUMMY	0.00	0.00	0.00	0.00	1	0.00
DL_844	DUMMY	0.00	0.00	0.00	0.00	1	0.00
L_808	TRAPEZOIDAL	10.00	950.00	7.41	125.00	1	9655.82
L_823	TRAPEZOIDAL	10.00	2850.00	8.46	335.00	1	24789.61
L_839	TRAPEZOIDAL	15.00	5662.50	8.63	655.00	1	77684.49
L_841	TRIANGULAR	10.00	1000.00	4.98	200.00	1	10098.48
L_850	TRAPEZOIDAL	10.00	1400.00	5.37	260.00	1	16665.33
L_708	TRAPEZOIDAL	10.00	420.00	6.29	62.00	1	20580.76
L_709	TRAPEZOIDAL	10.00	900.00	6.79	130.00	1	26173.35
L_710	TRAPEZOIDAL	10.00	900.00	7.85	110.00	1	23769.29
L_711	TRAPEZOIDAL	10.00	1130.00	7.27	153.00	1	19052.01
L_713	TRAPEZOIDAL	10.00	1550.00	6.05	255.00	1	17837.15
L_712	TRAPEZOIDAL	10.00	2560.00	6.30	406.00	1	60698.05
L_838	TRAPEZOIDAL	15.00	3735.00	7.86	474.00	1	25766.89
L_811	TRAPEZOIDAL	10.00	1670.00	7.30	227.00	1	26581.36
L_843	CIRCULAR	15.00	176.71	3.75	15.00	1	3285.42
L_819	TRAPEZOIDAL	10.00	1450.00	8.13	175.00	1	12765.94
L_824	TRAPEZOIDAL	10.00	9570.00	7.61	1257.00	1	237606.05
L_822	TRAPEZOIDAL	10.00	2850.00	8.46	335.00	1	88198.34
L_829	TRAPEZOIDAL	10.00	1250.00	7.06	175.00	1	36264.24
L_836	CIRCULAR	4.00	12.57	1.00	4.00	1	246.40
OV_836	TRAPEZOIDAL	15.00	3975.00	8.10	490.00	1	116720.41
L_831	TRAPEZOIDAL	15.00	2325.00	9.39	245.00	1	121915.29
L_834	TRAPEZOIDAL	15.00	2310.00	9.37	244.00	1	22129.56
L_809	RECT_CLOSED	15.00	75.00	1.88	5.00	1	3074.94

****
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	169.814	55.336
External Outflow	130.054	42.380
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	40.905	13.330
Continuity Error (%)	-0.674	

****
Highest Flow Instability Indexes
****
Link L_829 (1)

****

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: Fri Jul 12 14:18:31 2024
Analysis ended on: Fri Jul 12 14:18:31 2024
Total elapsed time: < 1 sec

Appendix F-5
Master Plan Hydrology Summary

Design Point		Drainage Area	Existing Conditions (cfs)	Future Conditions Do Nothing (cfs)	Future Conditions Concept Design (cfs)
Number	Type	(Acres)	Q_{100}	Q_{100}	Q_{100}
620	Basin	34	37	37	37
712	Basin	90	161	173	171
714	Basin	23	50	52	52
803	Junction	670	1,039	2,072	306
804	Basin	26	25	25	25
809	Junction	596	1,024	2,058	299
810	Basin	74	101	190	188
819	Junction	515	929	1,887	283
820	Basin	81	292	331	332
824	Basin	43	70	165	165
829	Junction	444	711	1,511	311
830	Basin	71	259	294	293
839	Junction	253	372	846	535
840	Basin	64	82	200	200
841	Junction	142	290	649	284
842	Basin	111	152	353	353
843	Junction	317	578	1,300	528
844	Basin	127	221	523	523
850	Basin	100	142	316	313
O_620	Outfall	34	37	37	37
O_708	Outfall	90	160	172	111
O_714	Outfall	23	50	52	52
O_803	Outfall	696	1,039	2,072	306

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}
620	Basin	34	2	5	9	19	27	37	62
712	Basin	90	14	28	46	91	127	171	284
714	Basin	23	2	6	12	27	38	52	87
803	Junction	670	23	38	57	111	191	306	534
804	Basin	26	0	0	1	5	14	25	56
809	Junction	596	26	43	62	110	190	299	497
810	Basin	74	26	43	62	108	145	188	303
819	Junction	515	15	24	32	92	184	283	385
820	Basin	81	70	102	134	202	259	332	513
824	Basin	43	37	53	69	102	130	165	254
829	Junction	444	15	18	23	77	179	311	479
830	Basin	71	60	88	117	177	228	293	456
839	Junction	253	16	17	46	201	347	535	1,065
840	Basin	64	44	63	82	124	159	200	309
841	Junction	142	7	7	8	8	128	284	396
842	Basin	111	70	103	136	215	277	353	549
843	Junction	317	16	17	45	198	341	528	1,064
844	Basin	127	117	168	219	325	415	523	806
850	Basin	100	53	79	111	184	245	313	500
O_620	Outfall	34	2	5	9	19	27	37	62
O_708	Outfall	90	1	6	8	37	68	111	215
O_714	Outfall	23	2	6	12	27	38	52	87
O_803	Outfall	696	23	38	57	111	191	306	534

Design Point		Drainage Area	Future Conditions Concept Peak Volume (Arce-ft)						
Number	Type	(Acres)	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_{500}
620	Basin	34	0	0	0	1	1	2	3
712	Basin	90	0	1	1	3	4	5	9
714	Basin	23	0	0	0	1	1	1	2
803	Junction	670	5	7	9	16	24	35	55
804	Basin	26	0	0	0	0	0	1	1
809	Junction	596	5	7	10	16	24	34	54
810	Basin	74	1	1	2	3	4	5	8
819	Junction	515	4	6	8	14	21	30	46
820	Basin	81	1	2	2	3	4	6	9
824	Basin	43	1	1	1	2	3	3	5
829	Junction	444	3	5	6	9	15	22	35
830	Basin	71	1	1	2	3	4	5	8
839	Junction	253	4	5	6	8	13	19	33
840	Basin	64	1	1	2	3	4	5	7
841	Junction	142	2	2	2	2	5	8	14
842	Basin	111	2	2	3	5	6	8	12
843	Junction	317	3	5	6	8	13	19	33
844	Basin	127	2	3	4	6	7	9	14
850	Basin	100	1	2	2	4	5	7	11
O_620	Outfall	34	0	0	0	1	1	2	3
O_708	Outfall	90	0	1	1	2	4	5	8
O_714	Outfall	23	0	0	0	1	1	1	2
O_803	Outfall	696	5	7	9	16	24	35	55

Appendix F-6
Master Plan HY-8 Culverts

Culvert Data: Structure#702

Site Data - Structure#702

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4867.00 ft
Outlet Station: 97.00 ft
Outlet Elevation: 4862.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#702

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
Inlet Depression: None

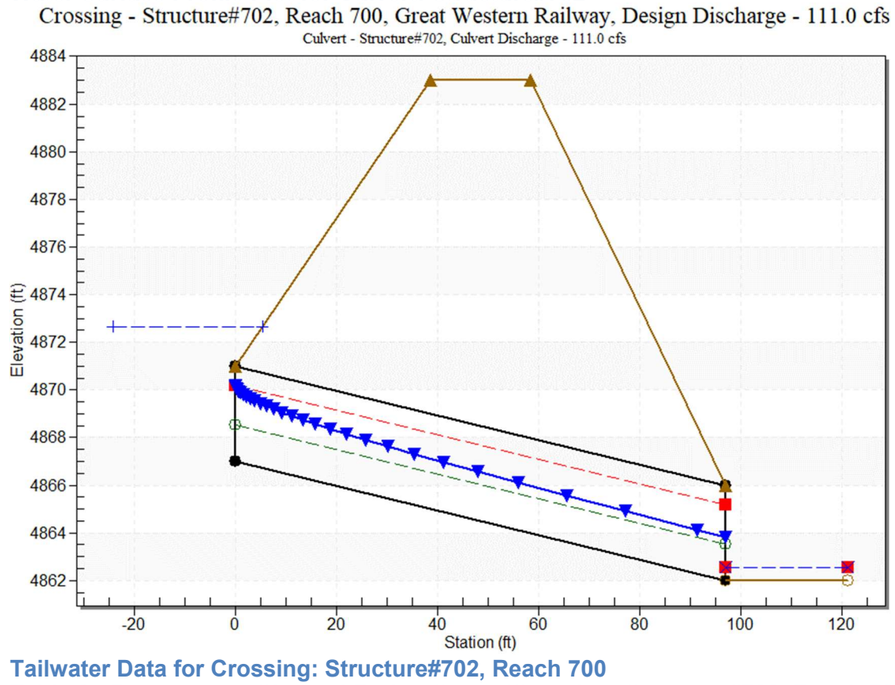
Table 1 - Culvert Summary Table: Structure#702

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	24.91 cfs	24.91 cfs	4868.96	1.96	0.0*	1-S2n	0.72	1.47	0.76	0.23	14.91	2.12
100 Year	111.00 cfs	111.00 cfs	4872.67	5.67	0.901	5-S2n	1.54	3.18	1.82	0.56	19.98	3.78

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4867.00 ft,
Outlet Elevation (invert): 4862.00 ft
Culvert Length: 97.13 ft,
Culvert Slope: 0.0515

Water Surface Profile Plot for Culvert: Structure#702



Tailwater Data for Crossing: Structure#702, Reach 700

Table 2 - Downstream Channel Rating Curve (Crossing: Structure#702, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4862.23	0.23	2.12	0.43	0.79
111.00	4862.56	0.56	3.78	1.05	0.91

Tailwater Channel Data - Structure#702, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0300
Channel Manning's n: 0.0450
Channel Invert Elevation: 4862.00 ft

Roadway Data for Crossing: Structure#702, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4883.00 ft
Roadway Surface: Gravel
Roadway Top Width: 20.00 ft

Culvert Data: Structure#704

Site Data - Structure#704

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4890.00 ft
Outlet Station: 89.00 ft
Outlet Elevation: 4888.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#704

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
Inlet Depression: None

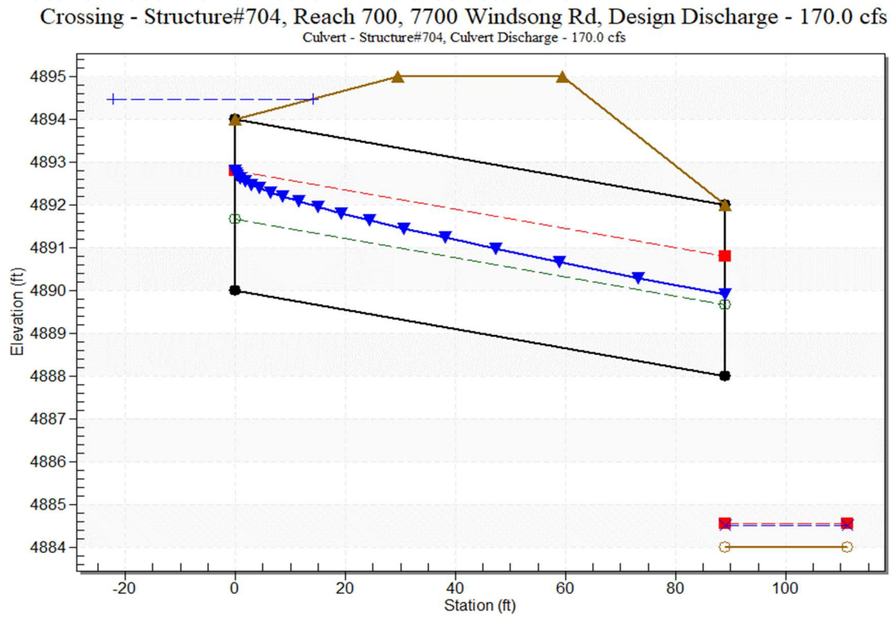
Table 3 - Culvert Summary Table: Structure#704

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	24.91 cfs	24.91 cfs	4891.39	1.39	0.0*	1-S2n	0.63	1.03	0.64	0.16	9.50	2.09
100 Year	170.00 cfs	170.00 cfs	4894.48	4.48	2.124	5-S2n	1.67	2.79	1.90	0.51	14.43	4.45

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4890.00 ft,
Outlet Elevation (invert): 4888.00 ft
Culvert Length: 89.02 ft,
Culvert Slope: 0.0225

Water Surface Profile Plot for Culvert: Structure#704



Tailwater Data for Crossing: Structure#704, Reach 700

Table 4 - Downstream Channel Rating Curve (Crossing: Structure#704, Reach 700)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.91	4884.16	0.16	2.09	0.28	0.92
170.00	4884.51	0.51	4.45	0.89	1.11

Tailwater Channel Data - Structure#704, Reach 700

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 73.00 ft
Side Slope (H:V): 4.00 (_:1)
Channel Slope: 0.0280
Channel Manning's n: 0.0350
Channel Invert Elevation: 4884.00 ft

Roadway Data for Crossing: Structure#704, Reach 700

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4897.00 ft
Roadway Surface: Paved
Roadway Top Width: 25.30 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: 74.00 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: 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

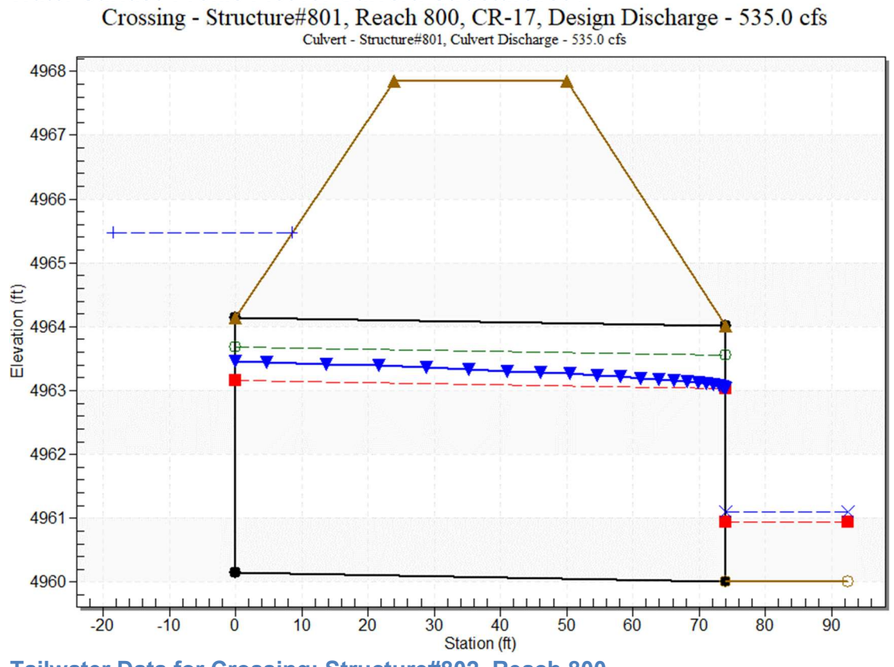
Table 5 - Culvert Summary Table: Structure#801

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	18.94 cfs	18.94 cfs	4960.71	0.56	0.560	2-M2c	0.39	0.33	0.33	0.15	3.24	1.25
100 Year	535.00 cfs	535.00 cfs	4965.47	5.32	5.188	7-M2c	3.54	3.02	3.02	1.08	9.85	4.45

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4960.15 ft,
Outlet Elevation (invert): 4960.01 ft
Culvert Length: 74.00 ft,
Culvert Slope: 0.0018

Water Surface Profile Plot for Culvert: Structure#801



Tailwater Data for Crossing: Structure#802, Reach 800

Table 6 - Downstream Channel Rating Curve (Crossing: Structure#802, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
18.94	4960.16	0.15	1.25	0.17	0.58
535.00	4961.09	1.08	4.45	1.25	0.79

Tailwater Channel Data - Structure#801, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 100.00 ft
Side Slope (H:V): 10.00 (_:1)
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

Culvert Data: Structure#804

Site Data - Structure#804

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4889.00 ft
Outlet Station: 90.00 ft
Outlet Elevation: 4881.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#804

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: 0.0130
Culvert Type: Straight
Inlet Configuration: Square Edge (30-75º flare) Wingwall
Inlet Depression: None

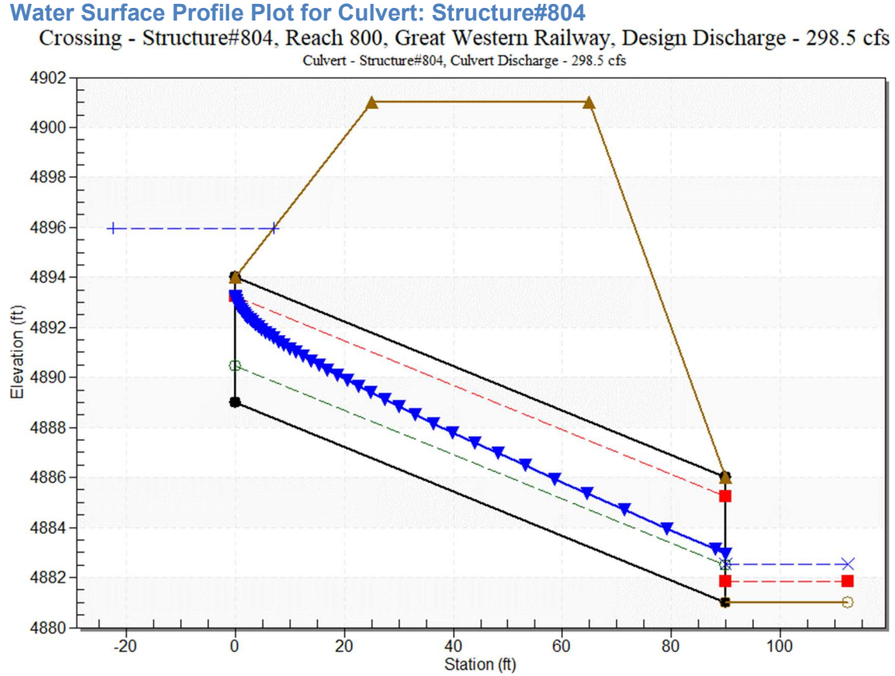
Table 7 - Culvert Summary Table: Structure#804

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-Yr	126.99 cfs	126.99 cfs	4892.50	3.50	0.0*	1-S2n	0.83	2.41	0.96	0.92	22.06	2.04
100-Yr	298.54 cfs	298.54 cfs	4895.97	6.97	0.0*	5-S2n	1.47	4.25	1.94	1.52	25.61	2.81

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4889.00 ft,
Outlet Elevation (invert): 4881.00 ft
Culvert Length: 90.35 ft,
Culvert Slope: 0.0889

Water Surface Profile Plot for Culvert: Structure#804



Tailwater Data for Crossing: Structure#804, Reach 800

Table 8 - Downstream Channel Rating Curve (Crossing: Structure#804, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
126.99	4881.92	0.92	2.04	0.63	0.38
298.54	4882.52	1.52	2.81	1.05	0.41

Tailwater Channel Data - Structure#804, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 65.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0110
Channel Manning's n: 0.0700
Channel Invert Elevation: 4881.00 ft

Roadway Data for Crossing: Structure#804, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4901.00 ft
Roadway Surface: Gravel
Roadway Top Width: 40.00 ft

Culvert Data: Structure#805

Site Data - Structure#805

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4892.00 ft
Outlet Station: 62.00 ft
Outlet Elevation: 4890.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#805

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
Inlet Depression: None

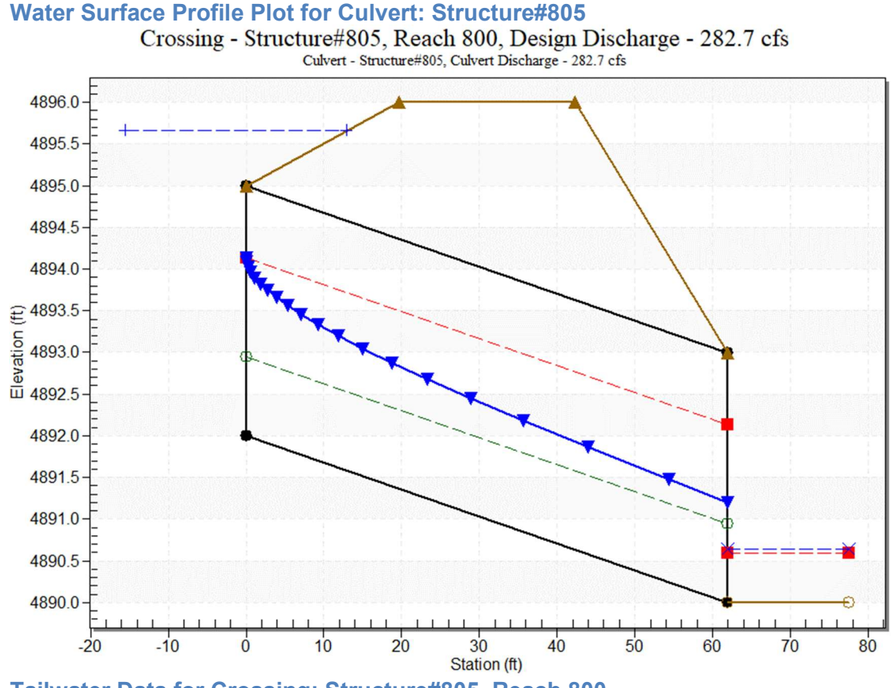
Table 9 - Culvert Summary Table: Structure#805

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-Yr	126.99 cfs	126.99 cfs	4894.07	2.07	0.0*	1-S2n	0.57	1.25	0.65	0.40	12.28	2.93
100-Yr	282.68 cfs	282.68 cfs	4895.66	3.66	1.064	5-S2n	0.95	2.13	1.20	0.64	14.67	4.00

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4892.00 ft,
Outlet Elevation (invert): 4890.00 ft
Culvert Length: 62.03 ft,
Culvert Slope: 0.0323

Water Surface Profile Plot for Culvert: Structure#805



Tailwater Data for Crossing: Structure#805, Reach 800

Table 10 - Downstream Channel Rating Curve (Crossing: Structure#805, Reach 800)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
126.99	4890.40	0.40	2.93	0.69	0.83
282.68	4890.64	0.64	4.00	1.11	0.90

Tailwater Channel Data - Structure#805, Reach 800

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 107.00 ft
Side Slope (H:V): 6.00 (_:1)
Channel Slope: 0.0280
Channel Manning's n: 0.0450
Channel Invert Elevation: 4890.00 ft

Roadway Data for Crossing: Structure#805, Reach 800

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4896.00 ft
Roadway Surface: Gravel
Roadway Top Width: 22.60 ft

Culvert Data: Structure#807

Site Data - Structure#807

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4917.00 ft
Outlet Station: 80.00 ft
Outlet Elevation: 4916.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#807

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 (30-75º flare) Wingwall
Inlet Depression: None

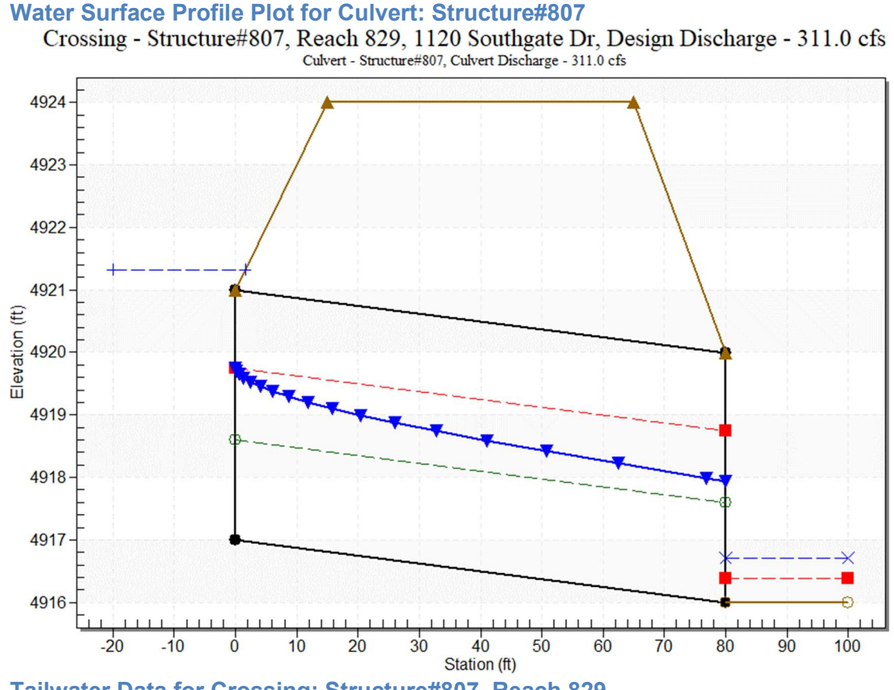
Table 11 - Culvert Summary Table: Structure#807

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	63.00 cfs	63.00 cfs	4918.44	1.44	0.0*	1-S2n	0.58	0.95	0.61	0.27	8.64	0.98
100 Year	311.00 cfs	311.00 cfs	4921.32	4.32	2.792	5-S2n	1.60	2.75	1.94	0.71	13.33	1.84

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4917.00 ft,
Outlet Elevation (invert): 4916.00 ft
Culvert Length: 80.01 ft,
Culvert Slope: 0.0125

Water Surface Profile Plot for Culvert: Structure#807



Tailwater Data for Crossing: Structure#807, Reach 829

Table 12 - Downstream Channel Rating Curve (Crossing: Structure#807, Reach 829)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
63.00	4916.27	0.27	0.98	0.09	0.33
311.00	4916.71	0.71	1.84	0.22	0.39

Tailwater Channel Data - Structure#807, Reach 829

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 235.00 ft
Side Slope (H:V): 5.00 (_:1)
Channel Slope: 0.0050
Channel Manning's n: 0.0450
Channel Invert Elevation: 4916.00 ft

Roadway Data for Crossing: Structure#807, Reach 829

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4924.00 ft
Roadway Surface: Paved
Roadway Top Width: 50.00 ft

Culvert Data: Structure#808

Site Data - Structure#808

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4942.00 ft
Outlet Station: 527.00 ft
Outlet Elevation: 4932.00 ft
Number of Barrels: 1

Culvert Data Summary - Structure#808

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

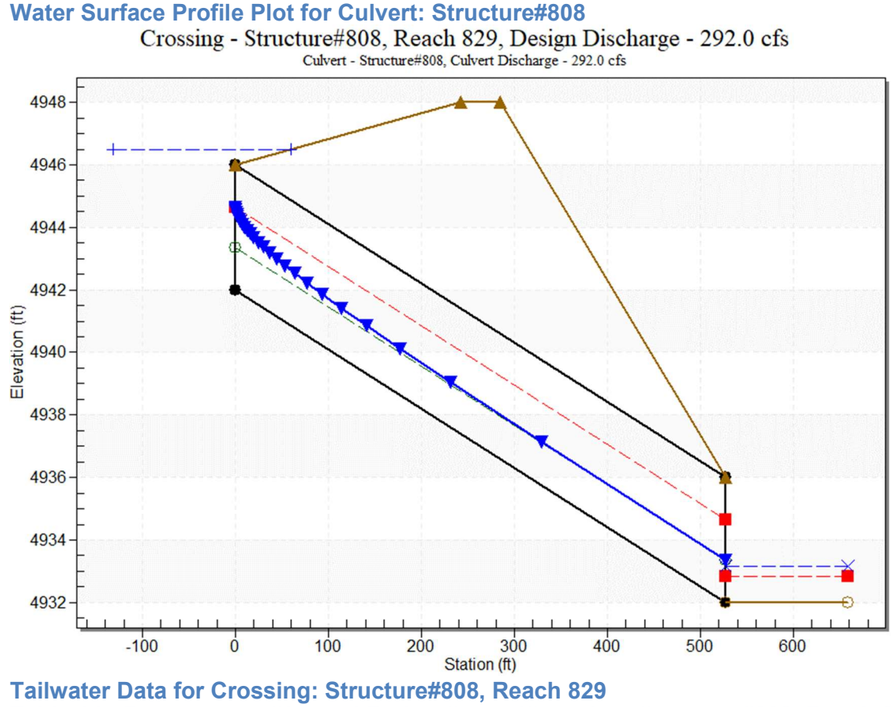
Table 13 - Culvert Summary Table: Structure#808

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	36.03 cfs	36.03 cfs	4943.10	1.10	0.0*	1-S2n	0.36	0.65	0.36	0.33	8.38	1.64
100 Year	292.00 cfs	292.00 cfs	4946.49	4.49	0.0*	5-S2n	1.34	2.64	1.36	1.16	17.89	3.60

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4942.00 ft,
Outlet Elevation (invert): 4932.00 ft
Culvert Length: 527.09 ft,
Culvert Slope: 0.0190

Water Surface Profile Plot for Culvert: Structure#808



Tailwater Data for Crossing: Structure#808, Reach 829

Table 14 - Downstream Channel Rating Curve (Crossing: Structure#808, Reach 829)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
36.03	4932.33	0.33	1.64	0.23	0.51
292.00	4933.16	1.16	3.60	0.79	0.62

Tailwater Channel Data - Structure#808, Reach 829

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 64.00 ft
Side Slope (H:V): 5.40 (_:1)
Channel Slope: 0.0110
Channel Manning's n: 0.0450
Channel Invert Elevation: 4932.00 ft

Roadway Data for Crossing: Structure#808, Reach 829

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4948.00 ft
Roadway Surface: Paved
Roadway Top Width: 43.00 ft

Culvert Data: Structure#809

Site Data - Structure#809

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4958.00 ft
Outlet Station: 304.00 ft
Outlet Elevation: 4948.00 ft
Number of Barrels: 2

Culvert Data Summary - Structure#809

Barrel Shape: Concrete Box
Barrel Span: 10.00 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

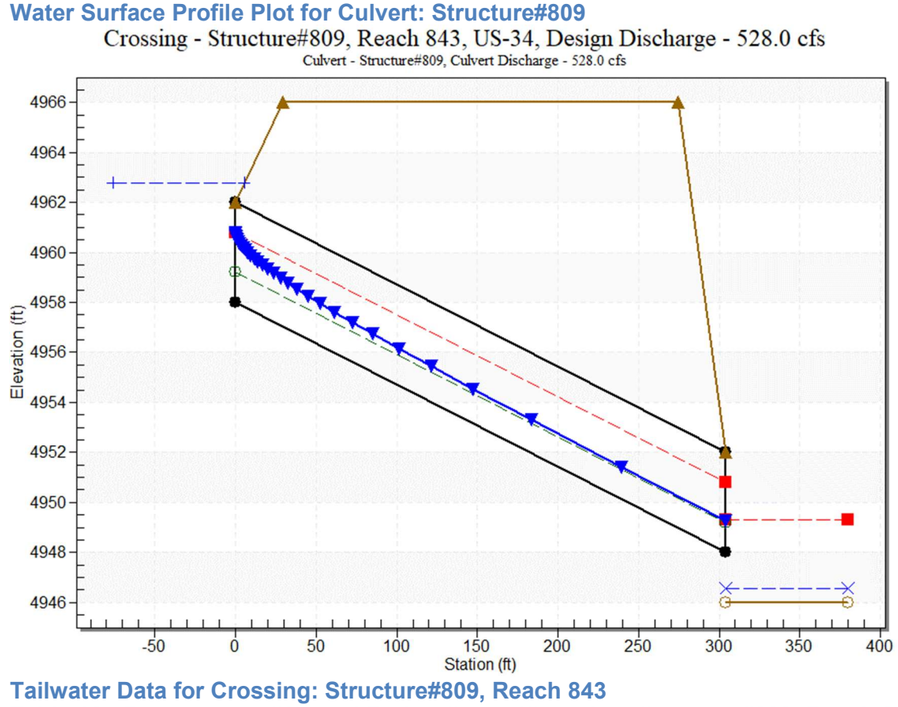
Table 15 - Culvert Summary Table: Structure#809

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	36.03 cfs	36.03 cfs	4958.77	0.77	0.0*	1-S2n	0.22	0.47	0.22	0.11	8.12	21.45
100 Year	528.00 cfs	528.00 cfs	4962.76	4.76	0.0*	5-S2n	1.20	2.79	1.26	0.56	21.01	61.42

Culvert Barrel Data

Culvert Barrel Type Straight Culvert
Inlet Elevation (invert): 4958.00 ft,
Outlet Elevation (invert): 4948.00 ft
Culvert Length: 304.16 ft,
Culvert Slope: 0.0329

Water Surface Profile Plot for Culvert: Structure#809



Tailwater Data for Crossing: Structure#809, Reach 843

Table 16 - Downstream Channel Rating Curve (Crossing: Structure#809, Reach 843)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
36.03	4946.11	0.11	21.45	34.03	11.45
528.00	4946.56	0.56	61.42	174.16	14.49

Tailwater Channel Data - Structure#809, Reach 843

Tailwater Channel Option: Rectangular Channel
Bottom Width: 15.40 ft
Channel Slope: 5.0000
Channel Manning's n: 0.0350
Channel Invert Elevation: 4946.00 ft

Roadway Data for Crossing: Structure#809, Reach 843

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 100.00 ft
Crest Elevation: 4966.00 ft
Roadway Surface: Paved
Roadway Top Width: 245.00 ft

Appendix F-7
Master Plan Cost Estimate

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Concept Design			
DRAINAGEWAY :	Drainageway 700			
REACH :	700			
JURISDICTION :	Greeley			
REACH ID:	LID_700-Reach700	Sabastian Ortega	DATE :	7/12/2024

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in)	Length (ft)	No. of Barrels				
48-inch	97	1	97	L.F.	$240.00	$23,280.00
48-inch	89	2	178	L.F.	$240.00	$42,720.00
Channel Improvements						
Soil Riprap, Type M			291	C.Y.	$117.00	$34,047.00
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)			6.5	AC-FT	$76,152.00	$494,988.00
Removals						
Removal of culvert pipe (D<48")			186	L.F.	$33.00	$6,138.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			1.3	ACRE	$1,670.00	$2,171.00
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	$66,000.00
Concrete Box Culverts	$0.00
Hydraulic Structures	$0.00
Channel Improvements	$34,047.00
Detention/Water Quality Facilities	$494,988.00
Removals	$6,138.00

Landscaping and Maintenance Improvements			$2,171.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$603,344.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$30,167.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$30,167.00
Subtotal Additional Capital Improvement Costs			**$60,334.00**
Land Acquisition Costs			
ROW/Easements			$14,596.00
Subtotal Land Acquisition Costs			**$14,596.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$99,552.00
Legal/Administrative	5%		$33,184.00
Contract Admin/Construction Management	10%		$66,368.00
Contingency	25%		$165,920.00
Subtotal Other Costs			**$365,024.00**
Total Capital Improvement Costs			**$1,043,298.00**

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, etc.)		359	L.F.	$2.00	$718.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)		1.3	ACRE	$2,505.00	$3,257.00
Total Annual Operation and Maintenance Cost				**$3,975.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$198,750.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	23.1447.001 Greeley - Comprehensive Drainage Plan Oklahoma Concept Design			
DRAINAGEWAY :	Drainageway 800			
REACH :	Drainageway 800			
JURISDICTION :	Greeley			
REACH ID:	LID_800-	Sabastian Ortega	DATE :	7/12/2024

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)			
6	5	1	90	L.F.	$1,095.56	$98,601.00
8	3	2	62	L.F.	$2,191.13	$135,850.00
12	4	1	80	L.F.	$1,529.18	$122,335.00
12	4	1	527	L.F.	$1,529.18	$805,879.00
9	4	2	74	L.F.	$2,537.62	$187,784.00
10	4	1	304	L.F.	$1,354.93	$411,900.00
Channel Improvements						
Soil Riprap, Type M			561	C.Y.	$117.00	$65,637.00
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)			43	AC-FT	$76,152.00	$3,282,151.00
Detention Facility 2 (Complete-in-Place)			17	AC-FT	$76,152.00	$1,294,584.00
Detention Facility 3 (Complete-in-Place)			2	AC-FT	$76,152.00	$182,765.00
Removals						
Removal of culvert pipe (D<48")			62	L.F.	$33.00	$2,046.00
Removal of culvert pipe (48"<D<84")			905	L.F.	$84.00	$76,020.00
Concrete Box Culvert			170	L.F./CELL	$167.00	$28,390.00
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)			10	ACRE	$1,670.00	$17,034.00
Land Acquisition						
Easement/ROW Acquisition			10.60	ACRE	$11,228.00	$119,017.00

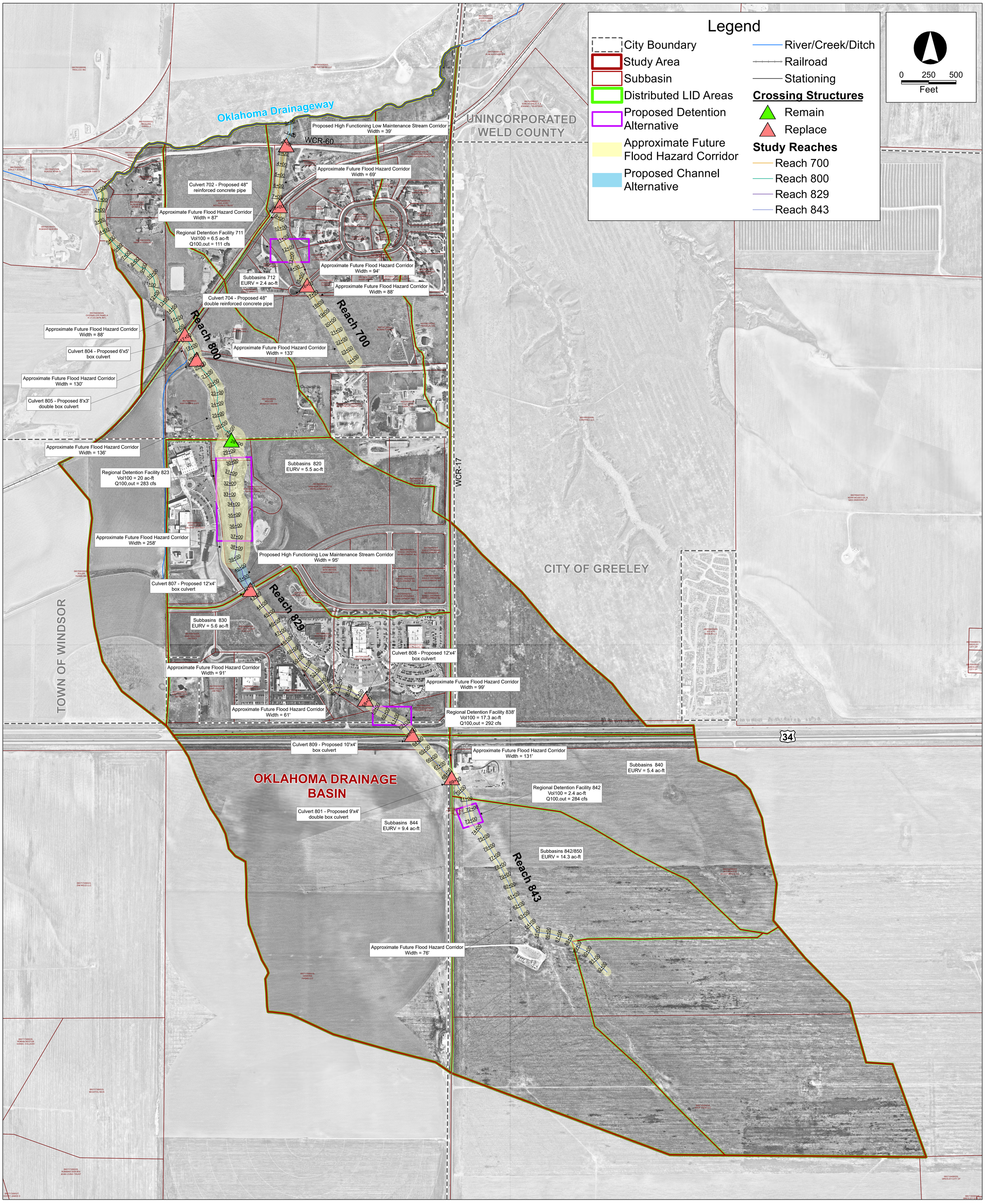
Master Plan Capital Improvement Cost Summary

Capital Improvement Costs			
Pipe Culverts and Storm Drains			$0.00
Concrete Box Culverts			$1,762,349.00
Hydraulic Structures			$0.00
Channel Improvements			$65,637.00
Detention/Water Quality Facilities			$4,759,500.00
Removals			$106,456.00
Landscaping and Maintenance Improvements			$17,034.00
Special Items (User Defined)			$0.00
Subtotal Capital Improvement Costs			**$6,710,976.00**
Additional Capital Improvement Costs			
Dewatering		L.S.	$0.00
Mobilization	5%		$335,549.00
Traffic Control		L.S.	$0.00
Utility Coordination/Relocation		L.S.	$0.00
Stormwater Management/Erosion Control	5%		$335,549.00
Subtotal Additional Capital Improvement Costs			**$671,098.00**
Land Acquisition Costs			
ROW/Easements			$119,017.00
Subtotal Land Acquisition Costs			**$119,017.00**
Other Costs (percentage of Capital Improvement Costs)			
Engineering	15%		$1,107,311.00
Legal/Administrative	5%		$369,104.00
Contract Admin/Construction Management	10%		$738,207.00
Contingency	25%		$1,845,519.00
Subtotal Other Costs			**$4,060,141.00**
Total Capital Improvement Costs			**$11,561,232.00**

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, etc.)		1273	L.F.	$2.00	$2,546.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)		10.6	ACRE	$2,505.00	$26,553.00
Total Annual Operation and Maintenance Cost				**$29,099.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$1,454,950.00**	

Appendix G – Master Plan Maps



City of Greeley Colorado

Matrix

Figure G-1: Major Drainageway 700 & 800
Comprehensive Drainage Plan Oklahoma Basin
Concept Design Map (July 2024)

Appendix H – Funding Sources

(funding sources were not included with this study)

Sponsor: City of Greeley Colorado

Consultant: Matrix